# Undergraduate Course Descriptions

## Effective Fall 2018

## Accounting

**ACC 2000 - Accounting Principles I**
Introduction to basic principles, concepts, and theoretical framework of financial accounting with the emphasis on its use by economically rational decision makers. Topics include the decision-making environment and the accounting cycles, processes, and statements.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring

**ACC 2100 - Accounting Principles II**
Emphasizes the role of accounting information within a firm. Topics include budgeting, responsibility accounting, cost allocations, cost behavior, decision models, capital budgeting, and an introduction to product costing in manufacturing and service sector firms.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** ACC 2000

**ACC 3000 - Accounting Theory/Practice I**
Studies the theory, concepts, and practices underlying financial reporting and measurement. Primary focus is on income measurement, and the valuation of assets, like cash, receivables, inventory, and long-lived assets, as well as multinational issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ACC 2000

**ACC 3100 - Accounting Theory/Practice II**
A continuation of ACC 3000 with theories, concepts, and practices underlying financial measurement and reporting. Focuses on the measurement and reporting of liabilities and equities, and includes multinational issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ACC 3000 and FIN 3000(C)

**ACC 3500 - Managerial/Cost Accounting I**
The primary emphasis is on traditional and contemporary product costing techniques, cost allocation practices, and basic cost-management issues. Topics include process costing, standard costing, activity-based costing, backflush costing, cost allocation issues, balanced scorecard, strategic profitability analysis, and the role of accounting in contemporary management practices.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ACC 2100

**ACC 3600 - Foundations of Taxation**
Introduction to basic principles, concepts, and theoretical framework of taxation systems, emphasizing income taxation and its impact on decision making. Topics include tax planning and compliance for individuals, corporations, and partnerships.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ACC 2000

**ACC 4100 - Attestation and Assurance**
Auditing procedures and techniques associated with public accounting and with internal auditing for business entities. Topics include auditor's responsibilities, professional ethics, generally accepted auditing standards, purpose and types of audits, objectives, internal control, evidence, organization within the public accounting profession, the audit program, and auditing procedures and techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ACC 3000 or ACC 5050

**ACC 4200 - Advanced Accounting**
The theory and practice of financial accounting and reporting pertaining to business combinations and consolidated financial statements, accounting for partnerships, and related business forms, foreign currency transactions, and financial statement translations, and other advanced accounting topics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ACC 3000

**ACC 4500 - Managerial/Cost Accounting II**
Emphasizes information requirements of contemporary management decision-making and strategic-planning processes. Covers contemporary control and evaluation practices (such as activity-based management), determining the costs of quality, and productivity analysis in the context of accounting information systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ACC 3500

**ACC 4600 - Advanced Tax Topics**
Continuation of ACC3600. Introduction to advanced principles and concepts of taxation, emphasizing income taxation and its impact on decision making. Topics include tax planning and compliance for estates and trusts, gratuitous transfers, multi-jurisdictional operations, and entity formations, liquidations, and reorganizations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ACC 3600

**ACC 4700 - Governmental and Not-for-Profit Accounting**
An in-depth study of the accounting principles and financial reporting unique to the governmental and not-for-profit sectors of the U.S. economy.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ACC 3000

**ACC 4800 - Accounting Systems**
Introduction to the basic principles, concepts, and theoretical framework for the design and operation of accounting information systems, emphasizing its use to enhance decision making. Topics include system design, internal controls, the use of databases, and electronic commerce.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ACC 2100 or ACC 5050

**ACC 4990 - Special Topics in Accounting**
Examines current issues in Accounting and other topics of interest to faculty and students in greater depth.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** ACC 3000

## Air Force ROTC

**AF 0120 - Physical Conditioning**
Activities that promote physical conditioning. Emphasis is on individual conditioning through strength and aerobic training and team sports such as ultimate frisbee and football. May be used once as a general education co-curricular course. Sports physical required prior to start of class (contact instructor for details).
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**AF 0130 - Air Force Elite Forces Workout**
An intense workout program that develops personal physical fitness and self-confidence. Workouts include an elite U.S. Military special operations training. Basic swimming skills required.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** AF 0120

**AF 0230 - Precision Drill Team**
Techniques and skills involved in precision drill movements, including marching, rifle spinning, ceremonial sabre handling, and color guard performance. Each student must have or purchase an appropriate drill-team uniform. May be used once as a general education co-curricular course. Non-cadets are required to provide a uniform cleaning deposit and purchase some non-returnable uniform items.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**AF 0340 - Field Training**
A rigorous program of physical conditioning, team activities, and survival training. Offered the summer semester after acceptance into the Field Training program. Course completed off campus.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Summer
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** AF 2002

**AF 1001 - Foundations of US Air Force I**
Introduces students to the USAF and ROTC. Topics include Air Force mission and organization, officership, professionalism, military customs and courtesies, officer opportunities, and communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall

**AF 1002 - Foundations of US Air Force II**
Introduces students to the USAF and ROTC. Topics include Air Force operations and installations, principles of war and tenets of Airpower, policy and strategy, and human relations in the Air Force. Leadership lab is mandatory for AFROT cadets and complements this course by providing cadets with followership and leadership experiences.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Spring

**AF 2001 - Evolution of US Air & Space Power I**
This course provides students with some knowledge-level understanding for the employment of air and space power, from an instituitional, doctrinal, and historical perspective.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall

**AF 2002 - Evolution of US Air & Space Power II**
This course provides the students with some knowledge-level understanding for the employment of air and space power, from an institutional, doctrinal, and historical perspective. Leadership and communications lessons and exercises will prepare cadets for upcoming summer training program.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** AF 2001

**AF 2010 - Evolution of US Air And Space Power I for Non-AFROTC Students**
For non-AFROTC students. AFROTC cadets should enroll in AF2001. This course provides students with some knowledge- level understanding fo rthe employment of air and space power, from an institutional, doctrinal, and historical perspective. Post-WWI through end of WWII will be discussed. Leadership and communications lessons and exercises.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Permission of instructor required

**AF 2020 - Evolution of US Air and Space Power II for Non-AFROTC Students**
For non-AFROTC students. AFROTC students should enroll in AF2002. This course provides students with some knowledge- level understanding for the employment of air and space power, from an instituitional, doctrinal, and historical perspective. Leadership and communications lessons and exercises. Leadership lessons designed to prepare cadets for upcoming summer training program.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** AF 2010

**AF 3001 - Leadership Studies I**
Study and practice of leadership in civilian and military organizations. Topics include leadership principles, problem solving, management fundamentals, counseling, motivation, mentoring, and effective communication. Various leadership theories are discussed. The course includes discussion, informal lecture, case studies, self-evaluation of leadership traits, and experiential exercises.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**AF 3002 - Leadership Studies II**
Study of leadership in civilian and military institutions. Topics include officership, team building, feedback, Air Force evaluation systems, leadership ethics, professional relations, and communication skills. The course includes discussion, informal lecture, case studies, and experiential exercises.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**AF 3010 - Leadership Studies I for Non-AFROTC Students**
For non-AFROTC students. AFROTC cadets should enroll in AF3001. Study and practice of leadership in civilian and military organizations. Topics include leadership principles, problem solving, management fundamentals, counseling, motivation, mentoring, and effective communication. Various leadership theories are discussed. The course includes discussion, informal lecture, self-evaluation of leadership traits, and experiential exercises.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**AF 3020 - Leadership Studies II for Non-AFROTC Students**
For non-AFROTC students. AFROTC cadets should enroll in AF3002. Study of leaderhip in civilian and military institutions. Topics include officership, team building, feedback, Air Force evaluation systems, leadership ethics, professional relations, and communication skills. The course includes discussion, informal lecture, case studies, and experiential exercises.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**AF 4001 - National Security Affairs I**
This course is designed to develop an understanding of the nature of conflict and how the United States military forces are developed, organized, and employed. Topics include the need for national security, the evolution and formulation of American defense policy and strategy, the origins of regional security issues, cross cultural competence, and joint doctrine.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**AF 4002 - National Security Affairs II**
This course examines selected roles of the military in society, unconventional warfare, current issues affecting the military profession, and the military justice system. Special topics of interest focus on information warfare, the law of armed conflict, the military as a profession, and officership.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**AF 4010 - National Security Affairs I - for Non-AFROTC Students**
For non-AFROTC students. AFROTC cadets should enroll in AF4001. This course is designed to develop an understanding of the nature of conflict and how the United States military forces are developed, organized, and employed. Topics include the need for national security, the evolution, and formulation of American defense policy and strategy, the origins of regional security issues, cross cultural competence, and joint doctrine.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**AF 4020 - National Security Affairs II - for Non-AFROTC Students**
For non-AFROTC students. AFROTC cadets should enroll in AF4002. This course examines selected roles of the military in society, unconventional warfare, current issues affecting the military profession, and the military justice system. Special topics of interest focus on information warfare, the law of armed conflict, the military as a profession, and officership.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

## Army ROTC

**AR 0340 - Internship in Advanced Military Leadership**
A rigorous program of physical conditioning, leadership development, and team building training. Offered the summer semester after completion of the Cadets junior year of college. Course completed off campus.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Summer
**Restrictions:** Permission of department required

**AR 1001 - Introduction to the Army and Critical Thinking**
Introduces cadets to the competencies that are critical for effective leadership. Cadets learn how the personal development of "life skills" such as critical thinking, time management, goal setting, stress management, and comprehensive fitness relate to the Army profession.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall

**AR 1003 - Leadership and Competence**
Introduces Cadets to the competencies that are critical for adaptive leadership. Cadets learn the basics of the communication process and the importance of developing the essential skills to effectively communicate in the Army. Students will examine the Army profession in depth.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring

**AR 1011 - Basic Leadership Lab I**
Practicum in basic military topics such as drill and ceremony, emergency preparedness, survival skills, and military communication.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall

**AR 1012 - Basic Leadership Lab II**
Practicum in basic military topics such as first aid, teambuilding, orienteering, profession of arms, and ethics in problem solving.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring

**AR 2001 - Leadership and Decision Making**
Explores the dimensions of creative tactical leadership styles by examining team dynamics and historical leadership theories that form the basis of the Army leadership framework. Aspects of motivation and team building are practiced through planning, executing, and assessing team exercises
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall

**AR 2002 - Army Doctrine and Team Development**
Examines the challenges of leading teams in complex operational environments. The course highlights terrain analysis, patrolling, and operation orders. Cadets develop greater self-awareness as they assess their own leadership styles and practice communication and team building skills.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring

**AR 2011 - Intermediate Leadership Lab I**
Practicum in basic military topics, such as drill and ceremony, emergency preparedness, survival skills, and military communication.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall

**AR 2012 - Intermediate Leadership Lab II**
Practicum in basic military topics, such as first aid, teambuilding, orienteering, profession of arms, and ethics in problem solving.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring

**AR 2068 - Fall Military Physical Conditioning**
Develops physical fitness, personal confidence, self-esteem and military skills. Students are exposed to both individual and group physical fitness procedures and techniques. Emphasis is on developing a good fitness program for each individual student. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall

**AR 2069 - Spring Military Physical Conditioning**
Develops physical fitness, personal confidence, self-esteem and military skills. Students are exposed to both individual and group physical fitness procedures and techniques. Emphasis is on developing a good fitness program for each individual student. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring

**AR 3001 - Warfighting Functions**
Teaches cadets to plan, coordinate, navigate, motivate, and lead a squad and platoon in the execution of mission during a classroom PE, a leadership lab, or during a leader training course.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall
**Co-Requisite(s):** AR 3011

**AR 3002 - Leadership and Operations**
Cadets will study, practice, and apply the fundamentals of Army leadership, officership, Army value and ethics, personal development, and small unit tactics at the platoon level.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Co-Requisite(s):** AR 3012
**Pre-Requisite(s):** AR 3001

**AR 3011 - Advanced Leadership Lab I**
Practicum in basic military topics, such as drill and ceremony, emergency preparedness, survival skills, and military communication.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Co-Requisite(s):** AR 3001

**AR 3012 - Advanced Leadership Lab II**
Practicum in basic military topics, such as first aid, teambuilding, orienteering, profession of arms, and ethics in problem solving.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Co-Requisite(s):** AR 3002
**Pre-Requisite(s):** AR 3011

**AR 3068 - Military Physical Leadership I**
Develops a cadet's leadership abilities to design, implement, and assess a platoon level Army physical training program. Cadets learn the basic leadership of designing and developing a physical conditioning program. May be used once as a general education co-curricular course.
**Credits:** 1.0; Repeatable to a Max of 12; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** AR 2068 and AR 2069

**AR 3069 - Military Physical Leadership II**
Develops a cadet's leadership abilities to design, implement, and assess a platoon level Army physical training program. Cadets improve their small group's level of physical conditioning while honing their own leadership skills. May be used once as a general education co-curricular course.
**Credits:** 1.0; Repeatable to a Max of 12; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** AR 3068

**AR 3775 - U.S. Military History for the Professional Officers**
History of the American military and its place in American society in both peace and war from the colonial period until the present.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Summer
**Restrictions:** Permission of department required

**AR 4001 - Mission Command I and the Army Profession**
Completes the Cadet to commissioned officer transition. Course stresses mission command and ethics to assist the Cadet in further embracing their role as an Army officer.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Co-Requisite(s):** AR 4011
**Pre-Requisite(s):** AR 3001 and AR 3002

**AR 4004 - Mission Command II and the Company Grade Officer**
Course will teach critical knowledge, skills, abilities, and competencies that newly commissioned officers will need to suceed in their first unit of assignment. Cadets will examine the Army profession in depth.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Co-Requisite(s):** AR 4012
**Pre-Requisite(s):** AR 3001 and AR 3002

**AR 4011 - Battalion Staff Operations I**
Develops personal confidence and advanced leadership ability using basic and advanced military skills. Students are given responsibility for planning and controlling the activities of the cadet battalion. Applied creativity, problem solving, decision making, and leadership are the cornerstones of this course.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Co-Requisite(s):** AR 4001

**AR 4012 - Battalion Staff Operations II**
Develops personal confidence and advanced leadership ability using basic and advanced military skills. Students are given responsibility for planning and controlling the activities of the cadet battalion. Applied creativity, problem solving, decision making, and leadership are the cornerstones of this course.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Co-Requisite(s):** AR 4004

**AR 4100 - Special Topics Leadership Development**
Study and discussion of topics in Military Leadership not included in regular undergraduate courses.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

## Atmospheric Science

**ATM 4640 - Fundamentals of Atmospheric Science**
Fundamental principles of atmospheric science, including thermodynamics, aerosol and cloud physics, radiative transfer, and atmospheric dynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** (PH 2200 or PH 2260) and (PH 1360 or PH 2300) and MA 3160 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

## Biomedical Engineering

**BE 2100 - Undergraduate Biomedical Engineering Seminar**
An overview of biomedical engineering designed especially for freshmen and sophomores that includes presentations by faculty, members of the community and other guest lecturers. Topics ranging from clinical engineering through basic biomedical engineering research are covered.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Freshman, Sophomore

**BE 2110 - Statistical Methods for Biomedical Engineering**
Topics include descriptive statistics, sampling methods, probability, statistical inference, causality, elementary design of experiments, statistical process improvement methods including Six-Sigma techniques, clinical trial methodology, and variance analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 1135 or MA 1160 or MA 1161

**BE 2400 - Cellular and Molecular Biology**
General principles and engineering applications of science and biology, including cell biology, physiology, molecular biology, genetics, and biotechnology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** CH 1150 and MA 1160 or MA 1161

**BE 2700 - Biomedical Signals & Systems**
Introduces the origin, processing and interpretation of biological signals. Mathematical modeling techniques used in the analysis of linear systems. Topics include: Fourier, Laplace and z-transforms, signal comparison techniques, power spectrum analysis, 2-dimensional signals, transfer functions, convolution, and simulations.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 1150 or CH 1112 and PH 2100 and MA 2160 and ENG 1102

**BE 2800 - Biomaterials I: Fundamental Materials Science and Engineering**
Introduction to the fundamental materials science principles and different classes of biomaterials (metals, ceramics, polymers and their composites), and some practical professional issues concerning the field of biomaterials.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BE 2400

**BE 3300 - Biomechanics I: Statics and Dynamics**
Course provides overview of two and three-dimensional force and structure systmes and their applicability to human body. Course topics will include principle of equilibrium, concept of free-body diagram, moment of inertia, centroids. Kinematics and equations of motion, principle of energy, work and momentum. Course materials tailored for biological applications, particulary for applications at human organ level.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Pre-Requisite(s):** BE 2400 and (MA 2321 or MA 2320 or MA 2330) and (MA 3521 or MA 3520 or MA 3530) and BL 2010

**BE 3350 - Biomechanics II: Soft Tissue and Bio-Fluid Mechanics**
This course teaches basic principles of mechanics that are closely related to human soft tissue and bio-flow, particularly, at the human organ level. Emphases are given to both engineering fundamentals and biomedical applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Pre-Requisite(s):** BE 3300

**BE 3400 - Experimental Techniques in Biomedical Engineering**
introduction to the experimental techniques used in biomedical engineering, technical report writing, and record keeping.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** BE 2800

**BE 3550 - Fluid Mechanics**
This course introduces fundamental fluid mechanics principles in a unified fashion so that students can describe biological fluid problems in precise mathematical language. Topics include nature of fluids, hydrostatics, differential and integral equations about conservation of mass and momentum, dimensional analysis and various types of flow.
**Credits:** 4.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CH 1150 and ENG 1102 and MA 2160 and PH 2100

**BE 3700 - Biomedical Instrumentation**
Introductory theory of measurement and analysis from biological systems. Covers the principles and use of transducers, data recording and analysis systems and signal processing techniques. Example measurements include life science research and clinical measurements such as the vital signs.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Co-Requisite(s):** BE 3701
**Pre-Requisite(s):** EE 3010 and PH 2200(C) and BL 2020(C) and BE 2700

**BE 3701 - Biomedical Instrumentation Lab**
Laboratory exercises to demonstrate basic instrumentation principles and biomedical measurements. Students will learn how to make non-invasive measurements on themselves and how to evaluate measurement instrumentation. Course will coincide with BE3700 lectures.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Co-Requisite(s):** BE 3700

**BE 3800 - Biomaterials II: Properties and Biological Interactions**
Biomaterials properties including structure-function relationships (materials composition and properties), protein/cell materials interactioins, characterization methods, and handling and processing considerations.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 2700(C) and BE 2800

**BE 4000 - Independent Study**
Students undertake an independent study under the guidance of a Biomedical Engineering faculty member. The course of study may either be research or academic and is decided upon between the study and faculty member.
**Credits:** variable to 6.0; Repeatable to a Max of 12
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor and department required

**BE 4115 - Finite Element Modeling**
This course teaches both fundamentals of finite element theory and hands-on experience for bio engineers.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** (MA 2320 or MA 2321) and (MA 3520 or MA 3521) and (BE 3350 or MEEM 2150)

**BE 4200 - Cellular and Molecular Biology II**
Covers, at an advanced level, the general principles and engineering applications of science and biology, including cell biology, physiology, molecular biology, genetics, and biotechnology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BE 2400

**BE 4230 - Stem Cell and Tissue Engineering**
This course will introduce basic concepts of tissue engineering; scaffold materials and biotechnologies for tissue engineering; basic concept of stem cells; review of stem cell sources and related policies; current progress in stem cell research, and application of stem cells in tissue engineering and regenerative medicine.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BE 2400 and BE 3350 and BE 3800

**BE 4250 - Biomedical Optics**
Light plays a significant role in modern clinical diagnostics and in the clinical treatment of disease. Examples include non-invasive surgery, optical biopsy, and cancer therapy. This course will focus on the study of how light propagates through biological tissue.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** (MA 2320 or MA 2321 or MA 2330) and (MA 3520 or MA 3521 or MA 3530 or MA 3560) and MA 3160

**BE 4300 - Polymeric Biomaterials**
A specialized study of polymers used in biomedical engineering. Topics include: processing-structure-properties relationships for polymers, polymer fibers and composites, degradation of polymers, and medical applications for polymeric biomaterials.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2009-2010 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 3800

**BE 4330 - Biomimetic Materials**
This course introduces students to biologically inspired approaches to design functional biomaterials. Topics include the discovery and incorporation of biological designs into novel materials and their application in the biomedical field.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 3350 and BE 3800

**BE 4335 - Smart Polymers**
This course introduces students to smart polymers that change their physical properties in response to various environmental stimuli. Topics include the molecular origin of the stimuli responsiveness of these materials and their applications in the biomedical field.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 3350 and BE 3800

**BE 4350 - Cell Biomechanics and Mechanical Transduction**
This course is designed to introduce the mechanical analysis and characterization of mammalian cells. Mechanotransduction, whereby cells detect loading and respond to the morphology and mechanical properties of the surrounding extracellular matrix, will be emphasized.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 2400 and BE 3350 and BE 3800

**BE 4410 - Medical Imaging**
This course covers the physical nature of the interactions between the waves and matter, especially the biological tissues, principle imaging modalities used in modern medicine and the common techniques used for the processing of the resulting images.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** BE 3700

**BE 4510 - Cardiovascular Engineering**
Fundamental cardiovascular pathology and the biomedical engineering approaches being developed and used toward problems resulting in significant cardiovascular deficiency such as myocardial infarction, chronic kidney disease, atherosclerosis, and heart valve disease.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BL 2020 and BE 2400

**BE 4670 - Micro & Nano Technologies**
This course will introduce students to micro- and nano- technologies and the processes involved in manufacturing. Particular emphasis will be on their use in biomedical applications. Goal is to provide information beneficial in research and development, and the industry.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BE 3700

**BE 4700 - Biosensors: Fabrication & Applications**
This course introduces the student to the fundamentals of biosensor development and applications. It provides an understanding of biological components, immobilization methods, transducers, and fabrication techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2009-2010 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BE 3700 and BE 3701

**BE 4755 - Medical Devices**
An introduction to medical devices used for diagnosis, monitoring, and treatment in clinical medicine. Topics covered include product planning, reliability, clinical trial design, regulatory as well as technical aspects of common medical devices.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**BE 4770 - Biomedical Microcontrollers**
The focus of this course is to provide biomedical engineering students the necessary skills to develop microcontroller-based devices. Provides basic knowledge on computer programming languages, microcontrollers, digital circuits, and microcontroller development kits. Students will design and fabricate a microcontroller-based device using a microcontroller development kit for a specific biomedical application.
**Credits:** 3.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 3700 and BE 3701

**BE 4800 - Biomaterials Interfaces**
This course introduces the students to the effects of topography and texture on the performance of biomaterials. Special emphasis is placed on tissue engineering scaffolds and microfabrication and nanofabrication techniques. Some of the topics also include self-organization of biomembranes and supramolecular systems, bioactive materials, and the molecular basis for surface recognition and masking.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BE 3800

**BE 4850 - Tissue Mechanics**
This course integrates contimuum mechanics, experiments, and computational methods to understand soft tissue mechanics. The first half of the course is dedicated to building continuum mechanics foundation, which will be used to formulate constitutive equations for arteries and the heart in the second half.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** BE 3300

**BE 4900 - Biomedical Design Fundamentals**
Design considerations and professional practice issues are addressed. Ethics, regulatory affairs, and intellectual property are addressed within the context of the biomedical engineering profession. Modern tools of biomedical design are presented and applied to current problems.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**BE 4901 - Biomedical Design Project I**
Team approach is used to resolve a defined problem in biomedical engineering. Projects are selected and undertaken with faculty guidance and sponsor input. Must be senior project ready, as defined by major, substitutes for prerequisites.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Biomedical Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** BE 3500(C) and BE 3600 and (BE 3750 or MEEM 4180) or (BE 3350 and BE 3700 and BE 3701 and BE 3800) and BE 4900

**BE 4910 - Biomedical Design Project II**
Continuation of Biomedical Design Project I (BE4901) under faculty guidance. Emphasizes design and testing of prototypes. Requires work project notebooks, oral and written reports, and presentations.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** BE 4900 and BE 4901

**BE 4930 - Biomedical Engineering Topics**
Biomedical engineering courses will be offered on new or emerging technical subjects depending on student demand and faculty interest and expertise.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate

## Biological Sciences

**BL 0600 - Clinical Practicum and Career Preparation Seminar**
Presents an overview of hospital-based clinical practicum experiences and outlines pathways to national certification. Also addresses other career options for the clinical laboratory scientist. Credits do not count toward graduation.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science; May not be enrolled in one of the following Class(es): Freshman

**BL 1010 - General Biology I**
A discussion of the principles of ecology and organismal biology, using the theme of physiological ecology and adaptations. This course will emphasize biodiversity, scientific method, experimental design and written and oral presentation of results.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall

**BL 1020 - General Biology II**
Discussion of the major principles by which life is organized. Topics include scientific methods, biological chemistry, cell structure and organization, multicellular organization, diversity of organisms, energetics and photosynthesis, cellular reproduction genetics, gene structure and expression, and recombinant DNA.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** BL 1010

**BL 1040 - Principles of Biology**
Basic principles through which biological systems operate. Topics include cell biology, structure, and function, energy production, genetics, physiology, diversity, evolution, and ecology.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences

**BL 1580 - First Year Experience in Biological Sciences**
Introduction to fields and career opportunities in the biological sciences.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Biological Sciences; Must be enrolled in one of the following Class(es): Freshman, Sophomore

**BL 1590 - First Year Experience in Health Professions**
Introduction to various careers in the health professions. Discusses required course work, entrance exams, and other requirements for entry to the various fields. Guest lecturers include representatives of many health areas.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Major(s): Pre-Professional; Must be enrolled in one of the following Class(es): Freshman, Sophomore

**BL 1600 - First Year Experience in Medical Laboratory Science**
Introduction to subdisciplines, the clinical practicum, career opportunities, and current issues in medical laboratory science.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall

**BL 1710 - Medical Terminology**
Autotutorial course covers the fundamentals of medical terminology, including recognition and use of common prefixes, roots, and suffixes, as well as single-syllable words. Exercises also include spelling and pronunciation.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall

**BL 2000 - Biology of Movement and Meditation**
Students will explore the science behind the practice of yoga, including poses, meditation, anatomy & physiology. Will read peer-reviewed literature excerpts regarding yoga research. Physical practice, no prior experience necessary. Yoga supplies required.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer

**BL 2001 - Valuing the Great Lakes**
The Great Lakes are used as the subject to examine environmental issues. A combination of reading, lecture, and discussion will be used to study the unique ecology, biology, and history of the Great Lakes.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall

**BL 2004 - Cooking and Nutrition**
Students will learn the basics of nutritional science while preparing healthy meals. Emphasis will be on the physiology of food metabolism and critically examining food claims. Students will also learn to make appropriate choices regarding food and cooking techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**BL 2010 - Anatomy & Physiology I**
Comprehensive introductory course in vertebrate anatomy and physiology with emphasis on the human body. Interrelates structure with function in regard to maintaining homeostasis and normal functioning of the body. Covers the integument, skeletal system, muscles, the nervous system, and special senses.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** CH 1000 or (CH 1150 and CH 1151)

**BL 2011 - Anatomy & Physiology I Lab**
The laboratory to accompany BL2010. Examines embryology, muscle and skeletal anatomy, and neuroanatomy. Explores the physiology of the nervous system, including vision and reflexes and muscle physiology. A student-designed lab project is used to teach experimental design.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** BL 2010(C)

**BL 2020 - Anatomy & Physiology II**
Continuation of BL2010. Covers the cardiovascular, respiratory, digestive, renal, and reproductive systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2010

**BL 2021 - Anatomy & Physiology II Lab**
The laboratory to accompany BL2020. Examines the structure and function of the digestive, respiratory, cardiovascular, and renal systems. A student-designed lab project is used to teach experimental design.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2011 and BL 2020(C)

**BL 2100 - Principles of Biochemistry**
Introductory overview to biochemistry. Topics include the biochemistry of amino acids, proteins, coenzymes, carbohydrates, nucleotides, nucleic acids, lipids, and water, as well as bioenergetics and photosynthesis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (BL 1020 or BL 1040 or BE 2400) and CH 1112 or (CH 1150 and CH 1151)

**BL 2160 - Botany**
Covers structure, function, reproduction, and classification of plants and algae, relating these current ecological, agricultural, or other human issues.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring

**BL 2170 - Zoology**
Biology of animals from first organized multi-cell through Hominids; the origin and evolution of the metazoa phyla, their physiology, development, ecology, behavior, natural history, and systematics.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall

**BL 2200 - Genetics**
A study of classical and molecular genetics. Topics include one- and two-locus genetics, recombination, gene structure, regulation and function, quantitative and population genetics, and genetic engineering. Covers both prokaryotes and eukaryotes.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** (BL 1020 or BL 1040 or BE 2400) and (BL 2100 or CH 4710)

**BL 2210 - Genetics Laboratory**
A laboratory to complement BL2200. Covers applications of techniques used in genetics, including Mendelian analysis, tetrad analysis, karyotyping, DNA and protein electrophoresis, DNA and plasmid purification, transformation and restriction mapping, and PCR amplification of DNA.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2200(C)

**BL 2410 - Basic Medical Laboratory Techniques**
Introduces a variety of fundamental diagnostic procedures performed in a typical clinical laboratory.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1020 or BL 1040

**BL 2700 - Principles of Bioinformatics**
This course discusses the core concepts in bioinformatics and how biology, math, and computer science combine to form the basis of bioinformatics. Students will be exposed to the applications of bioinformatics in analysis of DNA and protein sequences and be introduced to common methods for processing this data.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 1020 or BL 1040

**BL 2940 - Human Nutrition**
Covers basic and applied chemistry and biology of human nutrition. Includes practical information on planning and adopting a healthy diet as well as maintaining acceptable weight. Emphasizes social, global, and environmental issues pertinent to use of the world food supply.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**BL 3000 - Job Shadowing in Health Professions**
Designed for students to observe health professionals in clinical settings. Course will cover prerequisites, HIPPA rules, and shadowing etiquette. Students will complete at least 15 hours of shadowing arranged with the cooperating hospital or clinic.
**Credits:** 1.0; Repeatable to a Max of 3
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 2010(C)

**BL 3006 - Graduate Health Program Application Preparation**
Course will assist students with the application process for graduate health professional programs (medical, dental, PA, etc.). Topics covered will include writing about experiences, developing a personal statement, asking for letters of recommendation, and conducting interviews.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required

**BL 3010 - General Entomology**
A study of the form, function, and diversity of insects along with their relationship to humans as pests and disease vectors and their role in the natural world.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1010 or BL 1040

**BL 3012 - Essential Cell Biology**
This course will provide an understanding of cell structure and function with emphasis on eukaryotic cells. Topics include macromolecules, membranes, organelles, cytoskeleton, division, differentiation, cell-cell interactions, intracellular trafficking, protein sorting, cell signaling, and motility.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1020 or BL 1040 and BL 2100

**BL 3080 - Biological Concepts for Engineers**
An introduction to biological principles centered on human and ecological concepts for engineers and scientists. Course topics include chemistry for biologists, cell structure and function, genetics and heredity, human anatomy and physiology, ecology and the environment, and plant biology and toxicology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Environmental Engineering, Civil Engineering

**BL 3190 - Evolution**
A study of the patterns and processes of organic evolution. Topics include genetics of populations, mechanisms of deterministic and stochastic genetic change, history of life on earth, biogeography, molecular evolution, units of selection, sexual selection, speciation, and human evolution.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 1010 or BL 1040

**BL 3210 - General Microbiology**
Introduction to the general principles and techniques involved in the study of microorganisms, including bacteria, fungi, and viruses. Topics include cell structure and function, growth, metabolism, biodiversity, and interactions.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (BL 1020 or BL 1040) and (BL 2100 or CH 4710)

**BL 3220 - Medical Mycology and Virology**
Study of clinically important fungi and viruses.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3210

**BL 3230 - Medical Bacteriology**
Study of pathology, identification, isolation and antimicrobic susceptibility testing of clinically important bacteria.
**Credits:** 4.0
**Lec-Rec-Lab:** (2-0-5)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 3210

**BL 3300 - Introduction to Genomics**
Introduction to Genomics. Genome organization, mapping and characterization from humans and related organisms. Topics include hierarchical arrangement of genes, genome mapping, molecular markers of physical genome maps, genome sequencing, comparative genomics, analysis of important human genes and their products, and ethical and legal aspects of genomics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 2200 or FW 3320

**BL 3310 - Environmental Microbiology**
General principles of microbiology, focusing on both the use and control of microorganisms. Topics include microbial structure, function, growth, metabolism, and diversity, as well as microbial involvement in water and waste treatment, waterborne diseases, and pollution control.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biochem & Molec Biology-Bio Sc, Bioinformatics, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 1040 or BL 3080

**BL 3400 - Principles of Ecology**
Study of both accepted and currently debated principles that describe ecological relationships at the organism, population, community, and ecosystem levels.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** BL 1020 or BL 1040

**BL 3611 - Principles and Practice of Phlebotomy**
This course covers the collection, processing, and transportation of specimens for laboratory analysis. Emphasis will be placed on hands-on phlebotomy training using proper techniques and precautions.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 2410

**BL 3640 - General Immunology**
Investigates the immune defense system that has evolved to protect vertebrates from invading pathogens and cancer. Covers general principals of innate and acquired immunity, immunodeficiency and autoimmune diseases, as well as transplantation immunology, and the role of apoptosis in lymphocyte maturation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Bioinformatics, Medical Laboratory Science, Pharmaceutical Chemistry, Biochem & Molec Biology-Bio Sc, Biomedical Engineering, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 1020 or BL 1040 or BL 2020 or BE 2400

**BL 3780 - Medical Parasitology Laboratory**
Stresses the visual identification of common human parasites.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1710 and BL 2410

**BL 3782 - Writing Practicum in Biology**
Students will develop and improve their skill level in searching for scientific literature, incorporating that into scientific writing, evaluating and incorporating the work of others, and develop critique skills for review of scientific source material and basic statistical methods.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Biological Sciences, Biochem & Molec Biology-Bio Sc, Bioinformatics; May not be enrolled in one of the following Class(es): Freshman

**BL 3970 - Current Health Issues**
Current topics relevant to human health, with emphasis on health maintenance and disease prevention and the role of government in these matters. Topics include: tobacco use and poor diet/physical inactivity, infectious disease, mental and behavioral health, environmental health issues, and health care, including health insurance and models of universal health coverage.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**BL 3990 - Biological Sciences Teaching Experience**
Development of teaching skills through assisting in the instruction of a section of biological sciences laboratory. Students gain experience in leadership, group work, organization skills, laboratory preparation, and laboratory instruction.
**Credits:** variable to 4.0; Repeatable to a Max of 4
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**BL 4000 - Research in Biology**
A literature and laboratory research problem that culminates in a written report on the work performed.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**BL 4001 - Honors Research in Biology**
A laboratory-based research problem that culminates in a written report and a seminar presentation on the work performed. Open only to biological sciences and clinical laboratory sciences majors accepted into the Honors in Biological Sciences program.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**BL 4008 - Summer Workshop on Genome Editing of Human Disease Genes**
The course will focus on a survey and choice of disease-related genes, designing and constructing genome-editing tools, assaying for genome-editing efficiency, the detection and verification of the edited genes, and finally the production of stable disease-gene mutant cell lines.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**BL 4010 - Biochemistry I**
Structure, biochemical properties, and function of important biomolecules such as proteins and nucleic acids. Introduces enzyme biochemistry (structure, function, catalysis, kinetics, and inhibition).
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** (BL 1020 or BL 1040 or BE 2400) and BL 2100 and (CH 2410 or CH 2420)

**BL 4020 - Biochemistry II**
Dynamic aspects of living systems. Broad exposure to cellular metabolic pathways, intermediary metabolism and its regulation and bioenergetics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** BL 4010

**BL 4030 - Molecular Biology**
Molecular biology of gene structure, expression and regulation. Also topics covering various molecular techniques and applications of these techniques and biotechnology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (BL 1020 or BL 1040) and (BL 2100 or CH 4710)

**BL 4034 - Community Ecology and Evolutionary Dynamics**
This is an advanced course that looks at the study of ecology and evolutionary biology at the community level: how populations interact with the abiotic environment and each other to determine patterns of diversity, distribution, and abundance of plants and animals.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3400 and BL 3190

**BL 4035 - Bioimaging**
Current concepts in light and electron microscopy and scanning probe techniques. Theory and practice of fluorescence (including confocal and multi-photon), atomic force, scanning and transmission electron, and video microscopy as applied to biological specimens with emphasis on sample preparation. Half semester course.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**BL 4036 - Ecology and Evolution of Interactions Between Plants and Insects**
Plants and insects have played major roles in influencing each others evolutionary diversification. We will examine the ecology and evolution of plant-insect interactions in basic and applied contexts. A solid foundation of tools in ecology and evolution will be established and class will include lectures and interactive discussions from readings of the primary literature.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2013-2014 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3400 and BL 3190

**BL 4038 - Epigenetics**
An introduction to the fundamentals of epigenetic control that is not encoded by genomic DNA sequences of an organism. Topics include major regulatory mechanisms including DNA methylation, histone modification, and non-coding RNA (ncRNA) mediated gene regulation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3300 or BL 4030

**BL 4042 - Scanning Electron Microscopy of Biological Specimens**
Hands-on training in operation of the scanning electron microscope (SEM). Students prepare biological specimens of their choice for observation. Successful completion of course is prerequisite to becoming a certified SEM operator in the ACMAL. Half semester course.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-6)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Co-Requisite(s):** BL 4035

**BL 4044 - Human Pathophysiology**
Course will cover abnormal function (physiology) and investigate the signs and symptoms of major diseases in humans. Extension of Anatomy & Physiology by working through the systems of the human body. Course will include a clinical focus and case-study approach.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 2010 and BL 2020

**BL 4052 - Fluorescence and Video Microscopy of Biological Specimens**
Hands-on training in fluorescence microscopy and video microscopy. Students prepare biological specimens of their choice for observation. Half semester course.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-6)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BL 4035

**BL 4062 - Transmission Electron Microscopy of Biological Specimens**
Hands-on training in operation of the transmission electron microscope (TEM). Students prepare biological specimens of their choice for observation. Successful completion of course is prerequisite to becoming a certified TEM operator in ACMAL. Half semester course.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-6)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** BL 4035

**BL 4070 - Environmental Toxicology**
Introduction to the range of anthropogenic pollutants released into the environment. Concepts of bioaccumulation, biomagnification and environmental persistence, modes of toxicity and detoxification, transport and fate in aquatic and terrestrial ecosystems. Toxic equivalent factors and quotients, regulatory guidelines and practices.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (BL 1020 or BL 1040) and CH 1150 and CH 1160

**BL 4090 - Tropical Island Biology**
A survey of island biology, including marine and terrestrial habitats. Topics include formation of carbonate islands, geological history of the Bahamas, island plant communities, intertidal, grass bed, mangrove and coral reef communities. Special course fees. Consult department before enrolling. Completion of BL1020 or BL1040 desirable but not necessary.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring

**BL 4100 - Special Topics in Biological Sciences**
A study of recent developments in the biological sciences.
**Credits:** variable to 10.0; Repeatable to a Max of 10
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**BL 4120 - Environmental Remediation**
Toxicology of major environmental pollutants, their dose-response relationships and fundamentals of environmental remediation. Topics include physical, chemical, and biological remediation methods and effect of environmental toxins on biological systems. Laboratory will involve the application of chemical and biological remediation techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2011-2012 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 1020 or BL 1040

**BL 4140 - Plant Physiology**
Physiology and biochemistry of plants. Emphasizes photosynthesis, plant hormones, water and nutrient relations, and light-regulated development.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2005-2006 academic year
**Pre-Requisite(s):** BL 2160 and CH 2420

**BL 4145 - Plant-Microbe Interactions**
Interactions between plants and microorganisms in the environment. Topics include microbial virulence, signaling, gene expression, beneficial interactions and disease resistance in plants. Laboratory will focus on plant biochemical and microbiological methods as they relate to environmental problems.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2012-2013 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2200

**BL 4200 - Microbial Physiology**
Structure and function of microorganisms, with emphasis on mechanisms for responding to changing environmental and nutritional conditions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** BL 3210 or BL 3310

**BL 4370 - Advanced Cell Biology**
Celebration of the commonalities of life as exhibited in the basic building block of organisms - the cell. Course topics include details of basic genetic mechanisms, cell structure and function, and an examination of cells in their social context.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2200 and CH 2420

**BL 4380 - Cardiopulmonary Physiology**
Using a problem-based learning approach, course examines the physiology of the human body. In-class case-study analyses provide in-depth learning about the cardiovascular and pulmonary systems and their relationship with other organ systems. Promotes development of problem-solving skills.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** BL 2020

**BL 4421 - Lake Superior Exploration**
A field intensive course with significant time spent on a research vessel (R/V Agassiz or other) where students will learn the use of a variety of state-of-the-art techniques to characterize biological communities and measure important physical and biological processes.
**Credits:** 3.0
**Lec-Rec-Lab:** (4-0-6)
**Semesters Offered:** Summer - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**BL 4440 - Fish Biology**
Fishes and their habitat, native and exotic fishes of the Great Lakes region, and ocean fishery resources will be examined. Basic topics in Ichthyology and fish ecology, evolution, genetics, reproduction strategies and identification of early life stages, fish community structure, food webs and dynamics. Laboratory exercises on sampling, identification and classification of fishes and basic fish anatomy and discussion of scientific papers relevant to the subject material.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 1020 or BL 1040

**BL 4447 - Stream Ecology**
Field course combining river and stream ecosystem and foodweb study with fishes in lake systems. Students will be exposed to research methods used in lakes for comprehensive abiotic and biotic understanding.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Summer - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1010 or BL 1040 or BL 3400

**BL 4450 - Limnology**
The study of biological, physical, and chemical processes of freshwater eco systems using a watershed perspective, with emphasis on local lakes.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**BL 4461 - Ecosystem Ecology**
Study of processes in aquatic and terrestrial ecosystems, including energy flow, ecosystem production, and nutrient cycling. We will explore these processes through a historical overview of influential research programs and regional to global case studies.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2011-2012 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3400 and CH 1122 or (CH 1160 and CH 1161)

**BL 4465 - Biological Oceanography**
An overview of ocean environments and marine life. Topics include: trophic level interactions, nutrient cycling, ecology of plankton, invertebrates, fish, mammal and bird resources, and human influences on marine ecosystems. Will cover basic water chemistry and light in oceans.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1010 or BL 1040 or BL 3080

**BL 4510 - Senior Capstone Experience**
Reading, interpreting, and integrating information from the primary literature of biological sciences. Emphasizes oral and written presentation skills.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Biological Sciences, Biochem & Molec Biology-Bio Sc, Bioinformatics; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**BL 4530 - Senior Research Capstone Experience**
Reading, interpreting, and integrating information from the primary literature and research project data. Emphasizes oral and written presentations as well as peer review.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Biological Sciences, Biochem & Molec Biology-Bio Sc, Bioinformatics; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** BL 4000(C) or BL 4001(C) or BL 4995(C)

**BL 4550 - Clinical Chemistry**
A study of clinical biochemistry of the human body. Theory and practical applications used in routine analysis of body fluids. Includes the study of electrolyte balance, acid base balance, and the functions of major organs and systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Clinical Laboratory Science, Medical Laboratory Science, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2020 and BL 3640

**BL 4610 - Medical Laboratory Science Medical Practicum I**
Practical and didactic training in clinical chemistry, immunopathology, and medical microbiology under the direction of National Accrediting Agency for the Clinical Laboratory Sciences (NAACLS)-approved/accredited hospital internship program personnel.
**Credits:** 15.0
**Lec-Rec-Lab:** (15-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science

**BL 4611 - Medical Laboratory Science Medical Practicum II**
Practical and didactic training in hematology, urinalysis, and immunohematology under the direction of National Accrediting Agency for the Clinical Laboratory Sciences(NAACLS)-approved/accredited hospital internship program personnel.
**Credits:** 15.0
**Lec-Rec-Lab:** (15-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science
**Pre-Requisite(s):** BL 4610

**BL 4612 - Medical Laboratory Science University Clinical Practicum**
Practical and didactic training in Medical Laboratory Science for students who have completed the NAACLS accredited MLS 4+1 degree. Course is under direction of the MLS Practicum Coordinator and conducted in affiliated hospitals. Upon completion, students are eligible to sit for the ASCP Board Registry Exam.
**Credits:** 10.0
**Lec-Rec-Lab:** (0-0-10)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required

**BL 4630 - Cytotechnology Practicum I**
Practical and didactic training in recognition of normal cells and cellular changes, particularly malignant, in the female reproductive tract, respiratory tract, and gastrointestinal tract under the direction of Committee on Accreditation of Allied Health Education Programs (CAAHEP)-approved/accredited hospital internship program personnel. Acceptance by a CAAHEP-approved/accredited cytotechnology hospital internship program required.
**Credits:** 14.0
**Lec-Rec-Lab:** (14-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science

**BL 4631 - Cytotechnology Practicum II**
Practical and didactic training in normal cell identification and recognition of cellular changes with emphasis on the diagnosis of cancer in the urinary, excretory, and neurological systems under the direction of Committee on Accreditation of Allied Health Education Programs (CAAHEP)-approved/accredited hospital internship program personnel.
**Credits:** 14.0
**Lec-Rec-Lab:** (14-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science
**Pre-Requisite(s):** BL 4630

**BL 4640 - Clinical Immunology & Serology**
Integrates basic and clinical immunological principles as well as outlines the diagnosis and evaluation of immune disorders and selected infectious diseases.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2410 and BL 3640

**BL 4660 - Current Topics in Medical Laboratory Science**
Recent developments in Clinical Laboratory Science.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**BL 4720 - Hematology and Hemostasis**
Theory and laboratory applications. Emphasis will be placed on hematopoiesis, normal and disease states affecting blood cells and coagulation processes. The lab will focus on cell morphology and practical testing applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BL 4730(C)

**BL 4730 - Immunohematology Techniques**
Theory and practical applications. Emphasis will be placed on blood antigens and antibodies, compatibility testing techniques, blood component therapy and safety issues.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science, Biological Sciences; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BL 4720(C)

**BL 4750 - Medical Laboratory Instrumentation**
An overview of the principles, applications, and selection of instruments used in medical laboratory. Lab work includes operation, maintenance, and trouble shooting to obtain experience working with power supplies, centrifuges, spectrophotometers, pH meters, osmometers, radiation counters, and chemistry analyzers, blood cell counters, and other instruments commonly used in a diagnostic laboratory.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Spring

**BL 4752 - Cancer Biology**
Emphasis on characteristic genetic, molecular, and cellular changes leading to cancer. Topics will include the role of tumor viruses, oncogenes, tumor suppressors, immortalization, apoptosis, and angiogenesis in cancer initation and/or progression. Consideration of current therapies and future directions for treatment.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 3012 or BL 4370 or BE 2400

**BL 4800 - Molecular Diagnostics**
This course provides the scientific background behind modern molecular techniques applies in the diagnosis of human diseases. Topics to be covered include nucleic acid structure and function as well as introduction to nucleic acid characterization techniques used in disease diagnosis and genetic disorders.
**Credits:** 5.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2200

**BL 4820 - Biochemical Laboratory Techniques I**
Laboratory techniques basic to biochemistry and molecular biology with emphasis on protein isolation, characterization and kinetics.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** BL 4010(C) or CH 4710(C)

**BL 4840 - Molecular Biology Techniques**
Laboratory techniques in molecular biology, including methods of recombinant DNA technology for identification, cloning, and characterization of genes.
**Credits:** 3.0
**Lec-Rec-Lab:** (1-0-4)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2200 and BL 4030(C)

**BL 4980 - Medical Laboratory Science Core Concept Integration and Application**
SML Program Capstone Course. Review, and subsequently learn to integrate and apply, clinical core course material. Assignments include collaborative exercises involving development, peer review, and presentation of worksheets, case studies, and instrument evaluations, as well as other interactive learning activities.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Medical Laboratory Science; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3230(C) and BL 4550(C) and BL 4640 and BL 4720 and BL 4730

**BL 4995 - Research in Biochemistry**
A literature and laboratory research problem in biochemistry that culminates in a written report on the work performed.
**Credits:** variable to 6.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

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## Business

**BUS 1100 - Introduction to Business**
Introduction to planning, organizing, decision-making, leadership and control in a business. Business disciplines of accounting, finance, information systems, management, marketing, and operations are introduced, along with discussions of business ethics and social responsibility.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring

**BUS 2100 - Business Statistics**
Introduction to basic concepts and methods of probability and statistics, including the following topics: collection, description and presentation of data, probability, random variables, sampling, probability distributions, estimation and hypothesis testing, ANOVA, and selected non-parametric techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1135 or MA 1160 or MA 1161

**BUS 2200 - Business Law**
Provides an understanding of the legal basis of contracts and their enforcement in the areas of general contracts, contracts of commercial sales and of agency, and commercial paper.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring

**BUS 2300 - Quantitative Problem Solving**
Stresses development of quantitative decision and analysis skills to solve problems with cases, exercises, simulations, and mathematical modeling. Topics include regression analysis, decision analysis, stochastic environments, data sources and errors, utility theory risk preference, linear programming, and simulation analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** BUS 2100 or MA 2710 or MA 2720 or MA 3710 or MA 3720

**BUS 3900 - Business Internship**
A practical approach to business problem solving. Requires a report on work activity upon completion of the internship.
**Credits:** variable to 4.0; Repeatable to a Max of 4
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following College(s): School of Business & Economics

**BUS 4900 - Research Projects**
Under the general guidance of a faculty member, students read, conduct research, and prepare reports and papers as required. The SBE's Curriculum Committee must approve the subject of the proposed project.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor and department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**BUS 4950 - Business Project**
Students work individually or in a team on a project under the guidance of a faculty advisor. The student(s) analyze a problem, develop a project plan, summarize findings, and make recommendations.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**BUS 4990 - Special Topics in Business**
Business topics of interest to students and faculty.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**BUS 4991 - Business Development Experience I**
Provides students with hands-on entrepreneurial learning experience by placing them in close proximity of real world entrepreneurs and innovators. Students ascertain commercial viabilities of intellectual property, senior design or enterprise projects, independent new ventures or early stage business incubators.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** BUS 1100 and BUS 2300 and ACC 2000 and ACC 2100 and BUS 2200 and MGT 2000 and MIS 2000 and FIN 3000 and OSM 3000 and MGT 3000 or MKT 3000

**BUS 4992 - Business Development Experience II**
Completion and presentation of the business plan and recommendations on the commercial viability of intellectual properties, senior design or enterprise projects, independent new ventures, or early stage incubators.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** BUS 4991

## Civil & Environmental Engineering

**CEE 1000 - Civil Engineering**
An introduction to the civil engineering profession with emphasis on careers open to the civil engineering students. Topics include: scope, specialties, education, professional practice, life-long learning, contemporary issues, ethics and societal impacts related to civil engineering.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall

**CEE 1001 - Sustainability and Civil Engineering Practice**
Course will focus on characterizing the motivation for and principles of sustainable engineering and provide an introduction to tools used in sustainable design. Course topics follow a logical and linear progression which includes the societal context, scientific motivation, and application of sustainable practices in civil engineering.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Spring

**CEE 1501 - Experiences in Environmental Engineering**
Provides a series of activities that explore the field of environmental engineering. Through completion of the course, students will gain fundamental experiences with the skills, knowledge, and attitudes needed to solve the complex environmental problems needing solutions from today's environmental engineers.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall

**CEE 3101 - Civil Engineering Materials**
Covers properties and behavior of typical civil engineering materials, including wood, metals, aggregates, asphalt cement concrete, portland cement concrete, and composites. Laboratory exercises demonstrate selected engineering mechanics principles, including elastic, inelastic, and time-dependent material behavior. Additional topics include testing techniques, materials standards, report writing, and presentation of experimental data.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** ENG 2120 or MEEM 2150

**CEE 3202 - Structural Analysis**
Introduction to structural concepts and techniques for analyzing trusses, determinate and indeterminate beams, and frame structures. Apply concepts from statics and mechanics of materials to determine internal forces and deflections of structural members and systems, including loads and load paths.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (ENG 2120 or MEEM 2150) and (MA 2320 or MA 2321 or MA 2330)

**CEE 3331 - Professional Practice**
Professional expectations of civil and environmental engineers demonstrated through readings, discussion, and writing. Topics include the consequences of engineering, design issues, legal aspects, ethical considerations, government requirements, management, leadership, and contract issues.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CEE 3332 - Fundamentals of Construction Engineering**
Introduction to concepts required by professionals involved in the construction industry. Includes contracts, bidding, estimating, scheduling, cash flow, safety, labor issues, equipment ownership, and productivity.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**CEE 3401 - Transportation Engineering**
Introduction to transportation in the United States, transportation mode characteristics and applications, highway geometrics and design standards, pavement design and management.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**CEE 3490 - Introduction to Rail Transportation**
Introduction to topics related to rail transportation and industry. Overview of North American passenger and freight railroads in the past and today, system components (railroad track, rolling stock, and signals/communications), organizations, careers and safety, and techology and sustainability.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**CEE 3501 - Environmental Engineering Fundamentals**
Basic principles and calculations for environmental engineering. Covers application of mass balance, energy balance, and physical/chemical/biological principles to water and wastewater treatment, surface water quality, air quality, solid waste management, and groundwater quality.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2160 and CH 1112 or (CH 1150 and CH 1151)

**CEE 3502 - Environmental Monitoring and Measurement Analysis**
Introduction to environmental data acquisition and interpretation, fundamentals of environmental monitoring, instrumentation, measurement techniques, and statistical analyses. Measurements are conducted in a variety of engineered and natural environments. Probability and statistical analyses are applied to the collected data.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2160 and CH 1112 or (CH 1150 and CH 1151)

**CEE 3503 - Environmental Engineering**
Application of fundamental chemical, biological, and physical principles of environmental engineering to design and operation of systems used for water and wastewater treatment, solid waste management, air pollution control, and analysis of quality of surface water, air, and groundwater.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 2160 and CH 1112 or (CH 1150 and CH 1151)

**CEE 3620 - Water Resources Engineering**
Introduction to hydrologic engineering, including rainfall-runoff modeling and hydrologic frequency analysis. Analysis and design of hydraulic systems such as pipe networks and storm water management systems. Computational, field, and experimental laboratory sessions reinforce lectures and provide hands-on learning opportunities.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** ENG 3200 and (MA 3710(C) or ENVE 3502(C) or CE 3710(C) or CEE 3502(C) or CEE 3710(C))

**CEE 3710 - Uncertainty Analysis in Engineering**
Introduction to probability, statistics, and uncertainty analysis with examples from civil engineering (e.g. models of vehicle arrivals, structural reliability, flood distributions). Topics include: discrete probability theory, probability distributions, parameter estimation, confidence intervals, hypothesis tests, linear regression, and model selection.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2160

**CEE 3810 - Soil Mechanics for Engineers**
Develops the terminology and descriptions common to the field. Studies soil compressibility, fluid flow, response to mechanical compaction, and strength as well as methods of determining geostatic stresses and stress changes due to boundary loadings. An experimental laboratory experience reinforces the lecture material.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** GE 2000 and (MEEM 2150 or ENG 2120) and ENG 3200

**CEE 4010 - Introduction to Consulting Engineering**
Covers the role of consultants, organizational structure, accounting, getting work and dealing with clients, preparing proposals, presentations, estimating costs, project management, liability, and professional ethics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CEE 4020 - Computer Applications: Visualizing and Communicating Design Information**
Problem-solving using industry standard software, such as Civil3D, is applied to civil and environmental engineering projects such as terrain modeling, earth work calculations, and road alignment. Concepts involving data management, data visualization, and risk analysis are introduced.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CE 3332 or CE 3401 or CEE 3332 or CEE 3401(C)

**CEE 4101 - Bituminous Materials**
Applications and properties of asphalt binder, aggregates for bituminous mixtures, and analysis and design of asphalt concrete mixtures. Includes asphalt cement production, rheology, chemistry, and grading, aggregate grading and blending, and mixture design and characterization. Also discusses asphalt mixture production, construction, and recycling.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** CE 3101 or CEE 3101

**CEE 4201 - Matrix Structural Analysis**
Analysis of trusses and frames by the direct stiffness method. Use of a typical commercial computer code is stressed as a tool for complex structures. Introduces three-dimensional structures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CE 3202 or CEE 3202

**CEE 4213 - Structural Concrete Design**
Introduction to design of reinforced concrete structural components. Analyze and design reinforced concrete beams, columns, and footings. Understand material behavior, limit state criteria, and practical detailing considerations. Application of the ACI 318 to cast-in-place and precast systems.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CE 3202 or CEE 3202

**CEE 4223 - Steel Design I**
Behavior and design of structural steel members using both ASD and LRDF approaches. Covers material behavior, external loads, and the design of tension, compression, and flexural members (rolled, built-up, and composite), and simple welded and bolted connections.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** CE 3202 or CEE 3202

**CEE 4233 - Structural Timber Design**
Introduction to the use of wood as a structural engineering material. Includes design of beams, columns, nailed and bolted connection, glulam members, including tapered beams, tapered and curved beam, and design of wood shear walls and diaphragms.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CE 3202 or CEE 3202

**CEE 4244 - Loads for Civil Structures**
The course focuses on the theory and building code requirements for civil structural loadings that are used in design. The loads and load combinations will include dead loads, occupancy live loads, snow loads, wind loads, and seismic loads.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CE 3202 or CEE 3202

**CEE 4333 - Estimating and Planning of Construction Projects**
Examination of the principles and techniques of estimating construction costs leading to the development of an estimate and proposal submission. The relationship between the contract specification, drawings, and the estimate will be illustrated.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CE 3332 or CEE 3332 or CMG 3265

**CEE 4344 - Construction Scheduling**
This course will introduce students to the basics of construction scheduling. Topics covered will include: Fundamentals of different scheduling methods such as Critical Path Method and linear scheduling, Resource allocation in schedules, and Schedule monitoring and control methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CE 3332 or CMG 3265 or CEE 3332

**CEE 4401 - Pavement Design**
Analysis, behavior, performance, and structural design of highway pavements. Introduces pavement types and performance concepts, highway traffic and subgrade characterization, materials employed in highway construction, and highway drainage. Presents common methods used for designing pavement structures as well as mechanistic- empirical approaches.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** (CE 3401 or CEE 3401) and (CE 3101 or CEE 3101)

**CEE 4402 - Traffic Engineering**
Introduction to traffic engineering, traffic characteristics, data collection techniques, capacity analysis, traffic control devices, intersection control, traffic signal systems, parking, and street operations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CEE 4404 - Railroad Engineering**
Rail transportation systems require infrastructure, vehicles, motive power and energy, and control systems to move goods and people. This multi-disciplinary course provides students with understanding of these system components and related engineering and technology enabling efficient operation of today's system.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CEE 3490 or CE 4490

**CEE 4406 - Airport Planning and Design**
Introduction to the air transportation system, airport planning studies, demand forecasting, aircraft characteristics, runway requirements, airport layout and design. Also includes environmental impacts, airport capacity and operations, terminal and ground access planning and analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring

**CEE 4407 - Transportation Design**
Introduction to computer aided geometric design of highways and railways. Covers design principles and use of standards for horizontal and vertical alignments and cross sections, including road intersections, railway turnouts and grade crossings. Students develop engineering drawings and related cost estimates for road/rail project.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (CE 3401 or CEE 3401) and SU 2000

**CEE 4410 - Transportation Planning**
An introduction to urban transportation planning, planning data collection, transportation planning models, and development and evaluation of transportation plans. Includes extensive use of transportation planning software to evaluate transportation plans in multimodal networks.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CEE 4501 - Environmental Engineering Chemical Processes**
Application of chemistry, conservation principles, and mathematics to the analysis of chemical processes occurring in natural and engineered environments. Topics include acid-base phenomena, the carbonate system, precipitation/dissolution, redox chemistry, diffusion, mass transfer, and applications to engineering design.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (ENVE 3501 or CEE 3501 or ENVE 3503 or CEE 3503) and (ENVE 3502 or CEE 3502) and ENG 3200

**CEE 4502 - Wastewater Treatment Principles and Design**
Principles of physical, chemical, and biological processes employed in wastewater treatment. Design of selected individual units within wastewater treatment systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENVE 3501 or CEE 3501 or ENVE 3503 or CEE 3503

**CEE 4503 - Drinking Water Treatment Principles and Design**
Provides an overview of the principles and design of municipal water treatment practices. Understand the physical and chemical processes employed in water treatment. Design individual unit processes with a view toward integration into complete treatment systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENVE 3501 or ENVE 3503 or CEE 3501 or CEE 3503

**CEE 4504 - Air Quality Engineering and Science**
Overview of air quality regulation in the U.S. and world, including basic concepts of atmospheric chemistry and transport; fugitive, point, and area emissions; principles and tradeoffs of operation and design of air pollution control systems; and application of air quality models.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENVE 3501 or ENVE 3503 or CEE 3501 or CEE 3503

**CEE 4505 - Surface Water Quality Engineering**
Develops the scientific basis for water quality management in lakes and rivers. Considers the origin, behavior, and fate of nutrients and toxic substances. Introduces engineered approaches for lake management, including mass balance modeling. Presents techniques for water quality restoration and the legal framework supporting pollution control.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENVE 3501 or ENVE 3503 or CEE 3501 or CEE 3503

**CEE 4506 - Application of Sustainability Principles to Engineering Practice**
Study of sustainability, engineering and design including systems analysis, life cycle analysis, biogeochemical cycles, energy balances, energy conservation and development, models for sustainable engineering, environmental regulations as sustainability instruments, sustainability in the build environment, and industrial ecology and compliance.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENVE 3501 or ENVE 3503 or CEE 3501 or CEE 3503

**CEE 4507 - Water Distribution and Wastewater Collection Design**
Application of basic principles in civil and environmental engineering to the analysis and design of water distribution systems, wastewater collection systems, and their appurtenances.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (ENVE 3501 or CEE 3501 or ENVE 3503 or CEE 3503) and (CE 3620 or CEE 3620)

**CEE 4509 - Environmental Process & Simulation**
Provides a rigorous hands-on introduction to process control, laboratory and pilot-plant experimentation focused on physical, chemical and biological treatment systems used in environmental engineering.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (ENVE 3501 or CEE 3501 or ENVE 3503 or CEE 3503) and ENG 3200 and (ENVE 4502 or CEE 4502 and ENVE 4503 or CEE 4503)

**CEE 4510 - Baccalaureate Thesis**
Independent baccalaureate research project performed under the supervision of one or more faculty.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CEE 4511 - Solid and Hazardous Waste Engineering**
Characterization, treatment, separation, and disposal of solid and hazardous wastes. Science and engineering for the management of solid and hazardous waste problems. Technologies discussed include incineration, landfilling, vapor extraction, soil washing, and bioremediation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENVE 3501 or CEE 3501 or ENVE 3503 or CEE 3503

**CEE 4515 - Atmospheric Chemistry**
Study of the photochemical processes governing the composition of the troposphere and stratosphere, with application to air pollution and climate change. Covers radical chain reaction cycles, heterogeneous chemistry, atmospheric radiative transfer, and measurement techniques for atmospheric gases.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** ENVE 4504 or CEE 4504 or ENVE 4501 or CEE 4501 or CH 3510

**CEE 4518 - Aquatic Biogeochemistry**
Covers interactions among chemical, biological, and physical processes within aquatic ecosystems as well as role of aquatic ecosystems in global biogeochemistry. Modeling as an integrative tool is stressed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (ENVE 4501(C) or CEE 4501(C)) and (ENVE 4505(C) or CEE 4505(C))

**CEE 4528 - Global Biogeochemistry**
This course gives an overview of important biogeochemical processes occurring in land, air, and water. An emphasis is put on modeling as an integrating tool.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** ENVE 4501(C) or CEE 4501(C)

**CEE 4620 - River and Floodplain Hydraulics**
Analysis of open channel systems, including natural channels, designed channels, flow transitions, non-uniform flow, and unsteady flow.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CE 3620 or CEE 3620

**CEE 4640 - Stormwater Management and Low Impact Development**
Design techniques for stormwater collection, conveyance, infiltration, and detention storage systems are discussed, both traditional stormwater management systems and newer approaches based on the philosophy of low impact development (LID) that seek not to alter the natural ecology of a site.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Summer
**Pre-Requisite(s):** CE 3620 or CEE 3620

**CEE 4665 - Stream Restoration**
Basic mechanics of the transport of sediments in natural systems, including tractive forces and geomorphic functions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CE 3620 or CEE 3620

**CEE 4760 - Optimization Methods in Civil and Environmental Engineering**
Decision analysis and optimization techniques, including linear programming, nonlinear programming, and dynamic programming. Computer-based solutions of design problems in various civil and environmental engineering specialty areas are considered.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MA 2160 and (MA 2320 or MA 2321 or MA 2330)

**CEE 4820 - Foundation Engineering**
Applies the fundamentals learned in CE3810 to problems in geotechnical engineering. Learn the procedures used to design footings, piled foundations, retaining walls, marine structures, and slopes. Computational laboratory reinforces lectures; students have direct access to the instructor as the design is being developed.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CE 3810 or CEE 3810

**CEE 4830 - Geosynthetics Engineering**
Geosynthetic materials are grouped by mechanical characteristics and engineering use. They are widely used in highway, landfill, and embankment design. Develop designs for filters, soil separators, reinforced earth, and impermeable membranes. Also learn when using a geotextile is appropriate.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CE 3810 or CEE 3810

**CEE 4850 - Rock Engineering for Civil Engineers**
This course focuses on the applied behavior of rock encountered primarily in civil engineering projects. Topics include rock classification, rock durability, rock mass strength classification, use of stereo nets, rock reinforcement, blasting, rock socket application and bearing capacity on rock.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2009-2010 academic year
**Pre-Requisite(s):** CE 3810 or CEE 3810

**CEE 4900 - Engineering Design Project I**
An engineering design project related to civil and environmental engineering. Not available to students who have taken CE4905. Students must complete both CE4900 and CE4910 to fulfill senior design requirements. Must be senior project ready as defined by major department.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CEE 4905 - Engineering Design Project**
An engineering design project related to civil and environmental engineering. Not available to students who have taken CE4900 or CE4910. (Senior project ready as defined by major substitutes for prerequisites)
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CEE 4910 - Engineering Design Project II**
Continuation of CE4900. Not available to students who have taken CE4905. Students must complete both CE4900 and CE4910 to fulfill senior design requirements. Senior project ready as defined by major substitutes for prerequisites.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** CE 4900 or CEE 4900

**CEE 4915 - International Engineering Field Experience**
An engineering design project that incorporates an international experience. Must be taken in conjunction with CE4916 in order to fulfill senior design requirements. Must be senior project ready as defined by major department.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Senior

**CEE 4916 - International Senior Design Field Project**
An engineering design project that incorporates an international experience. Must be taken in conjunction with CE4915 in order to fulfill senior design requirements. Senior project ready as defined by major substitutes for prerequisites.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** CE 4915 or CEE 4915

**CEE 4920 - Civil Engineering Independent Study**
Approved research or design project in civil engineering, originating with an individual student or assigned by the instructor.
**Credits:** variable to 3.0; Repeatable to a Max of 3
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CEE 4930 - Environmental Engineering Independent Study**
Approved research or design project in environmental engineering, originating with an individual student or assigned by the instructor.
**Credits:** variable to 3.0; Repeatable to a Max of 3
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CEE 4990 - Special Topics in Civil and Environmental Engineering**
Topics of special interest in civil or environmental engineering.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer

**CEE 4993 - Engineering with Developing Communities**
Study of applying appropriate, community-based, and sustainable engineering in developing communities. Concepts of human-centered design and sustainable development are covered. Topics are drawn from several areas of engineering, including water and wastewater treatment, construction materials, solid waste, energy, and information systems.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** (ENG 2120 or MEEM 2150) and (CE 3620 or CEE 3620)

## Chemistry

**CH 0100 - Chemistry Coaching**
Scheduled weekly individual or study group session with an experienced chemistry coach to improve mastery of chemistry material, problem-solving skills, and awareness of expectations in first year chemistry.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer

**CH 0200 - Organic Chemistry Coaching**
Scheduled weekly individual or study group session with an experienced organic chemistry coach to improve understanding of organic structures, develop skills for predicting products of organic reactions, the drawing of mechanisms and determining synthesis strategies as well as awareness of expectations in a specific discipline of chemistry.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring

**CH 1000 - Introductory Chemistry**
Introduces fundamental concepts of chemistry to students who are interested in how chemical processes shape the world. Covers fundamental chemical concepts and integrates applications of chemistry that are relevant to the global community. High school chemistry is not required.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer

**CH 1112 - University Chemistry - Studio Laboratory I**
Introduces experimental and theoretical chemical concepts from a hands-on, inquiry-based perspective. Emphasis is placed on experimental methods, reactions and stoichiometry, states of matter, thermochemistry, periodicity and bonding, solutions, and kinetics.
**Credits:** 5.0
**Lec-Rec-Lab:** (3-1-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Biochem & Molec Biology-Chem, Pharmaceutical Chemistry, Chemistry, Cheminformatics
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C)

**CH 1122 - University Chemistry - Studio Laboratory II**
Introduces more complex experimental and theoretical concepts from a hands-on, inquiry-based perspective. Emphasis is on experimental methods, kinetics, equilibria, thermodynamics, electrochemistry, and special topics which may include chemical analysis, organic synthesis, computational methods, and biochemistry.
**Credits:** 5.0
**Lec-Rec-Lab:** (3-1-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Biochem & Molec Biology-Chem, Pharmaceutical Chemistry, Chemistry, Cheminformatics
**Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151)

**CH 1130 - Professional Development for Chemists I: Orientation**
Required for all entering chemistry majors. Intro to department, cover writing, technical software, library resources, reading and writing reports, academic integrity, career services, and other orientation topics. First course in a four-part professional development sequence.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Biochem & Molec Biology-Chem, Pharmaceutical Chemistry, Chemistry, Cheminformatics

**CH 1150 - University Chemistry I**
Introduces the foundations of chemistry, including electronic structure of atoms and molecules, intermolecular forces, states of matter, chemical reactions, organic chemistry, chemical equilibria, kinetics, and acid-base chemistry. Includes laboratory component that emphasizes lecture components.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** CH 1151
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C) or MA 1160(C) or MA 1161(C) or MA 1135(C) or ALEKS Math Placement >= 56 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**CH 1151 - University Chemistry Lab I**
Laboratory to accompany CH1150.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** CH 1150
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C) or MA 1160(C) or MA 1161(C) or MA 1135(C) or ALEKS Math Placement >= 56 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**CH 1153 - University Chem Recitation I**
Problem solving session to support University Chemistry I - CH1150.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** CH 1150
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C) or MA 1160(C) or MA 1161(C) or MA 1135(C) or ALEKS Math Placement >= 56 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**CH 1160 - University Chemistry II**
A continuation of CH 1150. Introduces more complex concepts in chemistry, including kinetics, chemical equilibria, acid-base equilibria, thermodynamics, electrochemistry, and chemical analysis. Additional topics may include chemistry of the metals and non-metals, biochemical systems, and nuclear chemistry. Includes laboratory component that emphasizes lecture concepts.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** CH 1161
**Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151)

**CH 1161 - University Chemistry Laboratory II**
Laboratory to accompany CH1160.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** CH 1160
**Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151)

**CH 1163 - Problem Solving in University Chemistry II - CH1160**
Problem solving session to support University Chemistry II - CH1160.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** CH 1160
**Pre-Requisite(s):** CH 1150 and CH 1151

**CH 2130 - Professional Development for Chemists 2: Career Planning**
Continuation from CH1130 and provides a more in-depth review of topics related to career planning, such as resume writing, interviewing, selecting research topics, research integrity, reading and writing reports, applying for scholarships and grants, and oral communication skills.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Biochem & Molec Biology-Chem, Pharmaceutical Chemistry, Chemistry, Cheminformatics
**Pre-Requisite(s):** CH 1130

**CH 2212 - Quantitative Analysis**
Measurements and calculations relevant to volumetric and gravimetric analysis as well as electrochemistry and separations. Error analysis and statistical treatment of data. In the laboratory, introduces classical and contemporary techniques that require high quality measurements.
**Credits:** 5.0
**Lec-Rec-Lab:** (3-0-6)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161)

**CH 2410 - Organic Chemistry I**
A study of the chemistry of carbon compounds. Review of hybrid orbitals, covalent bonding, and resonance. Introduction to nomenclature, stereochemistry, mass spectrometry and infrared spectroscopy, functional group chemistry based on reaction mechanisms, and multi-step synthesis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161)

**CH 2411 - Organic Chemistry Lab I**
Laboratory to accompany CH2410.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** CH 2410(C) and CH 1122 or (CH 1160 and CH 1161)

**CH 2420 - Organic Chemistry II**
Covers more functional group chemistry based on reaction mechanisms; more involved multi-step synthesis; introduction to nuclear magnetic resonance spectroscopy; introduction to carbohydrates, amino acids, proteins, nucleic acids; and topics of specialized interest.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** CH 2410

**CH 2421 - Organic Chemistry Lab II**
Laboratory to accompany CH2420.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** CH 2411 and CH 2420(C)

**CH 3020 - Laboratory Teaching Internship**
Requires teaching a section of undergraduate laboratory under professional supervision. Emphasizes communicating good laboratory practice and technique to beginning students as well as maintaining a safe working environment. Includes safety training and teaching orientation. Required for certification in the ACS chemistry/education option.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CH 3130 - Professional Development for Chemists 3: Communication**
Continuation from CH2130 and provides a more in-depth review of topics related to refining written and oral communication skills, including advanced library resources, reading and writing reports, and seminar attendance.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Biochem & Molec Biology-Chem, Pharmaceutical Chemistry, Chemistry, Cheminformatics
**Pre-Requisite(s):** CH 2130

**CH 3510 - Physical Chemistry I - Thermodynamics, Equilibrium and Kinetics**
Ideal and non-ideal gas laws, the kinetic theory of gases, equations of state, liquid-vapor equilibrium, the laws of thermodynamics, solid-liquid-vapor equilibria, the chemical potential, chemical equilibrium, electrochemistry, the phase rule, phase diagrams, and chemical kinetics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161) and MA 2160 and PH 2200(C)

**CH 3511 - Physical Chemistry Lab I**
Laboratory to supplement CH3510.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CH 3510(C)

**CH 3520 - Physical Chemistry II - Molecular Structure**
Continuation of CH3510. Covers solid-state chemistry, surface chemistry, atomic and molecular spectroscopy and structure, chemical applications of group theory, valence, the periodic table, elements of quantum mechanics, and statistical thermodynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161) and MA 3160 and PH 2200(C)

**CH 3521 - Physical Chemistry Lab II**
Laboratory to supplement CH3520.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 3520(C)

**CH 3540 - Biophysical Chemistry**
Examines fundamental physical principles underlying complex biological systems in order to understand the interactions and behaviors found in biological, biochemical, and physical systems. Topics include macromolecules in aqueous environments, spectroscopy and structure determination, kinetics, membranes, and transport phenomena.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (BL 1020 or BL 1040) and CH 1122 or (CH 1160 and CH 1161) and MA 2160 and PH 2200

**CH 3541 - Biophysical Chemistry Laboratory**
Examines the physical methods employed in the study of biological systems, including structure determination, spectroscopy, microscopy, imaging, and modeling. The core objective is application of the fundamentals developed in the Biophysical Chemistry course to systems of biological relevance.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring
**Co-Requisite(s):** CH 3540

**CH 4110 - Pharmaceutical Chemistry: Drug Action**
Focuses on structural and mechanistic approaches to pharmaceuticals and drug action. General principles of absorption, distribution, action, metabolism and toxicity of drugs will be presented followed by action of drug classes such as antibiotics, cardiovascular, and anti-inflammatory drugs.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 4010 or CH 4710

**CH 4120 - Pharmaceutical Chemistry: Drug Design**
Focuses on the important concepts in the design and synthesis of drugs. Rational basis for drug design including synthetic, computational and biochemical concepts will be discussed. Topics include structure-activity relationships, synthesis and reaction mechanism, and case studies of drugs.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** CH 2420

**CH 4130 - Professional Development for Chemists 4: Senior Seminar**
Continuation from CH3130 with emphasis on advanced topics of written and oral communication skills.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Biochem & Molec Biology-Chem, Pharmaceutical Chemistry, Chemistry, Cheminformatics
**Pre-Requisite(s):** CH 3130

**CH 4140 - Introduction to Pharmaceutical Analysis**
This course will present a systematic introduction to chemical analysis of pharmaceutical raw materials, finished pharmaceutical products, and of drugs in biological fluids, which are carried out in pharmaceutical laboratories worldwide.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CH 2410

**CH 4190 - Current Topics in Pharmaceutical Chemistry**
Discussion of recent topics in pharmaceutical chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4210 - Instrumental Analysis**
The lecture portion of CH4212; not open to undergraduate chemistry majors.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 2212 and CH 3510(C) and CH 3511(C)

**CH 4212 - Instrumental Analysis**
Chemical instrumentation applied to organic and inorganic analysis with emphasis on chromatography and spectroscopy.
**Credits:** 5.0
**Lec-Rec-Lab:** (3-0-6)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 2212 and CH 3510(C) and CH 3511(C)

**CH 4222 - Bioanalytical Chemistry**
An overview of modern analytical and instrumental techniques with emphasis on approaches relevant to measurements in biochemistry. Theory and methods of chromatographic separation methods, biomolecule quantification and electrophoretic characterization. Error analysis and statistical treatment of data also covered.
**Credits:** 5.0
**Lec-Rec-Lab:** (3-0-6)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Major(s): Cheminformatics, Chemistry; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161) and CH 3510(C) and CH 3511(C)

**CH 4240 - Advanced Mass Spectrometry**
Advanced instrumentation and methods are the focus of this course. Design of various mass analyzers and their advantages and limitations will be reviewed. Advanced identification methods such as tandem mass spectrometric analysis and exact mass analysis will be discussed.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Co-Requisite(s):** CH 4241
**Pre-Requisite(s):** CH 4212 or CH 4222

**CH 4241 - Advanced Mass Spectrometry Laboratory**
Students will learn how to perform mass spectrometry (MS) experiments to identify and quantify molecules. The experiments will include the following method approaches: electrospray ionization (ESI), matrix associated laser desorption (MALDI) and tandem MA analysis (MS/MS).
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Co-Requisite(s):** CH 4240
**Pre-Requisite(s):** CH 4212 or CH 4222

**CH 4290 - Current Topics in Analytical Chemistry**
Discussion of recent topics in analytical chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4310 - Inorganic Chemistry I**
Descriptive chemistry of the main group elements with some emphasis on the structure and theory of bonding with transition metal complexes. Examines bonding, physical and chemical properties, structure, and reactions of the chemical elements and their compounds.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 3520

**CH 4311 - Inorganic Chemistry Laboratory**
Laboratory preparations (selected inorganic and organometallic compounds) that illustrate appropriate experimental techniques for synthesis of molecules; measurement of chemical properties, structures, and phenomena; hands-on experience with modern instrumentation; computational data analysis (by means of single crystal X-ray Diffraction experiments).
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 4310(C)

**CH 4320 - Inorganic Chemistry II**
Continuation of CH4310. Descriptive chemistry of the transition group elements. Transition metal compounds; aspects of bonding, spectra, and reactivity; complexes of p-acceptor ligands; organometallic compounds and their role in catalysis; metals in biological systems; preparative, analytical, and instrumental techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 4310

**CH 4390 - Current Topics in Inorganic Chemistry**
Discussion of recent topics in inorganic chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4412 - Spectroscopy of Organic Chemistry**
Emphasizes use of spectral data interpretation to determine structures of organic compounds. Discusses proton and carbon nuclear magnetic resonance (including two- dimensional techniques, COSY, HETCOR, etc.), mass spectrometry, infrared spectrophotometry.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 2420

**CH 4430 - Intermediate Organic Chemistry**
Develop the chemical intuition necessary for advanced work in organic chemistry. Emphasizes reaction mechanisms and why reactions occur. Topics include heteraromatic chemistry, curved-arrow formalism and multi-step reactions, molecular orbitals and symmetry-controlled reactions, Hammett equation and structure-activity relationships, substitution reactions and carbonyl reactions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 2420

**CH 4490 - Current Topics in Organic Chemistry**
Discussion of recent topics in organic chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4515 - Atmospheric Chemistry**
Study of the photochemical processes governing the composition of the troposphere and stratosphere, with application to air pollution and climate change. Covers radical chain reaction cycles, heterogeneous chemistry, atmospheric radiative transfer, and measurement techniques for atmospheric gases.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** CH 3510 or CH 3520(C) or ENVE 4501 or ENVE 4504 or CEE 4501 or CEE 4504

**CH 4516 - Aerosol and Cloud Chemistry**
This course is focused on the chemistry of atmospheric aerosols and cloud processes. Students will learn about methods for chemical characterization, the chemical composition of aerosol and the chemical reactions pertinent to secondary aerosol and cloud composition.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** CH 3510 or CH 3520 or ENVE 4501 or ENVE 4504

**CH 4519 - Transport and Transformation of Organic Pollutants**
Assessment of factors controlling environmental fate, distribution, and transformation of organic pollutants. Thermodynamics, equilibrium, and kinetic relationships are used to quantify organic pollutant, partitioning, and transformations in air, water, and sediments. Use of mass balance equations to quantify pollutant transport.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2009-2010 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** ENVE 4501 or CEE 4501(C) or CH 3510

**CH 4535 - Physical Chemistry III - Molecular Driving Forces from Fundamentals to Applications**
Advance course design to bridge concepts in thermodynamics, kinetics, and quantum chemistry through the application of statistical mechanics to understand the molecular driving forces acting in chemical/physical/material/biological systems at both microscopic, and macroscopic level.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CH 3510 and CH 3520

**CH 4560 - Computational Chemistry**
Focuses on the theory and method of modern computational techniques applied to the study of molecular properties and reactivity through lecture and computer projects. Covers classical mechanical as well as quantum mechanical approaches.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2010-2011 academic year
**Pre-Requisite(s):** CH 3520

**CH 4590 - Current Topics in Physical Chemistry**
Discussion of recent topics in physical chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4610 - Introduction to Polymer Science**
Introductory study of the properties of polymers. Includes structure and characterization of polymers in the solid state, in solution, and as melts. Topics include viscoelasticity, rubbery elasticity, rheology and polymer processing. Applications discussed include coatings, adhesives, and composites.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161)

**CH 4620 - Polymer Chemistry**
Study of polymer chemistry dealing with the mechanisms of polymerization and copolymerization. Study of the chemistry of polymers, including polymer modification and degradation. Topics include methods for measuring and predicting the path of degradation and stabilization.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 2420

**CH 4631 - Polymer Science Laboratory**
Students undertake experiments covering aspects of polymer characterization, processing, and recycling. Also included are experiments in applications such as coatings, adhesives, and composites.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year
**Pre-Requisite(s):** CH 4610(C) or CM 4610(C) or BE 4300(C) or MY 4600(C) or MSE 4110(C)

**CH 4640 - Synthesis of Nanoparticles**
This hands-on course teaches methods of preparing different types of nanoparticles, and controlling nanoparticle size, structure, and functionalization. Students will analyze selected papers from professional literature to see emerging trends in nanoparticle design and use.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-4)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CH 2410 and CH 2411

**CH 4690 - Current Topics in Polymer Chemistry**
Discussion of current topics in polymer chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4710 - Biomolecular Chemistry I**
Examines chemical concepts underlying biomolecules and bioprocesses and interconnections between biology and chemistry. Bioorganic mechanisms and biophysical concepts in biochemistry are emphasized. Topics include biomolecules including proteins and nucleic acids and bioprocesses including catalysis and gene action.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** CH 2420

**CH 4720 - Biomolecular Chemistry II**
Focuses on structural and chemical logic of bioprocesses with emphasis on bioorganic mechanisms and the interconnections between biology and chemistry. Topics include metabolic pathways, membrane biophysics, ion-channels, cell communication, transcriptional control and molecular biology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 4010 or CH 4710

**CH 4721 - Research Methods in Biomolecular Chemistry**
Lab course will emphasize the research process in biomolecular chemistry by actively involving students in question formulation, experimental design, data gathering, critical analysis, team work, and communication in an inquiry-based format. Students will employ methods used in modern biochemistry/molecular biology in a series of open-ended experiments that will lead to a student-developed original research project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-7)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (CH 4710 and CH 4222) or CH 4212 and CH 4720(C)

**CH 4730 - Confocal Laser Scanning Microscopy: Foundations, Applications, and Advances**
Principles of fluorescence microscopy, confocal microscope design, practical aspects of confocal microscopy, live cell imaging, high speed imaging, fluorescent stains, quantitative fluorescence, immunofluorescence, fluorescent proteins, biosensors. Confocal applications in biology and health related sciences will be covered.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Level(s): Graduate

**CH 4790 - Current Topics in Biochemistry**
Discussion of recent topics in biochemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**CH 4800 - Current Topics in Undergraduate Chemistry**
Covers chemistry topics not included in regular courses. Topics may include designing organic syntheses, heterogeneous catalysis, homogeneous catalysis, solid-state chemistry, and heterocyclic chemistry.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**CH 4810 - Design and Operation of a High School Chemistry Lab**
Hands-on experience in the operation of a high school chemistry laboratory. Includes the design and preparation of experiments and demonstrations, setting up and maintaining a chemical storeroom, chemical waste disposal, and safety issues. Required for certification in the ACS chemistry/education concentration. Must be accepted into the Secondary Education Program.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2013-2014 academic year
**Restrictions:** Must be enrolled in one of the following Major(s): Secondary Education
**Pre-Requisite(s):** CH 2420 and CH 2411 and CH 3020

**CH 4990 - Undergraduate Research in Chemistry**
An undergraduate research experience in which students select a literature and laboratory research problem and write a report on the work performed. The student typically signs up for 1 to 3 credits per semester; most problems require more than one semester to complete. Requires GPA of 2.50 or better.
**Credits:** variable to 6.0; Repeatable to a Max of 12
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**CH 4995 - Undergrad Research in Biochem**
Undergraduate research experience in Biochemistry where students work on independent research projects under the direction of biochemistry faculty performing research in areas of biophysics, biochemistry, and molecular biology. Instructor permission required.
**Credits:** variable to 6.0; Repeatable to a Max of 12
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

## Chemical Engineering

**CM 1000 - Introduction to Chemical Engineering**
Introduces chemical engineering as a profession using the theme of industrial chemical production. Covered concepts include process flow diagrams, unit operations, green engineering, and career opportunities. Guest speakers from industry will provide their perspectives on working as a chemical engineer.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall

**CM 2110 - Fund of Chem Engg 1**
Application of chemical engineering fundamentals to the design and analysis of chemical processes. Mass balances, energy balances, and fundamentals concepts are applied. Introduces use of Process Flowsheet Simulation Software.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151)

**CM 2120 - Fund of Chem Engg 2**
Application of mass and energy balances to common chemical engineering operations. Mass balances, energy balances, and fundamental concepts are applied to flow in piping systems, pumps, compressors and stagewise separations (distillation, absorption/desorption, and extraction). Advanced use of Process Flowsheet Simulations software.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** CM 2110

**CM 2200 - Intro Minerals and Materials**
Fundamentals of minerals processing, raw materials production, and extractive metallurgy, including primary metals production.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall

**CM 3110 - Transport/Unit Operations 1**
Develop an understanding of the processes of momentum transfer (fluid mechanics) and heat transfer. Presents the basic equations of microscopic momentum and heat transfer, along with macroscopic transport equations that can be used in engineering analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** CM 2120 and (MA 3520 or MA 3521 or MA 3530 or MA 3560) and MA 3160 and PH 2100

**CM 3120 - Transport/Unit Operations 2**
Mass transfer fundamentals applied to unit operations. Topics include Fick's Law, continuity equation with reaction and mass transfer co-efficients. Transient heat transfer and numerical solution are covered. Applications include absorption, distillation, extraction, adsorption, and membrane separations.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 3110 and CM 2120 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**CM 3215 - Transport Laboratory**
This course will be an introduction to basic laboratory methods and instrumentation used in the measurement of fluid flow, heat transfer, and mass transfer. Topics to be covered include methods of statistical data analysis, experimental design, principles of measurement and instrumentation, and technical communication.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 2120 and CM 3110(C) and (MA 3520 or MA 3521 or MA 3530 or MA 3560) and UN1015

**CM 3230 - Thermodynamics for Chemical Engineers**
First and second law applied to closed and open systems. Topics include energy conversion, power cycles, entropy and enthalpy calculations on engineering systems; property estimation for non-ideal vapors, liquids, and other substances, non-ideal multicomponent equilibria, chemical reaction equilibria.
**Credits:** 4.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** CH 3510 and MA 3160 and (MA 3520(C) or MA 3521(C) or MA 3530(C) or MA 3560(C))

**CM 3310 - Process Control**
Covers methods of analyzing the transient behavior of chemical processing systems. Develops methods of analyzing systems and system components along with the special mathematical techniques needed. These concepts are then applied to illustrate mathematical modeling of large-scale chemical processing systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MA 3520 or MA 3521 or MA 3530 or MA 3560) and PH 2200 and CM 2110 and CM 2120

**CM 3410 - Technical Communication for Chemical Engineering**
Study of the purposes, genres, and applications of technical communication in chemical engineering professions, including written, oral, visual, and graphic communication. Assignments may include memos, progress reports, procedures, memo and formal reports, research citations, and job-seeking requirements. Emphasizes organization, support, coherence, usefulness, ethics, and professionalism.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Senior
**Pre-Requisite(s):** UN 1015

**CM 3450 - Computer-Aided Problem Solving in Chemical Engineering**
The use of modern software packages in chemical engineering. Packages include spreadsheet, symbolic manipulator, chemical process calculator, statistical and modeling software. Course develops knowledge and skills in using computer tools that will complement chemical engineering courses and practice.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year
**Pre-Requisite(s):** CM 2110(C) and MA 2160

**CM 3510 - Chemical Reaction Engineering**
A study of chemical reaction engineering including design and analysis of chemical reactors, the fundamentals of chemical kinetics, and analysis of reaction rate data.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CM 2110 and CM 3110 and CM 3230(C) and (MA 3520 or MA 3521 or MA 3530 or MA 3560) and CH 2410

**CM 3825 - Sampling, Statistics, and Instrumentation**
Solids sampling theory, practice, and instrumentation for process streams. Statistics/probability as they apply to representative samples from bulk lots. Minimization of errors, proper design of sample collection and size reduction apparatus, and statistical design and analysis will be covered.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year

**CM 3830 - Mineral Processing and Extraction Laboratory**
Laboratory course covering the major mineral processing and extractive metallurgy operations, such as crushing, grinding, sampling, particulate separation processes, dewatering, and hydrometallurgical processing.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CM 2200(C) or CM 2110(C)

**CM 3979 - Alternative Energy Technologies and Processes**
This course covers a wide range of alternative energy technologies with an emphasis on chemical and biochemical processing. Technologies covered may include biofuels, solar power, fuel cells, etc.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151) and (MA 1160 or MA 1161)

**CM 4000 - Chemical Engineering Research**
An undergraduate research experience on chemical engineering topics. Students work directly with faculty members on a research project. A report (written, poster, or oral) may be required.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Level(s): Graduate

**CM 4020 - Undergraduate Research in Mineral Processing Engineering**
An undergraduate research experience on mineral processing engineering topics. Students work directly with faculty members on a research project. A report (written, poster, or oral) may be required.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Level(s): Graduate

**CM 4040 - Undergraduate Research in Biological Engineering**
An undergraduate research experience on biological engineering topics, excluding biofuels. Students work directly with faculty members on a research project. A report (written, poster, or oral) may be required.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Level(s): Graduate

**CM 4060 - Undergraduate Research in Polymer Engineering**
An undergraduate research experience on polymer engineering topics. Students work directly with faculty members on a research project. A report (written, poster, or oral) may be required.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Level(s): Graduate

**CM 4080 - Undergraduate Research in BioFuels Engineering**
An undergraduate research experience on bio-fuels engineering topics. Students work directly with faculty members on a research project. A report (written, poster, or oral) may be required.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Level(s): Graduate

**CM 4110 - Unit Operations Laboratory**
Provides a rigorous introduction to experiments focused in the unit operations of fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-6)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 3120 and CM 3215 and CM 3230 and CM 3510 and CM 4310(C)

**CM 4120 - Chemical Plant Operations Lab**
A capstone laboratory course focused on chemical manufacturing processes using the department's pilot plants. Safety, process control, teamwork, and communication skills are stressed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-6)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 3215 and CM 3310 and CM 4110

**CM 4125 - Bioprocess Engineering Laboratory**
An integrated biological process laboratory experience, including fermentation with downstream bioseparation, for the production of a purified product of potential commercial interest. Features process measurement-analysis-improvement, metabolic pathway analysis, quality assurance, and safety.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2005-2006 academic year
**Pre-Requisite(s):** CM 4710(C) or BL 3210 or BL 3310

**CM 4310 - Chemical Process Safety/Env**
A study of the technical fundamentals of chemical process safety and designing for the environment. Includes toxicology, industrial hygiene, source models, fires and explosions, relief systems, hazard identification, risk assessment, environmental fate and transport, hazardous waste generation, pollution prevention, and regulatory requirements.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** CM 3120 and CM 3230

**CM 4505 - Particle Technology**
Fundamentals of particle processing, characterization, and separation. Topics include fine particle synthesis, mineral processing, automobile recycling, contaminated soils, recyclable materials such as batteries and tires, and sludges. Covers zeta potential, particulate surface chemistry, flocculation, and dispersion.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year

**CM 4510 - Interfacial Engineering**
Examines the physics and chemistry of interfaces, and the relevance of these principles in mineral processing, petroleum, water treatment, and other engineering applications. May include liquid surfaces, electric double layer, surface forces, contact angle phenomena, surfactants, adsorption, surface energy, emulsions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** CH 3510

**CM 4610 - Introduction to Polymer Science**
Introductory study of the properties of polymers. Includes structure and characterization of polymers in the solid state, in solution, and as melts. Topics include viscoelasticity, rubbery elasticity, rheology and polymer processing. Applications discussed include coatings, adhesives, and composites.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161)

**CM 4620 - Polymer Chemistry**
Study of polymer chemistry dealing with the mechanisms of polymerization and copolymerization. Study of the chemistry of polymers, including polymer modification and degradation. Topics include methods of measuring and predicting the path of degradation and stabilization.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 2420

**CM 4631 - Polymer Science Laboratory**
Students undertake experiments covering aspects of polymer characterization, processing, and recycling. Also included are experiments in applications such as coatings, adhesives, and composites.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year
**Pre-Requisite(s):** CM 4610(C) or CH 4610(C) or BE 4300(C) or MY 4600(C) or MSE 4110(C)

**CM 4650 - Polymer Rheology**
A systematic development of the principles and applications of the science of rheology. Reviews vector and tensor mathematics and Newtonian fluid dynamics. Develops the physical and mathematical nature of stress and deformations in materials. Covers the use of theory and application of rheological equations of state.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** (CM 3110 or MEEM 3210 or ENG 3200 or MY 3110 or MSE 3110 or CE 3600 or CEE 3600) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**CM 4655 - Polymer Rheology Laboratory**
Basic techniques for acquisition of shear rheological data in torsional shear (cone-and-plate or parallel-plate) and capillary shear will be taught. Also covered will be approximate methods for obtaining elongational viscosity.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CM 4610(C) or CH 4610(C) or CM 4650(C) or BE 4300(C) or MY 4600(C) or MSE 4110(C)

**CM 4710 - Biochemical Processes**
Presents an introduction to fundamental and applied aspects of industrial biochemical processing. Topics include cell structure and composition, enzymes and their use in industry, metabolism, bioreactor analysis and design, bioseparations for product recovery, industrial application, genetic engineering concepts, and applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2005-2006 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CM 3110(C)

**CM 4740 - Hydrometallurgy/Pyrometallurgy**
Extraction and refining of metals and industrial chemicals from natural and recycled materials. Includes solution- chemistry processes (hydrometallurgy) and thermochemical processes (pyrometallurgy).
**Credits:** 4.0
**Lec-Rec-Lab:** (3-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161)

**CM 4770 - Analytical Microdevice Technologies**
Course will provide background in micro/nano-scale technologies for biomedical diagnostic applications. Includes theoretical and experimental advances in chemical, mechanical, optical, and biological analysis. Reading of news and technical articles will develop skills/knowledge to envision microdevice applications for a semester-long project led by a graduate student team member.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2012-2013 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** PH 2200

**CM 4780 - Biomanufacturing and Biosafety**
This course will give students additional tools to perform as an engineer in a biomanufacturing facility. Focus is on mammalian cell culture derived products. Federal laws and compliance of biosafety in manufacturing facilities. Process design software will be introduced.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BL 2100 or CH 4710 or CM 4040 or CM 4080 or CM 4710 or (CM 3110(C) and BL 1040)

**CM 4855 - CM Process Analysis & Design I**
Capstone technical and economic evaluations of processes and unit operations. Application of cost estimation, energy efficiency, and economic evaluation techniques. Teams analyze an existing facility, identify improvement opportunities, demonstrate the economic consequences, and recommend a course of action.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 3120 and CM3215 and CM 3230 and CM 3510 and CH 2410

**CM 4860 - CM Process Analysis & Design 2**
Process and project design principles applied to realistic problems, including project evaluation and management. Problems include safety, environmental, and operability constraints. Emphasizes the profit motive in industry and the role of the chemical engineer.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 4855

**CM 4861 - CM Design Laboratory 2**
Individual/team projects to optimize designs for new ventures with realistic constraints. Requires process synthesis, market research, economic evaluation, and risk analysis techniques. Develops skills in problem solving, critical thinking, and communication. May include the AIChE National Student Design problem.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering
**Pre-Requisite(s):** CM 4860(C)

**CM 4900 - Interdisciplinary Design 1**
Focuses on an interdisciplinary chemical engineering design project. (Senior project ready as defined by major substitutes for prerequisites)
**Credits:** variable to 3.0
**Semesters Offered:** Fall
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CM 4910 - Interdisciplinary Design 2**
Focuses on an interdisciplinary chemical engineering design project. (Senior project ready as defined by major substitutes for prerequisites)
**Credits:** variable to 3.0
**Semesters Offered:** Spring
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CM 4990 - Special Topics in CM**
Covers chemical engineering topics not included in regular courses, which may include biochemical engineering, design of biochemical reactions, composite materials, and numerical analysis of transport processes.
**Credits:** variable to 3.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

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## Construction Management

**CMG 1000 - Introduction to Construction Management**
Introduction to the construction management profession, and current issues and trends in residential and commercial construction industries. Focuses on how the construction industry works, along with enhancing verbal, CAD, and print reading skills.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Freshman, Sophomore

**CMG 1140 - Basic Construction Materials**
Covers properties and behavior of basic construction materials, including wood, metals, aggregates, asphalt, concrete, and composites. Laboratory exercises include field testing techniques, materials standards, report writing, and presentation of data.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring

**CMG 1200 - Introduction to Building Information Modeling**
An introduction to Building Information Modeling (BIM) with an emphasis on the Autodesk Revit software.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Spring

**CMG 2110 - Building Utility Systems**
Overview of the mechanical, electrical, and plumbing components of building systems. HVAC systems and controls, water supply and drainage, electrical power distribution and lighting, fire detection, alarm, and communications. Includes construction drawing interpretation and design projects.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PH 1240(C)

**CMG 2120 - Statics and Strengths of Materials for Construction**
Composition and resolution of forces and force systems, principles of equilibrium applied to various bodies, simple structures, friction, centroids, and moments of inertia. Mechanical behavior of materials, including calculation of stresses, strains, and deformations due to axial, torsional, and flexural loading.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 1110 or PH 1140

**CMG 2140 - Building Materials & Methods**
Materials, structural systems, building codes, and management procedures appropriate for residential and commercial construction. Includes construction drawing interpretation and graphic design project.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CMG 1140

**CMG 2265 - Construction Quantity Survey**
An introduction to the interpretation of construction drawings to perform quantity take-offs. Emphasis is on the civil and architectural components of building construction, with some discussion of other elements.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Pre-Requisite(s):** CMG 1000 and CMG 1140

**CMG 3200 - Site Planning and Development**
An examination of land development issues including: site analysis, environmental concerns, contouring, earthwork and grading, soils, route alignments, storm water management, sewer systems, zoning, and land planning. Incorporates CAD applications in the lab.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SU 2000

**CMG 3250 - Structural Analysis and Design**
Elastic theory analysis and design of steel structural components, including tension, compression, truss frames, flexural beams, and connections. Includes an introduction to reinforced concrete structures and timber. All work is according to current applicable code manuals. Design projects include computer applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** CMG 2120 or MET 2120

**CMG 3265 - Construction Cost Estimating**
Advanced study of construction cost estimating topics. Includes conceptual estimating, unit price development, subcontract work, budgets, negotiated contracts, and related items. Extensive use of spreadsheets and estimating.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** CMG 2265

**CMG 4000 - Design-Build Project Delivery**
Professional practice, financial, legal, and ethical considerations in construction management are illustrated and discussed in the context of the design-build delivery system.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** CMG 3200(C)

**CMG 4100 - Construction Equipment Management**
Study of basic principles used in the construction industry for selecting and managing construction equipment. Focuses on understanding the time value of money, estimating equipment ownership and operating costs, selecting the proper equipment for specific tasks, and estimating equipment production.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** CMG 3265 and EC 3400

**CMG 4120 - Construction Planning and Scheduling**
This course will introduce students to the basics of construction scheduling. Topics covered will include: Fundamentals of different scheduling methods such as Critical Path Method and linear scheduling. Resource allocation in schedules, and Schedule monitoring and control methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** CMG 3265 or CE 3332 or CEE 3332

**CMG 4200 - Construction Contracts**
Legal aspects of construction to include a study of construction documents, the project manual, report requirements, agreements, change orders, and other administrative functions in building construction.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** BUS 2200

**CMG 4210 - Construction Project Management**
Provides students with an understanding of the principles required to deliver a construction project on time, within budget, and with acceptable quality. Topics include construction law, contracts, delivery systems, jobsite layout and control, submittals, record keeping, subcontracting and purchasing, quality management, change orders, claims, and dispute resolution.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** CMG 4200

**CMG 4300 - Construction Finance and Accounting**
Focuses on the principles of accounting and financial management needed to make construction projects and companies financially successful. Includes profitability, projecting costs, cash flow and cash requirements, and equipment costs.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** ACC 2000 and EC 3400

**CMG 4400 - Construction Safety Management**
Provides an awareness and understanding of workplace safety practices. Emphasis on the construction industry, including the OSHA construction regulations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**CMG 4800 - Sustainable Construction**
An introduction to the philosophy and practice of sustainable building construction with emphasis on underlying socio-environmental philosophies, sustainable directed building technologies and materials, and case studies of contemporary green buildings to culminate in a simple sustainable design project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**CMG 4900 - Construction Project Simulation**
Capstone course. Integrates all aspects of the construction management process. Students will explore the responsibilities of the construction manager and consider project management issues through semester-long simulated construction projects (commercial and design-build). Includes oral and written report components.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Construction Management; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** CMG 3200 and CMG 3250 and CMG 4120(C) and CMG 4210 and HU 3120

**CMG 4996 - Special Topics in Construction Management**
Selected additional topics of interest in Construction Management based on student and faculty demand and interest. May be a tutorial, seminar, workshop, project, or class study.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Construction Management; Must be enrolled in one of the following Class(es): Senior

**CMG 4997 - Independent Study in Construction Management**
Independent study of an approved topic under the guidance of a Construction Management faculty member. May be either an academic, design or research problem/project.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Construction Management; Must be enrolled in one of the following Class(es): Senior

**CMG 4998 - Undergraduate Research in Construction Management**
An undergraduate research experience in Construction Management. Under the guidance of a Construction Management faculty member, students work on a selected/approved research problem or work directly with faculty on active research projects/grants. May require more than one semester to complete.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Construction Management; Must be enrolled in one of the following Class(es): Senior

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## Computer Science

**CS 1000 - Explorations in Computing**
An introduction to the study of computing: fundamental concepts and skills; opportunities at Michigan Tech; career opportunities; social and ethical issues.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Software Engineering, Computer Science, Computer Systems Science, Computer Engineering, Electrical Engineering; Must be enrolled in one of the following Class(es): Freshman

**CS 1040 - Assembly Language Programming**
Programming in assembly language. Includes integer floating point, and instruction encoding in binary. Transition course for only those students affected by credit change in CS1141/3421.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CS 1122 or CS 1131

**CS 1090 - Special Topics in Computer Science**
Special topics in computer science offered on occasion based on student and faculty demand and interest.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**CS 1111 - Introduction to Programming in C/C++**
Introductory course in C/++ programming. Topics include top-down analysis of problems, structured programming, control structures, functions, arrays, pointers, and file I/O. Basic concepts of object-oriented programming (classes, objects, function overloading) will also be introduced.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Industrial Technology, Computer Network & System Admn, Electrical Engineering, Audio Production & Technology; Must be enrolled in one of the following Class(es): Freshman, Sophomore

**CS 1121 - Introduction to Programming I**
Starting point of the computer science programs. A high-level, object-oriented programming language is introduced as a problem-solving tool. Topics include design, coding, documentation, debugging, and testing of programs. Programming assignments are given in both a closed lab setting and as homework.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C)

**CS 1122 - Introduction to Programming II**
Continuation of CS 1121. Topics include data abstraction, class hierarchies and polymorphism, list, stack, queue and tree data structures, complexity-based algorithm and data structure choices, and recursion. Homework programming assignments are given.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CS 1121

**CS 1131 - Accelerated Introduction to Programming**
An alternative starting point of the computer science programs for students with some programming experience, combining material from CS1121 and CS1122, offered at an accelerated pace. Homework programming assignments are given.
**Credits:** 5.0
**Lec-Rec-Lab:** (0-4-2)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required
**Pre-Requisite(s):** MA 1031 or MA 1032 or MA 1160(C) or MA 1161(C)

**CS 1142 - Programming at the Hardware Software Interface**
Programming in assembly language and C for students with prior experience in Java. Topics include binary number encodings, instruction set architecture, assembly language programming, and instruction encodings. C programming topics include program structure, preprocessor, arrays, structures, pointers, input/output, dynamic memory management, and linked data structures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CS 1122 or CS 1131

**CS 2090 - Special Topics in Computer Science**
Special topics in computer science offered on occasion based on student and faculty demand and interest.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**CS 2311 - Discrete Structures**
Presents fundamental concepts in discrete structures that are used in computer science. Topics include sets, trees, graphs, functions, relations, recurrences, proof techniques, logic, combinatorics, and probability.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (CS 1121 or CS 1131) and (MA 1135 or MA 1160 or MA 1161)

**CS 2321 - Data Structures**
Presents fundamental concepts in data structures. Topics include abstract data types (priority queues, dictionaries and graphs) and their implementations, algorithm analysis, sorting, text processing, and object oriented design. A significant programming project is assigned.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CS 1122 or CS 1131

**CS 3000 - Ethical and Social Aspects of Computing**
An examination of social and ethical issues associated with computing. Topics include: ethical theories and decision making, intellectual property, freedom of expression, privacy, security, and professional responsibility.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** CS 3141

**CS 3090 - Special Topics in Computer Science**
Special topics in computer science offered on occasion based on student and faculty demand and interest.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**CS 3141 - Team Software Project**
This course introduces software design techniques (e.g., Design-By-Contracts), uses the UML for requirements and design specification, and requires implementation, unit testing and documentation in the context of a significant team project. Other topics: teamwork, user interfaces, social and professional responsibility.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** (CS 2311 or MA 3210) and CS 2321

**CS 3311 - Formal Models of Computation**
Introduction to the theory of formal languages and computation. Topics include regular languages and finite automata, context-free languages and push-down automata, Turing-acceptable languages, Turing machines and the halting problem. Proof techniques and applications, such as parsing, are also treated.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CS 2311 or MA 3210

**CS 3331 - Concurrent Computing**
Concepts and techniques in concurrent computing. Topics include: processes and threads, mutual exclusion, semaphores, monitors and condition synchronization, deadlock, safety and liveness, message passing, and concurrent architectures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** CS 1142 or (CS 1141 and CS 1040) and (CS 2311 or MA 3210) and CS 2321

**CS 3411 - Systems Programming**
Development of robust programs that provide efficient services to system software developers. Topics include: file I/O, process creation and management, linking and libraries, interprocess communication, performance measurement, and socket programming.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CS 3421

**CS 3421 - Computer Organization**
Introduction to the logical structure of computers, including the fundamentals of logic design, information storage and manipulation, control, and input/output. Topics include a review of current hardware technology, combinational and sequential logic, arithmetic, datapaths, hard-wired control, interrupts, caches, virtual memory, and an introduction to pipelining.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (CS 1141 and CS 1040) or CS 1142

**CS 3425 - Introduction to Database Systems**
This course provides an introduction to database systems including database design, query, and programming. Topics include goals of database management; data definition; data models; data normalization; data retrieval and manipulation with relational algebra and SQL; data security and integrity; database and Web programming; and languages for representing semi-structured data.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** (CS 2311 or MA 3210) and CS 2321

**CS 3712 - Software Quality Assurance**
Practices for ensuring quality through the software process. Topics include: requirements elicitation, analysis and documentation, testing, and quality assurance management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CS 3141

**CS 4090 - Special Topics in Computer Science**
Special topics in computer science offered on occasion based on student and faculty demand and interest.
**Credits:** variable to 4.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**CS 4099 - Directed Study in Computer Science**
Students study one or more special topics in computer science under the direction of one or more faculty members.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**CS 4121 - Programming Languages**
A discussion of the concepts underlying programming languages. Topics include programming paradigms; language properties (including syntax, semantics, run-time behavior, and implementation issues); data, procedure, functional, and control abstraction; functional programming; and logic programming.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** CS 2321 and CS 3421 and CS 3311

**CS 4130 - Compiler Design and Optimization**
Design, theory, and programming language translators and the theory and implementation of optimizers. Topics include: intermediate representations, advanced code generatin, control-and data-flow analysis, advanced compiler optimization, dynamic compilation, global register allocation and instruction scheduling.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CS 4121

**CS 4321 - Introduction to Algorithms**
Fundamental topics in algorithm design, analysis, and implementation. Analysis fundamentals include asymptotic notation, analysis of control structures, solving recurrences, and amortized analysis. Design and implementation topics include sorting, searching, and graph algorithms. Design paradigms include greedy algorithms, divide-and-conquer algorithms, and dynamic programming.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (CS 2311 or MA 3210) and CS 2321

**CS 4411 - Operating Systems**
Principles of the design and implementation of operating systems. Topics include: process management, process scheduling, memory management, I/O, file systems. Includes a significant implementation component.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CS 3331 and CS 3421

**CS 4425 - Database Management System Design**
This course covers the design issues concerning the implementation of database management systems, including distributed databases. The topics include data storage, index implementation, query processing and optimization, security, concurrency control, transaction processing, and recovery.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** CS 3425

**CS 4431 - Computer Architecture**
Advanced course in architecture of high-performance computer systems. Topics include instruction-set design, simulation of processor architectures, multiple functional units, pipelining, dynamically scheduled pipelines, speculative execution, multi-core and multi-processor systems, advanced I/O subsystems and analytic models of architectural features of processors.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** CS 3421

**CS 4461 - Computer Networks**
Computer network architectures and protocols; design and implementation of datalink, network, and transport layer functions. Introduction to the Internet protocol suite (TCP, UDP, IP), domain name service and protocols, file sharing protocols, wireless networks, and network security.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** CS 3411

**CS 4471 - Computer Security**
Development and administration of secure software systems. Topics include principles of software development, practical cryptography, program security, operating system security, database security, administration, legal and ethical issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CS 3411 or CS 4411

**CS 4496 - GPU and Multicore Programming**
Introduction to Graphics Processing Units (GPU) and multi-core systems, their architectural features and programming models, stream programming and compute unified driver architecture (CUDA), caching architectures, linear and non-linear programming, scientific computing on GPUs, sorting and search, stream mining, cryptography, and fixed and floating point operations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** CS 3411 and CS 3421

**CS 4611 - Computer Graphics**
Introduction to interactive computer graphics. Topics include 3D viewing, 3D transformation, interactive techniques, animation, modeling, lighting, texturing, vertex programs, fragment programs, and graphics algorithms. Requires substantial programming homework.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (CS 1141 or CS 1142) and CS 2321 and MA 2330

**CS 4710 - Model-Driven Software Development**
Focuses on the use of formal models throughout the software development life cycle. Topics include formal specification of requirements, behavioral modeling, automated analysis, architectural styles and design specification.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** CS 3311 and CS 3141(C)

**CS 4711 - Software Processes and Management**
Focuses on the software development process and related management issues. Topics include software process models, the Capability Maturity Model, process tools, use of standards, software maintenance, configuration management, project planning and tracking, team management, and measurement and estimation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CS 3141

**CS 4750 - Teaching Methods in Computer Science**
Provides teaching methods, models, and experiences for teaching computer science in secondary schools. Topics discussed include teaching methods, learning, security and maintenance of equipment, professional journals, ethics, legal issues, diversity, and problem solving. Requires admission to the Teacher Education Program.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** ED 4700

**CS 4760 - Human-Computer Interactions**
Principles of user interfaces (UI) design and implementation. Topics include: UI theory, design principles, evaluation, and tools. Requires completion of a group project implementing and evaluating a UI.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CS 3141

**CS 4791 - Senior Software Engineering Project I**
A capstone project course. Using software engineering principles and techniques, students work as part of a team responsible for developing a quality software project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-4)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** CS 3712 or CS 4760

**CS 4792 - Senior Software Engineering Project II**
A continuation of the capstone project experience, intended for Software Engineering majors.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-4)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** CS 4791

**CS 4811 - Artificial Intelligence**
Fundamental ideas and techniques that are used in the construction of problem solvers that use Artificial Intelligence technology. Topics include knowledge representation and reasoning, problem solving, heuristics, search heuristics, inference mechanisms, and machine learning.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CS 2321 and CS 3311

**CS 4821 - Data Mining**
Data mining focuses on extracting knowledge from large data sources. The course covers data mining concepts, methodology (measurement, evaluation, visualization, etc.), algorithms (classification/regression, clustering, association rules, etc.), and applications (web mining, recommender systems, bioinformatics, etc.).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** (CS 3425 or MIS 3100) and (MA 2330 or MA 2320 or MA 2321) and (MA 2710 or MA 2720 or MA 3710)

## Economics

**EC 2001 - Principles of Economics**
An introduction to economics. The microeconomics portion covers consumer choice, the firm, value and price theory, and distribution theory. The macroeconomics portion covers national income analysis, fiscal policy, money and monetary policy, the commercial banking system, and the Federal Reserve System.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1020 or MA 1031 or MA 1032 or MA 1135(C) or MA 1160(C) or MA 1161(C)

**EC 3002 - Microeconomic Theory**
The study of consumer and producer choices, market demand and supply, and market structures.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EC 2001 and (MA 1135 or MA 1160 or MA 1161) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 3003 - Macroeconomic Theory**
Analysis of the determinants of the level of output, employment, prices, and economic growth with an emphasis on fiscal policy and monetary policy.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EC 2001 and (MA 1135 or MA 1160 or MA 1161) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 3100 - International Economics**
Introduction to international economics, including balance of payments, accounting, foreign exchange markets, international trade theory, barriers to trade, trade and development, regional economic integration, and current U.S. international economic issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 3300 - Industrial Organization**
Economic analysis of market power and industry structure. Topics include the goals of public policy toward business, antitrust policy, economic regulation, public enterprise, and social regulation of health, safety, and the environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 3400 - Economic Decision Analysis**
Studies economic decision-making for actions occurring over time. Covers decision tools for comparing alternatives, public project evaluation, risk and uncertainty, mutually exclusive decisions, multiple objective decisions, interest rate calculations, cash flow analysis, depreciation and taxes, cost of capital, capital budgeting.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Finance, Operations and Systems Mgmnt, Management Information Systems, Marketing, Accounting, Management; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4000 - Senior Seminar in Economics**
A senior capstone seminar in which students discuss and conduct research under the guidance of several faculty members.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Economics; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**EC 4050 - Game Theory/Strategic Behavior**
The study of strategic situations involving the interactions of individuals. Modeling techniques are applied to game situations faced in business, entertainment, politics, and the daily routine of life.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4100 - Mathematical Economics**
Application of the principal mathematical techniques used in economic theory and modeling. Topics include optimization, marginal analysis, comparative statics, and other applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (EC 3002 or EC 3003) and (MA 1160 or MA 1161 or MA 1135)

**EC 4200 - Econometrics**
Introduces techniques and procedures to estimate and test economic and financial relationships developed in business, economics, social and physical sciences.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (EC 2001 or EC 3002 or EC 3003) and (BUS 2100 or MA 2710 or MA 2720 or MA 3710) and (MA 1135 or MA 1160 or MA 1161)

**EC 4400 - Banking and Financial Institutions**
Analysis of asset and liability management of financial institutions and the role of financial institutions in the U.S. and international economy.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** (EC 3003 or FIN 3000) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4500 - Public Sector Economics**
Economic analysis of how democratic governments generate revenue (primarily taxation) and make expenditure decisions and how such decisions impact the welfare of individuals. Topics include market failures, voting processes, income redistribution programs, efficiency and incidence of taxation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4620 - Energy Economics**
Introduction to the institutional, technical, and economic issues of the production and use of energy resources, including petroleum, natural gas, coal, nuclear, electric utilities, and alternative energy. Coursework applies economic analysis to supply, distribution, and use of energy resources, including environmental and social consequences.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4630 - Mineral Industry Economics**
Studies the role of minerals and metals in society and the economics of their use. Applies economic principles to examine the supply, demand, markets, and foreign trade for important minerals and metals. Examines the effect of government policies on the minerals industries. Requires a technical report.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4640 - Natural Resource Economics**
Studies the economics of nonrenewable resources (energy and minerals) and renewable resources (water, fisheries, forests and species). Discusses the economics of land use change, macroeconomic topics such as economic growth, sustainability and green accounting.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (EC 2001 or EC 3002 or FW 4080) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4650 - Environmental Economics**
Considers the efficient and equitable use of environmental resources, including air, water, land, wilderness and parks, wildlife and other ecological systems. Measures the benefits and costs of decreasing pollution, cleaner environment, and protecting scarce ecological resources. Addresses market failures and the economic valuation of environmental amenities.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (EC 2001 or EC 3002) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4710 - Labor/Human Resource Economics**
Economic analysis of labor markets and human resources. Topics include the supply and demand for labor, wage determination, human capital theory, returns to education and training, causes of wage differentials, and economic effects of discrimination.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**EC 4900 - Research**
Under the general guidance of a faculty member, students read, conduct research, and prepare reports and papers as required.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Pre-Requisite(s):** EC 2001

**EC 4990 - Special Topics in Economics**
Economic topics of interest to students and faculty.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Pre-Requisite(s):** EC 2001

## Education

**ED 2000 - Issues in American Education**
Introduction to schooling in the United States. Emphasis on history, role of education in social reproduction and transformation, laws, and the work of teaching, as these pertain to issues of social justice.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**ED 2010 - Field Study in Education: Elementary School**
Observations in an elementary school, offering relevant school experience to help clarify career goals.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**ED 2020 - Field Study in Education: Secondary School**
Observations in a secondary school, offering relevant school experience to help clarify career goals.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**ED 3210 - Foundations of Education**
Contemporary issues in education from historical, philosophical, sociological and legal perspectives. Emphasizes the structure/function of U.S. education as well as exceptional children, especially the handicapped and culturally different. This course is one component of the Teacher Education Early Block. Requires admission to teacher education program.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Co-Requisite(s):** ED 3410, ED 4110

**ED 3410 - Clinical Experience**
Observation, tutoring and classroom teaching in an area school classroom. This course is one component of the Teacher Education Early Block. Requires admission to the Teacher Education program.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Co-Requisite(s):** ED 3210, ED 4110

**ED 3510 - Communicating Science I**
Students design hands-on presentations for K-8 students and their parents at family science nights conducted at area schools and other events in a 4-county area (off campus 4:30-9:00PM). The course highlights presentation skills, teaching techniques, learning styles, and classroom management.
**Credits:** 3.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**ED 3511 - Communicating Science II**
Students will make presentations in local K-8 classrooms and/or at evening family science nights conducted at area schools. Classroom lectures will highlight the rationale for interacting with schools and communities as a professional, presentation skills, effective teaching techniques, learning styles, classroom management techniques, and model hands-on learning techniques.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** On Demand

**ED 4020 - Methods of Teaching Social Studies**
Application of learning and instructional theories and practice to the teaching of social studies. Emphasis will include application of state and national education standards and relevant assessment strategies for social studies. Requires admission to the Teacher Education program by the Department of Education.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required
**Pre-Requisite(s):** ED 4700(C)

**ED 4110 - Psychological Foundations of Learning**
The course examines how human beings grow and learn with major emphasis on the early adolescent and adolescent. Psychological basis of educational procedures and practices are established with special reference to learning disorders, gifted children, and culturally diverse classrooms.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**ED 4140 - Methods of Teaching English**
Application of learning theories and national and state professional standards to the teaching of English. Emphasizes methods, materials, and media used to teach adolescents. Requires admission to teacher education program or permission of instructor.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required
**Pre-Requisite(s):** ED 4700(C)

**ED 4150 - Literacy in the Content Areas**
An introduction to the best ways to use language for deepening comprehension and understanding of all the content areas. Includes inquiries into how cultural and learning differences relate to comprehension. A minimum of 28 tutoring hours in a local school is required.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-1)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ED 4110 and ED 3210 and ED 3410

**ED 4300 - Instructional Technology**
Provides the development of knowledge and skills required to make use of information and communication technologies as instructional tools. Use of instructional technology will be considered within a context of relevant research and theory pertaining to human learning.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Co-Requisite(s):** ED 4700

**ED 4510 - Special Topics in Education**
Students identify and develop an in-depth examination of current topics in education for further research and study. Working in consultation and agreement with select faculty, students engage in active inquiry on leading educational issues.
**Credits:** variable to 6.0; Repeatable to a Max of 9
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required

**ED 4700 - Fundamentals of Instruction**
Study of key areas of instruction in preparation for student teaching. Emphasis is placed on lesson planning, classroom management, and student assessment and evaluation. Requires admission to the teacher education program by the Department of Education.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Co-Requisite(s):** ED 4300
**Pre-Requisite(s):** ED 4110 and ED 3210 and ED 3410

**ED 4720 - Methods of Teaching Science**
Application of learning and instructional theories to the teaching of science.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** ED 4700(C)

**ED 4910 - Directed Teaching**
Knowledge of human growth and learning theories, methods and materials, and individual differences applied to classroom settings conducted under the supervision of an experienced middle or secondary school teacher. Requires admission to teacher education program.
**Credits:** 12.0
**Lec-Rec-Lab:** (0-0-36)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** ED 4300 and ED 4700 and (ED 4720 or HU 4140 or SS 4020(C) or MA 4905)

## Electrical & Computer Engineering

**EE 1110 - Essential Mathematics for Electrical Engineering**
Review of basic trigonometry, sinusoidal signals, amplitude, frequency and phase, addition of sinusoids. Complex numbers and complex arithmetic. Real exponential functions, complex exponentials, Euler's relations, decaying sinusoids and complex exponential functions. Differentiation and integration of sinusoids and exponentials.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MA 1160 or MA 1161

**EE 1111 - Introduction to Electrical and Computer Engineering**
A half-semester course intended to provide an introduction to the profession of Electrical Engineering and Computer Engineering freshman or sophomore students. The goals of this course are to provide perspective into the various subareas within ECE and highlight the technical, professional, and ethical behavior expected of the graduate.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering; Must be enrolled in one of the following Class(es): Freshman, Sophomore

**EE 2111 - Electric Circuits I**
This course will cover basic electrical concepts, resistive circuits, nodal and loop analysis techniques, superposition, Thevenin and Norton equivalents, maximum power transfer, capacitance and inductance, AC steady-state analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EE 1110(C) and MA 2160

**EE 2112 - Electric Circuits II and Lab**
This course will cover second order transient circuits, magnetically coupled networks, AC steady-state analysis, polyphase circuits, variable frequency network performance, and two port networks.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EE 1110 and EE 2111 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**EE 2174 - Digital Logic and Lab**
Introduces analysis, design, and application of digital logic. Includes Boolean algebra, binary numbers, logic gates, combinational and sequential logic, storage elements and hardware-description-language based synthesis.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EET 2241 or EE 2241 or CS 1121 or CS 1131 or CS 1111

**EE 3010 - Circuits and Instrumentation**
Designed for nonmajors. Covers the principles of electrical and electronic measurements, including dc, ac, semiconductor devices, amplifiers, and filtering.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering

**EE 3120 - Electric Energy Systems**
An overview of the generation and utilization of electrical energy. Covers three-phase circuits, transformers, photovoltaics, batteries, electromechanical energy conversion, and an overview of electric power systems, including economic issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EE 2110 or EE 3010 or (EE 2111 and EE 2112(C))

**EE 3131 - Electronics**
Covers the fundamentals of electronic devices and circuits; operational amplifiers, bipolar junction transistors, diodes, and MOSFETs.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EE 2112 or EE 3010

**EE 3140 - Electromagnetics**
Covers basic principles of engineering electromagnetics with an emphasis on Maxwell's equations.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** PH 2200 and MA 3160 and (EE 2110 or EE 2112)

**EE 3160 - Signals and Systems**
Introduces the mathematical analysis of signals, systems, and control. Topics include differential equations, Fourier series, Fourier transforms, LaPlace transforms, frequency response, Bode plots, state models, and an introduction to control systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (EE 2110 or EE 2112) and (MA 2320 or MA 2321 or MA 2330) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**EE 3171 - Microcontroller Applications**
Introduces the concepts of microcontroller-based systems. Describes basic characteristics of microcontrollers, then goes into significant detail in the applications of a specic microcontroller. Topics include C and assembly language programming, instruction set interface, ASICs, and polled, interrupt, and DMA input/output.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Computer Engineering
**Pre-Requisite(s):** (EE 2241 or CS 1121 or CS 1111) and (EE 2174 or EE 2173)

**EE 3173 - Hardware/Software System Integration**
Covers the integration of hardware and software into a complete working system. Includes design and construction of I/O devices for microprocessor or microcontroller-based systems, communication and bus protocols, programming in assembler language and in "C", system integration and testing. Also covers the use of FPGAs and HDL design tools.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering
**Pre-Requisite(s):** (EE 2304 or EE 2174) and (EE 3130 or EE 3131) and (CS 1111 or CS 1142 or CS 2141) and CS 3421 and (MA 3710 or EE 3180)

**EE 3180 - Introduction to Probability and Random Signal Analysis**
Probability density and distribution functions, expected value, correlation, and random vectors. Wide sense stationary random signals. The correlation function and spectral density. Random signals and noise in linear systems. An introduction to hypothesis testing and parameter estimation. Engineering applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EE 3160

**EE 3190 - Optical Sensing and Imaging**
Optical sensing techniques, including imaging and non-imaging systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MA 3520 or MA 3521 or MA 3530 or MA 3560

**EE 3250 - Introduction to Communications Theory**
Introduction to communications systems and theory; fundamentals of point-to-point communication link design and analysis; analog modulation and demodulation techniques; digital signal representation and filtering; binary data transmission.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** EE 3131 and EE 3160 and EE 3180

**EE 3261 - Control Systems**
Mathematical formulation of control problems (both transfer function and state-variable descriptions); analysis of feedback control systems (stability, transient performance, steady-state error, sensitivity, etc.); analog and digital simulation; and experiments with physical systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** EE 3160

**EE 3290 - Photonic Material, Devices, and Applications**
Light wave propagation in optical crystals and fibers, detection, and the creation of light in semiconductors.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Engineering, Physics, Applied Physics, Physics (BA), Biomedical Engineering, Materials Science and Engrg; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** EE 3140 or EE 3090 or PH 2400

**EE 3373 - Introduction to Programmable Controllers**
The design of discreet sequential controls using programmable logic controllers (PLCs). Relay logic is used to introduce ladder logic and ladder logic is used to program the PLC. Introduces a structured approach to sequential control design. Data acquisition is introduced using BridgeVIEW software
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering
**Pre-Requisite(s):** EE 2110 or EE 2112 or EE 3010

**EE 3901 - Design Fundamentals**
The design process; includes team design activities and studies project management, ethics, and professionalism.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** EE 3131(C) and UN 1015

**EE 4000 - Undergraduate Research**
An undergraduate research experience during the senior year in electrical or computer engineering. Students work on an active research project/grant with a faculty member. A report will be published in the department and archived.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Junior, Senior

**EE 4173 - Computer System Engineering and Performance**
Covers the principles and practices of modern computer architecture. Emphasizes quantitative performance evaluation of: memory hierarchies, from cache through virtual memory; pipelined processors with advanced hazard management; and combined processor/memory systems. Introduces RAID, superscalars, parallel processing, cache coherence, performance simulation software.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Engineering
**Pre-Requisite(s):** CS 3421 and EE 3173

**EE 4219 - Introduction to Electric Machinery and Drives**
Provides a thorough understanding of how electric machines can be used to drive loads with control of speed, torque and position. Topics include basic electro-mechanics, rotating machinery, dc machines, ac machines, power electronics and load modeling. Applications include industrial systems, hybrid/electric vehicles and electric power systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 2110 or EE 2112 or EE 3010

**EE 4220 - Introduction to Electric Machinery and Drives Laboratory**
Provides a hands on understanding of how electric machines can be used to drive loads with control of speed, torque, and position. Topics include basic electro-mechanics, rotating machineer, dc machines, ac machines, power electronics, and load modeling.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 4219(C)

**EE 4221 - Power System Analysis 1**
Covers power transmission line parameters and applications, symmetrical components, transformer and load representations, systems faults and protection, and the per unit system.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EE 3120 and (EE 2112 or EE 2110)

**EE 4222 - Power System Analysis 2**
Topics covered include symmetrical components; symmetrical faults; unbalanced faults; generating the bus impedance matrix and using it in fault studies; power system protection; power system operation; power system stability.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 4221

**EE 4226 - Power Engineering Laboratory**
A laboratory based course highlighting single phase and three phase power concepts, including: power factor, single and three phase transformer configurations, non-ideal transformers, synchronous machines, renewable energy, power flow and fault simulations, relay settings and relay testing and calibration.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring, Summer
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** EE 4221 and EE 4222(C)

**EE 4227 - Power Electronics**
Fundamentals of circuits for electrical energy processing. Covers switching converter principles for dc-dc, ac-dc, and dc-ac power conversion. Other topics include harmonics, pulse-width modulation, feedback control, magnetic components and power semiconductors.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** EE 3120 and (EE 3130(C) or EE 3131)

**EE 4228 - Power Electronics Lab**
Fundamentals of design, construction and control of circuits for electrical energy processing. Covers switching converter principles for dc-dc, ac-dc, and dc-ac power conversion. Other topics include harmonics, pulse-width modulation, feedback control, magnetic components and power semiconductors.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EE 4227(C)

**EE 4231 - Physical Electronics**
Device physics and physical models of the most basic solid-state device structures. Major topics include the terminal characteristics and their physical origin, device design, and device applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** EE 3130 or EE 3131

**EE 4232 - Electronic Applications**
Study of electronic circuits under small- and large-signal conditions. Typical topics include analysis and design of power and RF amplifiers, feedback circuits, oscillators, timing circuits, and wave-shaping circuits.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 3130 or EE 3131

**EE 4240 - Introduction to MEMS**
Fundamentals of micromachining and microfabrication techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are central to MEMS fabrication.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-1-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**EE 4252 - Digital Signal Processing and its Applications**
Digital signal processing techniques with emphasis on applications. Includes sampling, the Z-transform, digital filters and discrete Fourier transforms. Emphasizes techniques for design and analysis of digital filters. Special topics may include the FFT, windowing techniques, quantization effects, physical limitations, image processing basics, image enhancement, image restoration and image coding.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EE 3160

**EE 4253 - Real Time Signal Processing**
Practical implementation of digital signal processing concepts as developed in EE4252. Emphasis on applications of DSP to communications, filter design, speech processing, and radar. Laboratory provides practical experience in the design and implementation of DSP solutions.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 4252

**EE 4262 - Digital and Non-linear Control**
Introduction to state space analysis and design (state feedback, observers, and observer feedback); digital control system design and analysis (Z-transforms, difference equations, the discrete-time state model, and digital implementation of controllers); introduction to nonlinear systems (equilibrium states, linearization, phase plane analysis, and describing function analysis); and experiments with physical systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 3261

**EE 4271 - VLSI Design**
Design of VLSI circuits using CAD tools. Analysis of physical factors affecting performance.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** EE 3131 and EE 2174

**EE 4272 - Computer Networks**
Computer network architectures and protocols; design and implementation of datalink, network, and transport layer functions. Introduction to the Internet protocol suite (TCP, UDP, IP), domain name service and protocols, file sharing protocols, wireless networks, and network security.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CS 3411

**EE 4290 - Optical Communication**
Fundamentals of fiber optics communications, including sources, transmission media, detectors, signal processing, and networking.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Engineering
**Pre-Requisite(s):** EE 3291

**EE 4295 - Introduction to Propulsion Systems for Hybrid Electric Vehicles**
Hybrid electric drive vehicle analysis will be developed and applied to examine the operation, integration, and design of powertrain components. Model based simulation and design is applied to determine vehicle performance measures in comparison to vehicle technical specifications. Power flows, losses, energy usage, and drive quality are examined over drive-cycles via application of these tools.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MEEM 2200 or ENG 3200

**EE 4296 - Experimental Studies in Hybrid Electric Vehicles**
Hands-on course examines hybrid electric vehicles from an energy perspective. Topics include powertrain architecture, vehicle testing, fuel consumption, aerodynamics and rolling resistance, engines, batteries, electric machines and power electronics. Course culminates with study of system interactions with emphasis on idle reduction and regenerative braking.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**EE 4373 - Advanced Programmable Controllers**
Using Allen Bradley Micro Logix, SLC500, and PLC-5 programmable controllers, course covers structured programming, Sequential Function Charts, networking, proportional integral differential control, data acquisition and interfacing. The labs will require students to write and troubleshoot complex PLC programs.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** EE 3373

**EE 4411 - Engineering Electromagnetics**
A mathematically rigorous study of dynamic electromagnetic fields, beginning with Maxwell's equations. Topics include scalar and vector potentials, waves, and radiation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EE 3140

**EE 4490 - Laser Systems and Applications**
Survey of laser types and analysis of common physical and engineering principles, including energy states, inversion, gain, and broadening mechanism from a quantum mechanical perspective. Laser applications and laser properties are explored in the laboratory portion.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 3140

**EE 4723 - Network Security**
Learn fundamental of cryptography and its application to network security. Understand network security threats, security services, and countermeasures. Acquire background knowledge on well known network security protocols. Address open research issues in network security.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EE 4272 or CS 4461

**EE 4737 - Embedded System Interfacing**
Covers the use of low-power microcontrollers and hardware- dependent C for embedded sensing and control systems. Emphasizes direct interfacing with analog and digital sensors and actuators of several different modalities, to implement end-to-end embedded systems for applications including robotics and wireless sensor nets.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-1)
**Semesters Offered:** Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** (CS 1141 or EE 2241) and (EE 3171 or EE 3173)

**EE 4777 - Distributed Additive Manufacturing Using Open-Source 3-D Printing**
This course provides an overview of open-source hardware in theory and practice for an introduction to distributed additive manufacturing using open-source 3-D printing. Each student will build a customized RepRap and will learn all hardware and software for maintaining it.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Class(es): Junior, Senior

**EE 4800 - Special Topics in Electrical Engineering**
Covers specific topics in electrical engineering.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor and department required

**EE 4805 - Electrical Engineering Project**
A project in electrical engineering. An individual student or a group of students complete a mutually- agreed-upon project in consultation with a faculty member.
**Credits:** variable to 3.0; Repeatable to a Max of 6; Graded Pass/Fail Only
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor and department required

**EE 4870 - Special Topics in Computer Engineering**
Covers special topics in computer engineering.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor and department required

**EE 4901 - EE Design Project 1**
The first semester of a program of study in which a group of students work on an engineering design project in consultation with a faculty member. (Senior project ready as defined by major substitutes for prerequisites)
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** (EE 3131 or (EE 3130 and EE 3305)) and (EE 3901 or EE 4900) and (EE 3170(C) or EE 3171(C) or EE 3173(C))

**EE 4910 - EE Design Project 2**
The second semester of a program of study in which a group of students work on an engineering design project in consultation with a faculty member. (Senior project ready as defined by major substitutes for prerequisites)
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EE 4901

## Electrical Engineering Technology

**EET 1120 - Circuits I**
Defines resistance, voltage, current, energy, and power, followed by DC network analysis and network theorems. Includes the analysis of transients in capacitive and inductive networks. Lab exercises use electronic test equipment to analyze circuits constructed from schematics.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C) or MA 1160(C) or MA 1161(C) or MA 1135(C)

**EET 1411 - Basic Electronics**
Introduction to basic electrical principles and devices including DC and AC circuits, diodes, transistors, operational amplifier ICs, power supply regulation, and elements of communication systems.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering Tech, Surveying Engineering, Computer Network & System Admn
**Pre-Requisite(s):** MA 1031 or MA 1032 or MA 1160(C) or MA 1161(C) or MA 1135(C)

**EET 2120 - Circuits II**
Defines and applies sinusoidal steady-state AC concepts such as impedance, complex power, resonance, and frequency response. Applies basic network analysis tools to AC single phase and balanced three-phase networks, bridge circuits, and filters. AC circuit principles are reinforced by coordinated lab exercises.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 1120 and (MA 1160(C) or MA 1161(C) or MA 1135(C))

**EET 2141 - Digital Electronics and Microprocessor Fundamentals**
A study of the fundamental components used in digital logic circuits and microcomputer architecture and programming. Topics include: number systems and codes, Boolean algebra, combinational logic circuits, flip-flops, arithmetic circuits, counters and registers, decoders, multiplexers, memory organization, microcomputer addressing modes, stacks and subroutines.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 1120 or EET 1411

**EET 2142 - Digital Design and Modeling Using VHDL**
Emphasizes the language concepts of digital systems design using VHDL with emphasis on good design practices and writing verification testbenches. Students will gain valuable hands-on experience writing efficient hardware design code and performing simulations using ModelSim.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 2141

**EET 2220 - Electronic Devices & Circuits**
Introduction to solid-state electronic devices and their application. Studies diodes, transistors and operational amplifier ICs. Transistor biasing, temperature stabilization and gain calculations of single and multistage amplifiers. Studies power amplifiers, frequency response, heat sinking and power supply design.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 2120

**EET 2233 - Electrical Machinery**
Fundamental steady-state analysis of DC, AC polyphase and AC single-phase electrical machines as well as transformers.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** EET 1411 or EET 2120(C)

**EET 2241 - C++ and Matlab Programming**
Introduction to C++ programming and MATLAB for use in solving problems encountered in engineering technology. C++ topics include the basics of syntax and program structure. Focuses on the basic capabilities of MATLAB and its programming environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Eng Tech
**Pre-Requisite(s):** MA 2160(C)

**EET 2411 - Digital Electronics**
Introduction to the fundamentals of the digital electronics that make up microprocessors. Topics include number systems and codes, Boolean algebra, combinational and sequential logic circuits, arithmetic circuits, and digital memory.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn
**Pre-Requisite(s):** EET 1411 and (MA 1031(C) or MA 1032(C) or MA 1160(C) or MA 1161(C) or MA 1135(C))

**EET 2413 - Data Communications**
Introduction to the fundamentals of basic data communication methods. Topics include data transmission, signal encoding techniques, digital data communication techniques, transmission media, and frequency domain analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Eng Tech, Computer Network & System Admn
**Pre-Requisite(s):** EET 1411 or EET 1120

**EET 3131 - Instrumentation**
An investigation of transducers and where they are used. Topics include signal conditioning, sensitivity, linearity, hysteresis, process measurements, and position, motion and force measurements. Exposure to graphical data acquisition tools such as LabVIEW is incorporated.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 1411 or EET 2220 or PH 2230 or EE 2110 or EE 3010

**EET 3141 - Computer Architecture and Design**
Computer system components, instruction set design, hardwired control units, arithmetic algorithms/circuits, floating-point operations, introduction to memory and I/O interfaces.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 2241 and EET 2142(C)

**EET 3143 - Programmable Logic Devices**
Emphasizes the concept of design, simulation and implementation of large scale digital systems which incorporate digital devices at all complexity levels.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** EET 3141

**EET 3225 - Special Electronic Devices**
An advanced course in the study of linear integrated circuits. Includes op amps, comparators, wave form generators, timers and regulators. Emphasizes practical applications, including the interface of time-continuous measures to the discrete digital world.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 2220

**EET 3281 - Electrical Project Development and Troubleshooting**
Covers soldering, component layout, printed circuit board artwork, troubleshooting, electrical and environmental factors in design as well as an overview of the practical methods used by industry to process projects. The student designs and fabricates a circuit board and assembles a project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 2220

**EET 3367 - Communication Systems**
Basic course in communication systems. Topics include noise designation and calculation, bandwidth, frequency domain analysis, oscillators, AM/FM analysis, AM/FM transmission and reception, superheterodyne principle, and SSB.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 3225

**EET 3373 - Introduction to Programmable Controllers**
The design of discreet sequential controls using programmable logic controllers (PLCs). Relay logic is used to introduce ladder logic and ladder logic is used to program the PLC. Introduces a structured approach to sequential control design. Data acquisition is introduced using BridgeVIEW software.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Eng Tech
**Pre-Requisite(s):** EET 1411 or (EET 2120 and EET 2141) or EET 2411 or PH 2230 or EE 2110 or EE 3010 or EE 2112

**EET 3390 - Power Systems**
A study of the transmission of electrical power from generators to loads, system components and system performance. Covers basics of power systems and their analysis, the per-unit concept, faults on power circuit interrupting, system instrumentation, and automatic protection system.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 2233

**EET 4141 - Microcontroller Interfacing**
The design of systems, hardware, and software needed to perform serial and parallel data transmission between microcontrollers. Data collection using analog to digital converters, and analog and digital control outputs.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 2141 or CS 1121

**EET 4142 - Digital Signal Processing Applications**
Provides students with knowledge in architecture, instruction set, hardware and software development tools associated with a fixed point general purpose DSP. Includes applications of DSP in control of electric drives and power electronic devices.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 3367 and EET 4141

**EET 4144 - Real-Time Robotics Systems**
Covers the components of a robot system, safety, concepts of a work-cell system, geometry, path control, automation sensors, programming techniques, hardware, and software.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** EET 1411 or EET 2220 or PH 2230 or EE 2110 or EE 3010

**EET 4147 - Industrial Robotic Vision Systems and Advanced Teach Pendant Programming**
Procedures for setting up, teaching, testing, and modifying robot vision systems widely used in industrial automation. Introduces advanced Teach Pendant Programming to develop complex scenarios for integrating robots into industrial cells. Final project must demonstrate proficiency in setting up and programming an advanced robotic vision scenario.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** EET 4144

**EET 4253 - LabVIEW Programming for Data Acquisition**
An introduction to graphical programming using LabVIEW. Data acquisition and control programs will be written. Transducer utilization and signal conditioning are studied, including handling of noise. DAQ interfaces will be designed, built, and implemented.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 1411 or EET 2220 or EE 2112 or EE 3010 or PH 2230

**EET 4311 - Advanced Circuits and Controls**
This course considers the modeling, design and implementation of basic and advanced process control strategies. Process modeling and dynamics will be considered using LaPlace transform analysis. Control techniques addressed will include feedback, cascade, feedforward, multivariable and model based methods.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EET 3131 or EET 4253

**EET 4367 - Wireless Communications**
Topics include television systems, wave propagation, antennas, digital communications, wireless communications systems and standards, wireless communications channels, multiple access schemes, modern wireless technologies, wireless channel impairments and techniques to minimize them.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EET 3367 and MA 2160

**EET 4373 - Advanced Programmable Controllers**
Using Allen Bradley Micro Logix, SLC500, & PLC-5 programmable controllers, course covers structured programming, Sequential Function Charts, networking, proportional integral differential control, data acquisition and interfacing. The labs will require students to write and troubleshoot complex PLC programs.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** EET 3373

**EET 4380 - Alternative Energy Applications**
An overview of world energy resources and energy consumption trends. Fundamental principles, applications, and viability of alternative energy sources such as wind, solar, and tidal will also be presented.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** EET 2233

**EET 4460 - Senior Project I**
Capstone course phase I, requiring the application of knowledge gained in lower division courses. Projects are normally team oriented, require weekly progress reports, and culminate with a final report and oral presentation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** EET 3281

**EET 4480 - Senior Project II**
A capstone course requiring the application of knowledge gained in lower division courses. Projects are normally team oriented, require weekly progress reports, and culminate with a final report and oral presentation.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** EET 4460

**EET 4996 - Special Topics in Electrical Engineering Technology**
Selected additional topics of interest in Electrical Engineering Technology based on student and faculty demand and interest. May be a tutorial, seminar, workshop, project, or class study.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Electrical Eng Tech; Must be enrolled in one of the following Class(es): Senior

**EET 4997 - Independent Study in Electrical Engineering Technology**
Independent study of an approved topic under the guidance of an Electrical Engineering Technology faculty member. May be either an academic, design, or research problem/project.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Electrical Eng Tech; Must be enrolled in one of the following Class(es): Senior

**EET 4998 - Undergraduate Research in Electrical Engineering Technology**
An undergraduate research experience in Electrical Engineering Technology. Under the guidance of an Electrical Engineering Technology faculty member, students work on a selected/approved research problem or work directly with faculty on active research projects/grants. May require more than one semester to complete.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Electrical Eng Tech; Must be enrolled in one of the following Class(es): Senior

**EET 4999 - Professional Practice in Electrical Engineering Technology**
Addresses engineering professional ethics, legal issues, professional development, and corporate culture as they relate to engineering technology graduates and our global society.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Electrical Eng Tech; Must be enrolled in one of the following Class(es): Senior

## Engineering Fundamentals

**ENG 1001 - Engineering Problem Solving**
Introduction to the engineering problem solving method and to modern tools used to solve problems.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MA 1031(C) or MA 1032(C)) and (Spatial Visualization Score >= 19 or ENG 1002(C))

**ENG 1002 - Introduction to 3-D Spatial Visualization**
Intended for first-year engineering students with a demonstrated need for the development of 3-D spatial visualization skills. Topics include isometric sketching, orthographic projection, object transformations, 3-D coordinate systems, patterns folding to 3-D objects, and cross sections of solids.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**ENG 1003 - Introduction to Computer Aided Drafting**
Fundamentals of creating engineering drawings with modern CAD software. Topics include basic geometric construction, drawing modification, dimensioning, and working with layers. Designed for students with no CAD experience.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** ENG 1002 or ENG 1100 or ENG 1101

**ENG 1100 - Engineering Analysis**
An introduction to the engineering profession. Focuses on engineering analysis, computational skills, and communication skills.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENG 1001 and (MA 1160(C) or MA 1161(C)) and (Spatial Visualization Score >= 19 or ENG 1002(C))

**ENG 1101 - Engineering Analysis and Problem Solving**
An introduction to the engineering profession and to its various disciplines. Focuses on developing problem-solving skills, computational skills, and communication skills. Through active, collaborative work, students work on teams to apply the engineering problem-solving method to "real-world" problems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (MA 1160(C) or MA 1161(C) or MA 2160(C) or MA 3160(C)) and (Spatial Visualization Score >= 19 or ENG 1002(C))

**ENG 1102 - Engineering Modeling and Design**
Continuation of ENG1101. Introduction to the engineering design process with an emphasis on graphics and documentation. Focuses on engineering problem solving in the context of the design process.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (MA 1160 or MA 1161 or MA 2160(C) or MA 3160(C)) and (ENG 1101 or (ENG 1001 and ENG 1100)) and (Spatial Visualization Score >= 19 or ENG 1002)

**ENG 1505 - Introduction to Systems Engineering**
Students utilize a software tool to establish the utility of systems modeling through relevant examples.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENG 1001 or ENG 1101

**ENG 1990 - Special Topics in Engineering**
Engineering topics of interest to students and faculty that are not normally covered in the existing courses.
**Credits:** variable to 5.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**ENG 2060 - Facilitating Group Learning**
Development of facilitation skills in group environments. Topics include peer-learning strategies, developing inclusive classrooms, and facilitation techniques.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** ENG 1102

**ENG 2120 - Statics-Strength of Materials**
The composition and resolution of forces and force systems, principles of equilibrium applied to various bodies, simple structures, friction, and 2nd moments of area. Intro to the mechanical behavior of materials, including calculation of stresses, strains, and deformations due to axial, torsional, and flexural loading. Uses MATLAB.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Major(s): Mechanical Engineering, Civil Engineering
**Pre-Requisite(s):** MA 2160 and PH 2100 and ENG 1102

**ENG 2505 - Low Fidelity Systems Modeling**
Students utilize a software tool to model a range of natural and human-made systems to gain understanding and ability to apply a systems modeling approach for analysis of systems of increasing complexity.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENG 1505(C) and MA 2160 and (ENG 1102 or CS 1121 or CS 1131)

**ENG 2990 - Special Topics in Engineering**
Engineering topics of interest to students and faculty that are not normally covered in the existing courses.
**Credits:** variable to 5.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**ENG 3060 - Developing Mentoring Skills**
Provides an overview of mentoring. Topics include various mentoring techniques, providing effective feedback, and observational strategies.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** ENG 2060

**ENG 3200 - Thermodynamics/Fluid Mechanics**
Provides engineering students with a unified understanding of the fundamental conservation laws and property accounting applied to thermodynamic and fluid dynamic systems. Topics will include but are not limited to: ideal gas behavior; heat, work, and energy; 1st and 2nd laws of thermodynamics; heat pumps; cycles; hydrostatics; Bernoulli; pipe flow and loss; and lift and drag. Uses MATLAB.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MA 2160 and CH 1112 or (CH 1150 and CH 1151) and PH 2100 and ENG 1102

**ENG 3505 - Modeling Laboratory for Sustainable Systems**
A laboratory course to accompany Sustainable Futures I. Puts into modeling practice the concepts, methodologies, and systems modeling to generate design alternatives.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENG 1505 and ENG 2505 and ENG 4510(C)

**ENG 3830 - Engineering Professional Practice**
Students will integrate and solidify topics of professional communications, ethics, problem solving, and fundamental competencies of engineering. Students will enhance their understanding of consequences of engineering, design issues, legal aspects, ethical considerations, management, and leadership, through readings, research, and discussions.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required
**Pre-Requisite(s):** ENG 1101 or (ENG 1001 and ENG 1100) and ENG 1102 and ENG 2120 or (MEEM 2110 and MEEM 2150) and ENG 3200 or (MEEM 2201 and MEEM 3201) and EE 3010 and (CEE 3101 or CS 1121 or GE 2300 or MSE 2100)

**ENG 3990 - Special Topics in Engineering**
Engineering topics of interest to students and faculty that are not normally covered in the existing courses.
**Credits:** variable to 5.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**ENG 4060 - Leadership in Group Environments**
Develops collaborative leadership skills through active hands-on learning. Topics include collaborative software, communication, and group management strategies.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** ENG 3060

**ENG 4070 - LEAP Leadership Practicum**
Experience designed for the practical application of leadership knowledge, skills, and behaviors in the LEAP environment. The practicum experience will be designed and implemented by the student, with mentorship/guidance from the associated faculty.
**Credits:** variable to 6.0; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** ENG 2060

**ENG 4300 - Project Management**
The various stages in a project life cycle will be covered and include initiation, planning, execution, and closeout. Basic tools such as the Project Charter, Network Diagrams Gantt, and budgeting will be covered. Basics of MS Project are included.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BUS 2100 or CEE 3710 or MA 2720 or MA 3710 or EE 3180 or BE 2100

**ENG 4505 - Systems Analysis, Modeling, and Design**
This course will focus on a cross disciplinary subset of systems drawn from engineering, business, and natural science. Students will concentrate on modeling methodology appropriate for moderate to large systems environments and a collaborative project where they apply what they have learned.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENG 3505 and ENG 4510

**ENG 4510 - Sustainable Futures I**
Covers introductory and intermediate concepts of Sustainable Development. Explores methods/tools for assessing sustainability (economic, environmental, societal impacts) of current and emerging industrial technologies. Explores relationships between government policies and markets for introducing sustainable technologies into national economies and corporations.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**ENG 4900 - Multidisciplinary Senior Design Project I**
Introduction to engineering design, including modeling, simulation, economic decision making, and reliability. Integration of design principles in the solution of open-ended engineering problems. Projects are defined and planned with faculty and industrial guidance. Emphasizes economics and environmental constraints. Students must be Senior Project ready as defined by major.
**Credits:** variable to 4.0
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**ENG 4905 - Senior Engineering Design Project**
Students work in teams on one-semester open-ended capstone design projects developing and implementing original and creative solutions to real engineering problems. Students must be Senior Project ready as defined by major. May take ENG4905, ENG4900, or ENG4910.
**Credits:** variable to 4.0
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** ENG 3830(C) or ENG 4505

**ENG 4910 - Multidisciplinary Senior Design Project II**
Continuation of ENG4900. Introduction to engineering design including modeling, simulation, economic decision making and reliability. Integration of design principles in the solution of open-ended engineering problems. Projects are defined and planned with faculty and industrial guidance. Emphasizes economics and environmental constraints. (Senior project ready as defined by major substitutes for prerequisites)
**Credits:** variable to 4.0
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** ENG 4900

**ENG 4990 - Special Topics in Engineering**
Engineering topics of interest to students and faculty that are not normally covered in the existing courses.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

## Enterprise

**ENT 1960 - Enterprise Orientation-Spring**
An orientation for students to their specific enterprise. Covers enterprise specific topics but should also include organizational structure; past, present and future projects and their results.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**ENT 2950 - Enterprise Project Work I**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. Second-year students are responsible for achieving some prescribed objectives, as defined by their Enterprise team.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**ENT 2960 - Enterprise Project Work II**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. Second- year students are responsible for achieving some prescribed objectives, as defined by their Enterprise team.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**ENT 2961 - Teaming in the Enterprise**
Develops group problem-solving skills. Stresses interpersonal skills and skill assessment, communication, group process and teamwork, and action planning. Uses active, hands-on learning.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**ENT 2962 - Communication Contexts**
An introduction to the demands of technical and professional communication in workplace settings, through analyzing project design team experiences.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1025

**ENT 3950 - Enterprise Project Work III**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. Third-year students will practice designing approaches to solve problems and develop procedures to achieve specified project objectives.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**ENT 3953 - Ignite: Ideate, Innovate, Create!**
Whether starting a business or working for an established company, creativity and innovation are keys to success. Course will explore creativity tools and techniques such as design thinking and human centered design to help generate ideas that provide value to society.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**ENT 3954 - Enterprise Market Principles**
Examines the fundamental principles of marketing in the six stages of product life cycle (opportunity identification, product development, introduction, growth, maturity, and decline).
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior

**ENT 3956 - Industrial Health and Safety**
Instruction of health and safety in engineering practice. Integrates the study of health and safety regulations, risks, and potential for improvement. Also covers the tremendous financial, ethical, and public relations implications of disregarding this critical aspect of engineering.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior

**ENT 3958 - Ethics in Engineering Design and Implementation**
The focus of this course is on ethical considerations in the engineering design and implementation process. Basic ethical analysis tools will be explored through various exercises. Students will analyze and present life engineering ethics case studies.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Pre-Requisite(s):** ENG 1101 or (ENG 1001 and ENG 1100)

**ENT 3959 - Fundamentals of Six Sigma I**
This course introduces tools used for process improvement focusing on the DMAIC approach used widely in industry today.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior

**ENT 3960 - Enterprise Project Work IV**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. Third-year students practice designing approaches to solve problems and develop procedures to achieve specified project objectives.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**ENT 3961 - Enterprise Strategic Leadership**
This 1-credit module focuses on exploring research findings about leadership, the practice of leadership, and providing skill assessment and development opportunities. Topics include leadership traits, behaviors, theories, and leadership of change. Combines a variety of teaching methods, including self-assessment, cases, discussion, experiential exercises, role-playing, videotaping.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ENT 2961 and (EC 2001 or PSY 2000 or SS 2100 or SS 2200 or SS 2400 or SS 2500 or SS 2501 or SS 2502 or SS 2503 or SS 2504 or SS 2505 or SS 2600 or SS 2700)

**ENT 3963 - Deliver: Explore, Develop, Execute!**
if you have an idea that you believe addresses a need and could lead to commercialization, this course will help you to explore the path from idea to market through customer development, value assessment, business model planning, and execution.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior

**ENT 3964 - Project Management**
Project definition, developing a work breakdown structure, responsibility assignment and milestone development. Covers techniques for project scheduling and practical application of Gannt and PERT/CPM charts; resource management and application of critical chain method; project budgeting and cost estimation; project monitoring, control, evaluation, and termination; and project teams, their structure, and interactions.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**ENT 3966 - Design for Manufacturing**
This course supplements courses that address "design for function." Products "designed for manufacturing" are lower cost, higher quality, and have a shorter time to market. The course describes how the capabilities and limitations of common manufacturing processes translate into qualitative design guidelines. Topics include design for casting, forging, sheet metal forming, machining, plastics and assembly.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** ENG 1102

**ENT 3967 - Design for Six Sigma**
This course emphasizes the design for Six Sigma (DFSS) tools and methods used widely in industry to optimize new products and services.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**ENT 3970 - Enterprise Special Topics**
For the development of new, junior-level instructional modules in support of the enterprise.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**ENT 3971 - Seven Habits of Highly Effective People**
Focuses on personal and professional effectiveness through greater productivity, increased influence in key relationships, stronger team unity and complete life balance. This course will explore these areas through interactive exercises, case studies, videos, and sharing of experiences.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior

**ENT 3979 - Alternative Energy Technologies and Processes**
This course covers a wide range of alternative energy technologies with an emphasis on chemical and biochemical processing. Technologies covered may include biofuels, solar power, fuel cells, etc.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151) and (MA 1160 or MA 1161)

**ENT 3980 - Pre-Capstone Enterprise Project Work**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. This course is to be taken by third-year or fourth-year enterprise students who have completed the junior-level project work, but are not approved as capstone-ready by their department.
**Credits:** 1.0; Repeatable to a Max of 2
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** ENT 3950 and ENT 3960

**ENT 3982 - Continuous Improvement Using Lean Principles**
Fields from engineering through the social sciences are adopting continuous improvement using Lean principles to make their organizations successful. The evolution of these principles and the associated processes, methods, and tools are described and applied.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall

**ENT 3983 - The Culture of Continuous Improvement**
A continuous improvement culture is based on humility and respect for people. Problem solving in this environment is highly participative, focuses on the issue not the person, and seeks to empower the employees closest to the work being performed.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring

**ENT 3984 - Lean Six Sigma Principles**
Proven Lean Six Sigma problem-solving methods and statistical tools contribute to the success of any organization. Course covers Lean Six Sigma methodology, tools, and planning for a Green Belt certification project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**ENT 3985 - Lean Six Sigma Certification Project Execution**
Execute a previously defined project using Lean Six Sigma problem-solving methods and statistical tools. Establish baselines; identify and validate root causes; identify, test, and implement a solution; and propose a method to sustain the gains.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-4)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** ENT 3984

**ENT 4900 - Senior Enterprise Project Work V Non-Capstone**
Interdisciplinary teams work as part of an enterprise to address real-world projects or problems of significance to industry, government and communities. Fourth-year students gain experience in defining project objectives and planning strategies to achieve these objectives, and leading teams to accomplish project goals. This course is for students who are not participating in Enterprise to fulfill their capstone requirements.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Class(es): Senior

**ENT 4910 - Senior Enterprise Project Work VI Non-Capstone**
Interdisciplinary teams work as part of an enterprise to address real-world projects or problems of significance to industry, government and communities. Fourth-year students gain experience in defining project objectives and planning strategies to achieve these objectives, and leading teams to accomplish project goals. This course is for students who are not participating in Enterprise to fulfill their capstone requirements.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Class(es): Senior

**ENT 4950 - Enterprise Project Work V Capstone**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. Fourth- year students gain experience in defining project objectives, planning strategies to achieve these objectives, and leading technical teams to accomplish project goals. Must be Senior Project ready as defined by major.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Civil Engineering, Chemical Engineering, Computer Engineering, Electrical Engineering, Environmental Engineering, Mechanical Engineering, Materials Science and Engrg, Software Engineering, Construction Management, Computer Network & System Admn, Electrical Eng Tech, Mechanical Engineering Tech, Surveying Engineering, Biomedical Engineering; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** (BE 3350 and BE 3700 and BE 3800 and BE 4900) or (CE 3620 or CEE 3620 or CE 3810 or CEE 3810) or CM 4855(C) or (CS 3712 or CS 4711 or CS 4760) or (EE 3131 and EE 3901 and EE 3171(C) or EE 3173(C)) or (GE 3860 and GE 3880) or (ENT 3950 and ENT 3960 and MEEM 3000(C) and MEEM 3900 and MEEM 3502(C)) or (ENT 3950 and ENT 3960 and MA 3710 and MEEM 3750(C) and MEEM 3201(C) and MEEM 3911) or (MY 3110 or MSE 3110 and MY 3200 or MSE 3120 and MY 3210 or MSE 3130 and MY 3300 or MSE 3140 and MY 4940 or MSE 3190 and MSE 4131(C)) or (HU 3120 and CMG 3250 and CMG 4120 and CMG 4210(C)) or (HU 3120 and EET 3281 and EET 4253(C)) or MET 4460(C) or SAT 3812(C) or SU 4100(C) or ENG 3830

**ENT 4951 - Business Plans and Budgeting in the Enterprise**
Introduction to the mechanics, dynamics and concepts of the financial budgeting process. Applications of financial concepts is emphasized through the development of basic business plans. Topics and activities include budget preparation, performance assessment, and financial evaluation of projects.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Major(s): Business Administration; Must be enrolled in one of the following Class(es): Junior, Senior

**ENT 4954 - Global Competition**
Emphasizes unique economic, market, and political risks faced by organizations as operations expand beyond domestic borders. Discusses establishing risk profiles to analyze new labor, product, capital markets on a global scale and appropriate market entry strategies. Small teams will do a risk profile and recommend market entry strategies for selected countries.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENT 2961 and (EC 2001 or PSY 2000 or SS 2100 or SS 2200 or SS 2400 or SS 2500 or SS 2501 or SS 2502 or SS 2503 or SS 2504 or SS 2505 or SS 2600 or SS 2700)

**ENT 4960 - Enterprise Project Work VI Capstone**
Interdisciplinary teams work as part of an enterprise to address real-world design projects or problems. Fourth- year students gain experience defining project objectives, planning strategies to achieve these objectives, and leading technical teams to accomplish project goals.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** ENT 4950 and (BE 4900 or (CEE 3620 or CEE 3810) or CM 4855 or (CS 3712 or CS 4711 or CS 4760) or (EE 3171 or EE 3173) or (GE 3860 or GE 3880) or (MEEM 3000(C) and MEEM 3502(C)) or (MEEM 3750 and MEEM 3201) or (MSE 4131 and MSE 4141(C)) or CMG 4210 or EET 4253 or MET 4460 or SAT 4541 or SU 4100 or (ENG 3830 or ENG 4505))

**ENT 4961 - Enterprise Project Work VII**
Course intended for students who have completed all project courses in Enterprise and who wish to continue with the program through graduation.
**Credits:** 1.0; Repeatable to a Max of 2
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** ENT 3950 and ENT 3960 and ENT 4950 and ENT 4960

**ENT 4970 - Enterprise Special Topics**
For the development of new, senior-level instructional modules in support of the enterprise.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior

## English as a Second Language

**ESL 0210 - High Beginner Reading**
For students of English as a second language; not for native speakers of English. Emphasis is on preparing students for academic study through the development of effective reading strategies, vocabulary acquisition, note-taking, inferring, summarizing, and critical thinking.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0211 - High Beginner Vocabulary**
For students of English as a second language; not for native speakers of English. Emphasis is on vocabulary acquisition, word form, and morpheme recognition.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0220 - High Beginning Writing**
For students of English as a second language; not for native speakers of English. Students work collaboratively on writing tasks of various genres through multiple drafts emphasizing structural organization of sentences and paragraphs, and syntactical accuracy.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0230 - High Beginner Listening and Speaking**
For students of English as a second language; not for native speakers of English. Emphasis on developing oral fluency, conversation, listening strategies, and presentation skills on familiar topics.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0231 - High Beginner Pronunciation**
For students of English as a second language, not native speakers of English. Emphasis on prosodic elements of second language speech. Focus on listening for features of speech. Time is divided between classroom instruction and lab.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0240 - High Beginner Grammar**
For students of English as a second language; not for native speakers of English. Students receive explicit instruction and form-focused activities to develop mechanics and syntactical accuracy emphasizing various simple, complex, and compound structures, verb forms, and other grammatical elements.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0290 - Beginning Special Topics**
For students of English as a second language; not for native speakers of English. Concentrated study of a specific area of ESL. Example: English for computer users.
**Credits:** variable to 6.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0310 - Intermediate Reading I**
For students of English as a second language, not for native speakers of English. Emphasis is on comprehension of main ideas and structural details, critical-thinking skills and class discussion. Students learn to take notes, outline and summarize.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0311 - Intermediate Vocabulary I**
For students of English a second language; not for native English speakers. The emphasis is on vocabulary acquisition for academic study. Students will learn techniques for understanding vocabulary words from context; analyze lexical roots, prefixes and suffixes; and become familiar with word association mapping and idiomatic expressions.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0320 - Intermediate Writing I**
For students of English as a second language, not for native speakers of English. Students work collaboratively on writing tasks of various genres through multiple drafts; emphasizes structural organization, thesis development and syntactical accuracy.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0330 - Intermediate Listening and Speaking I**
For students of English as a second language; not for native speakers of English. Emphasis is on developing oral fluency, skills needed for group work, academic listening strategies and academic presentation skills on familiar, informative topics.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0331 - Intermediate Pronunciation I**
For students of English as a second language, not native speakers of English. Emphasis on prosodic elements of second language speech. Focus on identifying features of speech. Time is divided between classroom instruction and lab.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0340 - Intermediate Communicative Grammar**
For students of English as a second language; not for native speakers of English. Using explicit instruction and form-focused activities to develop students' syntactical accuracy; emphasizes various simple, complex and compound structures, verb forms and other grammatical elements.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0350 - Intermediate Reading II**
For speakers of English as a second language; not for native speakers of English. This is an intermediate reading course for acadmically oriented ESL students. This course is designed to further develop effective reading strategies for adapted academic texts of varying lengths.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0351 - Intermediate Vocabulary II**
For students of English a second language; not for native English speakers. Further emphasis on vocabulary acquisition but with more range and depth than in Intermediate Vocabulary I. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. Students will improve their ability to understand and correctly use academic vocabulary that is technical and precise, and meant to convey specific ideas, often with reduced context.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0360 - Intermediate Writing II**
For students of English as a second language, not for native speakers of English. Students work collaboratively on writing tasks of various genres through multiple drafts; further development on structural organization, thesis development and syntactical accuracy.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0370 - Intermediate Listening and Speaking II**
For students of English as a second language; not for native speakers of English. Further development of oral fluency, skills needed for group work, academic listening strategies, and academic presentation skills on familiar, informative topics.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0371 - Intermediate Pronunciation II**
For students of English as a second language, not native speakers of English. Emphasis on prosodic elements of second language speech. Focus on identifying and anticipating features of speech. Time is divided between classroom instruction and lab.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0380 - Intermediate Communicative Grammar II**
For students of English a second language, not for native speakers of English. Using explicit instruction and form-focused activities to develop students' syntactical accuracy; further developments on various simple, complex and compound structures, verb forms and other grammatical elements.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0390 - Intermediate Special Topics**
For students of English as a second language, not for native speakers of English. Concentrated study of a specific area of ESL in greater depth than in other courses. Examples: English for computer users, idioms. Contact Director of ESL Programs.
**Credits:** variable to 6.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0399 - Intermediate Independent Study**
For students of English as a second language, not for native speakers of English. Selected areas in ESL based on interest and need of student. Interested students should contact the Director of English as a Second Language Programs.
**Credits:** variable to 6.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0410 - Advanced Reading I**
For students of English as a second language, not for native speakers of English. Emphasis is on preparing students for academic study through the development of effective reading strategies, note-taking, inferring, summarizing, critical thinking and discussion.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0411 - Advanced Vocabulary I**
For students of English as a second language, not for native speakers of English. Emphasis is on helping students increase their command of idiomatic English and academic vocabulary in daily and academic situations with attention given to correct pronunciation. Additional practice with the Academic Word List (AWL) will include short writing assignments.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0412 - Advanced English for Business**
This course is designed for students of English as a second language, not for native speakers of English. Emphasis is on acquiring vocabulary necessary for academic study of courses required in business majors.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0413 - Advanced English for Engineering**
This course is designed for students of English as a second language, not for native speakers of English. Emphasis is on acquiring vocabulary necessary for academic study of courses required in engineering majors.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0414 - Advanced English for Math**
This course is designed for students of English as a second language, not for native speakers of English. Emphasis is on acquiring vocabulary necessary for academic study of mathematic courses.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0415 - Advanced English for Science**
This course is designed for students of English as a second language, not for native speakers of English. Emphasis is on acquiring vocabulary necessary for academic study of courses required in biological science majors.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0420 - Advanced Writing I**
For students of English as a second language, not for native speakers of English. Students work collaboratively on writing tasks of various genres through multiple drafts; emphasizes coherence and unity, source use and documentation and language formality.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0430 - Advanced Listening and Speaking I**
For students of English as a second language; not for native speakers of English. Emphasis is on developing oral fluency academic listening strategies, argument development, skills needed for group work and academic presentation skills with a focus on persuasive speaking.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0431 - Advanced Pronunciation I**
For students of English as a second language, not native speakers of English. Emphasis on prosodic elements of second language speech. Focus on anticipating features of speech. Time is divided between classroom instruction and lab.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0440 - Advanced Communicative Grammar I**
For students of English as a second language; not for native speakers of English. Using explicit instruction, and form-focused activities to develop students' error analysis skills; emphasizes correcting sentence constructions and connections, verb consistency and other common errors.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0450 - Advanced Reading II**
For students of English as a second language, not for native speakers of English. Emphasis is on preparing students for academic study through the development of effective reading strategies, note-taking, inferring, summarizing, critical thinking and discussion in academic settings using slightly adapted academic texts.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0451 - Advanced Vocabulary II**
For students of English as a second language, not for native speakers of English. Emphasis is on mastering the words and phrases that are specific to academic writing, speaking and research, as well as everyday idioms, expressions, and abbreviations. Predicting the pronunciation pattern of new words and phrases; lexical bundles and collocation usage will be also covered.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0460 - Advanced Writing II**
For students of English as a second language, not for native speakers of English. Students work collaboratively on writing tasks of various genres through multiple drafts; further development on coherence and unity, source use and documentation and language formality.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0470 - Advanced Listening and Speaking II**
For students of English as a second language, not for native speakers of English. Further development of oral fluency, academic listening strategies, argument development, skills needed for group work, and academic presentation skills with a focus on persuasive speaking.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0471 - Advanced Pronunciation II**
For students of English as a second language, not native speakers of English. Emphasis on prosodic elements of second language speech. Focus on producing features of speech. Time is divided between classroom instruction and lab.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0480 - Advanced Communicative Grammar II**
For students of English as a second language, not native speakers of English. Using explicit instruction and form-focused activities to develop students' error analysis skills; further development on correcting sentence constructions and connections, verb consistency and other common errors.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0490 - Advanced Special Topics**
For students of English as a second language, not for native speakers of English. Concentrated study in a specific area of ESL in greater depth than in other courses. Examples: academic writing, business English. Contact Director of ESL Programs.
**Credits:** variable to 6.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0491 - Transitional Writing**
For students of English as a second language, not for native speakers of English. Students work collaboratively on writing tasks of various genres through multiple drafts; emphasizes argument construction/deconstruction, source integration, sentence variety and cohesion.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0492 - Transitional Listening and Speaking**
For students of English a second language, not for native speakers of English. Emphasis is on developing oral fluency, academic listening strategies, research skills, skills needed for group work and academic presentation skills with a focus on academic research projects.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0493 - Transitional Reading and Vocabulary**
For students in English as a second language, not for native speakers of English. This course emphasizes the continued acquisition of higher level reading skills needed for university courses, expansion of receptive and productive academic vocabulary, comprehension of authentic American university texts as well as other authentic reading materials of varying lengths.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0495 - TOEFL Preparation**
This course is designed for students of English as a second language, not for native speakers of English. Emphasis is on the English used in colleges and universities in preparation for taking the iBT, the internet-based TOEFL (Test of English as a Foreign Language).
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0499 - Advanced Independent Study**
For students of English as a second language, not for native speakers of English. Selected areas of ESL based on student need. Interested students should contact the Director of English as a Second Language Programs.
**Credits:** variable to 6.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

**ESL 0520 - Academic Support Listening/Speaking**
For students of English as a second language; not for native speakers of English. Emphasis on improving pronunciation and conversation skills; academic discussion skills; academic presentations.
**Credits:** 3.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**ESL 0560 - Research Writing I**
For international graduate students of English as a second language, not for native speakers of English. Students work on improving academic reading and writing skills; emphasizes rhetorical analysis, cohesion and coherence, source use, research skills and syntactical accuracy.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall

**ESL 0580 - Research Writing II**
For international graduate students of English as a second language, not for native speakers of English. Students work on improving academic reading and writing skills; emphasizes graduate research writing and academic presentations.
**Credits:** 3.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring

**ESL 0590 - Academic Support Spec Topics**
For students of English as a second language, not for native speakers of English. Study a specific area of ESL in greater depth than in other courses. Examples: graduate/research writing, business English, academic presentations. Contact Director of ESL Programs.
**Credits:** variable to 4.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**ESL 0599 - Academic Support Indep Study**
For students of English as a second language, not for native speakers of English. Selected areas in ESL based on student need and interest. Interested students should contact the Director of English as a Second Language Programs.
**Credits:** variable to 6.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): English as a Second Language

## Visual and Performing Arts

**FA 1601 - Introduction to Audio Production**
An introduction to hands-on creative and technical work in sound. Work covers script analysis, story telling approaches, dialog direction and editing, sound effect and ambiance design, music integration and DAW based mixing.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**FA 1602 - Introduction to Music Mixing**
A hands-on introduction to mixing music with emphasis on the support of musical principles and style. Students develop a technical understanding and practice the manipulation of volume, frequency, dynamics, pitch, and time to support the focus, rhythm, melody, and mood of a wide variety of musical styles.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring

**FA 1701 - Backstage Technology**
Overview of the basic techniques, theories, and terminology of technical theatre. Focus on practical application of stagecraft and rigging for a theatrical production, safety in technical theatre, physical theatre structures, production processes, and theatre organization.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**FA 1702 - Lighting and Sound Technology**
Overview of the basics of theatrical lighting, stage electrics, audio systems, and techniques for theatrical production. Focus on practical application of static and automated lighting for a theatrical production, including instrumentation and control. Introduction to live sound reinforcement, recording, and complex playback.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**FA 1703 - Costume Technology**
Introduction to basics of costume shop technology, costume construction/sewing. Focus on costume shop procedures, practical use of tools, machines, and techniques through individual projects and costuming for mainstage productions. Overview of hand sewing and pattern fitting/alteration.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year

**FA 2050 - Drawing I**
Exploration and practice of fundamental principles of drawing. Develops skills in representational drawing, perspective, and composition. Develops creative and modern drawing techniques using a wide range of subject matter. Multi-media presentations and discussions illustrate classic principles while encouraging development of individual expression.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Summer

**FA 2123 - World Music**
This course introduces the student to the diversity of traditional music from around the globe. Students will explore the universal importance of music, its place within a global community, and effects of technology on the cross pollination of musical styles.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer - Offered alternate years beginning with the 2017-2018 academic year

**FA 2150 - Creative Drawing Processes**
Students redefine "drawing" and challenge preconceptions of what it means to be "creative" through a range of exercises using materials such as paint, pencils, photos, video, and collage. Practice close observation to see the world in new ways.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring, Summer

**FA 2160 - Creative Practices**
Students will mindfully cultivate their creativity while making art connected to specific interests. Hands-on practice with basic photo, drawing, painting, and/or collage compliments theories of how artists/designers find inspiration. Prior drawing experience recommended.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year

**FA 2190 - Art and Nature**
Explore "nature" through art using materials ranging from what you find outdoors to digital media. Visits to natural sites provide inspiration and practice with creative fundamentals. Explore expressivity, brainstorming, project development, and collaboration.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall

**FA 2222 - Film Music**
This course surveys the development of film music. Students will learn how music functions to support the aesthetic/narrative elements of the story. Students will learn skills to identify how music manipulates the listener and how composers shape that manipulation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer

**FA 2300 - Art and Design Studio**
Introduction to art and design as visual art. Explores design principles and creative problem solving using multiple materials. Students also examine design's ability to shape and interpret infromation. Hands-on studio work, lectures and discussions. Emphasizes creativity, inventiveness, and experimentation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Senior

**FA 2305 - Ceramics I**
Introduces handbuilding ceramic techniques, including coil, slab, pinch and wheel throwing. The goal is to allow students to be individually creative through experimenting with the possibilities in three-dimensional form. Historical, contemporary, functional and sculpture processes will be explored.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Summer

**FA 2315 - Beginning Wheel Throwing**
Learning to use the potters wheel as an expressive tool is the goal of this course. In the context of traditional techniques for creating vessel forms students will also be challenged to explore their individual expressive and creative abilities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Summer

**FA 2320 - Color and Meaning**
An introductory level course in which students discover their personal palettes and explore color schemes. Use paint, basic photography, and collage to tap the expressive potential of color. Solve practical color problems and create poetic color compositions.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall

**FA 2330 - Art Appreciation**
Introduces students to analytical tools to critically observe the visual world. By studying arts media, artists and designers, creative and technical processes, principles of design, as well as major works of art, students will express their own ideas about the visual experience in written form.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer

**FA 2361 - Scenic Art & Scenic Illustration**
Students will learn small-format drawing, painting, and illustration techniques for theatre and architectural design, as well as large-scale scenic painting techniques for painting of murals, faux finishes, theatre, and opera. Lectures, discussions, and hands-on studio practice.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** FA 1701(C)

**FA 2400 - Huskies Pep Band**
The Huskies Pep Band provides enthusiastic support for a number of athletic programs at MTU and participates in important events in the community. The HPB is one of the most visible programs in the University. We are known as one of the country's most spirited college pep bands anywhere. May be used once as a general education co-curricular course.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**FA 2402 - Campus Concert Band**
The Concert Band provides the opportunity for students to pursue an interest in instrumental performance through the medium of a concert wind band. Repertoire of the ensemble includes music of the highest calibre with moderate technical demands. Open to students with prior experience in a band or orchestra. May be used once as a general education co-curricular course.
**Credits:** 1.0; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring

**FA 2430 - Research and Development Jazz Band**
The Research and Development Jazz Band is for instrumentalists wishing to learn the fundamentals of jazz improvisation and the nuances of the jazz idiom. Repertoire includes swing, jazz, rock, Latin, ballads, fusion, and other contemporary jazz styles. Public performances are given on campus and in the surrounding area. Audition required.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**FA 2500 - Music Theory I**
Reinforcement of music fundamentals, including musical notation; major, minor scales; intervals; triads; rhythm; and an introduction to musical analysis. Provides rudimentary ear training. Introduces music writing, both manual and with notation software.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**FA 2501 - Basic Musicianship: Skill Acquisition in Music Reading, Sight-Singing, and Ear-Training**
Skill acquisition in music reading, sight-singing, keyboard harmony and ear-training. Provides an introduction to melodic and rhythmic solfege systems. Class should be taken before or concurrently with FA2500.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**FA 2520 - Music Appreciation**
Survey of the nature of Western music with an emphasis on the developments in the aesthetics, theories, and media of music, including electronic music, multimedia works, and non-Western influences.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer

**FA 2570 - Music Lessons for Brass, Woodwind, String, Percussion, Harp, Piano, Voice, Guitar**
Professional private music instruction on brass, woodwind, string, piano, guitar, voice, organ, and harp. Concert grand harp available on campus. Guitar rentals available from instructor. One semester may be counted toward General Education co-curricular requirements.
**Credits:** 0.5; May be repeated; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** Fall, Spring, Summer

**FA 2580 - Group Voice**
The fundamentals of speech and singing including information about the vocal instrument, the vocal process, vocal technique, and how to learn and perform simple solo songs.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand

**FA 2600 - Beginning Acting**
Teaches basic techniques of acting to include script and character analysis, internal and external approaches to performance, and basic use of voice and body.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**FA 2640 - Stage Makeup**
A practical guide to the theory and practice of makeup for the stage. Students will study basic techniques including corrective, aging, character makeup, and special effects.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year

**FA 2650 - Audition Techniques**
Students learn to prepare for the many types of auditions encountered in the professional world of performance through simulated audition situations, from the theatrical cattle-call to the screen test in film. Additionally, professional interviewing techniques are taught and practiced through simulation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** FA 2600

**FA 2660 - Acting Practicum**
Performance in a stage production or electronic media project. The project must be approved by the instructor either through audition or written contract of planned project.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**FA 2661 - Backstage Practicum**
Open to students selected for the crew of a mainstage theatre production sponsored by the Department of Visual and Performing Arts. Positions on stage crews are open to all MTU students. Work assignments will be made by the technical director of the Department of Visual and Performing Arts.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring

**FA 2662 - Sound Practicum**
Students get hands-on experience in live and recorded sound as well as in system maintenance and design. This work is done in a simulated internship experience. Students are expected to take this course multiple times and work towards leadership positions.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** FA 1702 and (FA 1662 or FA 1664)

**FA 2663 - Career Development**
Provides students the opportunity to attend professional events which contribute to the development of their careers. Students will experience seminars, workshops, performance opportunities, competitions, and may perform services and interact with professionals at such events as KCACTF, AES, USITT, and URTA.
**Credits:** 1.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Sound Design, Theatre & Entertain Tech (BS), Theatre & Electr. Media Perf., Audio Production & Technology

**FA 2701 - Drafting for the Entertainment Industry**
Basics of hand drafting conventions and standards used in the entertainment industry. Focus on design and technical techniques for views such as: ground plans, elevations, sections, detail drawings, orthographic projections, scale perspective drawings. Introduces industry-specific CAD programs.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer

**FA 2705 - Stage Properties - Designing and Crafting**
A focus on the design, research, production, and management of stage properties including: script, analysis, period and style, appropriateness, set dressing. Development and utilization of effective tools, materials, and techniques for structure, details, and finishing.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** FA 1701(C)

**FA 2710 - Movement for Performers**
Develops physical flexibility and strength, beginning with discovery of the body's physical center. The student will learn to create characters by focusing on posture, movement in space, and kinesics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2009-2010 academic year

**FA 2720 - Sound in Art and Science**
Engagement with critical, historical, and creative approaches to sound in Entertainment, Art, Technology, and Science. Integrated with a historical overview of aural environment and its application to designed environments from zen gardens to Harley exhaust.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Summer

**FA 2730 - Costume Crafts**
Research and exploration of the theatrical techniques used to create costume crafts and personal props. Practical projects will challenge students to develop skills in millinery, leatherwork, painting and dyeing, fabric manipulation, mask making, jewelry, and safe use of materials.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year

**FA 2820 - Theatre Appreciation**
Students engage theatre as a phenomenon precipitating experiences affirming life and sparking insight. Exploration of creativity comes through exercises and play writing; critical thinking is practiced in script analysis. Aesthetics, and production roles are applied in staging a short play.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**FA 2830 - Voice and Articulation**
An applied study of the use of voice. Students work to develop stronger, more vibrant and articulate professional speech. Accent reduction is covered extensively. Additionally, techniques for media are introduced.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2010-2011 academic year

**FA 3000 - Visual & Performing Arts Tour**
Students participating in fine arts performance tours taking place outside of regular academic terms are eligible to receive credit based on the time span of the tour and the nature of the itinerary. Requires active membership in the touring group or permission of director.
**Credits:** variable to 3.0; May be repeated; Graded Pass/Fail Only
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**FA 3112 - Music Composition I**
This course is a study in the art of acoustic instrumental, vocal and MIDI composition. Students will study music of contemporary composers and create compositions for performance.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** FA 2500 and FA 3530

**FA 3122 - Music Composition II**
This course is a continuation of Music Composition I. Students expand their skills to include composition for media including, film, television, and digital arts. Students will apply their skills to create fully realized live performances of their compositions.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FA 2500 and FA 3530 and FA 3112

**FA 3133 - Contemporary Music: The Search for New Sounds**
Contemporary Music will explore music from the late nineteenth century through today. The focus of the class will be modern composers' search for new sounds using electronic instruments, popular music, non-western music, and new performance techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** FA 2500 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3150 - Drawing II**
Observational and imaginative drawing including the human figure. Non-representational drawing. Contemporary drawing systems, concepts, and processes. Emphasizes proportion, structural framework, visual measurement, movement, and relationships. Students work in a variety of drawing media.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FA 2050 or FA 2150 or FA 2300 or FA 2305 or FA 2330 or FA 2160

**FA 3305 - Creative Ceramics**
Addresses ceramic theory, history, and science, and aims to develop the content and quality of students' work in clay. Students will learn new ways of creating forms through use of the wheel, molds, and study of clay and glaze technologies.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring, Summer

**FA 3330 - Art History - Prehistory to Renaissance**
Surveys world art and architecture from the Paleolithic (30,000BC) to the Renaissance (1500AD). Focusing on city building, cave painting, glass, ceramics, frescoes, and metal casting, students will interpret the visual arts as historical evidence and expressions of cultural beliefs.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3333 - Contemporary Sculpture Studio**
Introduction to contemporary sculpture using a range of materials and approaches. Emphasizes development of student's creative language. Hands-on studio work, lectures, disscusions. Class takes place in Rozsa gallery; includes student exhibit at end of semester.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3335 - Traditional Sculpture Studio**
Introduction to traditional ways of making sculpture around the world. Students develop studio skills while studying creative traditions from varied cultures. Hands-on studio work, lectures, discussions. Class takes place in Rozsa gallery; includes student exhibit at end of semester.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**FA 3340 - Art History - Renaissance to Today**
Surveys Western art from the Renaissance (1500AD) to today. Focusing on painting, sculpture, architecture, and photography. We will study art in relation to its national, international, social, cultural, and historical contexts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3360 - Ceramic Sculpture**
Explores the material properties and expressive potential of clay. Learning a variety of sculptured techniques, students will demonstrate the ability to incorporate the elements and principles of art (line, space, form, harmony) to create aesthetic artwork.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** FA 2305 or FA 3305

**FA 3400 - Keweenaw Symphony Orchestra**
The KSO is a college-community orchestra comprising Tech students, Tech faculty, and community musicians. The ensemble performs the great orchestra, opera, and ballet masterworks. The orchestra presents four-five yearly concerts, including regular concert tours. Auditions required.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**FA 3401 - Wind Symphony**
The Wind Symphony is a concert wind ensemble of variable size and instrumentation for students with a serious interest in musical performance at a high level. Features a comprehensive approach to the literature to be performed, including study of composers and historical background. Audition required.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**FA 3430 - Jazz Lab Band**
A select ensemble of approximately twenty instrumentalists studying jazz improvisation and performing literature for the jazz ensemble. Repertoire includes swing, jazz-rock, ballads, fusion, and experimental compositions. Activities include performances at festivals, concerts, and dances, and a spring-break tour. Course work includes topics in jazz history, music theory, and improvisation. Audition required.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**FA 3501 - Conducting and Interpretation**
Fluency in reading, analyzing, and interpreting orchestral, band, and choral music scores; principles and techniques of conducting a music ensemble; live conducting experiences with music ensembles; in-depth analysis of live and recorded classical, jazz, and rock music; fundamentals of musicianship.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FA 2500

**FA 3510 - Concert Choir**
A select ensemble made up of student and community singers studying and performing traditional choral literature ranging from chant to avant-garde compositions. Activities include campus and community performances and occasional international tours. Audition required.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**FA 3530 - Music Theory II**
Study of fundamentals of tonal harmony, including harmonic progression and principles of voice-leading. Introduction to formal and harmonic analysis. Students will complete beginning projects in music composition.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FA 2500

**FA 3550 - History of Jazz**
Covers the musical, historical, and sociological elements of America's only original musical art form, jazz. Focuses on the major stylistic eras from 1900 to the present in addition to the major artists and their contributions. Emphasizes developing interactive, aural, and critical skills.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer - Offered alternate years beginning with the 2009-2010 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3560 - Music History**
Developments in western classical music from the 1770s to 1970s in Europe and America. Includes a brief examination of Baroque music. Concentrates on music, style, aesthetics, culture, and biographies of major composers from the Classical, Romantic, and Twentieth-Century periods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3565 - Masterworks in Western Music Literature**
Examination of selected works from the canon of Western Music in context of relevant historical events. Students will explore the relation of text and music, ritual and music, rhetorical tropes in music as well as expressions of musical form.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** FA 2500(C) or FA 2501(C)

**FA 3580 - Chamber Choir**
Participation in the Chamber Choir provides opportunities for students to explore and perform music written for small choir. Repertoire from varied styles and time periods (from antiquity to the present) will be prepared and presented in formal and informal performance settings. Audition required.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**FA 3600 - Advanced Acting**
Students explore acting through analytical and theoretical study of script and characters. Understanding of characters in the context of a play or or film will prepare students to apply advanced acting techniques such as Meisner and Stanislavski.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 2600 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3620 - Acting for Television and Film**
Advanced applications of fundamental acting technique and presentation skills with the added dynamic of the camera. Students will explore scene work for television and film, as well as commercial performance techniques for advertising in digital media.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2013-2014 academic year

**FA 3625 - History of Rock**
This course will acquaint the student with the musical, historical, cultural, and sociological elements of Rock Music. It covers the major stylistic eras from 1948 - present, the "pre-rock" era and the major artists and their contributions. Emphasis is placed on students developing interactive, aural and critical skills.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Summer
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3630 - The Beatles and the Beach Boys: An Analysis of Their Music, Their Evolution, Their Rivalry**
Analysis of biography, formative vs. mature style, musical structure, and historical impact of both bands. Offered online, second half of summer term.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Summer

**FA 3650 - Stage Management**
Procedures and skills for effective stage management of theatrical productions, including coordination of performers and technicians during rehearsal and performance periods. Instruction in stage manager's notation used for blocking, scene shifts, and cues for lighting, sound, special effects, and performers.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2009-2010 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FA 3660 - Advanced Acting Practicum for Film/Video/Stage**
Practical experience of the production processes of theatre and media. Students will research, rehearse, and perform a role in an approved theatre or media project.
**Credits:** 1.0; Repeatable to a Max of 2
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** FA 2660

**FA 3661 - Design & Management Practicum**
Open to students who take significant responsibility for a Visual and Performing Arts production, such as stage manager, assistant designer, or assistant director.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** FA 2661

**FA 3662 - Advanced Sound Practicum**
Open to students who take significant responsibility for sound on a major production, such as sound designer, recording engineer, live sound engineer.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702 and FA 2662 and FA 3730

**FA 3663 - Professional Presentation**
Provides students the opportunity to present at professional events which contribute to the development of their careers. Students will prepare and present design, technical, or performance projects, papers, and/or posters to be viewed and critiqued by professionals at such events as KCACTF, AES, USITT, and URTA.
**Credits:** 1.0; Repeatable to a Max of 4
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** FA 3700(C) or FA 3730(C) or FA 3750(C) or FA 3760(C)

**FA 3666 - Professional Audition**
The objective of this course is to provide experience for performers to engage in auditioning for professional media and theatre companies. Students will research the expectations for unique acting opportunities and develop a plan for auditioning. Students will present their work at a professional audition.
**Credits:** 1.0; Repeatable to a Max of 2
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Theatre & Electr. Media Perf.; May not be enrolled in one of the following Class(es): Freshman

**FA 3680 - Period Acting Styles**
Provides knowledge and experience in playing the manners, movement, and language in plays of the most frequently performed periods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year
**Pre-Requisite(s):** FA 2600 or FA 2820

**FA 3700 - Scenic Design**
Fundamentals of designing theatrical scenery through various explorations and projects. Focus on professional design development and presentation techniques: theatrical drafting conventions, renderings, scale models. Also, designer/director relationships, script analysis, research design concepts/history/styles. Students are introduced to a mainstage theatre design.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2000-2001 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 1701 or FA 2820

**FA 3701 - Advanced Backstage Technology**
Techniques, theories, and terminology of technical theatre. Focus on practical application of advanced stagecraft through safety, woodworking, metalworking, budgeting, project management, and shop management.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2011-2012 academic year
**Pre-Requisite(s):** FA 1701 or FA 2701

**FA 3703 - Advanced Costume Construction**
Building on basic sewing skills and costume technology, students will explore fabrics and more advanced construction techniques: patterning methods such as flat patterning, draping, gridding, pattern alterations for fit and using slopers, construction of historical costumes such as corsets.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** FA 1703

**FA 3710 - Vocal Approaches for Theatre and Electronic Media**
Students will learn vocal approaches to specific types of speaking situations, including radio commercials, instructional videos, announcing, cartoons, and theatrical productions. Students will practice vocal projection for a large theatre/auditorium, as well as microphone technique for electronic media.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2008-2009 academic year

**FA 3730 - Sound Design**
Introduction to designing sound through design projects. Focuses on fundamental technical understanding, practical design presentation techniques, specific drafting conventions, exploration of sound equipment, designer/director/artist relationships, script analysis and design concepts, and design history.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702

**FA 3731 - Live Sound Design Intensive**
Students design, install, program, run, and record a major live production. Sound will be an essential part of the story telling experience requiring a close relationship with the actors and extensive integration with other design elements.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Sound Design, Theatre & Entertain Tech (BS), Theatre & Electr. Media Perf., Audio Production & Technology; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702 and FA 2662 and FA 3730

**FA 3732 - Audio Creative Lab**
A creative lab for students interested in the aural arts. Students will be challenged to create sound designs and compositions in response to various aesthetic, dramatic, and philosophical goals for radio, multimedia, and live performance.
**Credits:** 1.0; Repeatable to a Max of 4
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702 and FA 3730

**FA 3736 - Sound Systems Design and Engineering**
Fundamentals of sound systems design & engineering for a variety of entertainment industry scenarios, including: speaker coverage, system tuning, DSP programming, technical documentation, design phases, revision control, interaction with clients, interaction with design teams in other disciplines, and budget estimation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Theatre & Entertain Tech (BS), Sound Design, Audio Production & Technology; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702

**FA 3740 - Recording**
Learning in the art of the recording engineer. Students develop an understanding of pop and classical recording approaches, skills to decide which approach is appropriate for a given task, and the technical knowledge necessary to implement the chosen approach.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Sound Design, Theatre & Entertain Tech (BS), Theatre & Electr. Media Perf., Audio Production & Technology
**Co-Requisite(s):** FA 3741
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702

**FA 3741 - Recording Lab**
Hands-on learning in the art of the recording engineer. Students develop an understanding of pop and classical recording approaches, skills to decide which approach is appropriate for a given task, and the technical knowledge necessary to implement the chosen approach.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Theatre & Entertain Tech (BS), Sound Design, Audio Production & Technology
**Co-Requisite(s):** FA 3740
**Pre-Requisite(s):** FA 1662 and FA 1664 and FA 1702

**FA 3750 - Lighting Design**
Fundamentals of designing theatrical lighting through various explorations and projects. Focus on professional design development and presentation techniques: theatrical drafting conventions, light sketches, plots. Also, designer/director relationships, script analysis, research, design concepts/history. Students are introduced to a mainstage theatre design.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2005-2006 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 1702 or FA 2820

**FA 3760 - Costume Design**
Fundamentals of designing theatrical costumes through various explorations and projects. Focus on professional design development and presentation techniques: costume renderings, patterning, color/fabric analysis. Also, designer/director relationships, script/character analyses, research, design concepts. Students are introduced to a mainstage theatre design.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2003-2004 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FA 3780 - Directing for Theatre**
A comprehensive, in-depth study of mounting a theatre production with an emphasis on directing. Through script analysis, students study the necessary production elements, how they interrelate, and directing techniques to create a unified production from the director's vision.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** FA 2800

**FA 3810 - Theatre History I**
Study of the Cultural History of Theatre from is likely beginnings through the English Restoration, including traditions of both eastern and western theatre.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3821 - Theatre History II**
Study of the Cultural History of Theatre from the end of the English Restoration through the contemporary era.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3830 - The Broadway Musical**
A multimedia examination of important works of American musical theatre, how these works have mirrored or shaped our culture, and how New York City has shaped or been shaped by this vibrant art form.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand

**FA 3860 - Costume History**
A study of costume fashion, emphasis on the western world, from antiquity through the 20th Century. Including: basic characteristics of each period, environmental & cultural influences, specific costume terminology. Comparative analysis of historic costume choices found in film & theatre.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2012-2013 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 3880 - Readings in Dramatic Literature**
An examination of dramatic literature with an emphasis on theatre production. Students will examine a selection of plays each semester. Students can repeat the course up to four times; each semester examines different plays.
**Credits:** 1.0; Repeatable to a Max of 4
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Sound Design, Theatre & Entertain Tech (BS), Theatre & Electr. Media Perf., Audio Production & Technology; May not be enrolled in one of the following Class(es): Freshman

**FA 3975 - Portfolio Development**
Techniques for building a professional design and technical portfolio for the theatre and entertainment industry. The final result of the course will be a portfolio of all work to date.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FA 4150 - Advanced Drawing Studio**
Advanced independent exploration and experimentation in drawing theory and use of various drawing media. Students identify a problem or area of interest and develop an approach to it in close consultation with a faculty member, experimenting with a variety of media and methods.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** FA 2050 or FA 2150

**FA 4200 - Advanced Creative Mixed Media Studio**
Advanced work in mixed media such as watercolor, collage, drawing, and/or simple tech. Compositional theory as well as advanced applications of personal expression in mixed media may be included. Emphasis on independence in approach to materials, techniques, and concepts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** Permission of instructor required

**FA 4300 - Advanced Sculpture Studio**
An advanced studio course. Students create works of art inside the student gallery/classroom in the Rozsa, and study traditional & contemporary sculpture. Projects, lectures, readings, and discussions. Focus is on development of the student's personal arts language.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** FA 3333 or FA 3335

**FA 4400 - Chamber Music Seminar**
For students interested in the study and performance of instrumental chamber music. Small ensembles meet once each week for coaching, presentations, and discussion on literature and techniques of rehearsal and performance.
**Credits:** 1.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**FA 4420 - Music Performance: Jazz**
Jazz combos (e.g., Jaztec, Salsa Norte) are select small groups of musicians studying jazz improvisation and performing literature for the small jazz ensemble. Focuses on developing individual improvisational techniques, personal style, and unique original arrangements. Repertoire includes swing, jazz-rock, ballads, fusion, and experimental techniques. Activities can include performances and tours.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**FA 4620 - Musical Theatre Performance**
Provides specialized experience in performance styles of the musical theatre through scene-study and process from sheet music to the stage.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2009-2010 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FA 4650 - Production Management for the Entertainment Industry**
Focus on techniques to coordinate production and artistic operations for the theatre and entertainment industries and venues. Emphasis on effective event management processes including: safety, budgeting, scheduling, personnel, rehearsals, performance, communication, facilities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 3650

**FA 4690 - Voice Acting Lessons**
Private intensive in voice acting focusing on one specific genre (i.e. audio book narration, radio/television commericials, animated videos, technical narration, IVR messaging, etc.) Course covers basic skills for chosen genre and includes private coaching with the instructor as well as an industry professional.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Theatre & Electr. Media Perf.; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FA 2830 and FA 3710(C)

**FA 4701 - Stage Mechanics and Rigging**
Practical application and theory of stage mechanics and rigging. Emphasis will be placed on theatrical systems such as line-sets, turntables, and scenery lifts. Course will also explore automation through pneumatics, hydraulics, and motor control.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2010-2011 academic year
**Pre-Requisite(s):** FA 1701

**FA 4740 - Transducer Theory**
In depth study of Microphone and Loudspeaker design as it applies to usage in recording and live sound reinforcement with an emphasis on interaction with the acoustical environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Theatre & Entertain Tech (BS), Sound Design, Audio Production & Technology
**Co-Requisite(s):** FA 4741
**Pre-Requisite(s):** FA 1702 and FA 2662 and FA 3730 and PH 1090

**FA 4741 - Transducer Theory Lab**
Laboratory to practice the application of loudspeaker and microphone principles. Designed to be taken concurrently with FA4740 Transducer Theory.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Theatre & Entertain Tech (BS), Sound Design, Audio Production & Technology
**Co-Requisite(s):** FA 4740

**FA 4800 - Jazz Improvisation**
Explores the elements of jazz improvisation while developing creative ideas and technical facility in the individual musician. Emphasis will be placed on learning the idiomatic use of the major scale and associated modes, the jazz melodic minor scale, the blues scale, pentatonic scales, and the 8-tone dominant scale. Development of stylistic conformity by exploring the styles of swing, bebop, cool, blues, Latin and rock/funk. Emphasis on the II-V-I progression in major and minor keys and symmetric harmony.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2001-2002 academic year
**Pre-Requisite(s):** FA 3530

**FA 4820 - Jazz Arranging**
Explores elements of jazz arranging and composition while developing creative ideas in the individual musician. Emphasis on learning to arrange for jazz combo and traditional big band. Includes developing the shape concept of triad use, 4-part and 5-part chord voicing, construction of an arrangement, and competence with FINALE notational software.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2003-2004 academic year
**Pre-Requisite(s):** FA 2500 and FA 3530

**FA 4900 - Independent Study in Visual and Performing Arts**
Independent research directed by Visual and Performing Arts faculty. Projects focus on one or more of the visual and performing genres; theatre, music, visual art. Requires a written proposal setting out goals, plans for final project, and the resources required to complete the project.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**FA 4950 - Special Topics in Visual & Performing Arts**
Tutorial, seminar, or class study of a topic of special interest and importance in visual and performing arts.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**FA 4960 - Special Topics Workshop**
Special workshop projects in the fine arts.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**FA 4970 - Visual and Performing Arts Final Project**
Capstone course extending the student's knowledge and skill in a chosen fine arts discipline through independent research or other focused creative activity. A detailed proposal of the student's final project must be approved in writing by a Visual and Performing Arts faculty advisor before the student enrolls in FA4970.
**Credits:** variable to 3.0
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FA 4975 - Portfolio Presentation**
A public presentation of an array of art work completed by a student as part of the minor in Art or a Visual and Performing Arts degree program. Guidelines for the portfolio presentation are available from the student's advisor.
**Credits:** variable to 3.0; Repeatable to a Max of 3
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

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## Finance

**FIN 3000 - Principles of Finance**
Introduction to the principles of finance. Topics include financial mathematics, the capital investment decision, financial assets valuation, and the risk-return relationship
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (MA 2710 or MA 2720 or MA 3710 or BUS 2100) and ACC 2100(C)

**FIN 4000 - Investment Analysis**
Overview of financial products. Operations of the stock market, bond market, and other financial markets. Focus on portfolio theory and basic stock and bond valuation techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EC 3400 or FIN 3000

**FIN 4100 - Advanced Financial Management**
Advanced topics in managerial finance: Advanced capital budgeting, project analysis, capital acquisition, capital structure and dividend policy, and other topics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EC 3400 or FIN 3000

**FIN 4200 - Derivatives and Financial Engineering**
Covers the pricing and use of options, financial futures, swaps, and other derivative securities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** EC 3400 or FIN 3000

**FIN 4300 - Personal Financial Planning**
Overview of personal financial issues and services and instruments offered by economic and financial institutions. Topics include the personal financial environment, personal investments and asset managment, tax planning, the development of an adequate but cost-effective insurance program, and retirement planning.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BA 3400 or EC 3400 or FIN 3000

**FIN 4400 - Security Analysis**
Detailed analysis of security valuation. Topics include fundamental analysis (financial statement analysis, free cash flow valuation, credit analysis, ratio analysis), technical analysis, and quantitative analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** FIN 3000 or EC 3400

**FIN 4500 - Financial Risk Management**
Detailed analysis of the measurement of financial risk and the tools and techniques available to manage financial risk. Topics include financial disasters, risk measurement (market, default, currency exchange, value-at-risk) and the hedging of these risks.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** FIN 3000 or EC 3400

**FIN 4700 - Global Finance**
Studies international financial systems and markets. Covers the principle of comparative advantage, balance of payments, exchange rate systems, theories of international finance, identification of international risk exposures, the management and treatment of risk, and special topics of international finance.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** BA 3400 or EC 3400 or FIN 3000

**FIN 4801 - Applied Portfolio Management I**
Covers issues in the managment and administration of investments in an institutional setting. Students form a new investment firm and manage a real portfolio of financial assets.
**Credits:** variable to 3.0
**Semesters Offered:** Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FIN 4802 - Applied Portfolio Management II**
Covers issues in the management and administration of investments in an institutional setting. Students form a new investment firm and manage a real portfolio of financial assets.
**Credits:** variable to 3.0
**Semesters Offered:** Fall
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FIN 4803 - Applied Portfolio Management III**
Covers issues in the management and administration of investments in an institutional setting. Students form a new investment firm and manage a real portfolio of financial assets.
**Credits:** variable to 3.0
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FIN 4990 - Special Topics in Finance**
Examines current issues in Finance and other topics of interest to faculty and students in greater depth.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Pre-Requisite(s):** EC 3400 or FIN 3000

## Forest Resources & Environmental Science

**FW 1035 - Wood Anatomy and Properties**
An introduction to the anatomical and physical nature of woody materials and how these characteristics are related to its applications as a sustainable raw material.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring

**FW 1050 - The Natural Resource Professional**
Seminar introduces students to the various careers within forestry, conservation, ecology, and wildlife that represent specialties within natural resources. Students explore natural resource issues around the world.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring

**FW 2010 - Vegetation of North America**
Identification of trees and shrubs. Study of seed dispersal, dormancy, and community ecology, with an emphasis on trees. Systematic study of the major forested vegetation types of North America.
**Credits:** 4.0
**Lec-Rec-Lab:** (2-0-4)
**Semesters Offered:** Fall

**FW 2030 - Natural Resources Conservation**
This course explores the history and evolution of conservation in thought and practice, with an emphasis on the writings and legacy of conservation pioneers such as Aldo Leopold.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FW 2051 - Field Techniques**
Equipment and techniques used in forestry, wildlife, ecology, and recreation management. Topics include field safety, land measurement and navigation, establishment of sample locations, measurement of attributes of individuals and groups of trees, vegetation and other organisms.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Fall

**FW 3010 - Practice of Silviculture**
Methods of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis. Course held at Ford Center, Alberta, MI.
**Credits:** 4.0
**Lec-Rec-Lab:** (2-1-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Forestry, Wildlife Ecology & Mgmt, App Ecol & Environ Sci
**Pre-Requisite(s):** FW 2010 and FW 2051

**FW 3012 - Survey of Silviculture**
An introduction to the practice of silviculture including ecological principles which form the basis for forest management. The course emphasizes proper use of silviculture terminology and includes field examples of management practices. Course held at Ford Center, Alberta, MI.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, Natural Resources Management, App Ecol & Environ Sci, Forestry
**Pre-Requisite(s):** FW 2010 and FW 2051

**FW 3020 - Forest Ecology**
Environmental factors and plant and animal characteristics which control composition, structure, and function of forest ecosystems. Emphasis on how ecosystems change across space and time and knowledge needed to sustainably manage forest ecosystems for social, economic, and ecological benefits.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** FW 2010(C) and FW 2051(C)

**FW 3075 - Introduction to Biotechnology**
The course covers basic concepts and practical applications in biotechnology. Topics include the use of biotechnology in agriculture, healthcare, and environmental remediation. Advances in gene containment, regulatory, societal and environmental issues associated with commercialization of biotechnological products will be discussed.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**FW 3097 - Forest Biomaterials**
Examines the nature and use of forest biomaterials and their role in the larger economy. Local and global advantages and challenges for using forest biomaterials will be addressed within the context of sustainability, covering topics such as economics, material and product engineering, policy, life cycle analysis, and supply chain management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall

**FW 3098 - Adding Value to Forest Biomaterials**
Examines how forest biomaterials are converted from raw forms into intermediary or final products that can support a sustainable future. Manufacturing sites in the upper Midwest are visited during the week prior to the start of fall semester. Lecture topics include the forest bioeconomy, emerging and export markets, and industry challenges.
**Credits:** 2.0

**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** FW 1035

**FW 3110 - Natural Resource Policy**
Covers concepts related to social systems and natural resources. Offers a survey of natural resource policies and organizations. State and federal levels of policymaking will be linked to the human values, attitudes, and beliefs that set the context for natural resource policy processes.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring, Summer

**FW 3111 - Wild Foods: Nothern Forests**
This class engages students in learning practical skills utilizing vegetation of the Boreal Forest for food, medicines, and utilitarian purposes. Emphasis is on exploring the wisdom of the Indigenous peoples of this region. The course provides a basic overview of cultural and historical importance of the interactions between people and plants.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-1)
**Semesters Offered:** Summer

**FW 3116 - Ethnobotany**
The development and variety of plant use across cultures, the transition to commercialization of plants, how current uses are tied to traditional uses, and methods of ethnobotanical research.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FW 3150 - Timber Harvesting**
Methods and techniques used in timber harvesting systems. Emphasizes best management practices, aesthetic and ecological impacts, logging cost analysis, timber appraisal, and timber sale preparation and administration. Course held at Ford Center, Alberta, MI.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Forestry
**Pre-Requisite(s):** FW 2051

**FW 3170 - Land Measurements and GPS**
Introduces field measurements and computations involved in determining direction, distance, and area. Covers the hand compass, pacing, and use of GPS, including differential correction. Integration of GPS data with GIS is emphasized. Course held at Ford Center, Alberta, MI.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, Natural Resources Management, App Ecol & Environ Sci, Forestry
**Co-Requisite(s):** FW 3190
**Pre-Requisite(s):** FW 3540

**FW 3180 - Geomorphology, Landscapes and Ecosystems**
Provides basic understanding of the geologic and glacial processes that shaped the landscape of the Upper Midwest influencing the distribution and productivity of modern-day plant communities. Topics include geology of Michigan, glacial geomorphology, soil development, landscape and community ecology, and forestry. Course held at Ford Center, Alberta, MI.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Natural Resources Management, Wildlife Ecology & Mgmt, App Ecol & Environ Sci; May not be enrolled in one of the following Class(es): Freshman

**FW 3190 - Multi-resource Assessment**
Develops a basic proficiency in the application of multiple-resource measurement techniques. Gain familiarity with the application of individual tree and landscape measurements as well as estimation of growth, sampling techniques, computational procedures, and mapping procedures commonly used in forest and land management. Course held at Ford Center, Alberta, MI.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-4)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, Natural Resources Management, App Ecol & Environ Sci, Forestry
**Pre-Requisite(s):** FW 2051 and FW 3020 and FW 3200 and (MA 2710 or MA 2720 or MA 3710)

**FW 3200 - Biometrics and Data Analysis**
Sampling design, implementation and analysis for inventory and monitoring of attributes of stands, forests and landscapes. Includes computing skills for data entry, storage and analysis and application of statistical techniques to answer questions about ecological data.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FW 2051 and (MA 2710 or MA 2720 or MA 3710)

**FW 3313 - Sustainability Science**
Foundational scientific concepts (dynamic systems and catastrophe theory) as applied to socioecological systems. Use of indicators and indices to track progress towards sustainability goals. Review of local, national, and global sustainability policies to avoid catastrophes and guide sustainable development.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FW 3320 - Fundamentals of Forest Genetics and Genomics**
This course will teach fundamental and applied genetic principles that are essential for management of forest and other ecosystems to maintain their long-term health and sustainability. The class will cover the following topics: structure and function of DNA, inheritance, molecular evolution, population and quantitative genetics, gene conservation, genomics and biotechnology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FW 3330 - Soil Science**
Introduction to the chemical, physical, and biological properties of soil.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** CH 1112(C) or (CH 1150(C) and CH 1151(C))

**FW 3376 - Forest & Environmental Resource Management (The FERM) I**
Application of forest and environmental management practices by teams of students with the assistance of faculty, staff and representatives of state, federal and corporate land management groups as well as non-governmental organizations.
**Credits:** 2.0; May be repeated
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** FW 2010 and FW 2051

**FW 3377 - Forest & Environmental Resource Management (The FERM) II**
Application of forest and environmental management practices by teams of students with the assistance of faculty, staff, and representatives of state, federal, and corporate land management groups as well as non-governmental organizations.
**Credits:** 3.0; May be repeated
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** FW 2010 and FW 2051

**FW 3410 - Conservation Biology**
Introduction to biological, social, political, and economic facets of conservation biology. Emphasizes evaluation of how best to maintain and restore biodiversity through management of populations and ecosystems. Topics include mass extinctions, global change, loss and degradation of habitat, and over exploitation of biological resources.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**FW 3510 - Outdoor Recreation and Tourism**
Covers background on Americans and leisure; overview of primary providers of recreation in the US; management of outdoor recreation, measuring and valuing outdoor recreation and tourism; recreation and tourism in the Great Lakes region. Requires participation in field trips/workshops.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Spring

**FW 3540 - An Introduction to Geographic Information Systems for Natural Resource Management**
The fundamentals of GIS and its application to natural resource management. Spatial data, its uses and limitations are evaluated. Students work extensively with the ARCGIS software package.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2710(C) or MA 2720(C) or MA 3710(C) or ENVE 3502 or CEE 3502(C)

**FW 3600 - Wildlife Habitat**
Understand the ecological basis for management of forest wildlife and how forest management influences wildlife populations. Laboratory introduces techniques in wildlife research and management, especially methods of habitat analysis. Course held at Ford Center, Alberta, MI.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, Natural Resources Management, App Ecol & Environ Sci, Forestry; May not be enrolled in one of the following Class(es): Freshman

**FW 3610 - Ornithology**
An ecological and evolutionary approach to the study of birds. Topics include behavioral, anatomical, and physiological adaptations to flight, life history, mating systems, migration, communication and conservation. Laboratory emphasizes identification and experimental use of birds as model organisms.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 1040 or BL 1020

**FW 3620 - Field Ornithology**
An introduction to field techniques and identification. Weekend trip to Whitefish Point Bird Observatory during spring migration and field note taking.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Summer

**FW 3640 - Aquatic Ecosystems**
Students will be introduced to aspects of lake and stream ecosystems. Field trips will focus on sampling abiotic and biotic characteristics of aquatic ecosystems especially in regard to land use and management and conservation. Course held at Ford Center, Alberta, MI.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Natural Resources Management; May not be enrolled in one of the following Class(es): Freshman

**FW 3760 - Human Dimensions of Natural Resources**
Uses sociological concepts to cover facets of human relationships to natural resources, including human values, beliefs, and attitudes regarding the environment; rural resource-dependent communities; natural resource professions and expert knowledge; and the history of American perspectives on the environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FW 3765 - Maple Syrup Management and Culture**
Overviews cultural and historical importance of syrup production. Topics include methods of collecting and processing sap, syrup, sugar, and business marketing of maple products. Course includes one day field experience.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**FW 3800 - Insect Ecology**
Insects are widespread and diverse components of terrestrial and aquatic ecosystems. This course will consider aspects of insect ecology, including biodiversity and conservation of insects, the effects of biotic and abiotic factors on insect populations, and the trophic diversity of insects. Course held at Ford Center, Alberta, MI.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-1-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, App Ecol & Environ Sci

**FW 3840 - Forest Health**
Drawing on examples from the Great Lakes region, and other parts of North America, this course will consider which type of insects and pathogens attack our trees and forests, how they interact with each other, and what tools we can use to effectively reduce their negative impacts of forest pests. Course held at Ford Center, Alberta, MI.
**Credits:** 3.0
**Lec-Rec-Lab:** (1-1-3)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, Natural Resources Management, App Ecol & Environ Sci, Forestry
**Pre-Requisite(s):** FW 3020

**FW 4000 - Professional Experience Program**
Students create oral/written reports and reflection based on paid or volunteered work or field experience in natural resources.
**Credits:** 1.0; Repeatable to a Max of 4
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required

**FW 4080 - Forest Economics & Finance**
Financial analysis and economic theory applied to forestry project analysis and selection, focusing on prices. Covers risk, capital markets, taxation, auctions, and non-market valuation.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FW 4082 - Gene Expression Data Analysis**
This course is designed for students majoring in molecular biology, computer science, data science and related majors to develop fundamental but essential skills for manipulating, preprocessing, and analyzing high throughput gene expression data for pattern extraction and knowledge discovery.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** FW 4099 or CS 1121 or CS 1122 or CS 1131 or CS 1141 or CS 2321

**FW 4099 - Programming Skills for Bioinformatics**
Students will learn computer programming skills in Perl for processing genomic sequences and gene expression data and become familiar with various bioinformatics resources.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** CS 1121

**FW 4110 - Tree Seedling Production and Greenhouse Management**
Demonstrates greenhouse culture of trees from seed or vegetative cuttings. Topics include production of containerized seedlings; vegetative propagation via budding, grafting, and rooting of cuttings; and genetic manipulation. Students have hands-on roles in the routine greenhouse culture, such as media preparation, pest management, and fertilization.
**Credits:** variable to 4.0
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FW 4120 - Tree Physiology**
A study of tree structure, growth, development and function, and how these are related to the environment. We will focus on the cycling of water, carbon, and nutrients within the context of global change.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FW 4128 - Conservation Genetics**
This course explores how genetic variation and its loss affect the ability of natural populations to adapt to changing environments. The relevance for the long-term conservation of animal and plant populations is highlighted.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**FW 4140 - Stand & Forest Modeling**
Use of models that simulate tree, stand, and forest development. Emphasis on critical evaluation of model designs, outputs, uses in silvicultural decision-making, and forest to landscape management and planning.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** FW 3010 or FW 3012 and FW 3540(C)

**FW 4150 - Forest and Natural Resource Management**
Focuses on forest and natural resources management planning and decision making. Emphasizes structured problem solving frameworks and decision support tools/models. Three field trips to meet with natural resources professionals and discuss site-specific management issues and approaches.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** FW 3010 or FW 3012

**FW 4151 - Advanced Timber Harvesting**
Quantitative methods for evaluation of time harvesting systems, equipment, and transportation. Emphasizes detailed logging cost analysis, machine rates, depreciation, productivity, and optimization. Includes use of software, GIS, and systems of equations.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Forestry
**Pre-Requisite(s):** FW 3150

**FW 4170 - Consulting Forestry**
For students who are considering consulting forestry as a career. Covers issues specific to working with private landowners, stewardship plan writing, choosing a business entity, marketing, taxes, income/expenses, insurance, timber sale administration, and resolving landowner disputes.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring

**FW 4180 - Natural Resources, Ethics, and the Environment**
Discusses relationship between ecological science and environmental ethics as it relates to natural resource management.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FW 4220 - Wetlands**
Study of the physical, chemical, and biological characteristics of wetlands. Describes functions and values of individual wetland types. Presents management of wetlands and laws governing wetlands. Labs concentrate on field techniques used to assess specific plant, animal, soil, and hydrological characteristics of wetlands.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FW 4240 - Mammalogy**
Covers the classification, structure, and natural history of mammals, including physiological, behavioral, and ecological adaptations. Through laboratory and fieldwork, emphasizes field techniques and the distribution and identification of mammals, especially those species found in the western Great Lakes.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 1020 or BL 1040

**FW 4250 - The Wolves and Moose of Isle Royale**
Wolves and moose have been studied for 50 years on Isle Royale, a wilderness island in Lake Superior. The instructor leads this research and uses the research to explain predation, population dynamics, conservation genetics, and other ecological principles.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-1-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**FW 4260 - Population Ecology**
Covers the principles of population ecology. Topics include measures of populations, population dynamics, and models used to describe the theories related to population dynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**FW 4300 - Introduction to Wildland Fire**
An introduction to wildland fire based on an understanding of fire history, fuel properties, fire weather, fire behavior, ecological effects and management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** FW 3020 and (FW 3010 or FW 3012)

**FW 4370 - Forest and Landscape Hydrology**
The course will use a process-based approach to present the physical hydrology, geomorphology and water quality of forested watersheds. Course focuses on the interaction between watershed processes and forest management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FW 4371 - Snow Hydrology**
This course will cover snow formation in the atmosphere, snow accumulation and distribution, snow metamorphism, avalance dynamics, snowmelt and runoff, remote sensing of snow properties, and the impact of forests and under-snow biogeochemical processes.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** MA 2710 or MA 2720

**FW 4380 - Landscape Ecology and Planning**
Basic principles of landscape ecology, including pattern, process, and scale. Students will learn how to use quantitative tools to study landscape-scale patterns and processes, and how to apply these principles and tools to conservation, resource management, and planning issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FW 4400 - Urban Forestry**
Urban forestry is the science and art of managing natural resources in communities. It focuses on maximizing the wide range of economic, environmental, and social benefits associated with trees and urban greenspaces while minimizing maintenance costs and reducing tree-related risks.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**FW 4401 - Urban Forestry Lab**
The urban forestry field lab is a two-day tour held in Chicago for students to interact with and learn from professionals in the green industry, arboriculture, and urban forestry. It coincides with the Midwest Urban Tree Care Forum in mid-April.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FW 4400(C)

**FW 4500 - Independent Study**
Guided study or research on an approved forest resource or other natural resource topic with a chosen faculty member.
**Credits:** variable to 7.0; Repeatable to a Max of 7
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**FW 4540 - Remote Sensing of the Environment**
Remote sensing principles and concepts. Topics include camera and digital sensor arrays, types of imagery, digital data structures, spectral reflectance curves, applications, and introductory digital image processing.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**FW 4545 - Map Design with GIS**
Principles of making maps, from traditional to advanced visualization techniques, that convey information which is useful in decision making at many levels. Focus will be on creating maps using GIS software and digital data. A working knowledge of ArcMap is required.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-3)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** FW 3540 or FW 5550

**FW 4610 - Wildlife Ecology**
Covers the ecological basis for management of wildlife, including biological and sociological factors that influence management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 3400(C) or FW 3020(C)

**FW 4620 - Herpetology**
The biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior and physiology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** BL 1040 or BL 1020

**FW 4710 - Environmental Biogeochemistry**
Impacts of decisions regarding landuse, land management, and energy and mineral exploration on natural resources (i.e., air, water, land, and biodiversity) are discussed using the framework of the biogeochemical cycles of the elements.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CH 1150

**FW 4800 - Communication for Natural Resource Professionals**
This class completes the development of oral and written communication skills for students as they prepare to graduate and gain employment in the field of natural resources.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-1-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** FW 3190

**FW 4810 - Integrated Resource Assessment**
Provides a capstone experience by integrating techniques from many of the forestry, applied ecology, wildlife ecology, and management core courses. Covers multi-resource inventory of forested landscapes evaluation of forest parameters and the development of management plans for various natural resource alternatives.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-2-4)
**Semesters Offered:** Fall
**Pre-Requisite(s):** FW 3190

**FW 4811 - Integrated Resource Assessment Data Collection**
Students will collect field data needed for writing their Integrated Resource Assessment management plans. Field skills and ability to summarize and display data will be assessed. Students will develop appropriate sampling designs, collect needed field data with acceptable error limits, and summarize the data.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Wildlife Ecology & Mgmt, Natural Resources Management, App Ecol & Environ Sci, Forestry
**Pre-Requisite(s):** FW 3190

**FW 4830 - Integrated Natural Resource Assessment**
Course provides a capstone experience by integrating techniques from many of the forestry, applied ecology, wildlife ecology, and natural resources management core courses. Culminates in the development of management plans for various natural resource alternatives.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** FW 4811

**FW 4840 - Senior Research Thesis**
An independent study or research project on an approved topic in Forestry, Applied Ecology and Environmental Sciences, Wildlife Ecology, or Natural Resource Management, under the guidance of a faculty member. Available only to students in their graduating year.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** FW 3190

## Geological & Mining Engineering & Sciences

**GE 1100 - Geological Engineering and Sciences Orientation**
Introduction to geosciences as a profession, including discussions of career opportunities and geoscience programs. Earth materials and the earth's processes are also introduced. Includes frequent field trips. Intended for freshman or sophomore students in geological engineering, geology, applied geophysics, hydrology, geotechnics, earth science teaching, or any other geoscience program.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Geological Engineering, Sciences & Arts Undeclared, Engineering Undeclared, General Sciences and Arts, Applied Geophysics, Geology; May not be enrolled in one of the following Class(es): Junior, Senior

**GE 2000 - Understanding the Earth**
Introduction to materials and processes that shape the earth we live on. Lecture and laboratories acquaint students with minerals, rocks, earth resources, weathering, geologic time, landslides, groundwater, streams, shorelines, deserts, glaciers, geologic structures, earthquakes, plate tectonics, and the dynamics of the earth's crust, mantle, and core.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall, Spring

**GE 2020 - Introduction to Mining Engineering and Mining Methods**
Learn how various mining components, from prospecting to financing to reclamation, fit together. Includes advantages and drawbacks of different mining methods and their selection. Introduces ethics and professional development. Use of basic computer and mine design software.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2005-2006 academic year

**GE 2100 - Environmental Geology**
Introduction and study of current environmental issues related to the earth sciences. Covers major topics such as volcanism, earthquakes, shoreline erosion, and pollution of groundwater as multi-week modules with associated labs, lectures, and field projects.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**GE 2300 - Mineral Science**
Introduction to the study of minerals including chemical composition, crystal structure, physical properties, identification, and controls on and environments of formation. Laboratory focuses on hand specimen identification of minerals and includes introduction to X-ray diffraction and SEM mineral analysis techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** CH 1000 or CH 1112 or (CH 1150 and CH 1151)

**GE 2310 - Introduction to Petrology**
Identification, physical properties, chemical composition, occurrence, and origin of the important types of igneous, sedimentary, and metamorphic rocks. Laboratory includes hand specimen description and identification of rocks.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 2300

**GE 2320 - Mining Methods and Systems**
This course presents a study of the surface and underground mining methods practiced in coal, metal, and aggregate mine operations, classification of mining methods, support design and equipment selection, general mine planning requirements, mine development sequence, cycle of operations, and method application.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 2020

**GE 2500 - Introduction to Oceanography**
Effect of waves, tides, currents, natural hazards along shorelines, and air-sea interactions on the climate.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring

**GE 2640 - Atmospheric Observations and Meteorology**
Introduction to fundamentals of atmospheric science and meteorology through direct observations of the atmosphere.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2002-2003 academic year

**GE 3040 - Fundamentals of Applied and Environmental Geophysics**
An introduction to geophysical used in applied and environmental geophysics concentrating on the fundamentals of data reduction and interpretation. This course is not only pertinent for the practicing geoscientist but also for environmental engineers, civil engineers, and others interested in learning how physics can be used to investigate Earth's substance.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 2200

**GE 3050 - Structural Geology**
Rock structures and regional settings resulting from the application of deforming forces, including the geometry, origin, and mechanics of folds, foliations, lineations, faults ad joints, and structures in orogenic belts.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 2000

**GE 3100 - Depositional Systems**
Introduction to sedimentary processes and their products. Investigates the physical processes controlling sedimentation along with principles of correlation and interpretation of strata. Focuses on interpreting sedimentary rocks as a record of climate, sea-level and tectonic change.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** GE 2000 and GE 2310

**GE 3200 - Geochemistry**
Introduction to elements of modern geochemistry including aqueous solutions, isotopes, age dating, etc. Emphasizes concepts and quantitative methods. Teaches principles of thermodynamics and phase equilibria from an introductory perspective as they pertain to geologic systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 1150 and CH 1151

**GE 3250 - Computational Geosciences**
Introduction to quantitative analysis and display of geologic data using R/Matlab, covering basic R/Matlab syntax and programming, and analysis of one-dimensional (e.g. time series) and two-dimensional datasets (i.e. spatial data). Techniques are applied to geological datasets.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** MA 1160 or MA 1161

**GE 3320 - Earth History**
This course covers the history of the Earth from 4.5 billion years to the present. Plate tectonics is the organizing theme with emphasis on recognizing and evaluating the evidence for the major reorganizations of the Earth's crust.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** GE 2000 or GE 2100

**GE 3400 - Drilling and Blasting**
Rock penetration and fragmentation methods to include boring, cutting, drilling, and blasting techniques. Design of surface and underground blasting rounds. Formulation of design criteria to minimize the adverse effects of blasting. Field demonstration in the design, monitoring, and evaluation of blasts.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2006-2007 academic year
**Pre-Requisite(s):** GE 2020 and PH 2100

**GE 3410 - Mine Safety & Health Cert**
Principles of health and safety in mine practice, hazard recognition, and preventive and corrective actions.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Summer

**GE 3430 - Geomechanics Laboratory**
This course includes laboratory experiments to determine physical and mechanical properties of rocks including harness, tensile and compressive strength and stress, point load index, tri-axial tests, and slake durability test,
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** GE 2020 and GE 2320

**GE 3850 - Geohydrology**
Geologic and hydrologic factors controlling the occurrence, movement, and development of subsurface water. Quantitative methods for analyzing groundwater systems are introduced.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall, Spring

**GE 3860 - Engineering Geology and Geoinformatics**
Engineering geology relates the geologic factors with the location, design, construction, and maintenance of engineering projects and ensures they are accounted. Students will also be introduced to the fundamental concepts and components of geographic information systems (GIS) for engineering.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Fall
**Pre-Requisite(s):** GE 2000 or GE 2100 and (GE 3050 or ENG 2120 or MEEM 2150)

**GE 3870 - Resource & Reserve Estimation**
This course covers the classification of resource and reserve; resource estimation algorithms; linear, nonlinear, and indicator kriging; stochastic simulation; variogram modeling; block-variance relationship; recoverable reserve; and introduction to resource estimation software.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** GE 2020 and MA 3710

**GE 3880 - Mine Planning and Design**
Course provides the basics of mine planning, feasibility study, block modeling, economic analysis, cost estimation and price forecasting, mining method selection algorithms. Introduction and hands-on experience with mine planning and design software including Surpac, Vulcan, and Whittle.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 2320 and GE 3400 and GE 3870

**GE 3900 - Field Geophysics**
Introduction to field geophysical techniques including basic land surveying. Emphasizes the recording, reduction, presentation, and interpretation of gravity, magnetic, electrical, seismic, and electromagnetic data as well as the proper use, care, and calibration of equipment used to collect the data. Requires report writing. Students must provide their own transportation.
**Credits:** 5.0
**Lec-Rec-Lab:** (0-0-15)
**Semesters Offered:** Summer
**Restrictions:** Permission of department required
**Pre-Requisite(s):** GE 3040

**GE 3910 - Field Geology with Engineering Applications**
Introduction to methods and problems of field geology, interpretation of field relationships, and engineering site investigation. Field areas are located in northern Michigan. Requires geological and/or engineering report and memo writing.
**Credits:** 5.0
**Lec-Rec-Lab:** (0-0-15)
**Semesters Offered:** Summer
**Restrictions:** Permission of department required
**Pre-Requisite(s):** GE 2000 and GE 2310 and GE 3050

**GE 3915 - Introduction to Field Geology**
An introduction to geologic field mapping and site investigations. Requires geological and/or engineering report and memo writing.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-9)
**Semesters Offered:** Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Geological Engineering, Applied Geophysics
**Pre-Requisite(s):** GE 2000 and GE 2310 and GE 3050

**GE 4000 - Earth Science Teaching Experience**
Development of earth science teaching skills through assisting in instruction in a geology course laboratory. Students gain experience in organizing, preparing, and presenting earth science topics and answering questions.
**Credits:** variable to 3.0; Repeatable to a Max of 3
**Semesters Offered:** On Demand

**GE 4130 - Petroleum Geology**
Basic elements of petroleum geology, including the composition of crudes, exploration, subsurface techniques, petroleum migration, seals, traps, and types of gas and oil plays. Students will study geologic factors that control the genesis of major gas and oil fields, such as the Persian Gulf, California, and US Gulf Coast.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 2000 and GE 2300 and GE 2310

**GE 4150 - Natural Hazards**
This course focuses on current mitigation agencies and warning systems, case studies of successes and failures in hazard mitigation, and technical tools for hazard study and mitigation such as satellite remote sensing and GIS.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** GE 2000 or GE 2100

**GE 4180 - Volcanology**
Volcanoes and how they work. Volcanic eruption styles and products, their recognition, and significance. Volcanic hazards, volcano monitoring and impacts of volcanism on the environment, climate and society. Applies chemistry, physics, and fluid mechanics in a volcanological context.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** GE 2000 and (MA 1160 or MA 1161)

**GE 4190 - Magma Reservoir Dynamics**
Introduction to topics in advanced igneous petrology emphasizing processes that occur in magma reservoirs. Includes the application and integration of geochemistry, petrology, and geochronology to investigate magma dynamics and their influence on frequency, style, and magnitude of eruptions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** GE 2300 and GE 2310

**GE 4240 - Surface Geophysics**
Application of near surface geophysical methods to environmental and geological investigations through field work and case studies. An emphasis will be placed on ground penetrating radar, but will include other methods such as electrical resistivity, induced polarization, magnetics, and horizontal loop electromagnetics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** GE 3040 and GE 3900

**GE 4250 - Fundamentals of Remote Sensing**
This course focuses on the basic physics behind above- surface remote sensing and remote sensing systems. Topics covered include: properties of the atmosphere, absorption and scattering of electromagnetic radiation, instrument design, data acquisition and processing, validation, and basic applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** PH 2200 and MA 2160

**GE 4290 - Mine Ventilation, Health, and Safety Engineering**
Course deals with an introduction to mine ventilation, properties of air, gases, and dust, mine fans and its applications, flow distribution in mine network, computer analysis of ventilation network, mine health and safety overview, health and safety culture and practice.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-9)
**Semesters Offered:** Summer - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** GE 2020 and GE 2320 and ENG 3200

**GE 4360 - Materials Handling**
Surface and underground materials handling methods. Selection and performance analysis of materials handling equipment. Computer applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** PH 2100

**GE 4500 - Plate Tectonics and Global Geophysics**
Plate tectonics and the internal structure of the earth using information from seismology, geomagnetism, gravity, and heat flow.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3160 and PH 2200 and GE 2000

**GE 4504 - Air Quality Engineering and Science**
Overview of air quality regulation in the U.S. and world, including basic concepts of atmospheric chemistry and transport; futitive, point, and air emissions; principles and tradeoffs of operation and design of air pollution control systems; and application of air quality models.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** ENVE 3501 or ENVE 3503 or CEE 3501 or CEE 3503

**GE 4530 - Planetary Geology & Geophysics**
Geological, geophysical, and geochemical processes in the Solar System are examined. Topics include the formation and evolution of the Solar System, planetary surface processes and water distribution, impact structures, composition, structure, and dynamics of planetary interiors, geophysical exploration of planets.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** GE 2000 and PH 2200 and MA 2160

**GE 4560 - Earthquake Seismology**
Course covers fundamentals of the physics of earthquakes and seismic energy propagation, and seismic methods to determine Earth structure. Emphasis is placed on natural source techniques, with extension to exploration applications. Weekly labs apply techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** GE 3050 and PH 2100 and MA 3160

**GE 4600 - Reflection Seismology**
Principles of reflection seismic techniques, including theoretical background and application, and hands-on computer projects. Included are acquisition, data processing, and 2D/3D data interpretation. Students conduct projects using actual commercial-quality seismic data.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 3040

**GE 4610 - Formation Evaluation and Petroleum Engineering**
Principles and practice of formation evaluation, primarily through analysis of well logs and the principles and practice of petroleum engineering. Emphasizes reservoir engineering and simulation. Students conduct projects using actual field data.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Fall, Spring

**GE 4620 - Energy Economics**
Introduction to the institutional, technical, and economic issues of the production and use of energy resources, including petroleum, natural gas, coal, nuclear, electric utilities, and alternative energy sources. Applies economic analysis to industrial and policy problems of the supply, distribution, and use of energy resources, including environmental and social consequences.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** EC 2001 or EC 3002 or EC 3003

**GE 4630 - Mineral Industry Economics**
Studies the role of minerals and metals in society and the economics of their use. Applies economic principles to examine the supply, demand, markets, and foreign trade for important minerals and metals. Examines the effect of government policies on the minerals industries. Requires a technical report.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2009-2010 academic year
**Pre-Requisite(s):** EC 2001 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**GE 4640 - Fundamentals of Atmospheric Science**
Fundamental principles of atmospheric science, including thermodynamics, aerosol and cloud physics, radiative transfer, and atmospheric dynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** (PH 2200 or PH 2260) and (PH 1360 or PH 2300) and MA 3160 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**GE 4680 - Operation Research for Mining Engineers**
This course introduces the statistical analysis of mining data, statistical decision making of mining projects, random number generation, Monte Carlo methods, simulation methods, linear and integer programming, queueing theory, stochastic-process, PERT and CPM, applications of operations research (OR) in mining and mineral industry.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** GE 2020 or GE 2320

**GE 4690 - Discrete Event Simulation and Animation for Engineers**
This course focuses on discrete-event system simulation and animation techniques in modeling engineering projects, in particular mining projects.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** GE 2020 and GE 2320 and GE 3870

**GE 4700 - Geologic Mapping of Remote Terrain**
An introduction to the use of GIS (Geographic Information Systems) in geologic mapping. Uses remotely acquired data (e.g. LandSat) to produce geologic maps, cross sections, and make measurements such as strike and dip. Students work with both public domain programs (QGIS) and commercial packages (Arc Map) and emphasize the GIS aspects.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Spring

**GE 4720 - GIS Applications in Geology**
An introduction to the application of GIS to the geological sciences with emphasis on the characterization of rocks, minerals, and geologic structures using satellite imagery and elevation (DEM) data. Students will work with modern GIS software packages.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-1)
**Semesters Offered:** Fall
**Pre-Requisite(s):** GE 2000

**GE 4735 - Igneous Petrology**
An examination of the origin of a variety of igneous rocks from different tectonic environments using geochemistry, mineralogy, and rock textures.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** GE 2300 and GE 2310

**GE 4760 - Geology and Exploration for Mineral Deposits**
Geology, geologic evaluation, and exploration for mineral resources with emphasis on metals. Course covers geologic characteristics of a variety of classes of mineral deposits, design of exploration programs, design of drilling programs, concepts of resource estimation, and reporting requirements. Laboratory includes study of specimens from specific localities and simulated subsurface exploration.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** GE 2310 and GE 3050 and GE 3910

**GE 4800 - Groundwater Engineering**
Application of geohydrology principles to design water-well supplies, site investigations, and subsurface remediation systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** GE 3850

**GE 4860 - Computer Methods for Slope Stability and Geomechanics**
Computer methods for the design problems encountered in geomechanics. Applications to be selected from slope stability, earth retention systems, and seepage. Students will be introduced to limit equilibrium and finite element analysis through theory and computational labs.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** GE 3860 or CE 3810 or CEE 3810

**GE 4900 - Capstone I**
Capston engineering design course focusing on a realistic, complex, open-ended engineering problem. Project includes technical design, economic analysis, environmental impacts, and regulations. Report writing required. (Senior project ready as defined by major substitutes for prerequisites).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**GE 4910 - Capstone II**
Capstone engineering design course focusing on a realistic, complex, open-ended engineering problem. Project includes technical design, economic analysis, environmental impacts, and regulations. Report writing required. (Senior project ready as defined by major substitutes for prerequisites).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** GE 4900

**GE 4916 - Field Geology in East and South Africa**
Introduction to methods and problems of field geology. Data gathering and interpretation of field relationships using Brunton, GPS LandSat, etc. in East Africa. Requires geological report and digital maps.
**Credits:** 6.0
**Lec-Rec-Lab:** (0-0-18)
**Semesters Offered:** Spring, Summer
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** GE 3050

**GE 4930 - Special Topics in Geological Engineering**
Study and discussion of geological engineering topics.
**Credits:** variable to 5.0; Repeatable to a Max of 10
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**GE 4931 - Special Topics in Geology**
Study and discussion of geology topics.
**Credits:** variable to 5.0; Repeatable to a Max of 10
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**GE 4933 - Special Topics in Geophysics**
Study and discussion of geophysics topics.
**Credits:** variable to 5.0; Repeatable to a Max of 10
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**GE 4934 - Special Topics in Mining Engineering**
Study and discussion of topics in mining engineering not included in regular undergraduate courses.
**Credits:** variable to 5.0; Repeatable to a Max of 10
**Semesters Offered:** On Demand

**GE 4961 - Independent Geology Research Project**
Approved literature, laboratory, and/or field geology research problem originated by the student or assigned by the instructor. A final report is required.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**GE 4962 - Independent Geophysics Research Project**
Approved literature, laboratory, and/or field geophysics research problem originated by the student or assigned by the instructor. A final report is required.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**GE 4970 - Special Topics in Global Environment Change**
Course will focus on emerging topics on global environment change including changes in atmospheric composition and air quality, air pollution meteorology, extreme meteorological events, and ocean chemistry. Anthropogenic contributions to these changes will be presented and analyzed. Students will work on projects based on historical records from multiple datasets to evaluate and appreciate the long-term changes in the global environment and better understand the perturbations due to human activities.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Fall, Spring

## Pavlis Honors

**HON 1150 - Creating Your Path**
This course will guide students in the application of life design methods to create a path toward achievement of personal education, career & life goals. By applying a combination of activities, discussion, & reflection to principals of design thinking, problem solving, creativity, & communication, students will develop a framework for life success.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required; Must be enrolled in one of the following Class(es): Freshman, Sophomore

**HON 2150 - Pavlis Seminar I**
The first of three seminars designed for the Pavlis Honors College Experiental Learning Communities. Students are introduced to program requirements and engage in an active and reflective learning environment to explore personal and social identities, teamwork, culture, and perspectives
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**HON 2200 - Leadership, Culture, and Technology**
This course provides students with an understanding of the nature and process of leadership, and an opportunity to assess personal leadership skills/potential and develop a personal model of leadership. Leadership in other cultures and use of appropriate technology will also be explored.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**HON 2990 - Interdisciplinary Special Topics in Honors**
Study of interdisciplinary special topics as specified by section title.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**HON 3060 - Honors Practicum**
Reflective practicum for students fulfilling the immersion requirement in a Pavlis Honors College Experiential Learning Community.
**Credits:** variable to 12.0; Repeatable to a Max of 12
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** HON 2150 and HON 3150

**HON 3150 - Pavlis Seminar II**
The second of three seminars designed for Pavlis Honors College Experiential Learning Communities. Students engage in telling their stories to different audiences, learn about personal leadership, and craft a personal leadership vision statement.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** HON 2150 and UN 1015 and (UN 1025)

**HON 3300 - Innovation through Human Centered Design**
This course introduces students to the processes and tools associated with Human Centered Design (HCD). HCD is a key process used in identifying needs/opportunities and innovative solutions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**HON 3410 - Culture, Language, & Project Development**
Course is designed to help students gain culture and language awareness for their int'l travel to project sites in Ghana, India, Tanzania, Brazil, or Senegal. Students will gain insight working with and learning from different cultures to see the world and their leadership in new ways and will refine/finalize projects they will implement in country.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**HON 3990 - Interdisciplinary Special Topics in Honors**
Study of interdisciplinary special topics as specified by section title.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**HON 4060 - International Leadership Practicum**
Students traveling internationally in the Pavlis program will plan and direct a project abroad and spend time abroad participating in a variety of leadership and cultural awareness experiences.
**Credits:** variable to 9.0
**Semesters Offered:** Summer
**Pre-Requisite(s):** UN 3410(C)

**HON 4070 - Leadership Practicum**
Course designed for students pursuing the Leadership Minor, allows for a non-international leadership practicum experience, and the practical application of leadership knowledge, skills and behaviors, and development of leadership experience. The practicum experience will be designed and implemented by the student, with mentorship/guidance from the associated faculty.
**Credits:** variable to 9.0
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** HON 2200 or MGT 3100 or AF 3001

**HON 4100 - Leadership Capstone Project I**
This course, designed for students in the Pavlis program, is the first in a two part leadership capstone experience. Students engage in discussions and make oral presentations, outline a senior project report, mentor other students and apply their leadership skills by taking on leadership roles.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** UN 4060

**HON 4150 - Pavlis Seminar III**
The final of three seminars designed for the Pavlis Honors College Learning Community. Students engage in difficult dialogues, decision making, critical thinking, ethics, and goal setting while they synthesize their honors college experience.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** HON 3150 and UN 1015 and (UN 1025)

**HON 4200 - Leadership Capstone Project II**
This course, designed for students in the Pavlis program, is the second in a two part leadership capstone experience. Students engage in discussions and make oral presentations, write a senior project report, mentor other students and apply their leadership skills by taking on leadership roles.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** UN 4060 and (HON 4100(C) or UN 4100)

**HON 4300 - Introduction to the Fundamentals of Social Innovation and Social Entrepreneurship**
In this introductory course, students will be exposed to the key concepts and practices around social innovation and entrepreneurship. They will learn about different approaches to social entrepreneurship and strengths and weaknesses of various models and strategies. All students will participate in the Social Innovation Challenge Competition at semester end.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**HON 4990 - Interdisciplinary Special Topics in Honors**
Study of interdisciplinary special topics as specified by section title.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

## Humanities

**HU 0110 - Undergraduate Student Coaching**
Schedule weekly appointments with a writing coach to strengthen writing and reading effectiveness in any course except Composition. Specialized assistance available to students who speak English as a Second Language, students who have learning disabilities and students who are undergraduate writing coaches. Credits do not count toward graduation.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer

**HU 0122 - Global Issues Study Team**
Students who are enrolled in Global Issues (UN1025) may sign up for a study team led by a writing center coach. Teams meet twice weekly. The meetings address the challenges of the Global Issues course as well as develop students' effectiveness working in teams. Strongly recommended for students with English/Reading ACT of 20 or below. Credits do not count toward graduation.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** UN 1025

**HU 0123 - Composition Coaching**
Scheduled weekly appointment with a writing coach to improve writing and reading effectiveness in Composition (UN1015). Strongly recommended for students with English ACT of 20 or below. Credits do not count toward graduation.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** UN 1015

**HU 0124 - Graduate Student Coaching**
Scheduled weekly appointment with a writing coach to improve writing and reading effectiveness in graduate courses and to address the challenges of writing theses and dissertations. Credits do not count toward graduation.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Level(s): Graduate

**HU 0125 - Int'l GTA Assistance Program**
International graduate students can enroll in HU0125 to work on cultural differences in presentation skills and to practice speaking instructional English. These students will meet weekly in group and individual settings to improve their facility as speakers of English. Credits do not count toward graduation.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Level(s): Graduate

**HU 2130 - Introduction to Rhetoric**
Focuses on historical origins, cultural adaptations, and contemporary relevance of rhetorical traditions.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**HU 2201 - Level I-A Chinese Language and Culture**
Introduction to basic Chinese grammar, vocabulary, and idiomatic expressions, designed to help students acquire the basics of oral and written Chinese. Includes study of contemporary Chinese culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Senior

**HU 2202 - Level I-B Chinese Language and Culture**
Further study of Chinese grammar, vocabulary, and idioms with emphasis on conversation and communicative strategies. Includes continued study of Chinese culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2201 or Language Placement Chinese >= 100

**HU 2241 - Level I-A Less Commonly Taught Languages**
Introduction to basic grammar, vocabulary, and idioms, designed to help students acquire the basics of oral and written communication. Includes study of cultures in which the language is spoken.
**Credits:** variable to 5.0
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Senior

**HU 2242 - Level I-B Less Commonly Taught Languages**
Further study of grammar, vocabulary, and idioms with emphasis on conversation and communicative strategies. Includes continued study of cultures in which the language is spoken.
**Credits:** variable to 5.0
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2241

**HU 2271 - Level I-A French Language and Culture**
Introduction to basic French grammar, vocabulary, and idioms designed to help students acquire the basics of oral and written French. Includes study of contemporary French-speaking cultures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Senior

**HU 2272 - Level I-B French Language and Culture**
Further study of French grammar, vocabulary, and idioms with continued practice of conversation and basic readings in French. Continued study of contemporary French speaking cultures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2271 or Language Placement French >= 131

**HU 2273 - Transitional Level I French Language and Culture**
Intensive study of basic French grammar, vocabulary, and culture. Designed to prepare students with minimum essentials of oral and written French for intermediate and advanced level work. Students completing this course may apply for placement credits.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** Language Placement French >= 201

**HU 2281 - Level I-A German Language and Culture**
Introduction to the basics of the German language, acquainting students with the essentials of oral and written German and introducing cultures and societies of contemporary German-speaking Europe.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Senior

**HU 2282 - Level I-B German Language and Culture**
Further study of the basics of the German language acquainting students with the essentials of oral and written German, with emphasis on conversational skills. Includes continued discussion of cultures and societies of contemporary German-speaking Europe.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2281

**HU 2291 - Level I-A Spanish Language and Culture**
Introduction to basic Spanish grammar, vocabulary, and idioms, designed to help students acquire the basics of oral and written Spanish. Includes study of contemporary Spanish-speaking cultures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Senior

**HU 2292 - Level I-B Spanish Language and Culture**
Further study of basic Spanish grammar, vocabulary, and idioms with continued practice of conversation and basic readings in Spanish. Continued study of selected Hispanic cultures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2291 or Language Placement Spanish >= 131

**HU 2293 - Transitional Level I Spanish Language and Culture**
Intensive review of basic Spanish grammar, vocabulary, and culture. Designed to prepare students with minimum essentials of oral and written Spanish for intermediate and advanced level work. Students completing this course may apply for placement credit.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** HU 2291 or Language Placement Spanish >= 201

**HU 2324 - Introduction to Film**
Focuses on critical engagement with cinematic form and its relationship to cultural, historical, and/or theoretical contexts.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall

**HU 2500 - Ways of Reading**
This course introduces students to reading strategies, critical vocabularies, and critical writing practices. Individual sections will center on a unifying question or problem, emphasizing attentive reading, critical thinking, and qualitative interpretation of literary texts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**HU 2501 - American Experience in Literature**
A survey of major works in American Literature from origins to the present. Focuses on historical trends in the development of literature and culture in the Americas with particular emphasis on the United States.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year

**HU 2503 - Introduction to Literature**
Survey of transnational or transatlantic literary traditions, highlighting select historical periods such as Romanticism, and/or movements, such as the Harlem Renaissance.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**HU 2505 - Science, Technology, and Humanities**
A survey using literary texts, narrative history, documentary evidence, film, music, and cross-cultural references to contextualize the emergence of scientific, technological, and humanistic developments in the modern era.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand - Offered alternate years beginning with the 2000-2001 academic year

**HU 2510 - Intro to Creative Writing**
An introduction to creative writing with readings in contemporary and emerging literatures. Genres covered may include fiction, nonfiction, poetry, and screenplay. This course stresses individual production through process-oriented writing exercises, small group workshops, individual conferences, and creative theory.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**HU 2538 - British Experience in Literature**
A survey of selected works of British literature from its origins to the present. Focuses on historical trends in the development of the English language and the cultures of Great Britain.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year

**HU 2548 - Young Adult Literature**
Reading, reflecting on, and responding to age-appropriate adolescent literature. Works include authors from different races, cultures, historical periods, and genders. Discussion may be supplemented with films. Appropriate for students who plan to be parents, community volunteers, and teachers.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**HU 2600 - Introduction to the Field of Scientific and Technical Communication**
An introduction to the history, theory, and practice of scientific and technical communication as preparation for future study.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Scientific & Tech Comm (BS), Scientific & Tech Comm (BA)

**HU 2632 - Fundamentals of Digital Photography**
Explores the history, aesthetics, theory, and practice of photography in the digital environment. Students learn in-depth digital camera and imaging production techniques. Students provide their own digital camera, preferably a digital SLR.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** On Demand

**HU 2633 - Fundamentals of Digital Imaging**
Explores the history, aesthetic, theory, and practice of digital imaging. Students learn to find, make, and analyze images.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Fall, Spring

**HU 2642 - Introduction to Digital Media**
Basic principles, practices and implications of digital media communication and production. Provides foundation in tools, techniques and processes through hands-on production, readings, discussion and analysis of contemporary issues related to digital media.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**HU 2645 - Graphic and Information Design**
A computer-intensive introduction to the principles for creating clear, effective graphic communication. Students critique the work of other designers in terms of the work's audience and intended effect, and they construct and critique their own design projects as well.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**HU 2700 - Introduction to Philosophy**
A study of thought representing various traditions such as classical and contemporary philosophy, Eastern and Western religion, and issues in recent science. Some basic concepts of logic are also examined. Emphasizes moral philosophy, including ethical relativism, utilitarianism, and Kantian ethics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**HU 2701 - Logic and Critical Thinking**
Introduction to everyday reasoning and formal logic. Important goal is to develop skills of argument identification, analysis, and evaluation. Students learn how to symbolize ordinary language statements and arguments and to determine their validity or invalidity using proof and truth-table methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand

**HU 2702 - Ethical Theory and Moral Problems**
An introduction to the major concepts and theories of normative ethics and metaethics and an examination of a variety of issues in applied ethics including poverty and economic justice, lying and truth-telling, euthanasia, sexual conduct, and issues in communication ethics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer

**HU 2810 - Research and Writing in Communication**
Prepare students to evaluate, design, and conduct research in communication. Develops research-related writing strategies and proficiency.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015(C)

**HU 2820 - Communication and Culture**
Introduction to the ways that communication creates and maintains culture. Considers a variety of perspectives on the significance of communication. Explores the importance of communication for understanding culture
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**HU 2830 - Public Speaking & Multimedia**
Introduces the fundamentals of public speaking and multimedia applications. Emphasis on speaking/listening competencies in face-to-face and digital environments using online and digital tools.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring

**HU 2910 - Language and Mind**
Linguistic study of structural and cognitive aspects of language. Examines language design: how sounds, words, sentences, and conversation create meaning; the relationship of language, brain, mind, and thought; the ability of humans, animals, and machines to acquire language.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall

**HU 2920 - Language and Society**
Examines how societies use and organize themselves with respect to language. Considers attitudes towards language standardization and dialectal variations within the US based on geography, class, ethnicity, gender, age, etc., and speakers' choices of how they present themselves linguistically.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring

**HU 3015 - Advanced Composition**
Advanced instruction in composing substantive arguments based on primary and secondary research. Multidisciplinary inquiry-based projects ask students to write for both academic and lay audiences in print and digital forms. Specific research methods, writing technologies, and topics vary by section.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3120 - Technical and Professional Communication**
A study of written and oral communication in technical and scientific environments; emphasizes audience, writing processes, genres of scientific and technical discourse, visual communication, collaboration, professional responsibility, clear and correct expression. Students write and revise several documents and give oral report(s). Computer Intensive.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3130 - Rhetoric of Science and Technology**
A study of contemporary theories of rhetoric and their application to interpreting and critiquing various forms of persuasive discourse, especially in science and technology.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3150 - Topics in Literacy Studies**
A study of how and why different groups of people use reading and writing differently in varying situations and in varying textual media. Topics may include the various ways texts function and reading is used; the authority of written texts; access to reading and writing and to various textual media.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3151 - The Rhetoric of Everyday Texts**
The examination and production of everyday texts such as social media, image-texts, web pages, signs, museum exhibits, architecture, and fashion in terms of their theoretical, historical, cultural, and technological contexts. Student should expect to produce "everyday texts" of their own as well as write about texts examined in the course.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3201 - Level II-A Chinese Language and Culture**
Review and continued study of listening, speaking, reading, and writing in Chinese. Students learn how to communicate in Chinese societies. Includes study of various aspects of the Chinese culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2202 or Language Placement Chinese >= 201

**HU 3202 - Level II-B Chinese Language and Culture**
Further study of Chinese language. Includes study of vocabulary, idioms, and sentences structure to improve conversational, reading, and writing abilities. Includes discussion of various aspects of Chinese culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3201 or Language Placement Chinese >= 301

**HU 3204 - Level III Topics in Chinese Literature and Culture**
Study of various genres of Chinese literature and of various aspects of Chinese society, emphasizing, historical and cultural backgrounds. Conducted primarily in Chinese.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3202 or Language Placement Chinese >= 401

**HU 3241 - Level II A Less Commonly Taught Language and Culture**
Review and continued study of listening, speaking, reading, and writing in less commonly taught language. Students learn how to communicate in target culture. Includes study of various aspects of the culture in which the language is used.
**Credits:** variable to 5.0
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2242

**HU 3242 - Level II B Less Commonly Taught Language and Culture**
Further study of less commonly taught language. Includes study of vocabulary, idioms, and sentence structure to improve converstional reading and writing abilities and discussions of various aspects of culture in which the language is used.
**Credits:** variable to 5.0
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3241

**HU 3253 - World Literatures & Cultures**
Comparative approach to world literatures and cultures. May include literary works, critical essays, films, music, and other representations of world culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3261 - Topics in Communicating Across Cultures**
Examines communication practices and styles across selected cultures and multicultural groups, drawing on an interdisciplinary range of research fields. May address social issues, language and cultural differences, gender, race, ethnicity, class, disabilities, age, religion, family and national identity.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3262 - Topics in Francophone Cultures**
An introduction to Francophone cultures (in English) in a comparative perspective. Includes a survey of French history and its influence on Francophone societies. Includes study of film and other media and a critical examination of cross-cultural differences between French, Francophone, and U.S. cultures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**HU 3263 - Topics in German-Speaking Cultures**
An introduction to German-speaking culture (in English) in a comparative perspective. Includes a survey of Central-European history and its influence on modern-day German-speaking societies through movies, media, and recent technologies, and a critical examination of cross-cultural differences between German and North-American cultures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3264 - Topics in Spanish-Speaking Cultures**
An introduction to Spanish-speaking cultures (in English) in comparative historical perspectives. Includes a survey and a critical cross-cultural examination of Latin-American cultures and Spanish-speaking societies (European, Caribbean, and North, Central and South American) through literature, music, film, art, and other media.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3265 - Topics in East Asian Cultures**
Introduction to the contemporary and traditional cultures of China, Korea, and Japan taught through readings, films, lectures, and discussions. Taught in English.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand

**HU 3271 - Level II-A French Language and Culture**
Review and continued study of grammar, vocabulary, speaking, listening, reading, and writing in French. Includes written compositions and oral presentations. Cultural focus on several Francophone regions of the world.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2272 or HU 2273 or Language Placement French >= 331

**HU 3272 - Level II-B French Language and Culture**
Continued study of grammar, vocabulary, speaking, listening, reading, and writing in French. Includes written compositions, oral presentations, and reading of brief literary texts. Cultural focus on several Francophone regions of the world.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3271 or Language Placement French >= 421

**HU 3273 - Level II French Composition and Conversation**
Extensive work in the active, creative use of written and oral French. Includes development of communicative strategies, written compositions, and oral presentations in the context of contemporary French-speaking cultures. May include study of film and other media.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** HU 2272 or HU 2273 or Lang Placement French I-A Tran >= 301

**HU 3274 - Level III Topics in French Literature and Culture**
Topics in French literature and its historical and cultural contexts. May include selections from Francophone literature. Conducted in French.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** HU 3272 or HU 3273 or Language Placement French >= 501

**HU 3275 - Level III French for Special Purposes**
Study of business, technical, and/or scientific discourses in the context of French language and Francophone cultures.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** HU 3272 or HU 3273 or Language Placement French >= 501

**HU 3280 - Level I-C German Language and Culture**
Concluding study of the basics of the German language acquainting students with the essentials of oral and written German, with emphasis on conversational skills. Includes continued discussion of cultures and societies of contemporary German-speaking Europe.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2282 or Language Placement German >= 221

**HU 3281 - Level II-A German Language and Culture**
Review of the basics of the German language. Includes study of vocabulary, idioms, and sentence structure to improve conversational and reading abilities, and discussion of various aspects of contemporary German culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3280 or Language Placement German >= 301

**HU 3282 - Level II-B German Language and Culture**
Review of the basics of the German language. Includes study of vocabulary, idioms, and sentence structure to improve conversational and reading abilities, discussion of various aspects of contemporary German culture, readings of literary texts, screenings of German films, and writing of compositions in German.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3281 or Language Placement German >= 371

**HU 3283 - Level II German for Special Purposes**
Review of the basics of the German language. Extensive work on the creative use of written and oral German with emphasis on short themes in German.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3282 or Language Placement German >= 451

**HU 3284 - Level III in German Literature and Culture**
Study of German literature and cultures. Topics may include postwar German literature, Germany since WWII, or emphasis on a major contemporary writer. Readings, discussion and writing in German.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** HU 3282 or Language Placement German >= 521 or CEEB German Language >= 3

**HU 3285 - Level III German: Film and Media**
Focus on improving advanced language skills for professional communicative situations, including acquisition of discipline-specific vocabulary (preparation for language certification). Topics may include issues of science and technology in German-speaking countries.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** HU 3282 or Language Placement German >= 521 or CEEB German Language >= 3

**HU 3291 - Level II Spanish Language and Culture**
Review and continued study of grammar, vocabulary, speaking, listening, reading, and writing in Spanish. Includes written compositions and oral presentations. Cultural focus on several Spanish-speaking regions. Students completing this course may apply for placement credit.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2292 or HU 2293 or Language Placement Spanish >= 321

**HU 3292 - Level II-B Spanish Language and Culture**
Continued study of grammar, vocabulary, speaking, listening, reading, and writing in Spanish. Includes written compositions, oral presentations, and readings of short literary and documentary texts. Strong cultural focus on several Spanish-speaking regions. Students completing this course may apply for placement credit.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2232 or HU 3291 or Language Placement Spanish >= 401

**HU 3293 - Level IIC Spanish Composition and Conversation**
Advanced grammar, composition, and conversation practice. Readings may include texts from literary, social, economic, scientific, engineering, or business discourses in the context of Hispanic cultures. Students completing this course may apply for placement credit.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 2293 or HU 3291 or HU 3292 or Language Placement Spanish >= 480

**HU 3294 - Hispanic Literatures and Cultures**
Study of selected works of literature, culture, and civilization from selected regions of the Spanish-speaking world. May incorporate study of literary genres and historical periods as related to Spain and/or Latin American cultures. Students completing this course may apply for placement credits.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3293 or Language Placement Spanish >= 631

**HU 3295 - Level III Advanced Spanish for Literacies**
Spanish for Special Purposes is designed for students who anticipate careers in which they will need to interact with Hispanic communities in the U.S. or abroad and who wish to continue study of Spanish language and culture for specific professional purposes. Topics include Spanish for engineering and other sciences, healthcare, business, and legal professions.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** HU 3293 or Language Placement Spanish >= 631

**HU 3296 - Introduction to Hispanic Literatures and Cultures**
Overview of Iberian and/or Latin American literatures and cultures from colonial through contemporary periods, including the arts and popular movements, from a multidisciplinary perspective. Course is repeatable up to six credits.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** HU 3293 or Language Placement Spanish >= 631

**HU 3326 - Topics in World Cinema**
This course focuses on mainstream and/or independent films in their historical and sociocultural contexts from selected regions such as Latin America, Africa, the Middle East, Asia, and Europe.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** HU 2324 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3327 - Film Style and Genre**
Focus on film style and genre with an emphasis on study of directors, movements, and aesthetics and their technological, theoretical, and socio-cultural contexts. Includes small lab projects.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring, Summer - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** HU 2324 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3400 - Topics in Diversity Studies**
This course provides students with a better understanding of underrepresented populations within the United States by examining the culture and experience of African American; American Indian; Asian American; Latina/Latino American; Gay, Lesbian, Bisexual, and Transsexual; or Post-Colonial peoples.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3401 - Gender and Culture**
Interrelations of gender and culture, including comparative analysis of constructions of gender. May examine different societies and/or different historical periods.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3410 - Introduction to Diversity Studies in the United States**
This course provides students with a better understanding of underrepresented populations within the United States by examining the social, cultural, and personal consequences of gender, race, ethnicity, class, sexual orientation, (dis)ability, and other significant identities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3502 - Mythology**
Survey of the major mythological systems of the world with particular attention to those areas of commonality among various civilizations. Films may provide contextual background.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2001-2002 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3504 - Studies in the Novel**
Examination of the novel in world literature with special attention to the historical, cultural, and personal contexts within which the author is writing. Film versions may be examined.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3505 - Literary Forms, Genres, and Modes**
This course examines one or more literary forms, genres, and modes such as tragedy, satire, romance, science fiction, fantasy, comedy, epics, novels, short stories, poetry, and/or creative nonfiction.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3506 - Major Authors**
An intensive study of the life and works of one or more significant literary figures. This course will also focus on the social and historical contexts that shaped the author's reputation and standing in the literary, theatrical, or cinematic canon.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3507 - Cultural Traditions in Literature**
An advanced study of a specific transnational or trans-Atlantic historical period or aesthetic movement that illustrates the development of literary and/or cinematic traditions. Courses will include relevant theory and criticism.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3508 - Literature and the Environment**
In this course students examine the interdisciplinary relationship between literature and environmental and ecological studies. Topics to be explored include eco-criticism, eco-feminism, environmental (in) justice, indigeneity, sustainability, and animal studies.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3513 - Shakespeare**
In-depth study of a limited number of Shakespearean plays with special attention to dramatic structure, character development, theme presentation, and theatre history. Includes extensive study of Renaissance influences, possibly film versions of selected plays, and examination of current critical theories.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3514 - Workshop in Creative Nonfiction**
Advanced work in creative nonfiction writing; workshop format. Readings will include short memoirs, personal essays, lyric essays, and other sub-genres of contemporary creative nonfiction. Emphasis on individual production through process-oriented writing exercises, small group workshops, individual conferences, and revision/development.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2510 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3515 - Workshop in Poetry**
Advanced work in poetry writing; workshop format. Students will study contemporary and emerging works in order to enrich and stimulate their own poetic practice. Emphasis on individual production through process-oriented writing exercises, small group workshops, individual conferences, and revision/development.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2510 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3516 - Workshop in Fiction**
Advanced work in fiction writing; workshop format. Readings will include 'canonical', contemporary, and emerging examples of short-form fiction. Emphasis on individual production through process-oriented writing exercises, small group workshops, individual conferences, and revision/development.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 2510 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3517 - Literary Theory and Criticism**
A consideration of a variety of theoretical and critical approaches and methods of literary research in the study of British and American literature.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2004-2005 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**HU 3545 - Literature Across Borders**
Study of literary genres, themes, and movements, with emphasis on comparing and contrasting perspectives reflected in literatures from Western and non-Western cultures. Topics may focus on historical, social, aesthetic, and cultural factors as they influence these literatures. Films may be used.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2004-2005 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3554 - Science Fiction and Fantasy Literature**
Close study of significant works in science fiction and fantasy. Examines genre features and usage and attends to a writer's style and methods. Regularly focuses on historical fiction and fantasy using film to help establish literary context.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3557 - Literature and Science**
Focuses on depictions of science in literature and literary features of scientific texts from a range of historical periods, genres, and nationalities. May include the influence of scientific methods on literature and vice versa (for instance, narrative medicine).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3600 - Professional Development in the Humanities**
Addresses conventions and expectations for professional development through projects such as portfolio development and research into contemporary professional and work place issues. Explores career and graduate school opportunities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Comm and Culture Studies, Scientific & Tech Comm (BS), Liberal Arts, Scientific & Tech Comm (BA), Humanities, English; May not be enrolled in one of the following Class(es): Freshman

**HU 3605 - Grammar and Usage in Society**
Description and analysis of current standards of grammar and usage in the U.S. Students acquire an understanding of the structures of American English as well as an understanding of the social forces underlying standardization and the processes of language change.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**HU 3606 - Editing**
Examination of the responsibilities of an editor and grounding in basic editorial skills. Topics include situations of editing, levels of editing, readability, correctness, style, relations with authors, and social and political implications of editing.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**HU 3621 - Introduction to Journalism**
Introduction to the history and practice of journalism. Includes critical analysis of journalistic coverage, journalistic style and editing, and ethical issues in journalism.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3630 - Publications and Information Management**
Principles of information selection, editing, layout, and graphics essential to the scheduling, budgeting, and production of various print and digital publications.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** HU 2642 and HU 2633 or HU 2645

**HU 3693 - Science Writing**
Introduces writing, research, and editing that contribute to a public understanding of science. Possible topics: health, environment, medicine, public policy.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3694 - Grant Writing**
Introduces fundamentals of grant proposal writing and research. Possible topics: writing for nonprofits, grant writing in various disciplines, researching funding resources.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3695 - Digital Writing and Rhetoric**
Social, ethical, and historical implications of digital writing and rhetoric, investigating digital contexts, with special attention to analyzing and producing digital content.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** HU 2642 or HU 2130 or HU 3120

**HU 3700 - Philosophy of Science**
Examination of problems involved in scientific methodology such as theory structure, concept formation, scientific explanation, hypothetico-deductive model, role of experimentation, function of paradigms and analogies, distinction between science and pseudoscience, extent to which science is value-free or value-laden, social responsibility of scientists, and aims of science.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3701 - Philosophy of Technology**
A study of philosophical analyses of technology. Topics may include: the essence and nature of technology, technology and human existence; the notion that we live in a technological age; and ethical issues surrounding the use, abuse, and ubiquity of technology.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3702 - Philosophy of Religion**
An examination of some philosophical questions in diverse religious traditions including the existence of God, the problem of evil, and the nature of religious experience.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3710 - Engineering Ethics**
A study of ethical questions confronting individual engineers and the engineering profession. Among the issues to be explored are the meaning of professionalism, the social responsibilities of engineers, engineer-employer and engineer-client relationships, whistle-blowing, conflicts of interest, and competitive bidding.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3711 - Biomedical Ethics**
A study of several important ethical and philosophical issues that arise in medical practice and in biomedical science. Issues may include euthanasia, abortion, the physician-patient relationship, experimentation involving human subjects, and allocation of scarce biomedical resources. General ethical theories and concepts are used to shed light on those issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3800 - Media and Society**
Examines contemporary forms of mediated communication. Emphasis on understanding media economics and impacts of media on attitudes, values, behavior, and identity. Topics may include propaganda, advertising, political communication, journalism, media violence, social media, surveillance, and media policy.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3810 - Technology and Culture**
Considers interrelationships between technology and culture. Includes understanding the context within which technologies are developed and used, and how assumptions about technology shape knowledge, practice, and creative action. Issues such as progress, determinism, ethics, gender, race, class, globalization, and "humanness".
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3820 - Interpersonal Communication**
Examines practices and issues of relational communication and encourages critical awareness of common assumptions. Topics include verbal and nonverbal cues, conflict models, friendship, intimacy, and the interpersonal significance of race, gender, class, and disability.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3830 - Creativity, Culture, and Change**
Examines the sources of creativity and the ways that it has been used to change cultural values, feelings, beliefts, and practices. A project-based course that cultivates and applies creative action toward cultural change.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3832 - Advanced Digital Presentation**
Students will use digital delivery modes to design and deliver presentations for a variety of social and professional purposes. Students will explore the ethical, social, and political implications of digital delivery for civic life and public discourse.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3840 - Organizational Communication**
An approach to understanding organizations in their socio-historical contexts from a variety of theoretical perspectives in communication. Explores meanings, roles, relations, interactions, and structures from a communication perspective.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3850 - Cultural Studies**
Examines the way that culture communicates values, feelings, beliefs; structures differential relations of power and possibility; creates difference and hierarchy. Considers the struggles over meaning that open up possibilities for diversity and change.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3860 - Popular Culture**
Introduces fundamentals of cultural theory and media criticism. Considers historical, social, political, and economic contexts of popular culture from a media studies perspective.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3871 - New Media Theory**
Examines relationships among changing communication technologies and communication theories. Emphasizes issues involving emerging technologies and emerging theory.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3872 - Color, Visuality, and Culture**
Engages with color as an aesthetic, theoretical, historical, cultural, and political concept. Explores what color is made of, how color shapes meaning, and how color functions in various expressive and interpretative contexts including politics, science, and industry.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3882 - Media Industries**
Examines economic, political, and cultural aspects of media industries (cinema, broadcasting, music, gaming, telecommunications, and advertising) from historical and contemporary contexts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3890 - Documentary**
Considers technical, theoretical, aesthetic and ethical dimensions of documentary media through analysis and production.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall

**HU 3910 - Language and Globalization**
Considers the historical rise of the English language and other dominant languages, and present effects on minority and endangered languages within the US and abroad; World Englishes and dialectal variation; and the interaction of forces of globalization/standardization with localization/identity.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2009-2010 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3940 - Language and Identity**
Examines how individuals create and perform their social identities through and in response to language, considering social variables such as race, ethnicity, class, gender, sexuality, disability, geography, power, ideology, etc. Explores how these variables may intersect, clash, and be resolved.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 3961 - Theroetical Foundation of TESOL**
Introduction to key concepts and issues in teaching English to speakers of other languages. Topics covered may include nature of first-and-second acquisition, role of input and instruction in language learning, and evaluation of approaches to teaching and research.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Co-Requisite(s):** HU 3605
**Pre-Requisite(s):** HU 2910

**HU 3962 - TESOL Methods and Materials**
Enhance understanding and awareness of the developmental stages and needs of English language learners in various learning contexts. Show how to adjust, modify, and manipulate instructional techniques and materials to accommodate the linguistic and cognitive needs of English learners.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** HU 3961

**HU 3963 - Assessment and Testing in TESOL**
This course covers basic principles and approaches in the assessment and testing of English as a second or foreign language in various instructional contexts. Topics covered may include test construction and adaptation and the application of this knowledge to evaluating tests.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Co-Requisite(s):** HU 3961

**HU 3964 - Cross-Cultural Aspects of TESOL**
Course examines those places where language and culture come together to affect our interactions; concentrating on areas particularly important to language teaching, learning, and usage. Topics may include introduction to pragmatics, politeness theory, and conversational politeness strategies.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**HU 4050 - Special Topics**
Tutorial, seminar, workshop, or class study of special interest and importance in the humanities. Students should register by section number for the appropriate instructor and topic.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**HU 4060 - Humanities Workshop**
Special workshop projects in the humanities such as tutorials, editing, Shakespeare Faire drama workshop, writer's workshop, or study-abroad tours. Approved credit varies by degree program.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**HU 4101 - Multiliteracies Center Practicum**
Reflective practicum in which theories of learning, literacy, and cultural differences are applied in the Multiliteracies Center setting under the supervision of a writing center professional.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** UN 1015

**HU 4130 - Special Topics in Rhetoric and Composition**
An in-depth examination of particular issues, theories, methodologies, or concepts in the field of rhetoric and composition, such as comparative rhetorics, computers and writing, multi-lingual writing, feminist rhetorics, and multi-modal composition.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2000-2001 academic year

**HU 4140 - Methods of Teaching English**
Application of learning theories and national and state professional standards to the teaching of English. Emphasizes methods, materials, and media used to teach adolescents. Requires admission to teacher education program or permission of instructor. Includes significant time in the field.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required
**Pre-Requisite(s):** ED 4110 and ED 3210 and ED 3410 and ED 4700(C)

**HU 4150 - Literacy in the Content Areas**
Introduction to the best ways to use language for deepening comprehension and understanding in all content areas. Inquiries into how cultural and learning differences relate to comprehension. A minimum of 28 tutoring hours in a local school is required.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-1)
**Semesters Offered:** Spring
**Pre-Requisite(s):** ED 4110 and ED 3210 and ED 3410

**HU 4271 - Modern Language Seminar I-French**
Language and power. Critical study of the representation of politics, economics, and social institutions in literature, film, and authentic documents from French, German, and Hispanic language communities. Students read texts in French and English translations. Course offered third year beginning 2009-2010.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3274 or HU 3275

**HU 4272 - Modern Language Seminar II-French**
Individual and society. Critical study of the relationship between the individual and social institutions in literature, film, and authentic documents from French, German, and Hispanic language communities. Students read texts in French and in English translation. Course offered third year beginning 2010-2011.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2001-2002 academic year
**Pre-Requisite(s):** HU 3274 or HU 3275

**HU 4273 - Modern Language Seminar III-French**
Technology in literature and film. Critical study of the representation of modern technology in literature, film, and authentic documents from French, German and Hispanic language communities. Students read texts in French and in English translation. Course offered every third year beginning 2008-2009.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** (HU 3274 or HU 3275) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4281 - Modern Language Seminar I-German**
Language and power. Critical study of the representation of politics, economies, and social institutions in literature, film, and authentic documents from French, German, and Hispanic language communities. Students read texts in German and in English translation. Course offered every third year beginning 2008-2009.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3284 or HU 3285

**HU 4282 - Modern Language Seminar II-German**
Individual and society. Critical study of the relationship between the individual and social institutions in literature, film, and authentic documents from French, German, and Hispanic language communities. Students read texts in German and in English translation. Course offered every third year beginning 2009-2010.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2001-2002 academic year
**Pre-Requisite(s):** (HU 3284 or HU 3285) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4283 - Modern Language Seminar III-German**
Technology in literature and film. Critical study of the relationship between modern technology and literature, film, and authentic documents from French, German, and Hispanic language communities. Students read texts in German and in English translation. Course offered every third year beginning 2010-2011.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** HU 3284 or HU 3285

**HU 4291 - Level IV Modern Language Seminar I-Spanish**
Language and power. Critical study of the representation of politics, economies, and social institutions in literature, film, and authentic texts in French, German, and Hispanic language communities. Students read texts in Spanish and English translation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3294 or HU 3295

**HU 4292 - Level IV Modern Language Seminar II-Spanish**
Individual and society. Critical study of the relationship between the individual and social institutions in literature, film, and authentic documents from French, German and Hispanic speaking communities. Students read texts in Spanish and in English translation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3294 or HU 3295

**HU 4293 - Level IV Modern Language Seminar III-Spanish**
Technology in literature and film. Critical study of the relationship between modern technology and literature, film, and authentic documents from French, German, and Hispanic language communities. Students read texts in Spanish and in English translation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** HU 3294 or HU 3295

**HU 4327 - Visual Storytelling and Cinema**
Production-intensive focus on how filmmakers use narrative design, cinematography, and editing to tell a story, realize a creative vision, and engage an audience.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** HU 2324

**HU 4500 - Senior Seminar in English**
A course especially designed for English majors. In depth exploration of various topics with special emphasis on theory and production. Students wil be required to engage relevant secondary sources and theory in a longer, final seminar paper.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**HU 4501 - BA Thesis**
Students will be required to engage relevant secondary sources and theory in a longer, final seminar paper or creative project. Produce a cultural final project that demonstrates advanced critical and creative analysis. Proposals must be approved in the prior semester.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**HU 4600 - Humanities Internship**
Provides internship experience directly related to student's course of study. Students conduct work at internship site in addition to academic assignments that encourage them to connect their professional and academic experience. Requires approval of department internship coordinator.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required

**HU 4625 - Risk Communication**
Examines models for communicating risks associated with environmental, safety, and health hazards. Considers the diverse roles assumed by the public under each of these models and means of ensuring that risks are communicated fairly, honestly, and accurately.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4626 - International Technical Communication**
Focuses on international workplace communication. Introduces theories of globalization. Topics may include localization, contrastive rhetoric, technical translation, and international usability.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** HU 2600

**HU 4628 - Usability Evaluation and User Experience Design**
Theories and practices of usability evaluation and user experience design relevant to technical communication contexts. Individual and team projects with emphasis on the development of instructions and procedures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Spring
**Pre-Requisite(s):** HU 3120 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4634 - Advanced Practicum in Scientific and Technical Communication**
Provides technical communication majors with opportunities to design and produce various communication products expected in their working careers, such as sets of procedures, proposals, progress reports, sets of directions, and style sheets. The course will also require students to complete, with advice from the instructor, one major client-involved project such as a brochure, newsletter, web site, technical training module, etc.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Scientific & Tech Comm (BS), Scientific & Tech Comm (BA)
**Pre-Requisite(s):** HU 3120 and HU 2600

**HU 4642 - Advanced Topics in Media**
Critical and/or applied topics in advanced media, theory and development. Topics may include game design, mobile media, color, photography, film, or graphic design.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**HU 4690 - Special Topics in Technical and Professional Communication**
In-depth examination of selected topics in scientific and technical communication, or on professionial and workplace writing in selected genres such as reports, proposals, or whitepapers.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**HU 4700 - Topics in Philosophy**
The topics will ordinarily be in-depth examinations of a particular philosopher or philosophical problem, tradition, or historical period. Examples include the philosophy of Kant, the existence of God, American pragmatism, death and dying, and ancient Greek philosophy.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015

**HU 4701 - Political Philosophy**
Issues in political philosophy, such as the moral foundations of political systems, the proper relation between the individual and the state, and the justification of social institutions. Philosophers studied may include Plato, Aristotle, Machiavelli, Hobbes, Locke, Marx, de Tocqueville, Mill, Dewey, and Rawls.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4710 - Sports Medicine and Ethics**
Examines ethical issues in sports medicine. Topics include the ethical responsibilities and conflicts of interest for team physicians, research on athletes, sport-related concussions, and doping. Philosophical ethical foundations, and professional ethical codes for sports medicine will be studied.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**HU 4711 - Biomedical Research Ethics**
Examination of bioethical issues in biomedical research. Topics include research on human subjects, on vulnerable populations, and animals, principles of ethical research, and societal expectations for researchers.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** HU 3711

**HU 4725 - Existentialism and Phenomenology**
Introduction to the philosophical traditions of existentialism and phenomenology. Topics might inlude: the nature of human existence and of freedom; the importance of world, self, anxiety, death, and authenticity; and the foundations of knowledge, experience and meaning.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**HU 4800 - Media and Globalization**
Examines the development of modern international communication systems, the rise of transnational media industries and technologies, and debates about their global impacts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4850 - Surveillance, Media, and Film**
Considers surveillance practices and the surveillance imaginary through films that take surveillance as their principal feature. Covers perspectives such as those of the watchers and the watched; kinds and purposes of surveillance; and the relationship between filmic surveillance and our sense and practices of freedom versus control.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** UN 1015 or (UN 1025)

**HU 4890 - Topics in Communication**
In-depth examination of selected issues or problems in the study of communication, such as gender and communication, the environment and communication, sound and communication, violence and communication.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**HU 4961 - Practicum in TESOL**
Observation, case studies, tutoring, instructional assistance, and supervised teaching experience in English to speakers of other languages.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** HU 3962

## Kinesiology & Integrative Physiology

**KIP 1000 - Introduction to Exercise Science**
Introduction to the fields and career opportunities in the exercise sciences.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall

**KIP 1010 - Introduction to Sports and Fitness Management**
Introduction to the fields and career opportunities in sports and fitness management.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall

**KIP 1500 - Foundations of Kinesiology**
Introduces academic subdisciplines of kinesiology - anatomy, motor behavior, biomechanics, physiology, exercise and the environment, sport nutrition and the mind and brain in exercise. Provides the conceptual framework within which the scientific bases for movement during exercise, sport performance, and other forms of physical activity are studied.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**KIP 1900 - Student Athlete 101**
Read, discuss, and practice study skills, cognitive strategies, goal development, and address contemporary issues problematic in today's college environment.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required

**KIP 2000 - Professionalism in Kinesiology**
This course will assist students in gaining skills for entering into career-focused roles with professional competency, learning to apply these skills through shadowing experiences, and preparing to transition from a college student to a professional in kinesiology.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Sports and Fitness Management, Exercise Science; May not be enrolled in one of the following Class(es): Freshman

**KIP 2100 - Introduction to Athletic Training**
Covers first aid, adult CPR, child CPR, and other sport training issues. Students receive appropriate certification cards.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Fall, Spring

**KIP 2200 - Health Promotion**
This course emphasizes methods in planning, designing, implementing, and improving health/wellness promotion programs. Client motivation, behavior change, and physical activity for special populations will be addressed.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** EH 1500 or KIP 1500

**KIP 2300 - Sports and Fitness Leadership**
Course is designed to help students succeed in leadership principles, effective communication, team work, and introspection. Students will lead, teach, and collaborate with their peers through different assignments and active participation in class.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year

**KIP 2400 - Principles of Sports Officiating**
Theory and practice of officiating various sports common in the community and school setting.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year

**KIP 2500 - Athletic Training Practicum**
An experiential learning course in which students assist certified athletic trainers in preventive and post-injury care of collegiate athletes. Topics include professionalism, acute injury prevention techniques, and post-injury management and care.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-1)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** KIP 2100 or EH 3050

**KIP 2600 - Introduction to Public Health**
An overview of public health including the history of public health and major issues facing the U.S. and global populations. Topics include societal conditions that lead to health disparities, role of government, and the basic sciences supporting public health.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall

**KIP 2610 - Outdoor Emergency Care Training (Ski Patrol)**
Second of two-course sequence required for Alpine and Nordic Ski Patrol candidates. Ninety hours of instruction includes three weekends. Requires payment of dues to become member of National Ski Patrol. Certification in National Ski Patrol Outdoor Emergency Care is available upon completion.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** PE 2028

**KIP 2800 - Special Topics in Kinesiology**
Examination of current topics in the field of kinesiology. Literature and research topics are addressed.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Sports and Fitness Management, Exercise Science

**KIP 3000 - Sports Psychology**
Overview of psychological principles and their applications to individuals and groups in sport, exercise and/or therapy. For the laboratory portion, students observe and analyze behaviors in a setting of their choice.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** PSY 2000

**KIP 3100 - Exercise Assessment and Prescription**
Theory and practical aspects of exercise testing and prescription; topics include testing of strength, endurance, cardiovascular endurance, flexibility, body composition, muscle power, and balance with special considerations for arthritis, osteoporosis, dyslipidemia, immunology, and metabolic syndrome.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2020 and BL 2021

**KIP 3200 - Personal Training**
A pragmatic course of both theory and application in setting up a personal training program for individuals. Includes assessment, techniques, planning, safety and legal issues. Leads toward final preparation to earn certification as a personal trainer.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-1)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2020 and BL 2021 and (EH 3100 or KIP 3100)

**KIP 3300 - Foundations of Coaching**
Practical and relevant information appropriate for beginning and experienced interscholastic coaches.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-1)
**Semesters Offered:** Fall, Summer

**KIP 3310 - Methods of Coaching**
Students will demonstrate knowledge of skills, tactics, strategies, and sporting principles in coaching sport teams.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-1-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2013-2014 academic year

**KIP 3400 - Sports Administration**
Students will learn skills and competencies of sports management including ethics, marketing, law, finance, information, collegiate, olympic, professional, youth, campus recreation programs, parks, career opportunities, foundations, and future directions.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**KIP 3410 - Facilities & Events Management**
Students will learn about managing sports facilities including risk management, administration of personnel, organization, and administrative efficiency.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**KIP 3500 - Sports Medicine Practicum**
This course allows students to experience current topics in sports medicine along with learning up-to-date orthopedic injury assessment, treatment, and rehabilitation.
**Credits:** variable to 2.0; Repeatable to a Max of 2
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** KIP 2500

**KIP 3600 - Motor Development**
Designed for upper level undergraduates or graduates, this course will focus on the changes in motor behavior across a life span, and examine the study and practice of fundamental patterns within the context of development theory.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (EH 1500 or KIP 1500) and BL 2020

**KIP 3700 - Lifetime Fitness**
To gain a thorough understanding in all areas of personal fitness through functional anatomy, exercise physiology, health and physical fitness, screening and evaluation, nutrition, weight management, exercise prescription and programming considerations, training instruction, and consideration for special populations.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-2)
**Semesters Offered:** Summer

**KIP 4000 - Sports Nutrition Seminar**
Human nutrition as it specifically applies to athletes. Specific needs for proteins, carbohydrates, fats, electrolytes and micronutrients. Use of ergogenic aids is covered. Students will research, write and present orally their findings on nutrition topics.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2940

**KIP 4100 - Exercise Physiology**
Focuses on the functional changes brought by acute and chronic exercise sessions. Topics include muscle structure and function, bioenergetics, cardiovascular and respiratory adaptations, exercise training for sport, sport nutrition, ergogenic aids, and other health and fitness topics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Co-Requisite(s):** KIP 4110
**Pre-Requisite(s):** BL 2020 and BL 2021

**KIP 4110 - Exercise Physiology Laboratory**
A companion course to EH4210. Hands-on experience in making physiological measurements as related to exercise. Cardiovascular and respiratory changes during exercise will be monitored. A virtual lab is used to simulate changes in physiological measurements that cannot be performed on live subjects. A student designed laboratory project is required.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Co-Requisite(s):** KIP 4100

**KIP 4120 - Molecular Exercise Physiology**
Introduces cellular and molecular mechanisms by which exercise causes adaption. Topics include how gene variations affect human performance, signal transduction pathways involved in regulation of metabolism, and mechanism of exercise in prevention and treatment of chronic diseases.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2100 and (EH 4210 or KIP 4100)

**KIP 4200 - Biomechanics of Human Movement**
An in-depth view of the biomechanical properties of the musculoskeletal system. The course provides detailed analyses of the kinetics of human movement, material properties of the component tissues, and dynamic processes of adaptation to stress and strain of the system.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Co-Requisite(s):** KIP 4210
**Pre-Requisite(s):** BL 2020 and (EH 1500 or KIP 1500) and PH 1110 and PH 1111

**KIP 4210 - Biomechanics of Human Movement Laboratory**
A companion course to EH4500. Hands-on experience, including data collection, analysis, and interpretation using various equipment in biomechanics.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Co-Requisite(s):** KIP 4200
**Pre-Requisite(s):** BL 2020 and (EH 1500 or KIP 1500) and PH 1110 and PH 1111

**KIP 4300 - Motor Learning and Control**
This course will provide the current theories and concepts involved in the processes of motor skill acquisition and performance from a behavioral perspective.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (EH 1500 or KIP 1500) and BL 2020

**KIP 4400 - Strength and Conditioning**
Theory and practice in development and administration of comprehensive strength and conditioning programs for both the athlete and individual of any level. Includes knowledge, safety concerns and skill techniques necessary for teaching and administering at any strength and conditioning facility.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** BL 2020 and BL 2021

**KIP 4500 - Athletic Training Capstone**
Experiential learning that engages the student with mentorship and assisting certified athletic trainers.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** KIP 3500 or EH 3060

**KIP 4600 - Sports and Fitness Promotions**
Development and implementation of marketing plans for sports and fitness businesses. Topics include marketing of sporting events and fitness programs, use of traditional media for promotion, web-based advertising (new media), and business branding.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2011-2012 academic year
**Pre-Requisite(s):** MKT 3000

**KIP 4610 - Legal Issues in Sports and Fitness Management**
Review of legal issues that apply to sport and fitness organizations such as liability, risk management, facility concerns, and labor laws. Basic components of the U.S. legal system and guidelines, and rules of the National Collegiate Athletic Association will be covered.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2012-2013 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**KIP 4620 - Sports Media**
This course examines the impact sports and the media have on each other and the sports consumer. Students will gain a greater understanding of the operation of sports media and communications at all levels of sports (amateur, collegiate, professional) and the role of sports media in American society.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** MKT 3000

**KIP 4630 - Financial Aspects of Sports**
The course is designed to provide the student with an understanding of the basic concepts that underlie financial management, and an ability to apply these concepts to the analysis of financial issues within the sport industry.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** ACC 2000

**KIP 4690 - Coaching Practicum**
Students seeking coaching endorsement assist with a sport of their choice. Subject to approval of endorsement advisor, students may assist a head coach in season during student teaching; assist MTU head coach in season; assist head coach in season at public/private school or summer camp.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** (EH 3010 or KIP 3000) and (EH 3020 or KIP 3300)

**KIP 4700 - EKG Interpretation**
Course is designed for students who are going to pursue future career related to cardiac rehabilitation, physical therapy and students in the Pre-Med program. Students will learn cardiac electrophsiology, the pasthophysiology, the diagnosis, and treatment of cardiac arrhythmias, and related cardiovascular diseases. Class will build bridge between basic sciences and human health.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2020 and BL 2021

**KIP 4710 - Sports Medicine and Ethics**
Examines ethical issues in sports medicine. Topics might include the ethical responsibilities and conflicts of interest for team physicians, research on athletes, sport-related concussions, and doping. Philosophical ethical foundations, and professional ethical codes for sports medicine will be studied.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**KIP 4720 - Exercise Pharmacology**
Course will bridge between basic sciences and human health. The course focuses on understanding the fundamental concept of exercise pharmacology and pharmacological treatment of diseases of various systems including cardiovascular, respiratory, endocrine, neuronal, hormonal, and renal systems.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BL 2020 and BL 2021

**KIP 4730 - Physical Therapy Seminar**
Seminar for students who are interested in physical therapy profession. Course will include self-directed learning and group work. Topics may include evidence based medicine, literature review writing and evaluation, healthcare reimbursement, clincal decision making, health screenings, and other current topics.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BL 2020 and BL 2021

**KIP 4740 - Epidemiology**
An introduction to the principles and methods of epidemiology to understand the distribution and determinants of health in a population. Topics include basic epidemiological statistics, study design, and sources/impact of bias and error.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**KIP 4800 - Special Topics in Kinesiology**
Examination of current topics in the field of exercise science. Literature and research topics are addressed.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Sports and Fitness Management, Exercise Science; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**KIP 4900 - Internship in Exercise Science**
Practical and didactic training in Exercise Science in an approved internship site. Provides experience in a variety of exercise science or medical settings. Internships must be approved by the department internship coordinator and work 42 hours for each credit earned.
**Credits:** variable to 9.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Exercise Science; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** KIP 2000 or EH 2850

**KIP 4910 - Internship in Sports and Fitness Management**
Empirical experiences in an approved internship site. Provides practical experience in one or more work settings, assisting the upper level student in making an appropriate career choice. Internships must be approved by the department internship coordinator and work 42 hours for each credit earned.
**Credits:** variable to 12.0; Repeatable to a Max of 12
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Sports and Fitness Management; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** KIP 2000 or EH 2850

**KIP 4950 - Research in Kinesiology**
A literature and laboratory research experience in kinesiology that culminates in a written report or oral presentation of the work performed.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required

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## Mathematical Sciences

**MA 0010 - Development of Mathematics Skills**
Individualized instruction in mathematics problem solving and general study skills from professional math coaches. Helps students with demanding college-level mathematics courses. Credits do not count toward graduation.
**Credits:** 0.0; May be repeated
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**MA 1020 - Quantitative Literacy**
Stresses the role of contemporary mathematical thinking and the connection between mathematics and our daily lives. Topics include the mathematics of the Census, planning and scheduling, coding theory, game theory, symmetry and patterns, logic and modeling, and political flavor topics.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Anthropology, Communication, Culture & Media, Comm and Culture Studies, Theatre & Electr. Media Perf., English, Theatre & Entertain Tech (BS), Theatre & Entertain Tech (BA), Liberal Arts, Psychology, Sports and Fitness Management, History, Social Sciences, Liberal Arts with History Opt, Scientific & Tech Comm (BA), Scientific & Tech Comm (BS), Humanities
**Pre-Requisite(s):** ALEKS Math Placement >= 00

**MA 1030 - College Algebra I**
This course is the first of a two semester sequence. It examines the behavior of linear, polynomial, and rational functions. In addition, algebraic methods commonly needed in calculus are reviewed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Co-Requisite(s):** MA 0030
**Pre-Requisite(s):** ALEKS Math Placement >= 00

**MA 1031 - College Algebra II with Trigonometry**
This course is the second of a two semester sequence. It examines the behavior of exponential, logarithmic, and trigonometric functions. Also, algebraic and trigonometric methods commonly needed in calculus are reviewed. MA1030 and MA1031 together are equivalent to MA1032.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Co-Requisite(s):** MA 0031
**Pre-Requisite(s):** MA 1030

**MA 1032 - Precalculus**
This course examines the behavior of linear, polynomial, rational, exponential, logarithmic and trigonometric functions.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** ALEKS Math Placement >= 56

**MA 1135 - Calculus for Life Sciences**
Topics include analytic geometry, limits, continuity of functions, transcendental functions, derivatives, integrals, and applications of the derivative in the fields of economics, biological sciences, and socials sciences. Extensive use of graphing calculator. (See mathematical sciences department for recommended calculator). Credit applicable only to those curricula specifying this course.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following College(s): College of Engineering
**Pre-Requisite(s):** MA 1032 or MA 1031 or ALEKS Math Placement >= 70 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**MA 1160 - Calculus with Technology I**
An introduction to single-variable calculus, which includes a computer laboratory. Topics include trigonometric, exponential, and logarithmic functions, differentiation and its uses, and basic integration. Integrates symbolic tools, graphical concepts, data and numerical calculations.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-1)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 1032 or MA 1031 or ALEKS Math Placement >= 80 or CEEB Calculus AB >= 3 or CEEB Calculus BC >= 3 or CEEB Calculus AB Subscore >= 3

**MA 1161 - Calculus Plus w/ Technology I**
An introduction to single-variable calculus, which includes a computer laboratory. Topics include trigonometric, exponential, logarithmic functions, differentiation and its uses, and basic integration. Integrates symbolic tools, data and numerics, and graphical concepts and is similar to MA1160, going at a different pace.
**Credits:** 5.0
**Lec-Rec-Lab:** (0-4-1)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1032 or MA 1031 or ALEKS Math Placement >= 70 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**MA 1600 - Introduction to Scientific Simulation**
Introduction to simulation, a powerful computational tool for many scientific problems. Case studies and projects will be drawn from various fields. Prior programming experience is not required; all necessary computational skills will be developed in the course.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 1160 or MA 1161

**MA 1910 - Exploring Symmetry Groups**
Mathematical discovery and invention in group theory: transformations, finite figures, strip patterns, wall patterns, finite groups, and Cayley diagrams. Develops the ability to find and describe patterns, to generalize from observations, to formulate conjectures, and to support conjectures with analysis and, when possible, formal proof.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year

**MA 1920 - Exploring Knots and Surfaces**
Mathematical discovery and invention in topological graph theory: networks, graphs, graph coloring, surfaces and graphs, and knots. Develops the ability to find and describe patterns, to generalize from observations, to formulate conjectures, and to support conjectures with analysis and, when possible, formal proof.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year

**MA 1930 - Exploring Number Theory**
Mathematical discovery and invention in number theory: number puzzles, Chinese Remainder Theorem, codes, primitive roots, and quadratic reciprocity. Develops the ability to find and describe patterns, to generalize from observations, to formulate conjectures, and to support conjectures with analysis and, when possible, formal proof.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year

**MA 1940 - Exploring Non-Euclidean Geometry**
Mathematical discovery and invention in Non-Euclidean geometry: definitions of straight and angle, transformations, congruence, parallel transport, projections, and finite geometries. Develops the ability to find and describe patterns, to generalize from observations, to formulate conjectures, and to support conjectures with analysis and, when possible, formal proof.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year

**MA 1990 - Elementary Mathematics Topics**
Students study a particular area in mathematics, ordinarily not covered in existing courses. Intended for first-year students.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**MA 2160 - Calculus with Technology II**
Continued study of calculus, which includes a computer laboratory. Topics include integration and its uses, function approximation, vectors, and elementary modeling with differential equations.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-1)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1160 or MA 1161 or MA 1135 or CEEB Calculus AB >= 3 or CEEB Calculus BC >= 3 or CEEB Calculus AB Subscore >= 3

**MA 2320 - Elementary Linear Algebra**
An introduction to linear algebra and how it can be used. Topics include systems of equations, vectors, matrices, orthogonality, subspaces, and the eigenvalue problem. Not open to students with credit in MA2321 or MA2330.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Mathematics, Software Engineering, Computer Science
**Pre-Requisite(s):** MA 1160 or MA 1161 or MA 1135

**MA 2321 - Elementary Linear Algebra**
Offered first half of semester, to be taken concurrently with MA3521. The course is an introduction to linear algebra and how it can be used. Topics include systems of equations, vectors, matrices, orthogonality, subspaces and the eigenvalue problem. Not open to students with credit in MA2320 or MA2330.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Major(s): Mathematics, Software Engineering, Computer Science
**Co-Requisite(s):** MA 3521
**Pre-Requisite(s):** MA 2160

**MA 2330 - Introduction to Linear Algebra**
An introduction to linear algebra and how it can be used, including basic mathematical proofs. Topics include systems of equations, vectors, matrices, orthogonality, subspaces, and the eigenvalue problem. Not open to students with credit in MA2320 or MA2321.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MA 1160 or MA 1161 or MA 1135

**MA 2600 - Scientific Computing**
Use of mathematical modeling and computer simulation to solve scientific problems. Includes introduction to elementary numerical methods (numerical integration, solution of linear systems, solution of nonlinear equations, optimization) and to computer programming. Requires programming project(s).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2160 and (MA 2320 or MA 2321 or MA 2330)

**MA 2710 - Introduction to Statistical Analysis**
Introduction to statistical reasoning and methods. Topics include uses and abuses of statistics, graphical and descriptive methods, correlation and regression, probability and statistical inference. The course will include a written project and an introduction to statistical software. Not open to students with credit in MA2720 or MA3710 or MA3715.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Statistics, Mathematics
**Pre-Requisite(s):** MA 1160 or MA 1161 or MA 1135

**MA 2720 - Statistical Methods**
Introduction to the design and analysis of statistical studies. Topics include methods of data collection, descriptive and graphical methods, probability, statistical inference on means, regression and correlation, and single variable ANOVA. Not open to students with credit in MA2710, MA3710, or MA3715.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Mathematics
**Pre-Requisite(s):** MA 1020 or MA 1030 or ALEKS Math Placement >= 50 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**MA 2910 - Mathematical Experimentation**
Mathematical discovery and invention in topics such as algebra, analysis, applied mathematics, discrete mathematics, geometry, and statistics. Class projects require students to find and describe patterns, generalize from observations, formulate and support conjectures with analysis and, when possible, proof. Projects require written reports describing the student's findings, conjectures, and conclusions.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 1160 or MA 1161

**MA 2990 - Elementary Topics in Mathematics**
Students study a particular area in mathematics ordinarily not covered in existing courses. Intended for first- or second-year students.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**MA 3160 - Multivariable Calculus with Technology**
Introduction to calculus in two and three dimensions, which includes a computer laboratory. Topics include functions of several variables, partial derivatives, the gradient, multiple integrals; introduction to vector-valued functions and vector calculus, divergence, curl, and the integration theorems of Green, Stokes, and Gauss.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-1)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 2160 or CEEB Calculus BC >= 3

**MA 3202 - Introduction to Coding Theory**
Transmission via noisy channels, hamming distance, linear codes, the ISBN-code, encoding and decoding, finite fields, Reed-Solomon codes, deep space communication, the compact disk code, sphere packing bound, hamming codes, hamming decoding.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2320 or MA 2321 or MA 2330

**MA 3203 - Introduction to Cryptography**
Topics include private-key cryptography, shift substitution, permutation and stream ciphers, cryptanalysis, perfect secrecy, public-key cryptography, and the RSA cryptosystem.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** MA 2320 or MA 2321 or MA 2330

**MA 3210 - Introduction to Combinatorics**
Topics include set theory, mathematical induction, integers, functions and relations, counting methods, recurrence relations, generating functions, permutations, combinations, principle of inclusion and exclusion, graphs (including planar graphs). Further possible topics are graph coloring, trees and cut-sets, combinatorial designs, Boolean algebra.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** MA 2320 or MA 2321 or MA 2330

**MA 3310 - Introduction to Abstract Algebra**
Introduction to proofs in algebra. Topics include elementary number theory (induction, binomial theorem, fundamental theorem of arithmetic, Euclidean algorithm, congruences, Fermat's theorem), group theory (subgroups, cyclic groups, generators, Lagrange's theorem, normal groups, homomorphisms, quotients), ring theory (domains, fields, polynomials, homomorphisms).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** MA 2320 or MA 2321 or MA 2330

**MA 3450 - Introduction to Real Analysis**
Why calculus works: a careful study of the logical basis of calculus, with an emphasis on how to read and write proofs. Topics include set theory, real numbers, infinite sequences, continuity, derivatives and integrals for functions of one variable, sequences of functions, infinite series.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2160

**MA 3520 - Elementary Differential Equations**
First order equations, linear equations, and systems of equations. Not open to students with credit in MA3521, MA3530 or MA3560.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Major(s): Mathematics, Computer Science
**Pre-Requisite(s):** MA 2160 and (MA 2320 or MA 2321 or MA 2330)

**MA 3521 - Elementary Differential Equations**
Offered second half of semester, to be taken concurrently with MA2321. Topics include first order equations, linear equations and systems of equations. Not open to students with credit in MA3520, MA3530 or MA3560.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Major(s): Mathematics, Computer Science
**Co-Requisite(s):** MA 2321
**Pre-Requisite(s):** MA 2160

**MA 3530 - Introduction to Differential Equations**
First order equations, linear equations, systems of equations, and Laplace transforms. May include elementary separation of variables for partial differential equations. Not open to students with credit in MA3520, MA3521, or MA3560.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2160 and (MA 2320 or MA 2321 or MA 2330)

**MA 3560 - Mathematical Modeling with Differential Equations**
Creating differential equation models for physical problems such as population dynamics, kinetics, mass-spring systems. Topics include nondimensionalization, numerical methods, phase-plane analysis, first-order systems, linearization, and stability. Includes modeling case studies, using a computer algebra system, and a modeling project. Not open to students with credit in MA3520, MA3521, or MA3530.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2160 and (MA 2320 or MA 2321 or MA 2330)

**MA 3710 - Engineering Statistics**
Introduction to the design, conduct, and analysis of statistical studies aimed at solving engineering problems. Topics include methods of data collection, descriptive and graphical methods, probability and probability models, statistical inference, control charts, design of experiments. Not open to students with credit in MA2710, MA2720, or MA3715.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 2160

**MA 3715 - Biostatistics**
Introduction to the design and analysis of statistical studies in the health and life sciences. Topics include study design, descriptive and graphical methods, probability, inference on means, categorical data analysis, and linear regression. Not open to students with credit in MA2710, MA2720, or MA3710.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 1135 or MA 1160 or MA 1161

**MA 3720 - Probability**
Introduction to probabilistic methods. Topics include probability laws, counting rules, discrete and continuous random variables, expectation, joint distributions, and limit theorems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** MA 1160 or MA 1161

**MA 3740 - Statistical Programming and Analysis**
Project-based course enabling students to identify statistical metods and analysis using R and S. Topics include exploratory data analysis, classical statistical tests, sample size and power considerations, correlation, regression,and design experiments using advanced programming techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or MA 3715

**MA 3750 - Introduction to SAS Programming**
This course is a workshop focused on solving problems for SAS certified base/certified programmers for SAS credentials.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or MA 3715

**MA 3810 - Introduction to Actuarial Mathematics**
Nominal and effective rates of interest, present value, discount, annuities certain, sinking funds, bonds, yield rates, and amortization schedules. Financial calculator skills for professional exams. Immunization, swaps, interest rate policy. May include other topics on the FM exam.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3160(C)

**MA 3811 - Actuarial Exam Workshop**
Topics from the Society of Actuaries professional examinations, primarily financial mathematics and probability. Review, preparation, and practice using SOA exams and other materials.
**Credits:** 1.0; Repeatable to a Max of 4; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MA 3160

**MA 3924 - College Geometry with Technology**
Review of Euclidean geometry. Introduction to geometric constructions, conjecturing of theorems, methods of proof, 3-D geometry, finite geometries, and non-Euclidean geometries. Integrates computer software (e.g. Geometer's Sketchpad) throughout the course.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MA 2160 or MA 2330

**MA 3990 - Math Sciences Teach Experience**
Development of teaching skills through assisting in the instruction of a section of an entry-level undergraduate mathematics course. Students gain experience in leadership, group work, organization skills, cooperative exercise preparation, and class instruction.
**Credits:** variable to 4.0; Repeatable to a Max of 4; Graded Pass/Fail Only
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**MA 3999 - Intermediate Topics in Mathematics**
Students study a particular area in mathematics, not ordinarily covered in existing courses. Intended for third-year students.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**MA 4208 - Optimization and Graph Algorithms**
An introduction to linear and integer programming and related graph problems. Topics include simplex algorithm, duality, branch-and-bound and branch-and-cut, shortest paths, spanning trees, matchings, network flow, graph coloring, and perfect graphs.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 3210

**MA 4209 - Combinatorics and Graph Theory**
An introductory course in combinatorics and graph theory. Topics include designs, enumeration, extremal set theory, finite geometry, graph coloring, inclusion-exclusion, network algorithms, permutations, and trees.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3210

**MA 4310 - Abstract Algebra**
Detailed study of abstract algebra: elementary number theory (congruences, quadratic residues, arithmetic functions), group theory (monoids, permutation groups, homomorphisms, quotients, Lagrange's theorem, finite abelian groups, Sylow's theorems), ring theory (domains, prime and maximal ideals, quotients, PID's), splitting fields, finite fields.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 3310

**MA 4330 - Linear Algebra**
A study of fundamental ideas in linear algebra and its applications. Includes review of basic operations, block computations; eigensystems of normal matrices; canonical forms and factorizations; singular value decompositions, pseudo inverses, least-square applications; matrix exponentials and linear systems of ODEs; quadratic forms, extremal properties, and bilinear forms.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MA 2320 or MA 2321 or MA 2330) and MA 3160

**MA 4410 - Complex Variables**
A study of complex numbers, functions of a complex variable, analytic functions, elementary functions, integrals, Taylor and Laurent series, residues and poles, and conformal mapping.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 3160

**MA 4450 - Real Analysis**
Real analysis on Euclidean n-space. Topics include real and vector valued functions, metric and normed linear spaces; an introduction to Lebesgue measure and convergence theorems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MA 2320 or MA 2321 or MA 2330) and MA 3160 and MA 3450

**MA 4515 - Introduction to Partial Differential Equations**
An introduction to solution techniques for linear partial differential equations. Topics include: separation of variables, eigenvalue and boundary value problems, spectral methods, fourier series, and Green's functions. Studies applications in heat and mass transfer (diffusion eqn.), and mechanical vibrations (wave and beam eqns.).
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** (MA 3520 or MA 3521 or MA 3530 or MA 3560) and MA 3160

**MA 4525 - Applied Vector and Tensor Mathematics**
Introduction to vector and tensor mathematics with applications. Topics include vectors; vector differential calculus, space curves; dyadic products and matrices; gradients, divergence, curl, Laplacians; Stokes' integral theorem, Gauss theorem, conservation laws; curvilinear coordinates; tensors, material derivatives; applications of potential theory in electricity and magnetism, heat transfer, solid and fluid mechanics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3160 and (MA 2320 or MA 2321 or MA 2330)

**MA 4535 - Nonlinear Dynamics and Chaos**
Ordinary differential equations and dynamical systems via a modern geometric approach, including physical and engineering applications. May include chaotic phenomena and fractals.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MA 3520 or MA 3521 or MA 3530 or MA 3560) and MA 3160

**MA 4610 - Numerical Linear Algebra**
Derivation and analysis of algorithms for problems in linear algebra. Covers floating point arithmetic, condition numbers, error analysis; solution of linear systems (direct and iterative methods), eigenvalue problems, least squares, singular value decomposition. Includes a review of elementary linear algebra and the use of appropriate software.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2320 or MA 2321 or MA 2330

**MA 4620 - Numerical Methods for PDEs**
Derivation, analysis, and implementation of numerical methods for partial differential equations; applications to fluid mechanics, elasticity, heat conduction, acoustics, or electromagnetism.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MA 3520 or MA 3521 or MA 3530 or MA 3560) and MA 3160

**MA 4710 - Regression Analysis**
Covers simple, multiple, and polynomial regression; estimation, testing, and prediction; weighted least squares, matrix approach, dummy variables, multicollinearity, model diagnostics and variable selection. A statistical computing package is an integral part of the course.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or MA 3715

**MA 4720 - Design and Analysis of Experiments**
Covers construction and analysis of completely randomized, randomized block, incomplete block, Latin squares, factorial, fractional factorial, nested and split-plot designs. Also examines fixed, random and mixed effects models and multiple comparisons and contrasts. The SAS statistical package is an integral part of the course.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or MA 3715

**MA 4730 - Nonparametric Statistics**
Introduces nonparametric techniques that require less restrictive assumptions on the data. Topics include statistical inference concerning location and dispersion parameters as well as the general distributions. Goodness-of-fit tests for count and ordinal data are also discussed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710

**MA 4760 - Mathematical Statistics I**
Covers joint probability distributions, functions of random variables, sampling and limiting distributions, introduction to parameter estimation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3720

**MA 4770 - Mathematical Statistics II**
Continuation of MA4760. Theory of point and interval estimation; properties of estimators, theory of hypothesis testing, analysis of variance, analysis of categorical data and other topics as time allows
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 4760

**MA 4780 - Time Series Analysis and Forecasting**
Statistical modeling and inference for analyzing experimental data that have been observed at different points in time.Topics include models for stationary and nonstationary time series, model specification, parametric estimation, and time regression models.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MA 2710 or MA 2720 or MA 3710 or MA 3715) and MA 3720

**MA 4790 - Predictive Modeling**
Application, construction, and evaluation of statistical models used for prediction and classification. Topics include data visualization and exploratory methods, the normal theory regression model, logistic and Poisson regression, linear and quadratic discriminant analysis, and classification with logit models.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3740 or MA 4710 or MA 4720 or MA 4780

**MA 4810 - Financial Markets and Acturial Math**
Derivative Securities, hedging, arbitrage, binomial and Black-Scholes pricing models. Long-term insurance coverages, life insurance and annuities. May include other topics on professional SOA exams.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2004-2005 academic year
**Pre-Requisite(s):** MA 3720 and MA 3810

**MA 4820 - Loss Distributions and Acturial Math**
Loss distribution used for modeling insurance claims. Frequency, severity, coverage modifications, risk measures, models, credibility, short term insurance coverages. May include other topics on the C exam.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2005-2006 academic year
**Pre-Requisite(s):** MA 3720

**MA 4900 - Mathematical Sciences Project**
Independent study in an area of mathematical sciences under the guidance of a faculty member.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**MA 4905 - Methods of Teaching Mathematics**
This course focuses on trends and standards in secondary school mathematics education, with an emphasis on methods and materials for effectively supporting and assessing middle and high school learning. Requires admission to teacher education program.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** ED 4700(C)

**MA 4908 - Theory of Numbers with Technology**
Mathematical induction, Euclid's algorithm, prime and composite integers, algebra of congruences, Chinese remainder theorem, quadratic reciprocity law, number theoretic functions, first degree Diophantine equations, Pythagorean triples, Fermat and Mersenne numbers, factoring algorithms, tests for primality and various applications. Projects use Mathematica and EXCEL software packages.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 3210 or MA 3310 or MA 3924

**MA 4945 - History of Mathematics**
Survey of the development of mathematics from ancient times to today. How cultural, mathematical, and technological developments have influenced one another throughout history. Course provides all necessary historical background.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**MA 4990 - Topics in Mathematics**
Students study in greater depth a particular area of mathematics not studied in existing courses.
**Credits:** variable to 4.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

## Mechanical Engineering – Engineering Mechanics

**MEEM 2110 - Statics**
Force systems in two and three dimensions. Includes composition and resolution of forces and force systems, principles of equilibrium applied to various bodies, simple structures, friction, centroids, and moments of inertia. Vector algebra used where appropriate. Prerequisite of MA2160 with a grade of C or better is required.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following College(s): Sch of Forest Res & Envir Sci, College of Engineering
**Pre-Requisite(s):** MA 2160

**MEEM 2150 - Mechanics of Materials**
Introduction to mechanical behavior of materials, including stress/strain at a point, principle stresses and strains, stress-strain relationships, determination of stresses and deformations in situations involving axial loading, torsional loading of circular cross sections, and flexural loading of straight members. Also covers stresses due to combined loading and buckling of columns.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following College(s): Sch of Forest Res & Envir Sci, College of Engineering
**Pre-Requisite(s):** MEEM 2110

**MEEM 2201 - Introductory Thermodynamics**
This course introduces concepts of energy, energy conversion, mechanisms of heat and work transfer in processes and in cycles. It also covers the first and the second laws of thermodynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering
**Pre-Requisite(s):** MA 2160 and CH 1150 and CH 1151

**MEEM 2700 - Dynamics**
First course in the principles of dynamics, covering the motion of a particle, the kinematics and kinetics of plane motion of rigid bodies, the principles of work and energy, impulse and momentum. Uses vector methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** PH 2100 and (MEEM 2110 or ENG 2120) and MA 3160(C)

**MEEM 2901 - Mechanical Engineering Practice I**
Students develop laboratory and computer skills, Topics include product dissection, data acquisition, materials testing, 2D finite element modeling, 1D modeling and simulation.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 2110(C) and ENG 1102 and UN 1015

**MEEM 2911 - Mechanical Engineering Practice II**
Students further develop laboratory and simulation skills as they model and validate dynamic mechanical and thermal/fluid systems. They also fabricate system components using a variety of manufacturing methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 2901 and MEEM 2201(C) and (MA 2320(C) or MA 2321(C) or MA 2330(C))

**MEEM 3201 - introductory Fluid Mechanics & Heat Transfer**
Course emphasizes internal flow and modes of heat transfer: control volume analysis of mass, momentum and energy, pipe and duct flow, dimensional analysis, steady and unsteady heat conduction, internal convection and application of boundary conditions, and simple heat exchanger design.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 2201 and MEEM 2911 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**MEEM 3400 - Mechanical System Design and Analysis**
In this course, students learn mechanical synthesis and analysis methods. They use case studies to develop relationships between design and performance. They apply synthesis methods to the design of a new product.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 2150 and MEEM 2700

**MEEM 3600 - Introduction to Manufacturing**
This course introduces manufacturing processes, including deformation, subtractive, additive, and molding processes. Students learn how things are made in both low and high production environments. It includes design for manufacturing considerations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following College(s): School of Technology, College of Engineering
**Pre-Requisite(s):** MEEM 2150 and (MY 2100 or MSE 2100)

**MEEM 3750 - Dynamic Systems**
This course deals with the modeling, analysis and control of mixed physics systems. It covers differential equation generation for mechanical, thermal, and electrical systems, their simulation, and methods for analyzing their performance operating in both open and closed loop.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-4-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 2700 and MEEM 2911 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**MEEM 3901 - Mechanical Engineering Practice III - Model Based Design**
Students apply the engineering design process by combining engineering science with simulation tools to guide design decisions. They use energy-based models to determine design direction and design-based simulation to select and optimize components and subsystems to meet design requirements.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 2911(C) and MEEM 2150 and MEEM 2700

**MEEM 3911 - Mechanical Engineering Practice IV**
Students further develop their skills to identify and solve ill-defined problems. They tackle a complex system problem by gathering evidence, proposing a solution, and iterating to optimize the solution.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** MEEM 3901 and EE 3010 and MEEM 3400(C) and MEEM 3600(C)

**MEEM 3999 - Mechanical Engineering Undergraduate Research Project**
An undergraduate research experience during the junior year in mechanical engineering. Students work directly with faculty on active research projects/grants. A report will be submitted and graded.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Mechanical Eng-Eng Mechanics, Mechanical Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Senior

**MEEM 4150 - Intermediate Mechanics of Materials**
Basic concepts of three-dimensional stress and strain. Inelastic behavior of axial members, circular shafts and symmetric beams. Deflections of indeterminate beams. Unsymmetrical bending, shear flow and shear center for open sections. Energy methods for structures made up of one-dimensional elements. Introduction to theories of failures.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MEEM 2150

**MEEM 4170 - Failure of Materials in Mechanics**
Identifies the modes of mechanical failure that are essential to prediction and prevention of mechanical failure. Discusses theories of failure in detail. Treats the topic of fatigue failure extensively and brittle fracture, impact and buckling failures at some length.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MEEM 3501 or MEEM 3400

**MEEM 4180 - Engineering Biomechanics**
Engineering mechanics applied to the human body in health and disease or injury, which includes mechanics of human biological materials and engineering design in musculo-skeletal system. Also studies on mechanics of posture (occupational biomechanics) and locomotion (sports biomechanics) using mathematical models of the human body.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MEEM 2150 and MEEM 2700

**MEEM 4200 - Principles of Energy Conversion**
Introduces fundamentals of energy conversion and storage. Topics include fossil and nuclear fuels, thermodynamic power cycles, solar energy, photovoltaics, and energy storage.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** MEEM 4201(C) or MEEM 3230(C) or CM 3230 or ENG 3200 or MY 3100 or MSE 3100

**MEEM 4201 - Intermediate Thermodynamics**
A study of the principles of thermodynamics, including fundamental concepts and introduction of the analytical treatments of the first and second laws. Topics include exergy, ideal and real gas mixtures, gas and vapor power cycles, psychrometry, combustion, and chemical equilibrium.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
**Pre-Requisite(s):** MEEM 3201(C)

**MEEM 4202 - Intermediate Fluid Mechanics and Heat Transfer**
Intermediate fluid mechanics and heat transfer topics are covered. These include necessary considerations of: differential analysis of fluid flows based on Navier-Stokes equations, lift and drag, convective heat transfer in external flows, radiation, and simple considerations of condensation and boiling.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
**Pre-Requisite(s):** MEEM 3201

**MEEM 4210 - Computational Fluids Engineering**
Introduces computational methods used to solve fluid mechanics, and thermal transfer problems. Discusses theoretical and practical aspects. Modern computer-based tools are used to reinforce principles and introduce advanced topics in fluid mechanics, and thermal transport.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** MEEM 3201(C)

**MEEM 4220 - Internal Combustion Engines I**
This course teaches the operational principles of spark-ignition and compression-ignition internal combustion engines through the application of thermodynamics, fluid dynamics, and heat transfer. Course studies engine performance, efficiency, and emissions using cycle-based analysis, combustion thermochemistry, and compressible fluid flow.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** MEEM 4201(C)

**MEEM 4230 - Compressible Flow/Gas Dynamics**
Fundamentals of one-dimensional gas dynamics, including flow in nozzles and diffusers, normal shocks, frictional flows, and flows with heat transfer or energy release; introduction to oblique shocks.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MEEM 3201

**MEEM 4235 - Wind Energy**
Student will be introduced to the underlying principles of wind energy conversion, including wind turbine design, aerodynamics, construction, control, and operation. The evaluation of concurrent aspects such as wind resource turbine siting, grid integration, and environmental, and social impact will be covered.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MEEM 3201

**MEEM 4240 - Combustion & Air Pollution**
Introduces sources of emissions from combustion, applies thermo-chemical principles to model the formation of pollutants, and identifies impacts of air pollutants on the environment and human health. Addresses pollution regulation and societal impacts including emissions, climate change, and air quality.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** MEEM 2200 or MEEM 2201

**MEEM 4250 - Heating/Ventilation/Air Cond**
Elements of heat transfer for buildings. Thermodynamic properties of moist air, human comfort and the environment, solar energy fundamentals and applications, water vapor transmission in building structures, heating and cooling load calculations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2004-2005 academic year
**Pre-Requisite(s):** MEEM 3201

**MEEM 4260 - Fuel Cell Technology**
Fuel cell basics, operation principles and performance analysis. Emphasis on component materials and transport phenomena on proton exchange membrane fule cells along with other types of fuel cells. Hydrogen production, transportation, and storage. Balance of plant and systems analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MEEM 3201 or CM 3110

**MEEM 4295 - Introduction to Propulsion Systems for Hybrid Electric Vehicles**
Hybrid electric vehicle analysis will be developed and applied to examine the operation, integration, and design of powertrain components. Model based simulation and design is applied to determine vehicle performance measures in comparison to vehicle technical specifications. Power flows, losses, energy usage, and drive quality are examined over drive-cycles via application of these tools.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MEEM 2200 or ENG 3200 or MEEM 2201

**MEEM 4296 - Experimental Studies in Hybrid Electric Vehicles**
Hands-on course examines hybrid electric vehicles from an energy perspective. Topics include powertrain architecture, vehicle testing, fuel consumption, aerodynamics and rolling resistance, engines, batteries, electric machines and power electronics. Course culminates with study of system interactions with emphasis on idle reduction and regenerative braking.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**MEEM 4404 - Mechanism Synthesis/Dynamic Modeling**
Students apply kinematic synthesis techniques in design and analysis of mechanical systems. They develop synthesis software to link to dynamic analysis packages such as ADAMS, I-DEAS, Unigraphics, etc. They investigate influences of process variation on system output and learn methods to minimize the variation influences.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MEEM 3502(C) or MEEM 3400

**MEEM 4405 - Intro to the Finite Element Method**
Introduces the use of the finite element method in stress analysis and heat transfer. Emphasizes the modeling assumptions associated with different elements and uses the computer to solve many different types of stress analysis problems, including thermal stress analysis and introductory nonlinear analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MEEM 3400 and (MA 2320 or MA 2321 or MA 2330) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**MEEM 4430 - Advanced Computer Aided Design and Manufacturing Methods**
Students apply advanced solid modeling techniques to construct solid models of mechanical systems, document the design using GD&T conventions as per ASME standards, simulate the motion of the system, and learn the computer aided manufacturing and additive manufacturing techniques.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** ENG 1102 and MEEM 3600

**MEEM 4450 - Vehicle Dynamics**
This course will develop the models and techniques needed to predict the performance of a road vehicle during drive off, braking, ride, and steering maneuvers. Topics to be covered include: acceleration and braking performance, power train architecture, vehicle handling, suspension modeling, tire models, and steering control. Matlab, Adams Car, and Amesim, will be used as computational tools.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MEEM 3400 or EE 3261

**MEEM 4610 - Advanced Machining Processes**
Covers mechanics of 2-D and 3-D cutting and their extension to commonly used conventional processes such as turning, boring, milling, and drilling. Topics include force modeling, surface generation, heat transfer, tool life and dynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MEEM 2500 or MEEM 3600

**MEEM 4615 - Metal Forming Processes**
Covers analytical and experimental study of metal forming processes, such as forging, extrusion, rolling, bending, stretch forming, and deep drawing as well as progressive die design for sheet metal stamping and design of dies for bulk forming.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MEEM 2500 and MEEM 2150

**MEEM 4625 - Precision Manuf and Metrology**
Course presents theory and practice involved in manufacturing and measuring of precision components. Topics include precision machining processes, precision machine/mechanism design, and dimensional metrology. Also discusses current manufacturing challenges in the bearings, optics, and microelectronics industries.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** (MEEM 3700(C) and MEEM 3502(C)) or MEEM 3600(C)

**MEEM 4630 - Human Factors**
The usability of products and systems can be improved by considering human capabilities during their design. This course explores both the psychological and physical characteristics of human beings. It then presents how to apply human factors principles to the design process.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**MEEM 4635 - Design with Plastics**
Covers various complexities in design of plastic parts and design of molds for manufacturing of plastic parts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and MEEM 2150 and (MEEM 3201(C) or CM 3110)

**MEEM 4640 - Micromanufacturing Processes**
Introduces the processes and equipment for fabricating microsystems and the methods for measuring component size and system performance. Fabrication processes include microscale milling, drilling, diamond machining, and lithography. Measurement methods include interferometry and scanning electron microscopy.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MEEM 3400(C)

**MEEM 4650 - Quality Engineering**
Introduction to the concepts and methods of quality and productivity improvement. Topics include principles of Shewhart, Deming, Taguchi; meaning of quality; control charts for variables, individuals, and attributes; process capability analysis; variation of assemblies; and computer-based workshops.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MA 3710 or MA 3720 or MA 2710 or MA 2720

**MEEM 4655 - Production Planning**
Provides current issues, such as just-in-time production and reengineering, while covering fundamental production planning topics as scheduling, job design, inventory and forecasting. Provides the fundamental essence of the firm--how its services and products are created and how they are delivered to customers.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MEEM 3501(C) or MEEM 3400(C)

**MEEM 4675 - Design of Material Handling Systems**
Material handling deals with the handling operations and stock of material inside a warehouse. Emphasis is given to design, static and dynamic analysis and component sizing of lifts, cranes, continuous handling equipment (conveyors) and forklifts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering, School of Business & Economics; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** MEEM 2150

**MEEM 4685 - Env Resp Design & Manuf**
Examines the impact of engineering and design/manufacturing, decisions on the environment. Topics include sustainability; energy and material flows; risk assessment; life cycles, manufacturing process waste streams, and product design issues, including disassembly and post-use product handling and techniques for pollution prevention.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2001-2002 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**MEEM 4695 - Additive Manufacturing**
Background, principles, process chain, software aspects, post-processing, open-source tools, applications, and future directions of AM technologies are discussed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MEEM 3600

**MEEM 4701 - Analytical and Experimental Modal Analysis**
Combined experimental and analytical approach to mechanical vibration issues; characterization of the dynamic behavior of a structure in terms of its modal parameters; digital data acquisition and signal processing; experimental modal analysis procedures; parameter estimation for obtaining modal parameters; model validation and correlation with analytical models; structural dynamics modification.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MEEM 3750

**MEEM 4702 - Shock and Vibration**
Theory and experimental techniques in vibration control, Shock, structural health monitoring, condition based maintenance, dynamic measurements, test methods, and planning.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
**Pre-Requisite(s):** (MEEM 3911 and MEEM 3750) or MEEM 4775

**MEEM 4704 - Acoustics and Noise Control**
Analysis and solution of practical environmental noise problems. Fundamental concepts of sound generation and propagation, the unwanted effects of noise, assessment of sound quality, and source-path-receiver concepts in noise control. Lecture, measurement laboratory, and team project directed at solving a real noise problem under a client's sponsorship.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 3160 and MEEM 2700

**MEEM 4705 - Introduction to Robotics and Mechatronics**
Cross-discipline system integration of sensors, actuators, and microprocessors to achieve high-level design requirements, including robotic systems. A variety of sensor and actuation types are introduced, from both a practical and a mathematical perspective. Embedded microprocessor applications are developed using the C programming language.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** MEEM 3750

**MEEM 4707 - Autonomous Systems**
The main concepts of autonomous systems will be introduced including motion control, navigation, and intelligent path planning and perception. This is a hands-on project based course. Students will have the opportunity to work with mobile robotics platforms.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
**Pre-Requisite(s):** MEEM 3750 or MEEM 4700

**MEEM 4720 - Space Mechanics**
This course presents the vector-based solution of the two-body problem and the solution for Kepler's equations. The course will also cover basic orbit determination techniques, impulsive orbit transfer maneuvers, interplanetary trajectories, ground tracks, and rendezvous problems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** MEEM 2700

**MEEM 4730 - Dynamic System Simulation**
Methods for simulating dynamic systems described by ordinary differential equations using numerical integration are developed. Quantifying simulation errors for both batch and real-time, control system applications is covered along with numerical optimization strategies for model validation. MATLAB and Simulink are used to illustrate key concepts.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MEEM 3750

**MEEM 4775 - Analysis & Design of Feedback Control Systems**
This course covers topics of control systems design. Course includes a review for modeling of dynamical systems, stability, and root locus design. Also covers control systems design in the frequency domain, fundamentals of digital contol and nonlinear systems.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
**Pre-Requisite(s):** MEEM 3750

**MEEM 4810 - Introduction to Aerospace Engineering**
Introductory course on topics relevant to aerospace engineering and science. Topics include history, properties of the atmosphere, the solar system, atmospheric and space vehicles, mission design, and vehicle design and performance.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MEEM 2150 or ENG 2120) and (MEEM 3201 or ENG 3200)

**MEEM 4820 - Introduction to Aerospace Propulsion**
Principles of jet propulsion, cycle analysis and component analysis (non-rotating components, compressors, turbines). Principles of rocket propulsion, chemical rockets, propellants, turbomachinery, electrical propulsion. Review of thermodynamics for fluid flow, one-dimensional gas dynamics, and boundary layer theory included.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MEEM 4230(C)

**MEEM 4850 - Naval Systems and Platforms**
Concepts of semi- and fully-autonomous naval and marine sensors and sensing platforms demonstrated through classroom learning and hands-on experiences. Laboratories will focus on operating sensors and sensor packages, in oceanographic and other applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MEEM 3201 or ENG 3200 or MY 3110 or MSE 3110

**MEEM 4901 - Senior Capstone Design I**
Students work in teams on "open-ended" engineering capstone design projects - most with industrial sponsors - developing original and creative solutions to real engineering problems.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** (MEEM 3000(C) and MEEM 3502 and MEEM 3900) or (MEEM 3201(C) and MEEM 3750(C) and MEEM 3911 and MA 3710)

**MEEM 4911 - Senior Capstone Design II**
Design projects started in MEEM4901 are completed and evaluated using computer-aided engineering methods, physical models, and/or prototypes as appropriate.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering
**Pre-Requisite(s):** (MEEM 4901 and MEEM 3000(C) and MEEM 3502(C) and MEEM 3900) or (MEEM 3201 and MEEM 3750 and MEEM 4901)

**MEEM 4990 - Special Topics in Mech Engg**
Problems in mechanical engineering, engineering mechanics, manufacturing, or industrial engineering that are not covered in regular courses.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MEEM 4999 - Mechanical Engineering Senior Research Thesis**
An undergraduate research experience during the senior year in mechanical engineering. Students begin work on an active research project/grant with faculty or continue work from the previous year. A thesis will be published in the department and archived.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Mechanical Eng-Eng Mechanics, Mechanical Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

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## Mechanical Engineering Technology

**MET 1020 - Technology Computer Applications**
Introductory course intended to develop knowledge of computer modeling techniques such as solid modeling, spreadsheet, word processing, presentation, and project time line software utilized throughout the technology curriculum.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall

**MET 1540 - Materials Science**
Introduction to the fundamentals of materials. Introduces mechanical properties, phase diagrams, thermal processing, alloying, and corrosion. Examines material selection with regard to design considerations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** CH 1000 or (CH 1150 and CH 1151)

**MET 2120 - Statics and Strength of Materials**
Statics includes the study of forces, analysis of simple structures, equilibrium, moment of inertia, and friction. Materials considers stress and strain under axial, torsional, and bending loads. Laboratory exercises include materials testing and problem solving.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MA 1160(C) or MA 1161(C)) and (PH 1140 or PH 1110)

**MET 2130 - Dynamics**
Particle and rigid plane body kinematics and kinetics covers inertia force, work-energy-power and impulse-momentum methods. Emphasizes development of student skills in problem definition and problem solving.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MET 2120 or ENG 2120

**MET 2153 - Machine Tool Fundamentals and Applications**
A study of basic machining processes: including setup and operation of lathes, milling machines, drill presses, grinders and saws. Students are exposed to fundamental machining processes, nomenclature and machine operation with an overall focus on safety and quality control.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering Tech

**MET 2400 - Practical Applications in Parametric Modeling**
Intermediate course intended to expand the student's knowledge of computer modeling techniques, introducing advanced assemblies and GD&T concepts. Investigates advanced concepts available to the designer.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Mechanical Engineering Tech
**Pre-Requisite(s):** MET 1020 or TE 1020

**MET 3242 - Machine Design I**
An introduction to mechanical design for technology students. The coursework applies principles of statics, dynamics and mechanics of materials to the design of simple mechanical components and systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 2160 and MET 2130

**MET 3400 - Applied Fluid Mechanics**
This course provides an introduction to the principles of fluid mechanics and their application to natural and engineering problems. Students are expected to have a good understanding of statics and dynamics. Develpment of engineering problem-solving skills will be emphasized.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MET 2130

**MET 3451 - Machine Design II**
This course extends the study of mechanical design begun in MET3242, Machine Design I and looks at more complex components and systems. Design projects are given special emphasis.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MET 3242

**MET 3500 - Manufacturing Processes**
Focuses on practical aspects of design and manufacturing. Covers fundamentals of manufacturing processes and includes a weekly lab to provide hands-on experience with manufacturing issues that influence component design.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MET 1020 or ENG 1102) and (MET 1540 or MY 2100 or MSE 2100)

**MET 3700 - Applied Thermodynamics**
Engineering thermodynamics principles including work, heat and temperature, pure substances, closed and open systems, first and second laws of thermodynamics, and power and refrigeration cycles.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MET 3250 or MET 3400

**MET 4210 - Applied Quality Techniques**
Basic knowledge required to improve processes in the workplace. Includes the design of simple experiments, statistical process control, lean methodologies, and corrective and preventative action.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** MA 2720(C) or MA 3710(C)

**MET 4300 - Applied Heat Transfer**
Heat transfer principles including conduction, convection and radiation heat transfer mechanisms. Practical applications include thermal insulation, heat sink and heat exchanger design.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MET 3600 or (MET 3700 and MET 4360(C)) or MEEM 2200 or MEEM 2201

**MET 4350 - Principles and Application of Heating, Ventilating, and Air Conditioning Systems**
This course is designed to provide an introduction to heating, ventilating, and air conditioning systems that combines design principles with real-world applications. Students will conduct heating and cooling load calculations, learn psychrometrics, and have the opportunity to work on a realistic design project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MET 4300

**MET 4355 - Industrial Systems Simulation**
Creating simulation models of various industrial systems in order to analyze and experiment with characteristics of real life systems for the purpose of engineering process improvement and production design.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring

**MET 4360 - Thermal-Fluids Laboratory**
This course provides hands-on experience with selected thermal-fluid laboratory experiments. Site/plant visits will be included for exposure to some of the practical aspects of the thermal-fluids area.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MET 3400 and MET 3700 and MET 4300(C)

**MET 4377 - Applied Fluid Power**
An introduction to fluid power components and systems. The course includes component selection, circuit design, electrical interfaces, and system troubleshooting and maintenance. A laboratory exposes students to system hardware and circuit simulation techniques for mobile and industrial applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MET 3250 or (MET 3400 and MET 4360(C))

**MET 4390 - Internal Combustion Engines**
An introduction to the basic principles and applications of internal combustion engines. The course covers design, development and testing of engine components and systems. A laboratory exposes students to current industry methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MET 3600 or MET 4300 or (MET 3700 and MET 4360(C))

**MET 4460 - Product Design and Development**
A treatment of design and development issues such as design for manufacturing, prototyping, industrial design, and customer needs. Presents integrated methodologies that examine marketing, manufacturing, and cross-functional teams. Includes concurrent engineering and projects utilizing CAD systems.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MET 3451(C)

**MET 4510 - Lean Manufacturing and Production Planning**
Modern methods for the systematic planning and control of operations and an understanding of lean manufacturing concepts. Focus is on reduced lead times and elimination of waste. Not open to students with credit in MEEM4655 or OSM3000.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**MET 4550 - Computer Aided Manufacturing**
Course is designed to apply techniques used in parametric modeling (CAD) and convert this information to all phases of production planning, machining, scheduling and quality control.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MET 2153 and MET 2400

**MET 4575 - Senior Project I**
Research and beginning design projects using computer-aided engineering methods, physical models, and/or prototypes. Evaluation and design optimization methods for efficient and cost-effective designs.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MET 4460

**MET 4585 - Facilities Layout and Safety Design**
Examines the optimization concepts and safety topics necessary to design a low risk, high efficiency manufacturing facility layout. The focus will be on quantitative tools, flow analysis techniques, hazard recognition and resource selection.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**MET 4660 - CAE and FEA Methods**
Comprehensive use of both computer derived solutions and experimental validation of analytical and finite element solutions using methods such as strain gage testing.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MET 2400 and MET 3242(C)

**MET 4670 - Senior Project**
Completion and evaluation of design projects using computer-aided engineering methods, physical models, and/or prototypes. Evaluation and design optimization methods for efficient and cost-effective designs. Oral/written report and comprehensive exam.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MET 4460

**MET 4675 - Senior Project II**
Completion and evaluation of design projects using computer-aided engineering methods, physical models, and/or prototypes. Evaluation and design optimization methods for efficient and cost-effective designs.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MET 4575

**MET 4780 - Advanced Manufacturing**
An introduction to advanced manufacturing processes, both traditional and nontraditional. Study of both theory and practice will be tied to laboratory experiments utilizing a spectrum of unique materials and methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** MEEM 2500 or MET 3500

**MET 4996 - Special Topics in Mechanical Engineering Technology**
Selected additional topics of interest in Mechanical Engineering Technology based on student and faculty demand and interest. May be a tutorial, seminar, workshop, project, or class study.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Mechanical Engineering Tech; Must be enrolled in one of the following Class(es): Senior

**MET 4997 - Independent Study in Mechanical Engineering Technology**
Independent study of an approved topic under the guidance of a Mechanical Engineering Technology faculty member. May be either an academic, design, or research problem/project.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Mechanical Engineering Tech; Must be enrolled in one of the following Class(es): Senior

**MET 4998 - Undergraduate Research in Mechanical Engineering Technology**
An undergraduate research experience in Mechanical Engineering Technology. Under the guidance of a Mechanical Engineering Technology faculty member, students work on a selected/approved research problem or work directly with faculty on active research projects/grants. May require more than one semester to complete.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Mechanical Engineering Tech; Must be enrolled in one of the following Class(es): Senior

**MET 4999 - Professional Practice Seminar**
Course designed to review and evaluate the program objectives linked with industrial partners and accreditation body. Focus given to preparing the student to take the certification exam.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior

## Management

**MGT 2000 - Team Dynamics and Decision Making**
Develops individual and group problem-solving skills using active, hands-on learning. Emphasizes problem identification and problem solution under conditions of ambiguity and uncertainty. Stresses creativity, interpersonal skills and skill assessment, communication, group process and teamwork, and action planning.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**MGT 3000 - Organizational Behavior**
Covers concepts of human relations and organizational behavior through the study of people's behavior at work. Develop understanding, attitudes, and skills leading to increased personal effectiveness.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**MGT 3100 - Leadership Development**
Assesses students' current knowledge, abilities and values relevant to leadership and guides students in developing and implementing plans for new leadership abilities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**MGT 3650 - Intellectual Property Management**
Covers principles of intellectual property lawy, addressing managerial and policy issues in copyright, trademark, trade secret, and patents. Readings and discussions also cover how these property and legal systems impact the balance between property exclusivity, technological innovation and public access.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**MGT 3800 - Entrepreneurship**
Covers management issues associated with establishing a successful new enterprises as a small businesses or part of an existing firm. Emphasizes learning through creation of a business plan as well as case studies that develop an understanding of opportunity recognition, entrepreneurial teams, reward systems, financing alternatives, family ventures, ethical and legal contractual considerations, and resource needs.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MGT 4000 - Strategic Management**
A capstone course focusing on managing from a strategic perspective for gaining advantages in competitive and dynamic environments, emphasizing understanding of industry, business models, growth strategies, and managing business portfolios. Integrates knowledge from finance, marketing, and organizational behavior.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following College(s): School of Business & Economics; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MIS 2000 and FIN 3000 and OSM 3000 and MGT 3000 and MKT 3000 and BUS 2300

**MGT 4100 - International Management**
Addresses the complexities and challenges faced by companies operating in an increasingly globalized world. Focuses on political, legal, ethical, cultural, economic issues, and on the entry, growth and knowledge management strategies of developed and developing country firms.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MGT 3000 and EC 3100(C)

**MGT 4200 - Entrepreneurial Management**
Draws upon the fundamental concepts of entrepreneurship covered in MGT3800 (Entrepreneurship) and enhances the understanding of these concepts from a strategic and entrepreneurial management point of view.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MGT 3800

**MGT 4500 - Managing Change in Organizations**
Studies organizational theory with an emphasis on managing change in organizations. Examines forces for change in the external environment, methods for managing change (design and implementation), the impact of change on people, and leaders as agents of change. Case studies and student projects prepare the student to manage change in organizations.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MGT 3000

**MGT 4600 - Management of Technology and Innovation**
Introduces disruptive innovation concepts and provides occasions for their application to timely and relevant cases. Provides an understanding of technology management and innovation processes as they occur inside and outside of organizations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MGT 4700 - Human Resource Management**
Examines methods that organizations use to meet organizational goals through influencing worker attitudes, behaviors, and performance. Topics include recruitment, selection, training, performance appraisal, and compensation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MGT 3000

**MGT 4990 - Special Topics in Management**
Examines additional management topics and issues in greater depth. A single offering of this course will concentrate on one or two topics which vary.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** MGT 3000

## Management Information Systems

**MIS 2000 - IS/IT Management**
Focuses on the theory and application of the information-systems discipline within an organizational context, and identifies the roles of management, users, and information systems professionals. Covers the use of information systems and implications for decision support to improve business processes, and addresses the ethical, legal, and social issues of IT.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BUS 1100 or CS 1121 or CS 1131 or ENG 1101 or (ENG 1001 and ENG 1100) or SAT 1200

**MIS 2100 - Introduction to Business Programming**
Develops business problem solving skills through the application of a commonly used high-level business programming language. Topics include the nature of the business programming environment, fundamentals of the language (e.g., programming constructs, data management, manipulation of simple data structures), structured programming concepts, desirable programming practices and design, debugging and testing techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**MIS 2200 - Web Programming**
Covers technologies, tools, and environments related to the development of web-enabled business solutions. Topics include the development environment for web-based solutions, key development technologies, desirable development practices, and design, programming, debugging and testing methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** MIS 2100 or CS 1121 or CS 1131

**MIS 3000 - Business Process Analysis**
Studies business decision management discipline using business rules, process models (e.g. flowcharts, unified modeling language, swim lanes), and information systems to improve efficiency and effectiveness. Emphasis on industry standards and business process management used to increase productivity.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** MIS 2000

**MIS 3100 - Business Database Management**
Emphasizes database principles that are constant across different database software products through concrete examples using a relational database management system. Provides a well-rounded business perspective about developing, utilizing, and managing organizational databases.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MIS 2000(C)

**MIS 3200 - Systems Analysis and Design**
Provides an understanding of the IS development and modification process and the evaluation choices of a system development methodology. Emphasizes effective communication with users and team members and others associated with the development and maintenance of the information system. Stresses analysis and logical design of departmental-level information system.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MIS 2000(C)

**MIS 3400 - Business Intelligence**
Focuses on generation and interpretation of business analytics relative to organizational decision making. Includes core skills necessary for constructing data retrieval queries in a relational database environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** MIS 2000 and (MIS 3100 or CS 3425)

**MIS 3500 - User-Centered Design**
Studies user-centered design in development of effective interface solutions for business needs. Content may include input/output devices, user modeling, help and documentation, social issues, and usability evaluation. Emphasis on how interface design addresses human capabilities and capacities.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** MIS 2000

**MIS 4000 - Advanced Information Systems**
Focuses on understanding IT for competitive advantage and as an agent of transformation. Topics include managing IT infrastructure and architecture, facilitating information distribution throughout the enterprise, conducting case analyses to develop a framework for innovative Enterprise Systems to be used for sustainable competitive advantage.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MIS 3100 and MIS 3200

**MIS 4100 - Information Systems Projects**
MIS capstone course. Previous completion of required MIS coursework expected. Applies IS practices and artifacts as solutions to business problems using project teams and faculty project manager supervision. Emphasizes the latter portion of the systems development life cycle project management within an IS context.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** MIS 2100 and MIS 3100 and MIS 3200

**MIS 4200 - Management of Cyber Security**
Review of information systems security concepts and industry best practices. Subject matter is organized to provide students a foundation to sit for the Certified Systems Security Professional (CISSP) exam after completion.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** MIS 2000 or CS 1111 or CS 1121 or CS 1131

**MIS 4990 - Special Topics in Management Information Systems**
Examines current IS/IT topics and issues in greater depth from a managerial perspective. A single offering of this course will concentrate on one or two topics, which will vary.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Pre-Requisite(s):** MIS 2000

## Marketing

**MKT 3000 - Principles of Marketing**
Emphasizes decisions made in developing both strategic and tactical marketing plans. Uses computer simulations, experiential learning assignments, and marketing plan development to demonstrate principles of market segmentation, product development, pricing, distribution planning, and promotion.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer

**MKT 3200 - Consumer Behavior**
Introduces students to the general concepts, processes, and variables pertinent to consumers' decision making and lifestyle choices. Discussions will be based on a variety of disciplines: psychology, sociology, economics, and anthropology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MKT 3000

**MKT 3400 - Integrated Marketing Communications**
Discusses how a variety of marketing communication methods, such as advertising, public relations, sales promotion, point-of-purchase, and direct marketing are developed, implemented, and evaluated in an integrative manner.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** BA 3800 or MKT 3000

**MKT 3600 - Marketing Research**
Focuses on the application of the marketing research in marketing decision-making. Topics include survey methodology, research design, statistical analysis of data, and report writing.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MA 2710 or MA 2720 or MA 3710 or BUS 2100) and MKT 3000

**MKT 4100 - Sales and Sales Management**
Looks at the role of the selling function as an integral part of the total marketing effort. Examines the administrative functions of sales management, the dynamics of the buying-selling process, and sales strategies and tactics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** MKT 3000

**MKT 4200 - Business to Business Marketing**
Emphasis is on the firm's behavior and decision-making. Topics include the foundation of business value creation, business marketing programs development, and inter-firm relationship management.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** MKT 3000

**MKT 4300 - Global Marketing**
Discusses the critical elements of international marketing strategy: socio-politico-economic environment, global consumer culture, entry strategy, and global marketing mix. Utilizes cases and examples in order for students to better understand the globalized marketplace.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MKT 3000

**MKT 4500 - Introduction to Digital Marketing**
The class will include, but is not limited to: online video lectures, interactive chats, blogging, completing digital marketing plans and an Internet Marketing text book supported by a student web site. Basic familiarity with the internet, search engines and social media is assumed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MKT 3000

**MKT 4700 - Marketing Strategy**
Discusses various aspects of creative and value-enhancing marketing strategies. Topics include branding, new product development, market research, marketing communication, services, consumer culture, corporate social responsibility, social media marketing, and globalization.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** MKT 3200 and MKT 3600 and MKT 4300(C)

**MKT 4990 - Special Topics in Marketing**
Examines current issues in marketing. Topics are selected based on the interest to faculty and students
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required
**Pre-Requisite(s):** MKT 3000

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## Materials Science & Engineering

**MSE 2100 - Introduction to Materials Science and Engineering**
Introduction to the structure, processing, properties, and performance of engineering materials, including metals, polymers, glasses, ceramics, and composites. Presents case studies covering selection of materials, component design, and analysis of component failures.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** CH 1112 or CH 1122 or (CH 1150 and CH 1151) or (CH 1160 and CH 1161)

**MSE 2110 - Introduction to Materials Science and Engineering II**
Course is designed to address core competencies in the materials discipline. Materials processing methods are used as a vehicle to master concepts such as crystallography, imperfections, phase diagrams, microstructure, and development of mathematical skills and introduction to computational tools.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and (ENG 1100 or ENG 1101)

**MSE 3100 - Materials Processing I**
Classical chemical thermodynamics as applied to single and multicomponent materials systems. Topics include heat and mass balance, enthalpy, entropy, free energy, chemical reactions and equilibria, mass action, solution thermodynamics, phase diagram, stability/Pourbaix diagrams and electrochemistry.
**Credits:** 4.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and MA 2160

**MSE 3110 - Materials Processing II**
A continuation of Materials Processing I, which introduces the fundamental theories and equations governing transport phenomena. Topics include fluid flow, heat flow, diffusion, and chemical kinetics. Discusses the relationships between these subjects and the thermodynamic concepts covered in Materials Processing I.
**Credits:** 4.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MY 2110 or MSE 2110) and (MY 3100 or MSE 3100) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**MSE 3120 - Materials Characterization I**
Fundamentals of microstructural and chemical characterization of materials. Examines the physical principles controlling the various basic characterization techniques. Topics include crystallography, optics, optical and electron microscopy, and diffraction. Laboratory focuses on proper operational principles of characterization equipment, which includes optical and other microscopy methods and various diffraction techniques.
**Credits:** 4.0
**Lec-Rec-Lab:** (2-1-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and (MY 2110 or MSE 2110)

**MSE 3130 - Materials Characterization II**
Fundmentals and application of instrumental analysis in characterization of bulk materials and powders, and their internal phases and external surfaces. Demonstrates spectroscopic and surface analysis techniques in identification of ceramics and polymers and their phases. Discusses the limitations and capabilities of elemental, chemical and structural charcterization methods combined with statistical analysis of data.
**Credits:** 4.0
**Lec-Rec-Lab:** (2-1-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MY 2100 or MSE 2100

**MSE 3140 - Design of Microstructure**
Relates thermodynamic and kinetic principles to phase transformations and microstructural evolution. Topics include nucleation, solidification, precipitation, recrystallization, grain growth, and sintering. Applications of these concepts (e.g., heat treatment of steel, casting, powder processing, etc.) are presented to provide a bridge between phase transformation theory and industrial/laboratory practice.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MY 2110 or MSE 2110) and (MY 3100 or MSE 3100) and (MY 3200(C) or MSE 3120(C))

**MSE 3150 - Introduction to Semiconductor Materials & Devices**
An introduction to materials science and engineering of semiconductors. Topics include: semiconductor material electronic, thermal, and optical properties; how these properties are modified, how elementary devices made from these materials operate, and how devices function in electrical circuits depends on material selection and processing.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PH 2200 and MA 2160

**MSE 3190 - Material Design**
Integration of contemporary engineering design methodology with foundational structure-property-processing paradigm for materials design. Introduction to project planning, management, and six-sigma as applied to material design.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MY 3100 or MSE 3100) and (MY 3110(C) or MSE 3110(C)) and (MY 3200(C) or MSE 3120(C)) and (MY 3210(C) or MSE 3130(C)) and (MY 3300(C) or MSE 3140(C)) and ENG 1102

**MSE 4100 - Mechanical Behavior of Materials**
An introduction to the deformation and fracture behavior of materials. Topics include multiaxial stress and strain, elastic and plastic deformation, hardening mechanisms, viscoelasticity, fracture, fatigue, creep, and microstructure/property relationships.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** (MY 2110 or MSE 2110) and (MY 2100 or MSE 2100) and (MEEM 2150 or ENG 2120)

**MSE 4110 - Introduction to Polymer Engineering**
Introductory study of polymeric materials and polymer engineering. Basics in polymer science including molecular characteristics, synthesis, structure and properties of polymers, with strong emphasis on thermodynamics of polymers. Various processing techniques and mechanical/ structural applications of polymers.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and CH 1160

**MSE 4120 - Material and Process Selection in Design**
The principles of materials selection for engineering design. Topics include selection based on strength, stiffness, thermal properties, high temperature behavior, corrosion resistance, formability, joinability, manufacturability, recyclability, etc. Considers ethics and economics. Presents numerous case studies and examples.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MY 2100 or MSE 2100

**MSE 4130 - Materials Science & Engineering Senior Design Project I**
Conducted in teams of students working with industrial partners. Open to all engineering majors interested in interdisciplinary senior design projects. Non-MSE majors must be senior project ready as defined by their major program and obtain permission of the MSE department.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** (MY 3110 or MSE 3110) and (MY 3200 or MSE 3120) and (MY 3210 or MSE 3130) and (MY 3300 or MSE 3140) and (MY 4940 or MSE 3190)

**MSE 4131 - Capstone Professional Skills 1**
This course will include practical application of contemporary engineering design methodoloyg within the structure-processing-properties paradigm for material design project management, experimental design, written and oral communication.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Materials Science and Engrg
**Co-Requisite(s):** ENT 4950
**Pre-Requisite(s):** MSE 3190 or MY 4940

**MSE 4140 - Materials Science & Engineering Senior Design Project II**
Senior design project conducted in teams of students working with an industrial partner. Open to all engineering majors interested in interdisciplinary senior design projects. Senior project ready as defined by major substitutes for prerequisites.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** MY 4920 or MSE 4130

**MSE 4141 - Capstone Professional Skills 2**
This course includes practical application of contemporary engineering design methodology within the structure- processing-properties paradigm for material design, project management, experimental design, written and oral communication.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Materials Science and Engrg
**Co-Requisite(s):** ENT 4960
**Pre-Requisite(s):** MSE 4131

**MSE 4235 - Fundamentals of Corrosion**
Basic mechanisms of electrochemical processes and corrosion.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** CH 1150 and CH 1151

**MSE 4240 - Introduction to MEMS**
Fundamentals of micromachining and microfabrication techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are central to MEMS fabrication.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-1-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**MSE 4292 - Light and Photonic Materials**
Material properties controlling light wave propagation in optical crystals and optical wave guides. Photonic crystals and photonic devices based on electrical, magnetic, and strain effects.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Physics, Applied Physics, Electrical Engineering, Materials Science and Engrg; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** PH 2200 or EE 2190 or EE 3140

**MSE 4310 - Principles of Metal Casting**
Principles of metal casting, including melting practice, casting design, mold design, heat transfer and solidification, fluid flow and gating design. Introduction to computer simulation techniques for mold filling, solidification, and development of residual stress. Structure-property relations in cast metals. Recycling and environmental issues of the cast metals industry.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MY 2100 or MSE 2100

**MSE 4320 - Corrosion and Environmental Effects**
Mechanisms of corrosion processes, electrochemical and oxidation kinetics, and fundamentals of corrosion engineering.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MY 2100 or MSE 2100

**MSE 4330 - Advanced Physical Metallurgy**
Examines what exactly makes a particular industrial alloy useful. From the light metals (aluminum, magnesium and titanium) to the heavy weights (nickel and high alloy steels), this course examines the structure, properties, and processing of metals into industrially useful materials. Covers internationally accepted alloy designations, heat treatment standards, modification and processing.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and (MY 3300 or MSE 3140)

**MSE 4410 - Science of Ceramic Materials**
The structure, defect chemistry, and properties of crystalline and amorphous ceramics. Utilization of these materials in a variety of applications such as electrolytes in fuel cells and as bioceramics are examined.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MY 2100 or MSE 2100

**MSE 4430 - Composite Materials**
Mechanistic aspects of property development in metal, ceramic, and polymeric composites. The role of composite architecture, processing, and microstructure on properties.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MY 2100 or MSE 2100

**MSE 4510 - Contact Mechanics and Nanoindentation**
The application of elastic and plastic contact mechanics in relation to nanoindentation with emphasis on the application of instrumentation, models and experimental techniques used to examine the small-scale mechanical behavior of metals, ceramics, polymers, composites, biomaterials, hydrogels, and structured devices.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and PH 2200 and (MA 3521 or MA 3520 or MA 3530) and MEEM 2150

**MSE 4520 - Materials Forensics**
Probes fundamental physical principles important to various characterization techniques used to understand crystal structure, microstructure, and substructure in materials. Application of x-ray, electrons, and light to unravel the structural mystery of materials and apply techniques to material failure analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (MY 2100 or MSE 2100) and (MY 3200 or MSE 3120)

**MSE 4525 - Introduction to Scanning Electron Microscopy**
Introduction to scanning electron microscope (SEM) theory and application. Topics will include electron beam and image formation, beam-specimen interactions, and x-ray microanalysis. Course material will be of interest to biologists, chemists, and engineers. Completion of MY4201 is required for independent use of the equipment.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MSE 4530 - Scanning Electron Microscopy and X-ray Microanalysis**
Topics include electron beam and image formation, beam- specimen interactions, and x-ray microanalysis. Course content is relevant to students of the physical sciences, engineering, and related disciplines. Includes a laboratory experience that provides hands-on practical training sufficient to enable independent use of the SEM.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**MSE 4540 - Computational Materials Science: Theory, Modeling, Simulation, and Practice**
Theories of materials science from first principles to constitutive laws. Materials modeling and computer simulation at multiple length and time scales. Laboratory practice of various computational methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MSE 4740 - Hydrometallurgy/Pyrometallurgy**
Extraction and refining of metals and industrial chemicals from natural and recycled materials. Includes solution- chemistry processes (hydrometallurgy) and thermochemical processes (pyrometallurgy).
**Credits:** 4.0
**Lec-Rec-Lab:** (3-1-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** CH 1122 or (CH 1160 and CH 1161)

**MSE 4760 - Environmental Engineering for Materials Processing Industries**
Assessment and analysis of environmental impacts from materials processing industries. Regulations, permits, and industrial practices for monitoring and solving air, water, and solid environmental issues. Pollution prevention. Life cycle analysis. Material flow analysis.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MSE 4777 - Distributed Additive Manufacturing Using Open-Source 3-D Printing**
This course provides an overview of open-source hardware in theory and practice for an introduction to distributed additive manufacturing using open-source 3-D printing. Each student will build a customized RepRap and will learn all hardware and software for maintaining it.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Class(es): Junior, Senior

**MSE 4970 - Special Topics - Materials**
Special topics in materials science and engineering.
**Credits:** variable to 4.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**MSE 4990 - Undergraduate Research**
Undergraduate research in materials science and engineering. Independent research conducted under the guidance of a faculty member.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

## Operations & Supply Chain Management

**OSM 3000 - Operations and Supply Chain Management**
Fundamental principles of operations and supply chain management; includes strategic importance and relevant interrelated concepts and tools in product/process design, work systems, forecasting, inventory and materials management, just-in-time, scheduling, and capacity management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (MA 1135 or MA 1160 or MA 1161) and (MA 2710 or MA 2720 or MA 3710 or MA 3720 or EET 2010 or BUS 2100)

**OSM 3150 - Introduction to Supply Chain Management**
An introduction to supply chain management to gain a perspective on integration and coordination issues. Topics include strategy, network design, facility design, sourcing, logistics, forecasting, inventory, relationship management, and global and sustainable supply chain management.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** OSM 3000(C)

**OSM 3600 - Procurement and Supply Management**
Addresses processes that facilitate the managment of value added transactions and relationships between supplier and customer organizations. The course examines the management of the business purchasing function, including supplier selection and development, cost management, performance measures, buyer-supplier relationships, and negotiation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**OSM 4300 - Project Management**
The various stages in a project life cycle will be covered and include initiation, planning, execution, and closeout. Basic tools such as the Project Charter, Network Diagrams Gantt, and budgeting will be covered. Basics of MS Project are included.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** BUS 2100 or CEE 3710 or MA 2720 or MA 3710 or EE 3180 or BE 2100

**OSM 4350 - Advanced Project Management**
A project oriented business development class focused on real-life and advanced applications of project management techniques. Students participate in a competition, prepare for the PMI CAPM exam, and may sit for the exam to obtain certification.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** OSM 3200 or ENG 4300 or OSM 4300

**OSM 4650 - Six Sigma Fundamentals**
Course is framed in context of six sigma methodology. Topics include principles of Shewhart, Deming, Taguchi; meaning of quality; control charts for variables, individuals, and attributes; process capability analysis; variation of assemblies; and computer-based workshops.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or MA 3720 or BUS 2100 or CE 3710 or CEE 3710

**OSM 4700 - Logistics and Transportation Management**
Focuses on the transportation and distribution services that support demand fulfillment from the receipt of customer orders to order fulfillment. Topics include customer service, order fulfillment, inventory, transportation costs and modes, facility design and operation, carrier selection, and negotiation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (MA 2710 or MA 2720 or MA 3710 or CE 3710 or CEE 3710) and (MA 1135 or MA 1160 or MA 1161)

**OSM 4990 - Special Topics in Supply Chain and Operations Management**
Examines additional supply chain and/or operations management topics and issues in greater depth. A single offering of this course will concentrate on one or two topics, which vary.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** OSM 3000

## Physical Education

**PE 0101 - Flag Football**
Fundamental skills and rules will be learned for co-recreational play of flag football. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0103 - Bait and Fly Casting**
Bait and fly casting skills. Each student must have a valid current year Michigan fishing license. Trout stamp is optional. Equipment is available if needed. Requires some additional hours outside of class. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** On Demand

**PE 0104 - Ultimate Frisbee**
Fundamental skills, rules, and play of ultimate frisbee. The class is physically strenuous. Frisbees are provided. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0105 - Beginning Bowling I**
Fundamental skills, rules, and scoring of bowling. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0106 - Beginning Golf**
Rules, terminology, and etiquette of golf and the individual skills of grip, stance, and swing. Equipment is supplied. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0107 - Floor Hockey**
Individual skills, team techniques, rules and strategies of floor hockey. Hockey gloves or winter gloves are highly recommended. Sticks and goalie equipment are provided. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0108 - Broomball**
Students will learn the rules, strategy, and safety needed to compete in broomball. Offensive and defensive zone coverages and individual skills are stressed. Team play with officials. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0109 - Aikido**
Aikido is a specific martial arts training for physical and character development. Physically strenuous. Students should wear loose sweatsuits (with long sleeves) or white martial arts uniform. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0113 - Disc Golf**
Fundamental skills, rules and play of disc golf. Students will learn recreational play and organized tournament play (various formats). Students can bring their own disc (or discs); some are provided. The class meets at MTU's Disc Golf Course on Sharon Avenue by the Advanced Technology Development Complex. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0114 - Frisbockey**
Fundamental skills, rules and play of frisbockey will be taught. Class is physically strenuous. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** On Demand

**PE 0115 - Beginning Swimming**
Nonswimmers learn to have no fear of water, to float, and to swim the four fundamental strokes. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**PE 0116 - Beginning Basketball**
Theory, organization, and defensive and offensive skills of basketball. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0117 - Beginning Hockey**
Individual skills, team techniques, rules, and strategies. Requires basic hockey equipment of helmet with face mask, shoulder pads, hockey pants, shin pads, elbow pads, hockey gloves, skates, supporter, jersey, hockey socks, hockey stick. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0118 - Beginning Weight Training**
Training methods for physical development using stationary and free weights. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**PE 0119 - Beginning Fitness Training**
This course is designed to introduce students to a variety of activities to improve their fitness and well being. Activities will include using aerobic machines and strength training. Students will learn the basic concepts of fitness and how to safely and properly use the fitness center equipment.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0120 - Beginning Alpine Skiing (Downhill)**
Beginning skills of alpine skiing techniques taught, evaluated, and recommendations made for improvement. Students with skills above beginner level cannot take this class. Students must provide their own transportation to Mont Ripley. It is recommended that students provide their own equipment. Daily rental and "rent for the season" equipment available at Mont Ripley.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0121 - Beginning Snowboarding**
Beginning skills of snowboarding techniques taught, evaluated, and recommendations made for improvement. Students must be a beginner or have never snowboarded to this class. Students with skills above beginner level cannot take this class. Students must provide their own transportation to Mont Ripley. It is recommended that students provide own equipment. Daily rental and "rent for the season" equipment available at Mont Ripley. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0122 - Softball**
Fundamentals of throwing, fielding, and hitting a softball. Bats, balls, and bases are provided. Each student should bring a glove. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0123 - Telemark Skiing**
The beginning skills of Telemark skiing techniques will be taught, evaluated and recommendations made for improvement. Students must provide own transportation and Telemark ski equipment. A limited amount of rentals are available.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0125 - Sand Volleyball**
Sand volleyball rules, basic fundamentals and team play. Passing,setting, attacking, serving, blocking, round robin, 2 vs. 2, and 4 vs. 4 tournaments, 6 vs. 6 system and drills to improve one's overall play. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0126 - Beginning Volleyball**
Fundamental skills, rules interpretation, strategy, and conduct of tournament play. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0130 - Water Aerobics**
Improvement of fitness and body measurement through water exercise. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall

**PE 0132 - Beginning Soccer**
Fundamental skills, techniques, terminology, and rules of soccer. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0135 - Beginning Cross Country Skiing**
Develop the skills for touring/recreational cross-country skiing. Own equipment is recommended; rental equipment available. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0137 - Table Tennis**
Fundamental skills of table tennis will be taught. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0138 - Beginning Racquetball/Squash**
Fundamentals, rules, and basic strategies of racquetball/squash. Gives students opportunity to play singles, cutthroat, and doubles. Racquets, balls, and eyewear provided. Recommend use of personal racquet. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0139 - Beginning Badminton**
Fundamental skills, rules, and scoring of badminton. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0140 - Beginning Tennis**
Fundamentals of the game, rules, and etiquette of tennis. Meets at Gates Tennis Center. Non-marking court shoes must be worn. Tennis balls and racquets provided. Recommend use of personal racquet. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0145 - Beginning Rifle**
Using precision air rifles, beginners develop an awareness of firearms safety and marksmanship. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0146 - Beginning Billiards**
Introduction to the etiquette, rules, and recreational value of pocket billiards. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0148 - Beginning Skating**
Fundamental skills of ice skating, including proper stroking forward and backward, edges, crossovers, stops, and other basic skills. Requires own skates and helmets.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0150 - Outdoor Lifetime Activities**
This class will introduce students to a variety of recreational activities often used in a social/leisure setting (i.e. ladder golf, disc golf, croquet, etc.). May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Summer

**PE 0151 - Indoor Lifetime Activities**
This class will introduce students to a variety of recreational activities often used in a social/leisure setting (i.e., shuffleboard, billiards, table tennis, etc.). May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0152 - Social Dance I**
Fundamentals of social dance, providing the basic skills, concepts of movement, style, and fundamental step patterns. Emphasis on the development of fundamental dance skills and practice in utilizing dance techniques.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0153 - Aerobics I**
Improvement of cardiovascular fitness, strength, coordination, and body mechanics through exercise. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0155 - Beginning Road Biking**
Learn to be comfortable and confident while riding a regular road bike. Covers basic maintenance repair procedures. Requires own equipment and supplies, including a bike helmet. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall

**PE 0156 - Beginning Mountain Biking**
Learn to be comfortable and confident while riding a mountain bike off-road. Covers basic maintenance repair procedures. Requires own equipment and supplies as well as a biking helmet. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall

**PE 0166 - Moving for Fitness**
Introductory course to using the Student Development Complex and surrounding outdoor facilities in a variety of group and individual activities. Basic movement at your own level. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Summer

**PE 0167 - Beginning Yoga**
Learn the basics or compliment previous experience while improving flexibility, balance and concentration. Improve focus. Relax mentally and physically.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0168 - Beginning Pilates**
Students will learn a unique approach to exercise that develops body awareness. Pilates is one of the safest forms of exercise today. Students will improve coordination, posture and flexibility, as well as, release stress. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0169 - Indoor Cycling**
High energy, group cycling class. No complicated moves to learn. Upbeat music that gets your legs pumping.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0170 - TaeKwonDo and Hapkido I**
Introduction to the basic kicking, blocking, punching, joint locking, and self-defense techniques of TaeKwonDo and Hapkido. Emphasizes improvement of flexibility. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0175 - Hiking**
Fundamental knowledge and skills specific to hiking will be covered. Appropriate clothing and footwear for hiking is recommended. Course meets on weekends (usually Saturdays). May be use once as a general education co-curricular course. Due to class structure, students must attend all classes - No Exceptions.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Summer

**PE 0176 - Outdoor Adventure**
Students will engage in multi-day backpacking with overnight camping. Destinations are variable, possibilities include Isle Royale National Park, Porcupine Mountains, etc. Instructors will include trained wilderness guides and class/laboratory fee will cover miscellaneous costs such as park permits, transportation costs, camping gear, and group meals.
**Credits:** variable to 3.0; Repeatable to a Max of 3; Graded Pass/Fail Only
**Semesters Offered:** On Demand

**PE 0205 - Bowling II**
Intermediate to advanced techniques in bowling, including skills and strategy involved in tournament play. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0206 - Intermediate Golf**
Intermediate to advanced individual instruction in golf techniques, terms, courtesies, and tournament regulations. Equipment needed; some rental clubs available. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer

**PE 0209 - Intermediate Aikido**
This course is designed to be a continuation of Aikido.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** On Demand

**PE 0210 - Special Topics in Physical Education**
Unconventional activity courses that address varying and changing student interests. Topics vary. Each topic may count once as a general education co-curricular course as long as the topic and course content are different than other co-curricular courses taken.
**Credits:** 0.5; Repeatable to a Max of 1; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**PE 0215 - Intermediate Swimming**
Students learn to swim four basic strokes with proficiency. Requires ability to swim the length of pool comfortably. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0216 - Intermediate Basketball**
Intermediate to advanced techniques, skills, and strategies of basketball. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0217 - Intermediate Hockey**
Intermediate/advanced techniques, skills, and strategies. Requires basic hockey equipment of helmet with face mask, shoulder pads, hockey pants, shin pads, elbow pads, hockey gloves, skates, supporter, jersey, hockey socks, hockey stick. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0218 - Intermediate Weight Training**
Intermediate to advanced techniques of weight lifting. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0219 - Intermediate Fitness Training**
This course is designed to be a continuation of Beginning Fitness Training, providing the opportunity to continue in a variety of activities to improve fitness and well being. Activities include using aerobic machines and strength training. Students will learn fitness training concepts and how to safely and properly use fitness center equipment.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0220 - Intermediate Alpine Skiing (Downhill)**
Intermediate to advanced skills of alpine skiing techniques taught, evaluated and recommendations made for improvement. Students must provide their own transportation to Mont Ripley. It is recommended that students provide their own equipment. Daily rental and "rent for the season" equipment available at Mont Ripley. May be use once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0221 - Intermediate Snowboarding**
Intermediate to advanced skills of snowboarding techniques taught, evaluated, and recommendations made for improvement. Students must provide their own transportation to Mont Ripley. It is recommended that students provide their own equipment. Daily rental and "rent for the season" equipment available at Mont Ripley. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0226 - Intermediate Volleyball**
Organization and development of team competition in volleyball. Requires previous volleyball experience. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0230 - Water Polo**
Fundamental skills, rules, strategy, and play of water polo. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0232 - Intermediate Soccer**
Intermediate to advanced techniques, skills, and strategies involved in soccer. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**PE 0235 - Intermediate Cross Country Skiing**
Development of touring, recreational, and racing skills in cross country skiing. Own equipment is recommended; rental equipment available. Basic skills evaluated to ensure proper level of skiing proficiency. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0237 - Intermediate Table Tennis**
Intermediate/advanced skills of table tennis will be taught. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0238 - Intermediate Racquetball/Squash**
Reviews the fundamentals and instructs the students on the intermediate/advanced skills of racquetball and squash. Gives all students the opportunity to play singles, cutthroat, and doubles. Racquets, balls, and eyewear provided. Recommend use of personal racquet. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0239 - Intermediate Badminton**
Intermediate to advanced techniques, skills, and strategies involved in badminton. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0240 - Intermediate Tennis**
Intermediate to advanced techniques, skills, and strategies in tennis. Class meets at Gates Tennis Center. Non-marking court shoes must be worn. Tennis balls and racquets provided. Recommend use of personal racquet. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0246 - Intermediate Billiards**
Intermediate to advanced techniques, skills, and strategies in billiards. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0248 - Intermediate Skating**
Intermediate/advanced skills, including three turns, mohawk turns, jumps and spins, and drills for stops, starts, and power skating. Requires own skates. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0250 - Paintball**
Students will be exposed to the sport of paintball for enjoyment and physical exercise in a relaxed outdoor setting. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0252 - Social Dance II**
Continuation of developing social dance skills, concepts of movement, style, and step patterns. Emphasis on practice in utilizing dance techniques.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0253 - Aerobics II**
Intermediate to advanced techniques and steps involved in aerobics. Requires previous aerobics experience. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0256 - Intermediate Mountain Biking**
Intermediate to advanced techniques and skills involved in mountain biking. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall

**PE 0266 - Running for Fitness**
The techniques, skills, and strategies involved in running. The class is physically strenuous. Requires appropriate running shoes and attire. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**PE 0267 - Intermediate Yoga**
Combined ancient Hatha yoga poses with modern fitness movement to create a total mind/body workout for all fitness levels. Improve breathing and oxygen intake.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0268 - Intermediate Pilates**
Students will learn advanced techniques to build strength and flexibility while engaging the muscles of their abdominals, lower back and hips, otherwise known as the "Power House" for a more streamline shape.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0270 - Cardio TaeKwonDo**
Improvement of kicking, blocking, punching, joint locking, and self-defense techniques. Emphasizes improvement of skills and strategies involved in TaeKwonDo. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0315 - Fitness Swimming**
Practices the basic strokes; introduces knowledge in creating workouts to encourage swimming as a lifetime fitness activity. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0320 - Advanced Skiing**
Advanced skills of skiing techniques taught, evaluated, and recommendations made for improvement. Students must provide their own transportation to Mont Ripley. It is recommended that students provide their own equipment. Daily rental and "rent for the season" equipment available at Mont Ripley. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0321 - Advanced Snowboarding**
Advanced skills of snowboarding techniques taught, evaluated, and recommendations made for improvement. Students must provide their own transportation to Mont Ripley. It is recommended that students provide their own equipment. Daily rental and "rent for the season" equipment available at Mont Ripley. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring

**PE 0330 - Club Sports**
Club sport participation based on student interest. Group must be on the approved list of sports and all membership requirements must be up to date. Students enrolling in this course must participate in 14 hours of activity during the semester. Participation is tracked by instructor of record. No retroactive credit will be awarded for involvement in club sport activity.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**PE 0340 - Advanced Tennis**
Advanced skills and strategy to make play more efficient. Multiple spins on forehand and backhand, ground strokes, drop shots, and different types of serves. Non-marking court shoes must be worn. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PE 0240

**PE 0352 - Social Dance III**
Introduction of current dance trends.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0353 - Aerobics III**
Cardiovascular fitness course based on current trends in aerobics.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0355 - Advanced Road Biking**
Learn advanced road biking techniques and strategies. Course requires own equipment, including road bike/wheels, bike shorts, biking shoes/pedals, and a helmet. Course also requires sufficient fitness to ride continuously in excess of 15 mph for 1.5 hours. May be used once as a general education co-curricular course.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall

**PE 0367 - Mindful Yoga**
A restorative yoga class that is very gentle and has an emphasis on meditations/mindfulness.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 0420 - Ski Instructor Training**
Students will learn how to teach ski classes. Upon completion of this course students will have the knowledge to complete the Level I certification test with the American Snowsports Education Association, if they choose.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** On Demand

**PE 0421 - Snowboard Instructor Training**
Students will learn to teach snowboard classes. Upon completion of this course students will have the knowledge to complete the Level I certification test with the American Snowsports Education Association, if they choose.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** On Demand

**PE 0425 - Intramurals**
Intramural activity that addresses varying and changing student interests. Sports vary. Students must be a member of IMleagues.com/MTU. Students enrolling in the course must participate in 14 games/contests during the portion of the semester that the course is offered to receive a passing grade. Participation is tracked via IMleagues.com/MTU. No retroactive credit will be awarded for involvement in intramural activities.
**Credits:** 0.5; Repeatable to a Max of 1; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**PE 0430 - Club Sports Leadership**
Leadership in club sport participation based on student interests. Students enrolling in this course must hold a position of leadership within the club sport. Group must be on approved list of sports and all membership requirements up to date. Students must participate in 14 hours of leadership activity during the semester. Participation is tracked by instructor of record. No retroactive credit will be awarded for invlovement in club sport activity.
**Credits:** 0.5; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required

**PE 0450 - Physical Education Fusion-Full**
Students will submit activity logs, photos, etc. to the course site. A predetermined number of points will need to be earned doing various activities through the semester. Activities with point values will be posted on the electronic course site.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring, Summer

**PE 1000 - Fitness Foundations**
Students will be introduced to practices and physical activities that they can incorporate into their daily life to sustain their healthy body and mind.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1028 - Ski Patrol (Hill)**
National Ski Patrol training involving fitness, skiing proficiency, toboggan handling, and lift evacuation. Leads to qualifying membership test into National Ski Patrol. Requires payment of dues to become a member of National Ski Patrol. Participation in this course requires intermediate ski level. Students must provide own equipment. Some rentals available at Mont Ripley.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring

**PE 1101 - Team Sports**
Students will demonstrate fundamental skills, knowledge of rules, strategies, and safety of the following team sports necessary for participation: flag football, softball, volleyball, soccer, basketball, and floor hockey. Students should bring a glove for softball. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1105 - Bowling**
Students will learn skills, rules, and scoring of bowling. Including skills and strategy involved in tournament play. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1106 - Golf**
Intermediate to advanced individual instruction in golf techniques, terms, courtesies, and tournament regulations. Equipment needed; some rental clubs available. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall, Spring

**PE 1113 - Disc Sports**
Students will demonstrate fundamental skills, knowledge of rules, strategies, and safety disc golf, frisbockey, and ultimate frisbee. Equipment provided. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1118 - Weight/Fitness Training**
This course is designed to introduce students to a variety of weight and fitness activities to improve their well- being. Activities will include using aerobic and strength training machines. Students will learn basic concepts on how to safely and properly use the fitness center equipment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1119 - Conditioning**
Students will demonstrate the fundamental knowledge and skills of conditioning, leading to continued enjoyment and participation as a lifelong activity. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1138 - Raquet Sports**
Students will demonstrate fundamental skills, knowledge of rules, strategies, and safety of table tennis, racquetball, and badminton. Equipment provided. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1140 - Tennis**
Fundamentals of the game, rules, and etiquette of tennis. Non-marking court shoes must be worn. Tennis balls and racquets provided. Recommend use of personal racquet. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1170 - TaeKwonDo**
Introduction to the basic kicking, blocking, punching, joint locking, and self-defense techniques of TaeKwonDo and Hapkido. Emphasizes improvement of flexibility, skills and strategies. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1210 - Special Topics**
Unconventional activity courses that address varying and changing student interests. Topics vary. May count once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1215 - Introduction to Backcountry Travel**
Fundamental knowledge and skills of backpacking leading to continued enjoyment and participation as a lifelong activity. Students will learn/practice on how to pack a backpack, plan food, and be knowledgeable about proper care and use of equipment related to backpacking.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall

**PE 1220 - Introduction to Canoeing**
Fundamental knowledge and skills of canoeing leading to continued enjoyment and participant as a lifelong activity. Students will practice/learn the basic strokes, and be knowledgeable about proper care and use of equipment related to canoeing.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall

**PE 1225 - Indoor Rock Climbing**
Fundamental knowledge and skills of rock climbing leading to continued enjoyment and participation as a lifelong activity. Students will practice/learn the basic terminology, knots, equipment, policies and procedures, and be knowledgeable in the proper care and use of equipment related to climbing, as well as safety concerns when climbing.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1230 - Introduction to Kayaking**
Fundamental knowledge and skills of kayaking leading to continued enjoyment and participation as a lifelong activity. Students will learn/practice basic strokes, and be knowledgeable in the proper care and uses of equipment related to kayaking, as well as safety concerns when kayaking.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Fall

**PE 1235 - Introduction to Log Rolling**
Fundamental knowledge and skills of log rolling as a sport, the different steps including front, back, and skip steps, and techniques of getting on the log. Log rolling is a different style of workout that works on balance, core, and endurance. History of Log Rolling and current competitive opportunities will be covered.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**PE 1240 - Snowshoeing**
Fundamental knowledge and skills of snowshoeing leading to continued enjoyment and participation as a lifelong activity. Students will learn about equipment, proper care and storage of equipment, and basic concepts of snowshoeing.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** Spring

**PE 1245 - Wilderness First Responder**
The definitive wilderness course in medical training, leadership, and critical thinking for outdoor, low-resource, and remote professionals and leaders. This course is the ideal medical training for leaders in remote areas, as well as general recreation users in remote in wild settings.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-4)
**Semesters Offered:** On Demand

**PE 1435 – Self Defense for Women**
The Rape Aggression Defense System is a program of realistic, self-defense tactics and techniques. The R.A.D. System is a comprehensive course for women that begins with awareness, prevention, risk reduction and avoidance, while progressing on to the basics of hands-on defense training. R.A.D. is not a martial arts program.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 1436 - Self Defense for Men**
Course teaches the Rape Aggression Defense System for men (TM). Participants will have the opportunity to raise their awareness of aggressive behavior. Hands-on self-defense skills to resist and escape aggressive behavior will be practiced.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

**PE 2010 - Varsity Football**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required

**PE 2020 - Varsity Basketball**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**PE 2030 - Varsity Hockey**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**PE 2040 - Varsity Nordic Skiing**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Spring
**Restrictions:** Permission of department required

**PE 2050 - Varsity Soccer**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**PE 2080 - Varsity Track**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Spring
**Restrictions:** Permission of department required

**PE 2090 - Varsity Tennis**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

**PE 2130 - Varsity Volleyball**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required

**PE 2140 - Varsity Cross Country**
Selective collegiate-level sports participation requiring an elite level of skill and extensive time commitment. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall
**Restrictions:** Permission of department required

**PE 2150 - Cross Training**
A broad base understanding of sports cross training and activities that can be pursued as lifelong activities. May be used once as a general education co-curricular course.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-5)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of department required

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## Physics

**PH 1090 - The Physics Behind Music**
Physics concepts and methods associated with musical instruments, musical recording, and musical acoustics are discussed at an introductory level. Topics include periodic motion, normal modes and resonance, superposition and Fourier series, waves, sound and acoustics, magnetism and electromagnetic induction, and topics from non-linear physics. Course is also offered online on demand in spring and summer semesters.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1031(C) or MA 1032(C)

**PH 1091 - The Physics Behind Music Lab**
A companion hands-on lab course covering topics from PH1090.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** PH 1090(C)

**PH 1100 - Physics by Inquiry I**
Experiments covering kinematics, force, conservation of momentum, conservation of energy, and waves are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** MA 1160(C) or MA 1161(C)

**PH 1110 - College Physics I**
An overview of basic principles of kinematics, dynamics, elasticity, fluids, heat, thermodynamics, mechanical waves, and interference and diffraction of mechanical waves.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following College(s): School of Technology, College of Engineering; May not be enrolled in one of the following Major(s): Physics, Applied Physics
**Co-Requisite(s):** PH 1111
**Pre-Requisite(s):** MA 1031 or MA 1032 or MA 1135(C) or MA 1160(C) or MA 1161(C) or ALEKS Math Placement >= 56 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2

**PH 1111 - College Physics I Laboratory**
Experiments covering kinematics, forces, conservation of momentum and energy, waves, and thermodynamics are explored through guided construction. The course provides inquiry-based laboratory experiences for concepts explored in PH1110.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** May not be enrolled in one of the following College(s): School of Technology, College of Engineering; May not be enrolled in one of the following Major(s): Physics, Applied Physics
**Co-Requisite(s):** PH 1110

**PH 1140 - Applied College Physics I**
An algebra-based introduction to classical mechanics and its applications. Topics include kinematics, Newton's laws, impulse and momentum, work and energy, simple harmonic motion, mechanical waves and sound, and temperature and heat.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Construction Management, Mechanical Engineering Tech, Electrical Eng Tech, General Technology, Theatre & Entertain Tech (BS), Computer Network & System Admn
**Co-Requisite(s):** PH 1141
**Pre-Requisite(s):** MA 1031 or MA 1032 or MA 1160(C) or MA 1161(C) and (PH 1100 or PH 1111 or PH 1141(C) or PH 1161)

**PH 1141 - Applied College Physics I Laboratory**
Experiments covering kinematics, forces, conservation of momentum and energy, waves, and thermodynamics are explored through guided construction. The course provides inquiry-based laboratory experiences for concepts explored in PH1140.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Engineering Technology, Mechanical Engineering Tech, Computer Network & System Admn, Electrical Eng Tech, Theatre & Entertain Tech (BS), Construction Management
**Co-Requisite(s):** PH 1140

**PH 1160 - Honors Physics I - Mechanics**
Calculus-based introduction to classical mechanics. Topics include mathematical concepts, kinematics, Newton's laws, the gravitational force, work and energy, and collisions. Also introduces departmental facilities, research within the department, and professional opportunities in physics. Intended for physics majors; highly motivated students seeking an invigorating introduction to physics may enroll with permission of the instructor.
**Credits:** 4.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Physics (BA), Physics, Applied Physics
**Co-Requisite(s):** PH 1161
**Pre-Requisite(s):** MA 1160(C) or MA 1161(C) or MA 2160(C)

**PH 1161 - Introduction to Experimental Physics I**
A laboratory complement to PH1160. Experiments covering kinematics, force, conservation of momentum, conservation of energy, waves and thermodynamics are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Physics (BA), Physics, Applied Physics
**Co-Requisite(s):** PH 1160

**PH 1200 - Physics by Inquiry II**
Experiments covering Coulomb's law, electric and magnetic fields, circuits, induction, and geometric optics are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** PH 1100 or PH 1111 or PH 1141 or PH 1161

**PH 1210 - College Physics II**
An overview of basic principles of static and dynamic electricity and magnetism, electromagnetic waves, reflection and refraction of light, interference and diffraction of light, special theory of relativity, wave theory of matter, particle theory of electromagnetic waves, theory of the atom, the nucleus, and elementary particles.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** May not be enrolled in one of the following College(s): School of Technology, College of Engineering; May not be enrolled in one of the following Major(s): Physics, Applied Physics
**Pre-Requisite(s):** PH 1200(C) and (PH 1110 or PH 1100)

**PH 1240 - Applied College Physics II**
An overview of static and dynamic electricity and magnetism, electromagnetic waves, basic optics, and an introduction to modern and nuclear physics with an emphasis on problem solving and applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following College(s): School of Technology
**Co-Requisite(s):** PH 1200
**Pre-Requisite(s):** PH 1140 or PH 1110

**PH 1360 - Honors Physics II - Rotation and Vibration**
Continuation of PH 1160. Topics include rotational motion, simple harmonic motion and mechanical waves. Offered first half of spring semester.
**Credits:** 2.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Spring
**Co-Requisite(s):** PH 1361
**Pre-Requisite(s):** (PH 1160 or PH 2100) and MA 2160(C)

**PH 1361 - Introductory Experimental Physics II**
Laboratory complement to PH 1360. Waves and thermodynamics are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Spring
**Co-Requisite(s):** PH 1360

**PH 1500 - Extraordinary Concepts in Physics**
Extraordinary concepts will be surveyed. Included will be time dilation and length contraction in Special Relativity, physics of Time Travel, curvature in General Relativity, interpretations of Uncertainty Principle, counter-intuitive examples of Two-Slit Experiment, Schrodinger's Cat, Maxwell's Demon, Bell's Inequality, curvature in cosmology, dark matter, dark energy, black hole evaporation, string theory, and gravitational lensing.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** On Demand

**PH 1600 - Introductory Astronomy**
Introduces fundamentals of astronomy. Topics include Kepler's and Newton's laws of motion, origin and evolution of the solar system, galactic astronomy, extra-galactic astronomy, cosmology, and modern instrumentation, including space-based astronomy.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall, Spring, Summer

**PH 1610 - Introductory Astronomy Lab**
Demonstrates fundamentals of astronomy using non-telescopic and telescopic observations, and computer simulations. Topics include angular size measurements, season-dependent measurements, phases of the moon, phases and orbits of planets, brightness of stars, introduction to the use of MTU's Observatory, instrumentation, and applications of computer programs involving cosmology.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer
**Co-Requisite(s):** PH 1600

**PH 2020 - Introduction to Scientific Programming and Error Analysis**
Compiled programming languages, command lines, and scripts will be used to solve simple physics problems. Measurement uncertainties, significant figures, probability distributions, error propagation, and data reduction will be examined in the contexts of experiments and numerical calculations.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Physics (BA), Physics, Applied Physics
**Pre-Requisite(s):** (PH 1160 or PH 2100) and (MA 1160 or MA 1161)

**PH 2100 - University Physics I-Mechanics**
A calculus-based introduction to classical mechanics. Topics include kinematics, Newton's laws, impulse and momentum, work and energy, and the universal law of gravitation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** PH 1100(C) and (MA 1160 or MA 1161 or MA 1135 or MA 2160(C))

**PH 2200 - University Physics II-Electricity and Magnetism**
A calculus-based introduction to electromagnetism. Topics include Coulomb's law, electric fields, Gauss's law, electric potential, capacitance, circuits, magnetic forces and fields, Ampere's law, induction, Maxwell's equations, and electromagnetic waves.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** (PH 1200(C) or PH 2261(C)) and (PH 2100 or PH 1160) and MA 2160

**PH 2230 - Electronics for Scientists**
An introduction to analog and digital electronics with an emphasis on their use in the laboratory. Topics include linear devices and basic linear circuit analysis; diodes; transistors; op-amps; the use of digital components, including logic gates, flip-flops, counters, clocks and microcontrollers, and analog to digital conversions.
**Credits:** 4.0
**Lec-Rec-Lab:** (3-0-3)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering
**Pre-Requisite(s):** PH 2200 or PH 2260

**PH 2260 - Honors Physics III - Electricity and Magnetism**
Calculus-based introduction to electromagnetism. Topics include Coulomb's law, electric fields, Gauss's law, electric potential, capacitance, circuits, magnetic forces and fields, Ampere's law, induction, Maxwell's equations, electromagnetic waves and geometrical optics.
**Credits:** 4.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (PH 1160 or PH 2100) and (PH 1200(C) or PH 2261(C)) and MA 2160

**PH 2261 - Introduction to Experimental Physics III**
A laboratory complement to PH2260. Experiments covering Coulomb's law, electric and magnetic fields, circuits, induction, geometric optics, and modern physics are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall
**Co-Requisite(s):** PH 2260
**Pre-Requisite(s):** PH 1100 or PH 1161

**PH 2300 - University Physics III-Fluids and Thermodynamics**
A calculus-based introduction to fluids and thermal physics. Topics include fluid motion, propagation of heat and sound, temperature and the kinetic theory of gases, heat capacity and latent heat, first law of thermodynamics, heat engines and the second law, entropy, and an introduction to statistical mechanics. Offered second half of spring semester.
**Credits:** 2.0
**Lec-Rec-Lab:** (4-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 1160 or PH 2100

**PH 2400 - University Physics IV-Waves and Modern Physics**
A calculus-based introduction to waves and modern physics. Topics include interference and diffraction, special relativity, photons and matter waves, the Bohr atom, wave mechanics, atomic physics, molecular and solid-state physics, and nuclear physics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Pre-Requisite(s):** PH 2200 or PH 2260

**PH 3110 - Theoretical Mechanics I**
An intermediate study of mechanics, including the study of Newtonian mechanics of a single particle and multiple-particle systems, oscillations, motion in noninertial reference frames, gravitation and central-force motion, and Lagrangian mechanics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (PH 2200 or PH 2260) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 3111 - Theoretical Mechanics II**
A continuation of PH3110. Includes the study of the rigid body motion, relativistic mechanics, and coupled oscillations. Additional topics may include chaos theory, Hamiltonian mechanics, and continuous systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 3110

**PH 3210 - Optics**
An introduction to geometrical and physical optics. Topics in geometrical optics include ray analysis of mirrors, lenses, prisms, and optical systems. Topics in physical optics include polarization, interference, interferometry, and diffraction. The laboratory explores optics through experiments in imaging, fiber optics, interferometry, diffraction, polarization, and laser beam propagation.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PH 2400 and (MA 3520 or MA 3521 or MA 3530(C) or MA 3560)

**PH 3300 - Thermodynamics and Statistical Mechanics**
Thermodynamic systems, heat, work, laws of thermodynamics, formal mathematical relations, cycles, phase equilibrium, and multicomponent systems. Elementary kinetic theory. Introduction to microscopic view of entropy, ensemble theory, and applications of statistical mechanics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 2300 or PH 1360

**PH 3320 - Methods of Theoretical Physics**
Introduction to the techniques and methods frequently encountered in advanced physics with a particular emphasis on application to physical problems. Topics include, but are not limited to, complex numbers, vector analysis, partial differential equations, and integral transforms.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** MA 3160 and (MA 3520 or MA 3521 or MA 3530 or MA 3560) and (PH 2200 or PH 2260)

**PH 3410 - Quantum Physics I**
An introduction to the foundations of modern physics and Schrodinger's wave mechanics. Topics include thermal radiation, particle-like properties of radiation, Bohr's model of the atom, matter waves, Schrodinger's wave mechanics, quantization of angular momentum, and the one-electron atom.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 2400 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 3411 - Quantum Physics II**
A continuation of PH3410. Includes the study of spin and magnetic interactions, multi-electron atoms, quantum statistics, molecules, solids, and elementary particles.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PH 3410

**PH 3480 - Advanced Physics Laboratory**
Through a series of experiments, students investigate physical phenomena that underlie modern physics. In the process, students become familiar with experimental techniques and instrumentation used in modern research laboratories.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 2230 and PH 3210

**PH 4010 - Senior Physics Colloquium I**
Class discussion of the literature in the field of physics. Requires oral and written presentations.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Co-Requisite(s):** PH 4080

**PH 4011 - Senior Physics Colloquium II**
A continuation of PH4011. Class discussion of current literature and recent advances in physics. Requires oral and written presentations.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Co-Requisite(s):** PH 4081
**Pre-Requisite(s):** PH 4010

**PH 4050 - Qualitative Methods in Physics**
General methods and approaches of the physicist, including modeling, scaling, numerical estimation, and dimensional analysis as applied to the development, understanding, and solution of physics problems. Serves as an excellent preparation for students taking the GRE Subject Test in physics.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Physics, Applied Physics; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**PH 4080 - Senior Research I**
Introduction to research under the guidance of a faculty member. In addition, creative problem solving will be assessed via a student-initiated project.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Co-Requisite(s):** PH 4010
**Pre-Requisite(s):** PH 3480

**PH 4081 - Senior Research II**
Continuation of research under the guidance of a faculty member, culminating in a written report and presentation of results at an undergraduate research forum.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Co-Requisite(s):** PH 4011
**Pre-Requisite(s):** PH 4080

**PH 4090 - Senior Thesis**
Students prepare an in-depth written thesis on an approved topic in physics. Normally taken the last semester before graduation in conjunction with PH4081.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Spring
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**PH 4210 - Electricity and Magnetism I**
Intermediate study of the basic theory of electricity and magnetism, including a detailed study of electrostatic field theory and an introduction to magnetostatics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (PH 2200 or PH 2260) and PH 3110 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 4211 - Electricity and Magnetism II**
A continuation of PH4210. Intermediate study of magnetostatics, electrodynamics, and electromagnetic waves.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 4210

**PH 4292 - Light and Photonic Materials**
Material properties controlling light wave propagation in optical crystals and optical waveguides. Photonic crystals and photonic devices based on electrical, magnetic, and strain effects.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PH 2200(C)

**PH 4390 - Computational Methods in Physics**
An overview of numerical and computer methods to analyze and visualize physics problems in mechanics, electromagnetism, and quantum mechanics. Utility and potential pitfalls of these methods, basic concepts of programming, UNIX computing environment, system libraries and computer graphics are included.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PH 2020 and PH 3410

**PH 4395 - Computer Simulation in Physics**
Role of computer simulation in physics with emphasis on methodologies, data and error analysis, approximations, and potential pitfalls. Methodologies may include Monte Carlo simulation, molecular dynamics, and first-principles calculations for materials, astrophysics simulation, and biophysics simulations.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-0-3)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PH 3300 and PH 4390 and (PH 2400 or PH 3410)

**PH 4510 - Introduction to Solid State Physics**
Crystal structures, X-ray diffraction, phonons, free electron theory of metals, rudiments of band theory, an overview of semiconductors, and other topics in solid-state physics.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (PH 2300 or PH 1360) and PH 2400 and (CH 1150 and CH 1151) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 4610 - Stellar Astrophysics**
Topics include an overview of observational astrophysics, stellar atmospheres, stellar structure, atomic properties of matter, radiation and energy transport in stellar interiors, and stellar evolution to and from the main sequence. Course offered every third year beginning 2008-09.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2008-2009 academic year
**Pre-Requisite(s):** PH 1600 and PH 2400 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 4620 - Galactic Astrophysics**
Topics include the composition and dynamics of our galaxy, dynamics of stellar encounters, spiral density wave theory, clusters of galaxies, theoretical cosmology, physics of the early universe, and observational cosmology. Course offered every third year beginning 2009-10.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2009-2010 academic year
**Pre-Requisite(s):** PH 1600 and PH 2400 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 4630 - Particle Astrophysics**
Introduction to the twin fields of elementary particle physics and high energy astrophysics. Topics include an overview of particles and interactions, the expanding universe, conservation laws, dark matter and dark energy, large scale structure, and cosmic particles. Course offered every third year beginning 2007-08.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2007-2008 academic year
**Pre-Requisite(s):** PH 2400 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 4640 - Fundamentals of Atmospheric Science**
Fundamental principles of atmospheric science including thermodynamics, aerosol and cloud physics, radiative transfer, and atmospheric dynamics.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2013-2014 academic year
**Pre-Requisite(s):** (PH 2200 or PH 2260) and (PH 1360 or PH 2300) and MA 3160 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**PH 4710 - Methods of Teaching Physics**
Hands-on exploration of physics education methods in classroom, laboratory, and tutoring environments. Students study highlights of physics education research and explore use of several tools and pedagogical techniques, including web-based homework systems, simulations, classroom feedback systems, and equipment for laboratories and lecture demonstrations.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2010-2011 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PH 1210 or PH 2200 or PH 2260

**PH 4999 - Special Topics in Physics**
Selected additional topics in physics for advanced students based on interests of faculty and students. Interested students should contact the physics department.
**Credits:** variable to 9.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer

## Psychology

**PSY 2000 - Introduction to Psychology**
Introduction to the scientific study of psychological structures and processes involved in individual and group behavior. Explores theoretical accounts of the foundations of human behavior and examines empirical support. Topics may include personality, disorders, therapy, development, and social psychology, perception, learning, cognition, emotion, and states of consciousness.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer

**PSY 2100 - Counseling Psychology**
Major approaches used in contemporary counseling psychology, the current status of the profession, and ethical issues encountered will be examined to provide students with a broad understanding of the field. This course does not train students to be counselors.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** PSY 2000

**PSY 2200 - Behavior Modification**
An introduction to techniques of behavior modification through the application of learning theories such as classical and operant conditioning. Students will conduct a case study project designed to modify a personal behavior.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** PSY 2000

**PSY 2300 - Developmental Psychology**
A survey of human development across the life span (prenatal, infant, child, adolescent, and adult) in the areas of biological, cognitive, social, emotional, and personality development. Provides insight into both the universality of human development and the uniqueness of individuals.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** PSY 2000

**PSY 2400 - Health Psychology**
Examines the theoretical, empirical, and historical bases for health psychology. Topics may include the effects of stress, determinants of addictive behavior, the impact of psychological factors on physical health, obesity, and the causes and treatment of chronic pain.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** PSY 2000

**PSY 2501 - Intro to the Psychology Major**
Psychology majors examine the field of psychology and major degree requirements resulting in an undergraduate plan of study focused on graduate school admission or career preparation. Students will be introduced to department research and other opportunities.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Psychology; Must be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** PSY 2000(C)

**PSY 2600 - Psychology of Death and Dying**
An examination of theory, research, and issues in the psychology of death and dying. Topics may include the development of death concepts, death anxiety in society, the needs of the dying person, the psychology of grieving, and unexpected losses.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** PSY 2000

**PSY 2720 - Statistics for the Behavioral Sciences**
An understanding of statistical concepts and ability to conduct statistical analyses (using both hand calculation and SPSS) as used in Social and Behavioral Sciences research. Topics include descriptive statistics, correlation, and inferential statistics through ANOVA.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Social Sciences, Psychology
**Pre-Requisite(s):** MA 1031 or MA 1032 or MA 1160(C) or MA 1161(C) or MA 1135(C)

**PSY 2800 - Critical Thinking for Social and Behavioral Sciences**
This course will help develop critical thinking skills central to the social and behavioral sciences. Topics may include arguments, logic, evaluating causal claims, evaluating surveys, theory evaluation, experiment evaluation, writing in psychology, and ethical considerations in the social and behavioral sciences.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PSY 2000(C)

**PSY 3000 - Research Methods & Stats**
Introduction to experimental design, general research methodology, computer analysis and interpretation of data. Emphasizes issues and methods involved in psychological research. Topics include experimental design and validity, choosing appropriate data analysis techniques, statistical analysis, and APA writing style.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000 and (MA 2720 or PSY 2720)

**PSY 3001 - Experimental Methods and Statistics II**
Second course in psychological research methodology and statistics, both experimental and non-experimental. Students design, execute, interpret, and report psychological research.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000 and PSY 3000

**PSY 3010 - Theories of Personality**
Introduction to the variety of approaches to personality that underlie many clinical models. Discusses the formulation of personality theory, its purpose, and problems associated with personality theory generation. Emphasizes classical and contemporary theories of personality, their various applications to human behavior, and a review of relevant research findings.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PSY 2000 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**PSY 3020 - Moral Psychology**
This course focuses on moral behavior and reasoning informed by empirical science and philosophy. Topics may include moral motivation, moral responsibility, character traits, virtues, cross-cultural differences, reactive attitudes, moral development, and applied issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2014-2015 academic year
**Pre-Requisite(s):** PSY 2000 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**PSY 3030 - Abnormal Psychology**
Helps the student build an understanding of abnormal behavior through critical examination of historical and contemporary models used in this field. The student learns the causes and treatment proposed by Cognitive-Behavioral, Psychodynamic and Socialcultural Models with particular emphasis placed on the Diagnostic and Statistical manual used by clinicians for diagnoses.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** PSY 2000 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**PSY 3040 - History and Systems of Psychology**
Traces major historical contributions to current psychology from ancient to modern times. Examines significant ideas and discoveries from philosophy, mathematics, and the natural and medical sciences as they relate to the development of psychology. Discusses philosophical, theoretical, and methodological controversies that surfaced as part of these historical developments.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PSY 2000

**PSY 3060 - Physiological Psychology**
Study of the relations between psychological manipulations and resulting physiological responses to promote understanding of mind/body interaction. Will examine psychophysiological measurement methods, research, and the application of psychophysiology.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** PSY 2000 and (BL 1020 or BL 1040 or BL 2010)

**PSY 3070 - Cross-Cultural Psychology**
Introduces the student to cross cultural psychology and sociocultural theory as it is applied to psychology. Examines research on cultural specific and universal behaviors. Emphasizes the benefits and challenges of diversity in organizations and diversity skills that promote interpersonal and organizational success.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** PSY 2000 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**PSY 3090 - Directed Research: Undergraduate Research Assistant in Psychology**
Directed research in the field of Psychology through the application of research techniques.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 3095 - Teaching Assistant**
Undergraduate Teaching Assistant for Principles of Psychology or other Psych course, including tutoring, assessment, test construction.
**Credits:** variable to 3.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Psychology
**Pre-Requisite(s):** PSY 2000

**PSY 3100 - Applied Counseling Techniques**
An applied review of counseling techniques, their strengths and weaknesses, and the fundamental concepts that support the use of each type of counseling. This is a course in which students will be required to apply and practice one of the counseling techniques with a voluntary client.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 3200 - Motivation and Emotion**
Introduction to the theoretical, physiological, cognitive, and behavioral factors underlying the processes of motivated behaviors and emotional states. Emphasis is placed on methods for studying motivation and emotion and their role in human behavior.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 3250 - Persuasion and Attitude Change**
Human beings develop attitudes as a result of experience. Attitudes shape future behavior and impact perception. This course will explore how attitudes are identified, categorized and measured, and will examine many of the variables associated with changing established attitudes.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** PSY 2000

**PSY 3300 - Psychology of Deviance**
This course will guide the student through a scholarly study from how deviance is defined to an in-depth analysis of the numerous theories that seek to explain why individuals commit deviant acts.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Pre-Requisite(s):** PSY 2000

**PSY 3700 - Industrial Organizational Psychology**
The psychology of work and organizations. Introduction to the use and application of psychology in the workplace. Focus is on the development of employees and organizational structure, and social behavior including the management of work groups and organizations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2012-2013 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 3720 - Social Psychology**
Survey of social, cultural, and cognitive influences on individual and group behavior. Introduces attitude formation, social conformity, personal perception, aggression, cooperation, and interpersonal and intergroup relations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** PSY 2000 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**PSY 3850 - Human Factors Psychology**
Basic psychological concepts critical to the design of human-technological systems. This class provides an applied perspective of psychological research and insight into the most unpredictable and error-prone component of human-machine systems - the human! Appropriate for both psychology and engineering students.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 3860 - Human Performance**
An overview of the psychology of human performance, including topics of movement, attention, perception, speech, expertise, and performance enhancement and degradation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Pre-Requisite(s):** PSY 2000

**PSY 4010 - Cognitive Psychology**
Through lecture, demonstrations, and participation in classic cognitive experiments, this course provides a survey of topics in human cognition, including perception, attention, mental representation and processing, the architecture of memory, knowledge, visual imagery, problem solving, reasoning, and decision making.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 4015 - Cognitive Task Analysis Methods**
Cognitive task analysis (CTA) is a cognitive-systems engineering method to unpack complex cognitive work. The results support design requirements for new systems, strategies, or training. Students will practice collecting and analyzing CTA data using several methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 4060 - Cognitive Neuroscience**
Topics in the field of cognitive neuroscience, examining the neural basis of cognition. Topics may include perception, attention, memory and language.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 3060

**PSY 4080 - Topics in Psychology**
An examination of a specific area or approach within the field of Psychology.
**Credits:** variable to 4.0; May be repeated
**Semesters Offered:** On Demand
**Pre-Requisite(s):** PSY 2000

**PSY 4090 - Independent Study in Psychology**
Designed to allow students to participate in independent readings or research in a variety of areas within psychology.
**Credits:** variable to 6.0; Repeatable to a Max of 9
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** PSY 2000

**PSY 4095 - Field Experience in Psychology**
Firsthand experience with the application of psychological principles in the field through volunteer placement with a community agency or business. Students are responsible for obtaining field placement site in coordination with instructor. Students complete a comprehensive paper.
**Credits:** variable to 3.0; Repeatable to a Max of 6; Graded Pass/Fail Only
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** PSY 2000

**PSY 4110 - Learning and Memory**
Theories of learning and memory from traditional animal research findings, human research, and more recent trends examining the neural basis of learning and memory will be examined to understand changes in behavior, including the acquisition and retention of knowledge.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 4160 - Sensation and Perception**
Examination of basic sensory mechanisms and perceptual phenomena. Sensory mechanisms reviewed will include vision, audition, olfaction, gustation, vestibular system and touch.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** BL 1040 or BL 1020

**PSY 4220 - Psychology and Law**
Application of psychological principles to legal concerns and the interaction of psychology and law. Topics include perception, memory, and decision-making processes as applied to eyewitnesses, identification and evaluation of suspects, jury trials, capital punishment, and other current topics.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2000

**PSY 4400 - Tests and Measurements**
Review of psychological tests and test theory, along with principles of construction and analysis of psychological tests.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2720 or MA 2720

**PSY 4500 - Senior Seminar: Psychology Capstone**
Focusing on application to graduate programs, an intensive exploration into an area (e.g., experimental, developmental, clinical) of psychology or related field, will enhance learning and synthesize career goals in an effort to transition to an advanced educational program.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Psychology; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** PSY 3000(C)

**PSY 4750 - Judgment and Decision Making**
How can we make better decisions? Using examples from medicine, politics, law, business, and daily life, we reveiw "descriptive" (psychological), "normative" (rational), and "prescriptive" (decision-engineering) theory. Topics include judgment, cognition, emotion, risk, uncertainty, heuristics, biases, and applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2720 or MA 2720

**PSY 4870 - Human-Centered Design**
This course will focus on the human-system (computers, appliances, mobile devices, etc.) Interaction regarding the design and development of products. Students will experience hands-on HCI activities (analysis-design-evaluation) and practice research methods based on HIC theory and perspectives.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

## Sciences and Arts

**SA 1000 - Exploring Majors at Michigan Tech**
Exploration of majors and related career opportunities. Includes an introduction to University resources such as the Career Center, presentations by students in various majors, an examination of individual interests and abilities, opportunities for discussion and reflection, and guidance in choice of appropriate courses.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring

## Systems Administration Technology

**SAT 1200 - Introduction to Programming**
Introductory course in C/C++ programming. Topics include top-down analysis of problems, structured programming, control statements, loops, and functions, arrays, and pointers. Basic concepts of object-oriented programming (classes, objects, function overloading) will also be introduced.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Industrial Technology, Computer Network & System Admn; Must be enrolled in one of the following Class(es): Freshman, Sophomore

**SAT 1610 - Computer and Operating Systems Architecture**
Fundamentals of computer organization, operating system architecture, PC/WS major subassemblies, PC and server configuration planning, power interfaces, system assembly/set-up, connection of peripherals, installing fundamental operating system software, system testing/debugging and planning and installation of application software portfolios.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** SAT 1200 or CS 1111

**SAT 1700 - Cyber Ethics**
Ethics, morality, and privacy issues when working with technology. Topics include: foundational and professional issues in cyber ethics; privacy, security, and crime in cyberspace; intellectual property and internet regulation; the digital divide and online communities; and emerging and converging technologies.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn

**SAT 2343 - Network Administration I**
Introduction to basic networking concepts and implementation. Topics include OSI model, subnetting, network addressing, data encapsulation, network topologies, and basic configuration of networking hardware including cabling, bridges, routers, and other communications.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** SAT 1610

**SAT 2511 - Microsoft System Administration**
Microsoft server installation and configuration in an enterprise environment. Topics include: planning for server deployment and management; monitoring and maintaining servers; planning application and data provisioning; and planning for business continuity and high availability.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring, Summer
**Pre-Requisite(s):** SAT 2343

**SAT 2711 - Linux System Administration**
Linux system installation and configuration in an enterprise environment. Topics include: Linux system architecture; Linux installation and package management; GNU and UNIX Commands; Linux file systems; hierarchy standards; shells, scripting and data management; user interfaces and desktops; administrative tasks; essential system services; and networking fundamentals and security.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-3)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** SAT 1200 or CS 1111(C) or CS 1121 or CS 1131 or CS 1142 or MIS 2100

**SAT 3002 - Application Programming Introduction**
Students will develop problem solving skills through the application of a commonly used high-level programming language. Topics include: nature of the programming environment; fundamentals of programming languages; structured programming concepts; object-oriented programming concepts; desirable programming practices and design; and debugging and testing techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**SAT 3200 - Storage Area Networking**
Study of distributed network storage methods that include ISCSI, DAS, NAS, and SAN technologies. Other topics include configuration management, storage farms, backup, and recovery.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring
**Pre-Requisite(s):** SAT 2511 and SAT 2711

**SAT 3210 - Database Management**
Introductory course on database management. Topics include data modeling, database design, implementation techniques, SQL Language, database administration and security.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SAT 1200 or CS 1111 or CS 1121 or CS 1131 or CS 1142 or MIS 2100

**SAT 3310 - Scripting for Administration and Automation**
Scripting in PERL, Python, BASH, and Powershell to accomplish and automate common system administration tasks such as working with files, network and web communication, and database interaction.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior, Senior
**Pre-Requisite(s):** SAT 1200 or CS 1111 or CS 1121 or CS 1131 or CS 1142 or MIS 2100

**SAT 3343 - Network Administration II**
Study of network devices in various architectures. Topics include routing protocols, TCP/IP, access-lists, remote network structures, network topologies, telnet and SSH authentication, switch programming, VLAN and STP configuration, IP traffic control, network troubleshooting and WAN encapsulation.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** SAT 2343 or CS 3411

**SAT 3611 - Infrastructure Service Administration**
Administrating Linux and Microsoft servers together to provide infrastructure services to mixed clients. Topics include: DNS; DHCP; file, web, mail, and directory services; and best practices for combining and mixing server platforms in an enterprise environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Summer
**Pre-Requisite(s):** SAT 2511 and SAT 2711

**SAT 3812 - Cyber Security I**
The evolution of information security into cybersecurity and its relationship to nations, organizations, society, and individuals. Exposure to multiple cybersecurity technologies, processes, and procedures; analyzing threats, vulnerabilities and risks present; and developing appropriate strategies to mitigate potential cybersecurity issues. Applied lab to develop cyber security offensive attributes and learn how to prevent and/or mitigate threats.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SAT 1200 or CS 1111 or CS 1121 or CS 1131 or CS 1142 or MIS 2100

**SAT 3820 - Wireless System Administration**
Study of wireless communications, standards, and regulations in an enterprise environment. Topics include: various radio frequency and light communications; IEEE 802.11 Regulations and Standards; protocols and devices; network implementation; network security; and site surveying.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SAT 1200 or CS 1111 or CS 1121 or CS 1131 or CS 1142 or MIS 2100

**SAT 3900 - New Technologies Seminar**
Offered first half of semester, to be taken concurrently with SAT3901. Weekly seminar series in which speakers from industry, universities, and government discuss current developments in networking and computer technology. The emphasis is on open research topics and questions that may lead to collaborative work with faculty and graduate students.
**Credits:** 1.0; Repeatable to a Max of 6; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall
**Co-Requisite(s):** SAT 3901

**SAT 3901 - Becoming Human - Communication and Technical Improv Seminar**
Offered second half of semester, to be taken concurrently with SAT3900. Weekly seminar series aimed at developing leadership qualities, soft skills, public speaking, and reactionary skills for students in technical fields. A fun and safe environment to develop and improve communication skills through situation and scenario-based exercises that include team building and games.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall
**Co-Requisite(s):** SAT 3900

**SAT 4240 - Voice over IP Engineering**
Voice over IP (VoIP) engineering and design. Topics include call and session protocols such as SIP, H.323, IAX and MGCP; VAD and PLC; common practical issues such as call redirection; codec integration and quality of service measurements.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** On Demand - Offered alternate years beginning with the 2011-2012 academic year
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn
**Pre-Requisite(s):** SAT 2511 and SAT 2711 and SAT 3343

**SAT 4310 - Advanced Scripting Programming**
Emphasizes advanced portions of scripting programming, testing, implementation and documentation (i.e. PERL, PHP, Python and Scripting). Other topics include language syntax data and file structures, input/output devices, file, database access, and graphical user interfaces.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn
**Pre-Requisite(s):** SAT 3002 or SAT 3310

**SAT 4343 - Network Engineering**
Topics include router and switch flow control; VoIP, compression and load balancing; VPN networks involving MPLS, IPSEC and PPP; advanced access-list configuration; AAA; Kerberos; TACACS; firewalls; and configuration of advanced routing protocols.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2010-2011 academic year
**Pre-Requisite(s):** SAT 3343

**SAT 4411 - Data Center Engineering**
Data center and virtualization strategies and design for an enterprise environment. Topics include: data center planning; disaster recovery; virtualization methods; and cloud computing services to provide business continuity.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** (SAT 3200 and SAT 3611) or (SAT 3511 and SAT 3711)

**SAT 4422 - Clinical Applications**
Introduces the concepts and processes of clinical applications. Critical insight into the medical field will be provided by blending both the clinical and medical informatics perspectives. Students will gain hands-on clinical application experiences within predefined clinical settings.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Biological Sciences, Computer Network & System Admn, Exercise Science, Medical Laboratory Science, Sports and Fitness Management, Biomedical Engineering, Pharmaceutical Chemistry; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**SAT 4424 - Population Health Management**
Introduces the concepts and processes of population health management with a special emphasis on clinical care coordination and case management assessment. Students will gain hands-on experience working on case management teams through MICARE and participating local healthcare organizations.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** SAT 4422 or BL 2010 or BL 3080 or EH 1500 or KIP 1500 or SAT 5121

**SAT 4480 - Senior Project I**
Capstone course requiring the application of knowledge gained in lower division courses. Projects are team oriented, require weekly progress reports, and culminate with a final report and oral presentation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** SAT 3812(C)

**SAT 4600 - Web Application Development**
An introduction to the building and administration of web applications. Topics covered include: Apache web server development; Tomcat application server; HTML; cascading style sheets; JavaScript; JQuery; server side includes; server side application development; web services; SSL/TLS; and authentication/authorization.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** SAT 3002 or SAT 3310

**SAT 4812 - Cyber Security II**
An advanced course in cyber security that covers information assurance, cryptography and data security, and malware analysis. Key topics include: buffer overflow; security audits; cryptographic systems (symmetric and public-key algorithms); public-key certificates (X.509); message authentication; Kerberos; authentication applications; electronic mail security; IP security; and SELinux.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** SAT 3812

**SAT 4816 - Digital Forensics**
Introduction of the basic principles and technology of digital forensics, including acquisition, preservation, and recovery and investigation of the evidence stored in digital devices.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Science, Computer Network & System Admn, Computer Engineering; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SAT 3812

**SAT 4880 - Senior Project II**
Capstone course requiring the application of knowledge gained in lower division courses. Projects are team oriented, require weekly progress reports, and culminate with a final report and oral presentation.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-0-6)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** SAT 4480

**SAT 4996 - Special Topics in Computer Network Systems Administration**
Selected additional topics of interest in Computer Network Systems Administration based on student and faculty demand and interest. May be a tutorial, seminar, workshop, project, or class study.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Senior

**SAT 4997 - Independent Study in Computer Network Systems Administration**
Independent study of an approved topic under the guidance of a Computer Network Systems Administration faculty member. May be either an academic, design, or research problem/project.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Senior

**SAT 4998 - Undergraduate Research in Computer Network Systems Administration**
An undergraduate research experience in Computer Network Systems Administration. Under the guidance of a CNSA faculty member, students work on a selected/approved research problem or work directly with faculty on active research projects/grants. May require more than one semester to complete.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Computer Network & System Admn; Must be enrolled in one of the following Class(es): Senior

## Social Sciences

**SS 1001 - Orientation to the Social Sciences**
Introduction to departmental requirements, relevant university resources, careers in social sciences and history, skill expectations, and portfolio development; assessment of current knowledge.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): History, Social Sciences, Anthropology

**SS 1002 - Introduction to Law and the Legal Practice**
An introduction to how one becomes an attorney, what it is like to be an attorney, and the career options available to attorneys.
**Credits:** 2.0
**Lec-Rec-Lab:** (2-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year

**SS 2001 - Introduction to Social Science Research**
Students are introduced to various social science research methods and design. Covers scientific reasoning, developing questions, sampling, ethics, and quantitative and qualitative data collection using experiments, content analysis, survey, interview, oral history, statistics, GIS, comparative analysis, and archaeology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1025(C) and (SS 2100(C) or SS 2300(C) or SS 2400(C) or SS 2600(C) or SS 2700(C))

**SS 2050 - Fundamentals of Geographic Information Systems and Technologies**
Introduction to geospatial sciences and technologies that are widely used for mapping and analyzing geographic patterns of human activities. Students gain hands-on experience in data collection, spatial data editing, georeferencing, spatial analysis, cartography, and spatial problem solving.
**Credits:** 3.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall

**SS 2100 - Introduction to Cultural Anthropology**
Introduction to the field of cultural anthropology with a focus on human diversity, patterns of culture and human organization, globalization, and social change.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall

**SS 2200 - Introduction to Archaeology**
Introduction to the methods of archaeology and the contributions of the discipline to understanding of world prehistory. Topics include the ways archaeologists discover and excavate sites, the analysis of archaeological artifacts and features, human evolution, and the patterns of world prehistory.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**SS 2210 - Evolution of Cities: Their origins, growth, and future**
This instroductory course will explore questions by examining the physical, social, and spatial systems that influence how and where we live, work, and play in the ever-changing industrial and post-industrical city.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year

**SS 2300 - Environment and Society**
Examines social approaches to understanding why environmental problems happen and how environmental problems are resolved. Includes concepts such as sustainability, market-based environmental policies, property systems, and environmental justice. Case studies may include biodiversity, deforestation, climate change, water quality, and toxics.
**Credits:** 3.0
**Lec-Rec-Lab:** (2-1-0)
**Semesters Offered:** Fall, Spring

**SS 2400 - Introduction to Human Geography**
This course introduces students to concepts, problems, and case studies that make up the study of human geography: the spatial differentiation and organization of human activity, environmental sustainability, and the role of space and place in our everyday lives.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall

**SS 2500 - United States History to 1877**
This broad historical survey will examine the social, political, and economic development of North America and the US from initial human settlement through the civil war.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year

**SS 2501 - United States History Since 1877**
This broad historical survey will examine important intellectual, political, and social changes and events in the United States over the course of the twentieth century and beyond, representing the perspective of a wide variety of diverse individuals and groups.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year

**SS 2502 - European History to 1650**
A survey of the history of Europe from the Archaic Greek period to 1650. Covers political, social, intellectual, religious, economic, and artistic developments of the European continent.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year

**SS 2503 - European History Since 1650**
A survey of the history of Europe from the mid-seventeenth century to the present. Covers political, social, intellectual, religious, economic, and artistic developments on the European continent.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2013-2014 academic year

**SS 2504 - World History to 1500**
An introduction to the basic themes and content of world history from antiquity to 1500 CE.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year

**SS 2505 - World History Since 1500**
Survey of world history from 1500 CE to the present. Traces the evolution of different societies from around the world, emphasizing exchanges, interactions, and conflicts that produced global change.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year

**SS 2510 - Gender and the Past**
This course has two main goals: to explore the relationship between gender in the past and present; and to evaluate the actual empirical evidence that speaks to people's gendered lives in many times and places.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** UN 1015

**SS 2600 - American Government & Politics**
Outlines the principles and logic of American Government and politics and explores contemporary issues in national and state government.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring

**SS 2601 - Politics and Contemporary Issues of the European Union**
A general introduction to the politics and contemporary issues of the European Union (EU). The course will explore the evolution of the EU and its expanding role in the lives of the citizens of its member states.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand

**SS 2610 - Introduction to Law and Society**
Examining the civil and criminal justice system to explain how law informs yet is shaped by political, economic, and social forces. This course covers issues such as individual rights, the jury system, tort law, legal reform movements and constitutional interpretation.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall

**SS 2635 - Comparative Politics**
Study of the government and politics of non-U.S. countries. Covers parliamentary, authoritarian, and presidential systems. Some attention to politics of the European Union.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year

**SS 2700 - Introduction to Sociology**
Introduces students to the way that sociologists think about different components of society. Topics include the family, religion, markets, organizations, political systems, and educational systems. Also covers the source of individual values, beliefs, and attitudes.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring

**SS 3105 - Native American and Indigenous Communities**
Exploration of contemporary Native American and Indigenous communities worldwide, using a cross-cultural and comparative approach, with some historical context. Topics examined include the legacy of settler colonialism, issues facing Indigenous communities today, and Indigenous renewal and resistance, with emphasis on Native North America.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3110 - Food Systems & Sustainability**
Compares the embedded nature of culturally defined food production and consumption habits: the crux of nature meeting and mixing with culture. The course features classic food system scholarship as well as emerging topics and contemporary case studies.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3200 - Archaeology of the Modern World**
Introduction to historical archaeology. Topics include the methods of historical archaeology, theoretical approaches, and sources of evidence. Emphasizes archaeological contributions to understanding of the American past, and the contributions of historical archaeology to an alternative view of American history and culture.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3210 - Field Archaeology**
Practical experience and training in the methods and techniques of field archaeology. Selected readings are followed by active participation in site survey, testing, excavation, record keeping, and analysis. Students benefit through involvement in ongoing research projects.
**Credits:** variable to 8.0; Repeatable to a Max of 8
**Semesters Offered:** Summer
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3215 - Archaeology Laboratory Practicum**
This hands-on lab practicum course exposes students to various stages of artifact processing and analysis in archaeological research. Projects teach best practices for cleaning, identification, data analysis, report preparation, and curation, all undertaken within critical framework structured by professional ethics.
**Credits:** variable to 6.0; Repeatable to a Max of 12
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required

**SS 3221 - Archaeological Sciences**
Introduction to the archaeological sciences, including geo/bioarchaeology and materials science. Course emphasizes connections between field and laboratory, and scientific and environmental perspectives on the world's peoples and cultures, both ancient and industrial.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Co-Requisite(s):** SS 3222

**SS 3222 - Archaeological Sciences Laboratory**
Using hands-on exercises and project-based learning, labs include identification, analysis, and stabilization of metals, ceramics, and organics from archaeological contexts, and include elements of geo- and bioarchaeology, and materials science.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Co-Requisite(s):** SS 3221

**SS 3225 - Capitalism and the Modern World**
This course explores from an anthropological perspective themes concerned with the increasing interconnectedness of world cultures and economies after 1400. Focusing on Western expansion and the establishment of global networks in the Modern Era and tracing the social, political, and economic interactions that have shaped our contemporary world.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**SS 3230 - Archaeology of Industry**
The study of industrial heritage using archaeological and historical perspectives. Covers theories, methods, and techniques by means of lectures, readings, and case studies. Students conduct original research, generally on Copper Country industrial sites, under the guidance of the instructor.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** SS 2200 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3240 - Reading the Landscape: Anthropology, Geography, History**
Landscape is a lens through which scholars study people, environment, and place. The concept transcends traditional disciplinary boundaries. Students will read and discuss different approaches to landscape, with special focus upon anthropological, geographic, and historical perspectives.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3250 - Biological Anthropology**
A human evolution course focusing upon a summary of general bio - anthropological principles of evolutionary change, the current fossil record evidencing human evolution, and the consequences of human evolutionary change for modern human variability, health, and behavior.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2007-2008 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3260 - Latin American Cultural History**
This course examines the diverse, but interconnected, cultures of Latin America. The class will examine the sources and patterns of particular cultural traditions, while at the same time understanding the trajectory of social, political, and economic transformations throughout the region.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3270 - Archaeology of the African Diaspora**
Forced into slavery, the 'scatterlings' of Africa adapted and struggled to thrive in the New World. Archaeologists studying the Diaspora generally examine: ethnogenesis and blending of identity, migration, structural inequalities, and the construction of race and racism.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3300 - Environmental Problems**
An examination of local, regional, and global contemporary environmental problems. Critical consideration of underlying social, historical, and economic causes. Case studies drawn from topics such as global warming, ozone depletion, groundwater pollution, solid waste disposal, deforestation, and resource depletion. Studies proposed solutions and their impacts.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3313 - Sustainability Science**
Foundational scientific concepts (dynamic systems and catastrophe theory) as applied to socioecological systems. Use of indicators and indices to track progress towards sustainability goals. Review of local, national, and global sustainability policies to avoid catastrophes and guide sustainable development.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3315 - Population and Environment**
This course investigates relationships between the world's population, population change, population distribution, resource consumption, and environmental and social consequences. Addresses local and global relationships and the population processes (mortality, fertility, and migration) involved.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** (MA 1030 and MA 1031) or MA 1032 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3400 - Contemporary Europe**
Examination of the landscapes and cultures of modern Europe. Emphasizes cultural patterns and diversity, environmental quality, economic development, and forces of economic and political unification. Examines urbanization, industry, population, nationalism, and political change through regional examples.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3410 - World Resources & Development**
Examination of the human geography and resources of various world regions. Emphasizes factors affecting prospects for development, including population dynamics, natural resource endowment, social and cultural systems, and spatial structure of society. Case studies of individual countries supplement general concepts and theories.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3500 - Modern American History**
Surveys American history since 1945 using popular literature and film as a window onto social, economic, and political change.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3505 - Military History of the U.S.**
History of the American military and its place in American society in both peace and war from the colonial period until the present.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3510 - History of American Technology**
Survey of the technological changes that transformed a rural, agrarian America into an urban, industrialized nation. Focuses on how America's social values and geographical situation influenced the direction taken by its technology and engineering community and how America's industrialization, in turn, had significant effects on American society.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3511 - History of Science in America**
Examines the development of scientific enterprises in the U.S. from the colonial period through the present day. Emphasizes institutional bases of science and the place of scientific activities within American society.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3512 - Building America: The History of Planning, Engineering, and Development in the United States**
This course surveys the landscapes and environments that Americans have designed, built, and inhabited. Students will consider how places both reflect and shape ideas, policy, technologies, and social relationships.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3513 - History of Making Things: Craft and Industry in America**
Examines historical relationships between skill, tool use, embodied knowledge, and the design process in America from the colonial era to today. Includes production techniques, distribution systems, technological changes, industrialization, post-war globalization, and current craft and design.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3515 - History of American Architecture**
Survey of North American architecture from prehistoric times to the present. Focuses on principal architectural styles, building types, and construction technologies. Also examines ideas about architecture to understand the American past.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3520 - U.S. Environmental History**
Examines how human interaction with physical environment has changed in North America over the last four centuries. Topics include uses of land by Native Americans, changes associated with European colonization, incorporation of natural resources into industrial economy, early conservation and preservation movements, and environmental concerns accompanying urbanization and industrialization.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3521 - Energy in American History**
Examines changes in energy use throughout American history, beginning with energy use by American Indians and Europeans during colonial settlement and continuing through fossil fuels and adoption of nuclear power. Helps students see energy in all we do.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand

**SS 3530 - The Automobile in America**
Examines the automobile in diverse ways, seeing it as a complex product to be manufactured, as a stimulus to reshaping the environment, as an object that has altered social behavior, and as a problem solver and problem maker.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3540 - History of Michigan**
The history of Michigan from before European settlement to the present.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3541 - The Copper Country**
Examines the social, labor, and technological history of the Copper Country from the frontier era until the shutdown of the mines.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3552 - Renaissance & Reformation**
The history of Europe from 1300 to 1650.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3553 - Empires in World History**
This course examines the social, political, cultural, economic, and geographical dimensions of imperialism. Students will research ancient and modern empires, with an emphasis on the long-run effects of the emergence, evolution, and collapse of empires.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3560 - History of England I**
The social, economic, and political history of England from Stonehenge to 1750.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3561 - History of England II**
History of England from 1750 to the present, including political, social, and economic developments in the period of Britain's greatest influence in the world.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3570 - History of Canada**
Political, social, economic, and cultural development of Canada from earliest European settlement to the present.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3580 - Technology and Western Civilization**
An overview of the evolution of technology in Western civilization from classical antiquity to mid-twentieth century. In addition, the course looks at ways technology influenced development of Western civilization and ways values of Western civilization have conditioned Western technology.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3581 - History of Science**
A survey of the development of scientific ideas (abstractions about how nature is and behaves) from the Greeks to the modern world, including major physical and life science revolutions by natural philosophers like Copernicus, Galileo, Darwin, and Einstein.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3600 - American Foreign Policy**
Explores the nature, sources, and institutions associated with the making of American foreign policy, paying attention to explanations for American behavior and to current problems for policy. Reviews major events in U.S. diplomatic history.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3610 - International Law**
Explores the principles, content, and logic of public international law, the law of nations. Students brief cases, prepare longer briefs to defend a side in a moot case, and engage in a moot court.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3612 - International Relations**
An introduction to the field and study of International Relations (IR). This course will cover major IR theories and current topics in global politics including: globalization, terrorism, human rights, and environmentalism.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3621 - Introduction to Public Policy and Public Management**
Key public policy and public management concepts are introduced and applied to the student's field of interest.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3630 - Environmental Policy and Politics**
A broad survey of how environmental policy making actually works in the U.S. Covers both environmental policy processes and politics, and the major environmental policies themselves for control of air pollution, water pollution, hazardous wastes, and other major environmental problems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3636 - Perceptions of The Modern State and Governance**
Classic and contemporary theories of the state and approaches to governance are examined.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3640 - Selected Topics in Cyber-Law**
Applies legal and ethical principles to evolving computer technology. Explores current legal issues such as surveillance, privacy, free speech, crime, encryption, on line contracting, intellectual property and censorship, as well as legislative efforts to resolve these and other computing dilemmas.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3650 - Intellectual Property Management**
Covers principles of intellectual property law, addressing managerial and policy issues in copyright, trademark, trade secret, and patents. Readings and discussions also cover how these property and legal systems impact the balance between property exclusivity, technological innovation, and public access.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3660 - Constitutional Law**
Introduces the U.S. Constitution and how it has been interpreted by the Supreme Court over time. Explores historical, social and political consequences of major constitutional themes such as federalism, judicial review, and evolving view of individual rights and liberties.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3661 - Civil Rights & Civil Liberties**
Seminar focused on the rights and liberties guaranteed by US Constitutional amendments. Students learn constitutional theory and interpretation on topics of privacy, speech, media, religion, criminal justice, and gender/ethnic equality. Constitutional Law I is not required.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2014-2015 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3665 - Crime, Incarceration, and Social Policy**
Explores criminal and social justice policies including policing and control of crimes involving violence, drugs, sexual offenses, and terrorism. Sentencing, effects of mass incarceration, and inequalities based on race and class will also be examined in student writing and debate.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3710 - Social Problems**
Examines both the social construction of social problems and substantive problems confronting modern society by considering the distinct understandings of social problems offered by the two major theoretical traditions in sociology and analyzing specific macro and micro social problems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3750 - Social Inequality**
A critical assessment of social and cultural processes associated with group-based or categorical patterns of inequality. Examines the creation, persistence, and attempts at reduction of structured inequality based on categorical factors such as social class, race, ethnicity, and gender. May explore other significant sources of social inequality.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3760 - Human Dimensions of Natural Resources**
Uses sociological concepts to cover facets of human relationships to natural resources, including human values, beliefs, and attitudes regarding the environment; rural resource-dependent communities; natural resource professions and expert knowledge; and the history of American perspectives on the environment.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3800 - Energy Policy and Technology**
This course examines the policies and technologies affecting the production, transportation, and use of energy. It focuses on U.S. domestic energy policy and places it in the context of the global energy system. The course aims at providing a holistic view of energy systems connecting technological options with societal and environmental concerns.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3801 - Science, Technology, & Society**
Examines the relationship between science, technology, society, and the environment. Topics may include effects of technologies such as computers, biotechnology, and chemicals on society and nature, science and technology policy, and the history of technology and its global consequences.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3805 - Environmental Justice**
This course focuses on the histories, theories, and practices of environmental justice in local, national, and global contexts. Topics to be explored include environmental racism, industrial facility siting, sustainable development, as well as food, energy, and climate justice.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**SS 3811 - Energy Security and Justice**
This course focuses on concepts that are fundamental to energy policy: energy security and energy justice. It introduces students to the three main views of energy security (supply, demand, and energy services). In addition, the course provides a critical perspective of evaluating energy decision-making through the lenses of justice.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3815 - Energy and Society**
This course reviews extent that our lives are integrated with energy production and consumption, and related problems and solutions in our interwined energy and social systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3910 - Histories and Cultures**
Covers selected topics in world history, geography, or anthropology. Important concepts are the relationship between societies and regional geography, the sources and patterns of major cultures, and transformations of social, cultural, political, and economic institutions over time. May be repeated if topic differs.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3920 - Topics in Anthropology/Archaeology**
Survey of a major branch of American anthropology or archaeology, or a specific time period or region. Topics may include North American prehistory, experimental archaeology, applied anthropology, economic anthropology, or other specialized themes. Readings will emphasize both theoretical and substantive contributions. May be repeated if topics differ.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Pre-Requisite(s):** (SS 2100 or SS 2200) and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3950 - Topics in American History**
Examines an important theme, topic, or era in the development of American society, ranging from the colonial era up to the present. May include such topics as the Vietnam War, sports in America, American vernacular architecture, or urban America, all from a historical viewpoint. May be repeated if topic differs.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3951 - Topics in European History**
Examines important themes, topics, or eras in European history, from late Antiquity to the present. Topics may include intellectual history, revolutions, monarchy, military history (incl. the Crusades), or migrations. May be repeated if topic differs. See department for current offering.
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3952 - Topics in World History**
Examines major ideas, processes, and events in world history. Topics may include trade and commodities, imperialism, slavery, migration, or other subjects with transnational significance. May be repeated if topic differs
**Credits:** 3.0; Repeatable to a Max of 6
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3960 - Cultural Immersion**
Course designed for students on supervised study abroad or exchange programs in which they investigate and report on cultural patterns and behaviors.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Summer
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3961 - Preparing for Cross-Cultural Immersion Experiences**
Preparation for study abroad, service learning, and cross-cultural research or internships. Students reflect on their cultures; explore how to live and work effectively with other cultural groups, discuss cross-cultural professional ethics; and consider holistic approaches to social problems and change.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 3990 - Topics in the Social Sciences**
Examines an important theme or topic in the social sciences, such as social theory, work and society, or the engineer in American society. May be repeated if topic differs.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 4000 - Independent Study**
Independent study of topic of special interest with assistance and supervision from appropriate faculty.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required

**SS 4001 - History of Social Thought**
An intensive survey of the literature of 19th-20th century history of social thought, including the writings of Marx, Durkheim, Weber, and other prominent anthropologists, sociologists, and political philosophers.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 4009 - Introduction to Survey Methodology**
A general introduction to survey methods. Students will learn the basics of survey design from questionnaire construction to the measurement of complex social science concepts. Students will also demonstrate their ability to conduct an original survey through a class project.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**SS 4010 - Statistics for the Social Sciences**
Covers basic concepts and methods used in conducting empirical research in the social sciences. Topics include research design, hypothesis testing, measurement of concepts, and computer-based data analysis. Assumes familiarity with Social Sciences concepts.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** PSY 2720 or MA 2720 or BUS 2100

**SS 4020 - Methods of Teaching Social Studies**
Application of learning and instructional theories and practice to the teaching of social studies. Emphasis will include application of state and national education standards and relevant assessment strategies for social studies. Requires admission in the Teacher Education program by the Department of Education.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2017-2018 academic year
**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
**Pre-Requisite(s):** ED 4700(C)

**SS 4030 - Advanced Research in Anthropology**
Capstone course for anthropology majors. Students examine career and graduate studies in anthropology and prepare proposal for senior research project.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**SS 4050 - Advanced GIS Methods and Projects**
Advanced application of Geographic Information Systems in social sciences as a tool to collect and analyze qualitative and quantitative data. Students gain hands-on experience in data collection, advanced spatial analysis, and scripting.
**Credits:** 3.0
**Lec-Rec-Lab:** (1-0-2)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** SS 2050 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 4120 - Anthropology of International Development**
Advanced anthropology course that focuses on cultural, social structural, historical, and environmental analyses of international development. Students engage with relevant social theory and practical applications in international development case studies.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**SS 4200 - Environmental Anthropology**
A seminar on the study of culture and politics in marginal environments and disadvantaged communities. Draws upon research in anthropology and geography to examine the interaction in the Americas, Asia, Africa, Europe, the Pacific, and the Arctic.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** SS 2100 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 4205 - Applied Anthropology**
Course examines the ways anthropology is used outside of an academic context. Students study how anthropological theory and methods are used in a variety of contexts and how they benefit society. This course also emphasizes the impact of applied anthropology on the development of American anthropology as a whole, and how it has advanced our theoretical knowledge of culture and human behavior.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**SS 4211 - Ethnographic Methods**
Field-based course that surveys basic concepts of ethnography and applies them in a class research project. Provides practical experience in field observation, interviews, field notes, and write-up of research.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015

**SS 4220 - Archaeological Thought in Society**
This course explores themes concerned with the intellectual development of archaeology, including research methods, theoretical concepts, and problems that have characterized the history of the discipline. Particular emphasis is placed on the broader social contexts in which archaeology has developed.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2009-2010 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**SS 4230 - Archaeological Anaylsis and Interpretation**
Course focuses on how archaeologists mobilize material data to understand everyday life in the past. Discussion, exercises, and lab time are used to cover the goals of archaeology, nature of archaeological data, research design, sampling, typology, classification, database management, and quantitative and qualitative analytical methods.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** On Demand - Offered alternate years beginning with the 2017-2018 academic year
**Pre-Requisite(s):** SS 2200

**SS 4325 - Water Policy, History, and Governance**
This course will explore the global history, politics, and governance of freshwater resources. Topics will include the effects of forestry, mining, watershed management, sanitation systems, climate change, fisheries, contaminants, and agriculture on water history, governance, and policies.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** SS 3520

**SS 4380 - Landscape Ecology and Planning**
Basic principles of landscape ecology, including pattern, process, and scale. Students will learn how to use quantitative tools to study landscape-scale patterns and processes, and how to apply these principles and tools to conservation, resource management, and planning issues.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**SS 4390 - Seminar in Sustainability**
This seminar in sustainability topics will cover a rotating set of topics, depending on semester offereing. Topics may inclued energy use, justice, pollution, green design, or regulations bearing on sustainability.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 4500 - Historiography**
The history of historical writing from Herodotus to the present.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2015-2016 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**SS 4501 - Senior Thesis**
Directed study leading to production of a senior thesis for all social science majors.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Major(s): Liberal Arts with History Opt; Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SS 4500(C)

**SS 4502 - Historical Research**
This course supports historical research in conjunction with any upper-division history seminar. Students must take both courses simultaneously, and will work directly with the instructor to produce an original research paper.
**Credits:** 1.0; May be repeated
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman

**SS 4530 - Deindustrialization and the Urban Environment**
This course examines economic, environmental, and social problems associated with deindustrialization in postwar North American cities and the strategies adopted to ameliorate them. Major topics include segregation and housing, environmental regulation, environmental justice, industrial heritage, and economic and urban development policy.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**SS 4540 - Global Environmental History**
This course explores changes in human interactions with earth systems over time, starting with the development of agriculture and continuning to the present. Case studies include mining, forestry, water, agricultural, sustainability, and urban development.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** SS 3520

**SS 4550 - History of Technology**
Advanced reading and discussion course focusing on the various ways in which we understand writing about the history of technology. This course provides the theoretical framework for research and writing in the field, and culminates in a major research project with primary source research as well as a required interpretive component.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** (SS 2500 or SS 2501 or SS 2502 or SS 2503 or SS 3510 or SS 3580) and UN 1015 and (UN 1025)

**SS 4551 - Industrial Communities**
Introduces advanced students to scholary literature on industrical communities and company towns. Focus will be in North America, but also includes cases in Latin America, Europe, Africa, and Asia. Students will acquire skills in oral history, work with archival materials, and conduct field-based research.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**SS 4552 - Historical Archaeology**
This course examines the relevance of archaeology and the varied approaches archaeologists use in examining our Modern World. How do archaeologists interpret the archaeological record and how do archaeological perspectives effect the questions, interpretations, and meanings we bring to understanding the past, the present, and the future.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2019-2020 academic year
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**SS 4553 - Material Culture Studies**
Advanced reading and research in material culture studies. Learn to interpret the cultural and historical meanings in physical objects such as tools, housewares, memorials, furniture, etc. Emphasis on American craft, industry, and deindustrialization. Methodologies from archaeology, American studies, museum studies, public history, art history, etc.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2019-2020 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** SS 3513 and UN 1015 and (UN 1025)

**SS 4600 - Industrial Archaeology**
This course is an advanced exploration of the industrial past using archaeological perspectives. It is a seminar combining scholarship from different fields and using material evidence to examine the evolution of work and production in industrial society.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring - Offered alternate years beginning with the 2018-2019 academic year
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SS 2200 or SS 3200 or SS 3230 or SS 3270

**SS 4630 - Advanced Research in the Social Sciences**
Capstone course for students to develop an original social science thesis researcy project in the areas of Politics, Law, Sociology, or Sustainability. Students will prepare a proposal for a senior research project.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-2-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

**SS 4700 - Communities and Research**
A rural sociology course analyzing the sustainability of rural communities (socially, environmentally, economically, and culturally). The course involves participatory research conducted together with a local community organization. Students practice research skills while making a difference in improving community life.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall - Offered alternate years beginning with the 2016-2017 academic year
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore
**Pre-Requisite(s):** UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

**SS 4900 - Seminar in Social Sciences**
An intensive seminar study of a topic of importance and special interest in the social sciences. Topics could focus on the history of anthropological theory or on world religious systems in comparison. May be repeated if topic differs.
**Credits:** variable to 3.0; Repeatable to a Max of 9
**Semesters Offered:** On Demand
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**SS 4910 - Professional Development for the Social Sciences**
Assessment of learning and preparation for post-graduate work, professional training, or graduate school.
**Credits:** 1.0
**Lec-Rec-Lab:** (1-0-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): History, Social Sciences, Anthropology; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**SS 4920 - Internship Experience**
Internship, on or off campus, providing appropriate practical, professional experience in an area related directly to a student's course of study. Students work under professional supervision. Requires a written evaluation of the work.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required; Must be enrolled in one of the following Major(s): Liberal Arts with History Opt, Social Sciences

**SS 4921 - Washington Internship - Professional Practicum**
Practicum participants experience professional hands-on learning as intern in governmental, public-interest, non-profit, or national organization in DC or select cities abroad. Internship placements made through approved affiliate institution providing placements, mentorship, supervision, classes, orientation, and housing for MTU's DC interns.
**Credits:** 3.0; Repeatable to a Max of 9
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of department required
**Pre-Requisite(s):** UN 1015 and (UN 1025)

**SS 4990 - Directed Study in Anthropology**
An original study of an anthropological problem, including literature search, data collection, and analysis, culminating in a research report.
**Credits:** variable to 3.0
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Class(es): Senior

## Surveying

**SU 1000 - Surveying Engineering Orientation**
Introduction to the surveying engineering profession with emphasis on technology and careers. Topics include: technology, specialties, education, professional practice, life-long learning, and ethics related to surveying engineering.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Major(s): Surveying Engineering

**SU 2000 - Introduction to Surveying**
Surveying topics will include distance measurements, leveling, angles, directions, traversing, horizontal and vertical curves, percent grade, and coordinate geometry.
**Credits:** 2.0
**Lec-Rec-Lab:** (0-1-2)
**Semesters Offered:** Fall, Spring

**SU 2050 - Plane Surveying**
An introductory course studying surveying instruments and their use in the measurement of angles, distances, and elevations. Topics include taping, leveling, traversing, construction surveys, route surveys, use of modern instrumentation, and computer applications.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-1-6)
**Semesters Offered:** Fall
**Pre-Requisite(s):** SU 2000(C)

**SU 2220 - Route and Construction Surveying**
Study of the geometry and field stake-out techniques of circular curves, spiral curves, compound curves, reverse curves, equal-tangent vertical curves, and unequal-tangent vertical curves. Other topics include horizontal and vertical alignment design, earthwork quantities and mass diagrams.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Pre-Requisite(s):** SU 2050 or SU 2000

**SU 3110 - Surveying Field Practice**
Survey projects from field to finish using current surveying equipment and software. Basic statutes and ethics governing the practice of surveying. Projects cover level networks, horizontal control, design surveys, construction layout, section subdivision, map and report preparation.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-2-6)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SU 2220

**SU 3180 - Boundary Surveying Principles**
Interpretation of property descriptions used to establish land boundaries. Resolving conflicts in boundary descriptions as well as conflicts in evidence. Review doctrines pertaining to transferring title and the role of the surveyor in issuing opinions on boundary location in boundary disputes.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SU 3600(C)

**SU 3210 - Site Planning and Development**
An examination of land development issues including: site analysis, environmental concerns, contouring, earthwork and grading, soils, route alignments, storm water management, sewer systems, zoning, and land planning. Incorporates CAD applications in the lab.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman
**Pre-Requisite(s):** SU 2000

**SU 3540 - Geospatial Information Technology with Elements of Field Cartography**
Application of GIS technology methods for processing surveying data obtained in the field. Concepts of interoperability and metadata organization are considered. Includes map projection review and 2D and 3D cartographic data visualization.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Spring
**Pre-Requisite(s):** MA 3710

**SU 3600 - Surveying Computations and Adjustments**
Basic computations and analysis of surveying measurements by adjustment theory are introduced. Students will gain the ability to use computer software to perform the computations. Analysis of measurements and errors based on statistical principles and least squares principles will be discussed.
**Credits:** 4.0
**Lec-Rec-Lab:** (0-3-2)
**Semesters Offered:** Fall
**Pre-Requisite(s):** (SU 2000 or SU 2050) and (MA 2320 or MA 2321 or MA 2330) and SU 3110(C) and MA 3160(C) and MA 3710(C)

**SU 4010 - Geospatial Concepts, Technologies, and Data**
High level review of geospatial data acquisition systems, sensors, and associated processing technologies. Course considers geospatial metadata generation principles, interoperability, and major tools for manipulation with geospatial data. Course may help in transition of non-geospatial majors to geospatial field.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**SU 4045 - Geospatial Data Fusion**
Fundamentals of GIS data, aerial photographs, satellite imagery, airborne/terrestrial laser scanning data. Characteristics of remotely sensed data including information specific to the sensors used to obtain it. Term project on how to combine and fuse to a specific application.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** SU 4140

**SU 4060 - Geodesy**
Concepts of astronomy and geodesy that are relevant to the practice of surveying. Covers theory, field techniques, and computations involved in the determination of true north, an introduction to the figure of the earth and its geometric and physical characteristics, geodetic datums, and coordinate systems.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Major(s): Surveying Engineering; Must be enrolled in one of the following Class(es): Senior
**Pre-Requisite(s):** SU 3600(C) or SU 3250

**SU 4100 - Geodetic Positioning**
Introduces the instruments and procedures used in surveying projects that require a high order of accuracy. Discusses some conventional instruments and techniques but the greater emphasis is on GPS techniques.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SU 4060(C)

**SU 4140 - Photogrammetry**
Basic principles of photogrammetry and its role as a technology for spatial data collection. Use of photogrammetry in the fields of surveying, engineering, and geographic information management will be discussed.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-2)
**Semesters Offered:** Fall, Spring

**SU 4142 - 3D Surveying and Modeling with Laser Scanner Data**
Theory and application of terrestrial LIDAR scanning. Typical application scenarios are also included. Intensive lab component provides hands-on experience in LIDAR point cloud processing and visualization.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-1)
**Semesters Offered:** On Demand
**Restrictions:** Must be enrolled in one of the following Class(es): Senior

**SU 4180 - Land Subdivision Design**
Introduces the physical, economic, and social aspects of optimum land use within the framework of state and local regulations of land divisions, condominiums, mobile home parks, and residential subdivisions.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior
**Pre-Requisite(s):** SU 3180 and (CMG 3200 or SU 3210)

**SU 4900 - Capstone Design Project**
An engineering design project which integrates multiple aspects of previous surveying coursework while working with an industry partner. Includes project description, project planning, field work, office analysis, computer-aided design, final project completion and oral presentation skills.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-2-3)
**Semesters Offered:** Fall, Spring
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Surveying Engineering; Must be enrolled in one of the following Class(es): Senior

**SU 4996 - Special Topics in Geospatial Technologies**
Selected additional topics of interest in Geospatial Technologies based on student and faculty demand and interest. May be a tutorial, seminar, workshop, project, or class study.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Surveying Engineering; Must be enrolled in one of the following Class(es): Senior

**SU 4997 - Independent Study in Geospatial Technologies**
Independent study of an approved topic under the guidance of a Surveying Engineering faculty member. May be either an academic, design, or research problem/project.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Surveying Engineering; Must be enrolled in one of the following Class(es): Senior

**SU 4998 - Undergraduate Research in Geospatial Technologies**
An undergraduate research experience in Geospatial Technologies. Under the guidance of a Surveying Engineering faculty member, students work on a selected/approved research problem or work directly with faculty on active research projects/grants. May require more than one semester to complete.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following Major(s): Surveying Engineering; Must be enrolled in one of the following Class(es): Senior

**SU 4999 - Professional Practice Review**
A review of the elements of the NCEES Fundamentals of Surveying examination, utilizing on-line quizzes, as well as administering the Michigan Tech Surveying Engineering Exit Exam. Course taken in final semester only.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** Must be enrolled in one of the following Class(es): Junior, Senior

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## Technology

**TE 4996 - Special Topics in Technology**
Selected additional topics of interest in Technology based on student and faculty demand and interest. May be a tutorial, seminar, workshop, project, or class study.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following College(s): School of Technology; Must be enrolled in one of the following Class(es): Senior

**TE 4997 - Independent Study in Technology**
Independent study of an approved topic under the guidance of a School of Technology faculty member. May be either an academic, design, or research problem/project.
**Credits:** variable to 3.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following College(s): School of Technology; Must be enrolled in one of the following Class(es): Senior

**TE 4998 - Undergraduate Research in Technology**
An undergraduate research experience in Technology. Under the guidance of a School of Technology faculty member, students work on a selected/approved research problem or work directly with faculty on active research projects/grants. May require more than one semester to complete.
**Credits:** variable to 6.0; Repeatable to a Max of 6
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required; Must be enrolled in one of the following College(s): School of Technology; Must be enrolled in one of the following Class(es): Senior

## University Wide

**UN 1000 - Frameworks for Success for ExSEL**
Course that explores ways to become a more effective student. The course focuses on metacognition and individual learning styles, the skills and habits that support academic success, and utilizing campus resources. Counts as a free elective.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**UN 1005 - Initiatives for Success**
Course that explores ways to become a more effective student. The course focuses on metacognition and individual learning styles, the skills and habits that support academic success, and utilizing campus resources. This course includes a mandatory learning center appointment assigned upon registration. Course counts as a free elective.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**UN 1010 - Creating Your Success for Themed Communities**
First year seminar course that develops community among members of residential themed communities and provides an introduction for creating academic, professional, and personal success. This course is required for all first-year and transfer (with less than 30 credits) students living in a residential themed community. Course counts as a free elective.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**UN 1011 - Strategies for Success**
Seminar course that provides a framework to assess the strategies a student is currently using to achieve academic, professional, and personal success. The course is designed to look at ways to improve upon a student's strategies for success or adopt new ones. This course is required for all first-year or transfer (with less than 30 credits) students who are on academic probation for the first time after fall or spring of their first year. This course is also available with permission from the Dean of Students, to any student who feels they would benefit from additional strategies for success. Course counts as a free elective.
**Credits:** 1.0
**Lec-Rec-Lab:** (0-0-2)
**Semesters Offered:** Fall, Spring, Summer

**UN 1012 - Academic Language & Practice**
This course is designed for speakers of English as a second language admitted into academic study, not native speakers of English. It assesses language ability and focuses on academic language and practices.
**Credits:** 1.0; Graded Pass/Fail Only
**Lec-Rec-Lab:** (0-0-3)
**Semesters Offered:** Fall, Spring

**UN 1015 - Composition**
Provides direct instruction in composition. Students examine and interpret communication practices and apply what they learn to their own written, aural, and visual compositions. Class projects ask students to communicate in a variety of modes and to attend to audience, purpose, and context.
**Credits:** 3.0
**Lec-Rec-Lab:** (0-3-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Freshman

**UN 1025 - Global Issues**
Study of contemporary global issues, their origins, impacts, and solutions through the thematic and comparative exploration of worldview and culture, population, globalization, development, politics and global governance, environment, and sustainability. Emphasis on global literacy and information literacy.
**Credits:** 3.0
**Lec-Rec-Lab:** (3-0-0)
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Must be enrolled in one of the following Class(es): Freshman

**UN 2600 - Fundamentals of Nanoscale Science and Engineering**
Team-taught introduction to the fundamentals of nanotechnology, emphasizing the interdisciplinary nature of this field. Modern instrumentation, key scientific foundations, and current and potential applications will be discussed. Real and potential societal implications of nanotechnology will be explored.
**Credits:** 2.0
**Lec-Rec-Lab:** (1-1-0)
**Semesters Offered:** Spring, Summer - Offered alternate years beginning with the 2007-2008 academic year

**UN 3002 - Undergraduate Cooperative Education I**
Credits may count as free or technical electives based on academic department. Requires good standing, registration with Career Services, and an official offer letter from the employer.
**Credits:** variable to 2.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Level(s): Graduate

**UN 3003 - Undergraduate Cooperative Education II**
Credits may count as free or technical electives based on academic department. Requires good standing, registration with Career Services, and an official offer letter from the employer.
**Credits:** variable to 2.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** UN 3002

**UN 3004 - Undergraduate Cooperative Education III**
Credits may count as free and technical electives based on academic department. Requires good standing, registration with Career Services, and an official offer letter from the employer.
**Credits:** variable to 2.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** UN 3002 and UN 3003

**UN 3005 - Undergraduate Cooperative Education IV**
Credits may count as free or technical electives based on academic department. Requires good standing, registration with Career Services, and an official offer letter from the employer.
**Credits:** variable to 2.0; May be repeated
**Semesters Offered:** Fall, Spring, Summer
**Restrictions:** Permission of department required; May not be enrolled in one of the following Level(s): Graduate
**Pre-Requisite(s):** UN 3002 and UN 3003 and UN 3004

**UN 3990 - Special Topics - Interdisciplinary**
Study of interdisciplinary special topics as specified by section title.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required

**UN 4000 - Seminar Series in Earth, Planetary, and Space Sciences**
A seminar series that covers topical issues in remote sensing, ecosystem research, global change, and space sciences.
**Credits:** 1.0; Repeatable to a Max of 2
**Lec-Rec-Lab:** (0-1-0)
**Semesters Offered:** Fall, Spring
**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**UN 4990 - Special Topics - Interdisciplinary**
Study of interdisciplinary special topics as specified by section title.
**Credits:** variable to 6.0; May be repeated
**Semesters Offered:** On Demand
**Restrictions:** Permission of instructor required