Graduate Bulletin

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The Graduate School
1400 Townsend Drive
Houghton, Michigan 49931
Phone: 906.487.2327
Fax: 906.487.2463
e-mail: **MTU Grad School**

The following pages are archived at the beginning of each academic year and comprise the official Bulletin of the MTU Graduate School. Links from these pages are not archived.

Michigan Technological University is an equal opportunity educational institution/equal opportunity employer. In keeping with its responsibilities as an educational institution, Michigan Technological University is committed to a policy of affording equal opportunity to all of its employees, students, applicants for employment, and applicants for admission without regard to race, religion, color, national origin, age, sex, sexual orientation, height, weight, or marital status. The University is also committed to a policy of educating and employing handicapped individuals and veterans without discrimination. These policies are to be implemented with due regard for the relative qualifications of all involved. The Affirmative Action Officer is Sherry Kauppi, 207 Administration Building, 906-487-3310.

Last Updated: 20-Sep-2005

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To All Grad Students at Michigan Tech...

It is your responsibility as a graduate student to be knowledgeable about and to comply with University, Graduate School, and individual program policies and procedures. The Graduate School Bulletin as well as the extended Graduate School Website will familiarize you with the opportunities and graduate programs available at Michigan Tech. The Bulletin will inform you about the policies and procedures under which these programs are administered. Information about other University policies is available in the MTU Student Handbook.

The Graduate School Office will make every effort to provide accurate, current information regarding Graduate School and University policies. In order to do so, we will edit the on-line Graduate School Bulletin as changes occur. Michigan Tech's Graduate School thus reserves the right to change without notice statements in the Bulletin concerning rules, policies, fees, curricula, courses, and/or other matters. We log substantive changes in order to help you stay informed. The Bulletin also provides general University information via links to other departments' documents. The Graduate School does not control edits and/or substantive changes to these secondary documents, which may also be changed without notice.

The Graduate School Bulletin is archived at the beginning of each fall semester. Beginning with the 2001-03 issue of the Bulletin, PDF files are available through the Bulletin Archives Index. Copies of earlier printed volumes of the Bulletin are available in the J.R.Van Pelt Library Archives (Call No. LD3315 .M52).

Freedom of Information Act and University Information

Michigan Tech is committed to maintaining a free exchange of information throughout the University community, and it is our general practice to release most types of information immediately upon request.

In addition, as a publicly funded institution, Michigan Tech is subject to the provisions of the state and federal Freedom of Information Acts (FOIA). FOIA requires the University to provide copies of most administrative documents, with the exception of certain legal and personnel records, to anyone filing a FOIA request. If you wish to file a Freedom of

	Information Act request, or if you would like to view University documents, contact the Office of the President, 487-2200.

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Last Updated: 01-Jul-2005

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Recent Changes to the MTU Graduate Bulletin

The following changes have been made since the 5 October 2004 archiving of the Bulletin:

- Conduct Violations—clarification of procedures
- Change in Graduate Faculty appointment procedures for new tenure/tenure-track faculty - appointment automatic with letter of tender
- Change in appointment of Emeritus Graduate Faculty - from annual renewal to continuing
- Provisional / conditional admit clarification—MTU does not offer
- Walking in commencement—Deadlines changed
- Dismissal of graduate students—Addition of language clarifying the joint role of the Graduate School and the Dean of Students/Office of Student Judicial Affairs in certain cases
- Full-time status for dual-enrolled students—Addition of language providing for full-time status for students who are dual-enrolled for credits at Tech and an affiliated university
- Off-campus programs—Removal of provisional language
    - Change in number of transfer credits allowed
    - Residency requirement for partnered programs
    - Plan D (Distance) coursework master's
- Oral examination, Plan C Master's—Removal of provisional language

The following changes were made with the summer 2004 revisions to the Bulletin, and are included in the version archived 5 October 2004.

- Medical Withdrawal and Late Drop Procedures—Approval moved from Student Affairs to Graduate School
- Change of Status—New language regarding mandated shift from PhD to Master's
- Grad Faculty Policy—Rewrite to reflect current practice; clarification of adjunct/ad hoc
- Provisional Plan C changes—Language approved by GFC and Dean changing
    - Oral examination requirement

	○ External on Plan • Clarification, grades below B • Non-degree graduate status • Master's Path Program—For students who have completed a three-year degree outside the US • Academic Probation—Link provided to letter of notification from "Good Standing" section

Last Updated: 20-Sep-2005

When You Have Questions . . .

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- Department Policies & Procedures
- Graduate School Policies & Procedures
- Outreach and Multiethnic Programs
- Graduate Faculty Council Representatives
- Graduate Student Council Representatives

Department Policies & Procedures

Graduate Program	Faculty Coordinator	Secrecy / Aide
Applied Ecology	Shekhar Joshi	Sherry Sandretto
Applied Science Education	Brad Baltensperger	Debbie Meyers
Biology	Don Lueking	Pat Asselin-Rastello
Biomedical Engineering	Michael Neuman	Judy Schaefer
Business Administration	Dana Johnson	Judy Chapman
Chemical Engineering	Joseph Holles	Cindy Usitalo
Chemistry	Dick Brown	Celine Grace
Civil & Environmental Engineering	Neil Hutzler	Corrine Leppen
Computer Science	Jean Mayo	Sandy Kalcich
Computational Science and Engineering (EPD1)	Phil Merkey	Allyson Jabusch
Electrical and Computer Engineering	Warren Perger	Michele Kamppinen
Engineering, Master of	Sheryl Sorby	Sherry Saarinen
Engineering Mechanics	Ghatu Subhash	Marlene Lappeus
Environmental Engineering, PhD (EPD2)	Neil Hutzler	Corrine Leppen
Environmental Engineering Science	Neil Hutzler	Corrine Leppen
Environmental Policy	Kathy Halvorsen	Lisa Dwyer
Forestry, Forest Science, Forest Molecular Genetics & Biotechnology	Shekhar Joshi	Sherry Sandretto
Geological Engineering, Geology, Geophysics	Alex Mayer	Amie Ledgerwood
Industrial Archaeology	Pat Martin	Lisa Dwyer
Mathematics	Mark Gockenbach	Margaret Perander
Mechanical Engineering	Ghatu Subhash	Marlene Lappeus
Materials Science and Engineering	Walt Milligan	Margaret Rothenberger
Mineral Economics	Gary Campbell	Judy Chapmen
Mining Engineering	Alex Mayer	Amie Ledgerwood

Physics, Engineering Physics	Don Beck	Elizabeth Pollins
Rhetoric & Technical Communication-Humanities	Dennis Lynch	Marjorie Lindley
Sponsored Educational Programs	Varies with program	Joan Hoffman

Graduate School Policies & Procedures

Graduate School Offices are located on the 4th floor of the Administration Building.

Assistant Dean of the Graduate School, Marilyn Vogler, Room 401

Application Process	Admissions Coordinator	Carol Wingerson	Room 408
Billing/Support	Office Assistant	Carol Wingerson	Room 408
Blue Room Reservations	Office Assistant	Pat Ross	Room 409
Commencement	Assistant to the Dean	Nancy Byers-Sprague	Room 411
Degree Progress	Assistant to the Dean	Nancy Byers-Sprague	Room 411
Health Insurance		Mary Anne Brunner	Room 235B

Outreach and Multiethnic Programs

Last Updated: 20-Sep-2005

International Exchanges and Services: International Programs and Services, Admin. Room 131, 487-2160

Outreach / Multiethnic Programs: Betty Chavis, Alumni House Room 204, 487-2920

Appointment to Grad Faculty

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Summary by Appointment Category

Item	Regular	Adjunct	Ad Hoc
Need to involve HR in appointment	yes	yes	no
Is only related to graduate faculty status	no	no	yes
Appointment to GRAD FACULTY requires Grad Dean approval	yes	yes	yes
Appointment to FACULTY requires Grad Dean approval	no	no	n/a
Can be used by current MTU faculty	yes	yes	no
Grad faculty appointment has an end date	no	yes	yes
Grad faculty status may be renewed at request of chair	n/a	yes	yes
For one-time service on advisory/examination committee	n/a	no	yes
For repeated use as member of advisory/examination committees	n/a	yes	no
Can serve as external in own field/discipline/department	no	no	yes
May work for lengthy period with student including committee	yes	yes	yes
May be co-advisor	yes	yes	yes

May be advisor	yes	no	no

Membership

The Graduate Faculty consists of members of the academic faculty holding the rank of Lecturer, Assistant Professor, Associate Professor, or Professor who have been appointed by the Dean of the Graduate School. The Dean of the Graduate School may also appoint persons with a continuing appointment such as Research Professor or Research Scientist to the Graduate Faculty.

The Dean of the Graduate School may also grant Emeritus Graduate Faculty status to Emeritus or retired faculty; appointments remain in effect until the faculty member and the department chair determine that the appointment is no longer needed.

The Dean of the Graduate School may also grant Adjunct Graduate Faculty status to MTU faculty holding a rank with a prefix of part-time or visiting, and to Adjunct faculty (approved through Human Resources) whose primary appointment is not at MTU. These appointments are for one year and must be reviewed on an annual basis

The Dean of the Graduate School may also grant ad hoc graduate faculty status to individuals from institutions other than MTU for a specific purpose, such as serving as a member of a particular student's advisory committee or teaching a particular graduate class. Ad hoc appointments terminate with the completion of the particular student and/ or task for which the appointment was requested. Ad hoc faculty are considered external to the department for purposes of constituting examination committees.

Members of the graduate faculty who leave the University may, upon request of the chair of any department affected, remain on the graduate faculty in adjunct or emeritus status for a period of time sufficient for completion of any students they may be advising or serving on committees for.

Only graduate faculty are eligible to teach graduate courses (5000 level and above), serve as examining members on MS, MEngg, and PhD committees, and supervise master's and doctoral students.

Faculty who hold an adjunct appointment in a second department need not be nominated for graduate faculty membership by the adjunct department. Adjunct status within a department, however, means that a faculty member may not serve as the

external examining member on committees for students in that department. They may, however, serve as an internal committee member for students in the department.

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"Qualifications of Graduate Faculty

1. Qualifications expected for graduate faculty appointment

- Experience and continued interest in the conduct of research
- The necessary background for, and a continued interest in, teaching graduate courses
- Continued interest in serving as a graduate student advisor

2. Evidence of qualifications

Faculty may meet the qualification requirements if they:

- Are currently involved in research work or graduate instruction or in advising graduate students
- Regularly publish articles in recognized journals having national distribution or books related to their field of study
- Have earned the terminal degree in their field

Appointment Procedures

Graduate faculty appointment and retention decisions are made by the Dean of the Graduate School with recommendations and advice from department heads/chairs, deans of colleges and schools, and the Graduate Faculty Council.

For tenure and tenure-track faculty, appointment to the Graduate Faculty will be concurrent with their initial appointment, and is made with the approval of the Dean of the Graduate School.

For other persons, recommendation for Graduate Faculty status is made in writing by the department head/chair of the appropriate unit or by the deans of the Schools of Business and Forestry. These recommendations are forwarded to the college dean, where appropriate, and then to the Graduate Dean.

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Review of Graduate Faculty

Department heads/chairs/school deans are expected to continually review the

performance of all individuals holding graduate faculty status in their respective units using criteria outlined in part 2 above.

When, in a department head/chair/school dean's professional judgment, a faculty member holding a graduate faculty appointment is no longer satisfactorily functioning in this capacity, s/he must recommend that the individual in question be removed from graduate faculty status. The Dean of the Graduate School may also initiate the removal process in consultation with the appropriate head/chair/dean. The Dean of the Graduate School will act on recommendations with the advice and consent of the Graduate Faculty Council.

2/24/88
8/92 Update
10/03 Update

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Notes on the differences between **adjunct** and **ad hoc** status for members of the Graduate Faculty

ADJUNCT faculty appointments are handled through Human Resources and require all the HR paperwork to be completed. ADJUNCT appointments are used for persons, generally from outside the University, who have a continuing relationship with a department at Tech. There may be occasions on which a person who is appointed to a faculty position in one MTU department would want or be expected to hold an adjunct appointment in another MTU department. These, too, must be processed through HR.

Faculty with a primary appointment AND grad faculty status in one department who also have an adjunct faculty appointment in another department do not need to be appointed to graduate faculty by the second (adjunct) department. A person simply is, or is not, graduate faculty. One is not graduate faculty in department A or department B.

We verify adjunct status through HR for purposes of determining eligibility to serve as the external/cognate member on examining committees. Except in very rare, pre-approved cases where no other suitable external can be found, adjuncts in a department MAY NOT serve as the external/cognate member of examining committees for either Master's or PhD students in that department. DO NOT appoint someone an adjunct in your department so that they may serve as the external. This will disqualify them.

DO NOT use adjunct appointments for persons external to MTU who are serving *one* time as a committee member for *one* of your program's students, even if the person will be actively engaged with the student and committee for a lengthy period of time. If you want to bring in someone external to MTU to serve on a student's committee, either as an internal member or as the external member, fill out a Graduate Faculty Appointment form and submit it to the Graduate

School. Ad hoc appointments do not currently need to go through HR. The form is at http://www.admin.mtu.edu/rgs/graduate/forms/GradFacultyAppointment.pdf

This is an excerpt from the letter the Graduate School sends to new ADJUNCT faculty who are appointed to grad faculty:

“Your adjunct status in __[Department A]__ means that except in those very unusual circumstances when no other suitable external can be found, you should not serve as the external examining member of committees for students in ___[Department A]_____. You are, however, encouraged to serve as an internal committee member for students in _____[Department A]__.”

This is an excerpt from the letter we send to new AD HOC graduate faculty:

“Your nomination to ad hoc standing on Michigan Tech’s graduate faculty for the purpose of serving on __[student’s] _____ advisory/examination committee has been received from __[chair/program]___ and approved by the dean of the Graduate School. Your appointment extends until ___[student’s first name]____ completes the degree.

The special expertise you bring is a valuable resource. We especially appreciate your willingness to serve in this capacity as we recognize it is an additional burden on your time. The student’s department and major advisor are encouraged to locate funding to bring you to campus for the student’s defense, and we hope at that time that you will be able to share your work through a seminar, lecture, or similar event on campus.”

19 February 2004

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Last Updated: 19-Apr-2005

Graduate Study at MTU - BasicExpenses

The basic estimated expenses of a full-time graduate student living in a University residence hall are shown below. When estimating annual expenses, students should figure in travel and personal allowances based on their own situations. Although the University researves the right to change fee schedules and other student charges without advance notice, every effort is made to maintain high academic standards and adequate living facilities at the lowest possible cost to the student.

Tuition and Fees*	Basic	Engg, CS	Peace Corps & Appl Sci Ed	Peace Corps-Engineering
Tuition/AY semester @ 9 credits	4,212.00	4,612.00	2,907.00	3,307.00
Summer tuition @ 1 credit	468.00	668.00	323.00	523.00
Computing, lab, & course fees (avg, per term)	470.00	470.00	470.00	470.00
Cost of Living	Standard expenses for all students			
GSC cost of living avg @ 774/ month (2001)	Academic Year	Summer	Add for PhD per Acad Yr	
Avg cost / month @ $848	7,632.00	2,544.00		
Insurance	489.00	241.00		
Books & supplies	455.00	150.00	400.00	
Student fees (by term)	254.80	93.10		
Travel for conferences, etc.			1,000.00	
Total expenses minus tuition & fees	**8,830.80**	**3,028.00**	**1,400.00**	
Master's	Basic	Engg, CS	Peace Corps & Appl Sci Ed	Peace Corps-Engineering
Tuition and fees Academic Year	9,364.00	10,164.00	6,754.00	7,554.00
Tuition and fees Summer	938.00	1,138.00	793.00	993.00
Cost of living Academic Year	8,830.80	8,830.80	8,830.80	8,830.80
Cost of living Summer	3,028.10	3,028.10	3,028.10	3,028.10
Subtotal Academic Year	18,191.80	18,994.80	15,584.80	16,384.80
Subtotal Summer	3,966.10	4,166.10	3,821.10	4,021.10
Total 12 Months	**22,160.90**	**23,160.90**	**19,405.90**	**20,405.90**
PhD	Basic	Engg, CS		
Tuition and fees Academic Year	9,360.00	10,560.00		
Tuition and fees Summer	938.00	1,138.00		

Cost of living Academic Year	10,230.80	10,230.80
Cost of living Summer	3,028.10	3,028.10
Subtotal Academic Year	19,590.80	20,790.80
Subtotal Summer	3,966.10	4,166.10
Total 12 Months	**23,556.90**	**24,956.90**

* This does not apply to Distance Learning students.

Student
Chapter 9. Fees

Effective Date: 06/24/2005

9.4. Tuition Rates

2005-2006 Tuition	
Undergraduate Resident per Credit Rate	$252.00
Undergraduate Non-Resident per Credit Rate	$625.00
Graduate Resident and Non-Resident per Credit Rate	$468.00
Graduate Resident and Non-Resident per Credit Rate for Applied Science Education and on-campus Peace Corps Students	$323.00
Engineering/Computer Science Tuition fee per semester for Undergraduates taking fewer than 6 credits and Graduate Students taking fewer than 5 credits	$200.00
Engineering/Computer Science Tuition fee per semester for Undergraduates taking 6 credits or more and Graduate Students taking 5 credits or more	$400.00
The Engineering/Computer Science Tuition fee applies to all students in the College of Engineering - all majors except Applied Geophysics, Geology, and Geophysics and to all students in Computer Science in the College of Science and Arts. **This fee does not apply to First-Year students.**	

History

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07/19/91
11/22/91
05/22/92
05/21/93
05/20/94
06/16/95
06/21/96
06/27/97
05/22/98 Implemented differential tuition
07/07/99 Implemented per credit hour
06/29/2000
07/17/2001
05/10/2002
06/25/2003
06/25/2004

Adopted: 06/24/2005

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Address policy questions to Janet Hayden at jkhayden@mtu.edu.
Address web questions about this page to Ann Roth at aroth@mtu.edu.

Departmental Computing Access Fees

Students are required to pay their academic departments a fee for basic computing as designated below. The Departmental Computing Access Fee is based on Major as shown below **plus** an additional $8 security surcharge.

Department	Undergraduate Fee/Semester	Graduate Fee/Semester
Biological Sciences and Clinical Laboratory Sciences	$225	$325
Biomedical Engineering	$210	$295
Chemical Engineering	$210	$210
Chemistry	$240	$262
Civil & Environmental Engineering	$210	$295
Computer Science	$75	$100
Computer Engineering	$225	-
Electrical Engineering	$190	$300
Engineering (BS)	$195	$300
Engineering Fundimentals	$210	-

Forest Resources and Environmental Sciences	$165	$300
General Sciences & Arts	$225	-
Geological and Mining and Engineering Sciences	$235	$340
Humanities	$225	$235
Materials Science and Engineering	$210	$295
Mathematical Sciences	$80	$80
Mechanical Engineering-Engineering Mechanics	$195	$300
Physics and Applied Physics	$108	$143
Psychology	$205	-
School of Technology	$195	-
Social Sciences	$205	$205

NOTE: Following are the departments (as well as the repective computing access fee) offering computer access to Non-Degree Seeking or Post Degree Study students who would like full computing access (onsite and offsite) during Fall/Spring Semester 2005/2006:

Chemistry, 717 Chem Sci Bldg	shane@mtu.edu	$240
Forest Resources & Env Science, 144D Noblet Bldg	jmoore@mtu.edu	$165
Humanities, 130 Walker	klwest@mtu.edu	$225
School of Business & Economics, G 008 Academic Office Bldg	mpheyse@mtu.edu	$165

Michigan Technological University
Office of Student Records and Registration
1400 Townsend Dr, Houghton, Michigan 49931-1295
Email: stuosrr@mtu.edu
Phone: (906) 487-2319
Fax: (906) 487-3343
Webmaster

Last modified Monday August 29th, 2005

General Student Fees Paid by All On-Campus Students (per semester)	
Memorial Union Expansion Fee	15.00
Graduate Student Activity Fee	44.30 (10.00 in summer)
Student Development Complex Support Fee	31.00
Memorial Union Building Support Fee	37.10

Financial Assistance & Opportunities

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All US citizens and eligible non-citizens are strongly encouraged to complete the FAFSA.

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Grant & Fellowship Opportunities

Internal and external fellowship and grant opportunities for domestic and international students, links to external sources of information, selected agency web sites, & employment opportunities

H1-Visa Jobs.Com—Career Center service providing an on-line database with contact information of companies that actually offered H-1B jobs to international professionals.

Campus / Local Student Job Postings

Assistantships

The application forms for admission to the Graduate School are also regarded as application forms for assistantships. All students admitted to the Graduate School are considered for these awards, which are made by the departments. In general, departments make awards in March and April for the ensuing academic year. Recipients of awards are notified by the department as soon as the awards are made. All departments with graduate programs support students through teaching assistantships. Positions associated with research grants or contracts are often available in some departments and research centers.

Regular assistantship appointments are for half-time work (20 hours/week), but departments can divide appointments, resulting in three-quarter time, half-time, or quarter-time appointments (with proportional adjustments of the stipend and tuition & fee support). Students' work load assignments, including teaching preparation and grading of papers, should not exceed the level of their appointments. Students on assistantship are paid bi-weekly.

Support includes stipend, a proportional amount of tuition and academic fees for full-time enrollment. Student-voted fees —for instance, the student union expansion and student activities fees are not covered by support and must be paid by the student. If your department has not notified the Graduate School Office (GSO) about your assistantship by the time bills are mailed, you will be billed for tuition. If the GSO has still not been notified of the award by the payment deadline, you are responsible for your tuition. You will get a refund when your sponsor notifies the GSO that the award has been made.

All supported students must be registered as full-time graduate students. If you are supported at 20 hours per week, your support pays standard full-time tuition plus some fees. You are responsible for paying for any credits over the department cap that you enroll for, as well as for student activity fees. Note, too, that the 9 credits required for full-time status may include regular graduate course work and research credits, courses in other departments, audited courses, PE, modern languages, fine arts, ESL, undergraduate courses, and so on.

If you are on partial support, you must still be registered as a full-time student, but only a portion of your tuition and fees will be paid by your support. You are responsible for the rest. Support for 10 hours per week, for example, covers 50 percent of tuition and fees for 9 credits; support for 5 hours per week covers 25 percent of tuition and fees for 9 credits.

Teaching Assistantships (GTA, GTI)— Teaching assistantships are awarded by the department requiring instructional services. GTAs assists a faculty member in teaching. GTIs have full responsibility for the course(s) they are assigned to teach. The appointment is usually for the academic year of two semesters. Some opportunities exist for summer teaching assignments.

Research Assistantships (GRA, GA) —Research assistantships, usually associated with a specific research grant, contract, or internally supported research project, are awarded by the professor/department supervising the research activity. The appointment is usually for the academic year, but frequently includes the summer term. For standard

support, time devoted to the research activity is expected to total an average of twenty hours per week, though in cases where the research is related to the student's thesis or dissertation, additional time is expected to meet requirements for research credits in which the student is enrolled. Coding indicates external support (GRA) or internal support (GA.

Administrative Assistantships (GADE, GADI)— Administrative assistantships are awarded by the departments to assist in their efforts to further develop graduate programs and enhance research. Students' duties may include, for instance, system administrator or journal editing responsibilities. The hours, stipend, and tuition support are the same as for a teaching assistant. Administrative assistants must be registered as full-time students. Coding indicates external (GADE) or internal (GADI) sources of funding.

SPEAK Test (International students whose first language is not English)—The Michigan Tech Center for Teaching, Learning, and Faculty Development (CTLFD) administers the SPEAK (Speaking Proficiency English Assessment Kit) Test to all international graduate students whose first language is not English. The SPEAK Test must be taken prior to the beginning of a student's assignment as a graduate teaching assistant (GTA).

The test is administered year round, but most incoming students take it during fall orientation week. Students are encouraged to take the SPEAK Test as early as possible after they arrive on campus so that if they do not pass the test and need to improve their English language skills, there will be adequate time to do so before departments make funding decisions for the following year. Practice SPEAK Tests are available for students to review prior to taking the actual test. Students wanting to take the test should contact the Center for an appointment.

The SPEAK Tests are administered and evaluated by trained CTLFD staff. Students who do not pass the test may not take it again. Instead, they are referred to the International Graduate Teaching Assistants Assistance Program (IGTAAP) for help in improving their English skills, presentation strategies, and cultural understanding. The IGTAAP has many resources for increasing vocabulary, improving pronunciation, understanding slang and idioms, and practicing conversation. In working one-on-one and in small groups with undergraduate coaches, the international graduate students gain insight into what students from the United States expect from their instructors. IGTAAP is coordinated by Sylvia Matthews in the Humanities Writing Center and is supported by the CTLFD for this purpose.

IGTAAP has many requirements that are clearly explained to the students who are referred to this program. Once those requirements are met, the student can schedule a mini-lesson presentation which is observed by a committee consisting of a faculty member (or designee) from the student's home department, an undergraduate student whose first language is English (preferably one majoring in the graduate student's home department), and a representative from the CTLFD. The committee must reach a consensus that the candidate is ready for instructional duties for the student to receive a "pass" on the mini-lesson. However, if the observers feel that the student's English skills need further improvement, the committee can make a variety of recommendations to the department chair—all of which include the student's continuing with IGTAAP. In either case, "pass" or "continue work", a letter will be sent to the student's home department chair with the committee's recommendations.

Because the SPEAK Test is a test of conversational English, passing it provides only partial assurance that the student

will perform adequately in an instructional setting. The ultimate responsibility for assuring a GTA's adequacy in classroom teaching rests with the academic units. And in all cases, funding decisions rest with the academic units and the Graduate School.

Co-ops and Internships

Graduate students may seek placement in co-ops with corporations and service groups and receive academic credit as well as the co-op salary. The MTU Career Center is a member of JOBTRAK and assists students looking for co-ops, internships, and employment following degree completion.

Check the Website at http://www.ucc.mtu.edu/students.php. See also instructions and application form for UN5000, the grad level co-op course: http://www.admin.mtu.edu/rgs/graduate/forms/co-opform.pdf and information about visa issues at http://www.mtu.edu/cie/is/imm_cpt.html.

The Orion Grassroots Network offers internship and career employment opportunities. Their listing includes jobs in non-profit organizations as well as teaching.

The Rockridge Institute's summer internships are a great opportunity for students and recent graduates to explore the effects of framing in public discourse and make a contribution to American progressivism. The Rockridge Institute is a non-profit, non-partisan research organization located in Berkeley, California. The current deadline for applications is April 22, 2005. All internships are unpaid. More information, as well as links to application materials, can be found at: http://www.rockridgeinstitute.org/aboutus/internships/2005/announcement

US Army Reserve Officers Training Program (ROTC)

The Department of Military Science offers instruction in leadership issues, management functions, teams and communications within an organization through guided discussions and experiential learning. The program provides two-year scholarship opportunities through the U.S. Army to graduate students who meet all qualification standards. In order to qualify for this program students must attend a four week summer training session called the Leaders Training Course, for which all travel, food and lodging expenses are paid for. They additionally receive a $750.00 stipend and 10–12 credit hours for the first two years of Army ROTC at Michigan Tech. Two-year scholarships are awarded upon the successful completion of the summer training. In order to qualify students must have a minimum 2.5 GPA, and meet all medical and physical requirements. They must also meet an age requirement of 27 years old or less by June 30 of the year of completion of degree and commissioning. Veterans are given waivers up to 32 years of age.

Need-based Financial Aid

To be considered for need-based financial aid, e.g. federal student loans and Graduate Assistance in Areas of National Need (GAANN Fellowships), students must submit the Free Application for Federal Student Assistance (FAFSA) to the federal processor with Michigan Technological University listed to receive the result (federal school code 002292). You have the option of applying over the Internet, http://www.fafsa.ed.gov/, or using the paper form. To assure optimum

processing, file the FAFSA by March 1. Awards will be determined approximately July 1, when cost of attendance and resource information is available.

Financial assistance is awarded for one academic year at a time. After January 1, you must reapply utilizing the FASFA or Renewal FAFSA provided by the US Department of Education.

For more information regarding financing opportunities available through the Financial Aid Office, visit http://www.admin.mtu.edu/finaid/finaid.htm.

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Loans

Loans are available to graduate students who meet the scholastic and loan program requirements.

Federal Stafford Loans—Students may be eligible for a student loan from the William D. Ford Federal Direct Loan Program. The FAFSA or FAFSA Renewal form is the application form needed. The annual loan limit for subsidized and unsubsidized Stafford Loans is up to $18,500 each academic year (only $8,500 of this amount may be in subsidized loans). Students may borrow up to a cumulative maximum of $138,500 as a graduate or professional student (only $65,500 of this amount may be in subsidized loans). The graduate debt limit includes Stafford Loans received for undergraduate study.

Federal Perkins Loans—These loans are provided by federal and University funds. Students may borrow up to a cumulative maximum of $20,000 as an undergraduate and $6,000 per year as a graduate student for a maximum cumulative total of $40,000, provided they demonstrate financial need. As long as the borrower is engaged in at least half-time study, there is no interest or repayment. Interest begins nine months after the borrower ceases to be at least a half-time student and may extend over a maximum period of ten years. Minimum payments are required. Deferment of repayment is permitted for certain kinds of federal and volunteer service.

Work-Study Programs: Michigan and Federal

These programs provide financial assistance through employment on campus. Every effort is made to place students in jobs related to their skills, interests, and field of study. Work-study participants generally are employed ten hours per week. Money awarded for a work-study job will be paid through biweekly paychecks after the work has begun.

Bureau of Indian Affairs Program

Financial assistance based on need is available to students who are enrolled Native American tribal members. Students should contact their tribal education office for application procedures.

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FinancialAid Policies

Satisfactory Progress Policy Statement

Federal financial aid regulations require students to make satisfactory progress to remain eligible for financial aid. Financial aid programs affected by this policy include:

Federal and Michigan Work-Study	Federal Perkins Loans
Federal Direct Subsidized Loans	Federal Direct Unsubsidized Loans

This policy defines the minimum requirements for financial aid eligibility at MTU. Note that other types of financial aid (e.g., scholarships) may have more stringent requirements.

Students who do not meet the **GPA requirements** after **any semester** are not considered to be making satisfactory progress, and the affected financial aid for subsequent semesters will be canceled with the following exception. Students who do not meet the GPA requirement after their **first semester** at MTU will be placed on financial aid probation, and will remain eligible for financial aid for one semester. Students not meeting the **schedule of credits passed** after **spring semester** are not considered to be making satisfactory progress. **Both GPA and credits passed requirements must be met for aid to be reinstated.**

Graduate students receiving any kind of financial assistance, including fellowships and assistantships not listed above, are required to maintain, at the end of each term, a cumulative grade point average (GPA) of at least 3.0. Failure to do so will result in the student being placed on financial aid probation and may result in the loss of funding. After receiving notification of probation, graduate students must meet with their graduate program director as soon as possible to plan a course of action for resolving the situation.

Every student must adhere to the following schedule of credits passed, even if the academic major is changed. Audits (U or V) do not count toward credits passed. To reference credits passed, access your Unofficial Transcript at the Records and Registration website http://www.admin.mtu.edu/em/.

Semesters full-time at MTU	Master's credits passed at MTU	PhD credits passed at MTU
1	4	4
1.5*	6	6
2	8	8
3	12	12
4	16	16
5	20	20

6	24	24
7	28	28
8	32	32
9	no aid	36
10	no aid	40
11	no aid	44
12	no aid	48
13	no aid	52
14	no aid	56
more than 14	no aid	no aid

*half-time example

Credits passed include Progress grades (P). Audit grades (U or V) do not count as credits passed.

Note: For the complete statement, see http://www.admin.mtu.edu/finaid/documents/satprogpolicy.pdf.

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Eligibility Defined

All students, regardless of whether they are receiving aid, have a limited number of semesters for which they are eligible for such aid. For example, undergraduates who have attended MTU for 8 full-time semesters may be eligible for another 4 semesters of aid, regardless of whether or not they have received aid in the past. The record of full-time semesters increases by one for every semester an undergraduate student is enrolled for 12 or more credits at the end of the official add period. If an undergraduate student is enrolled for 6 through 11 credits, the full-time semesters increase by one-half. Full-time semesters will not increase during the semesters undergraduate students carry fewer than 6 credits.

M.S. and Ph.D. students' records of full-time semesters increase by one each semester in which they are enrolled for 9 or more credits at the end of the official add period. If an M.S. or Ph.D. student is enrolled for 5 through 8 credits, the full-time semesters increase by one-half. In all other cases, full-time semesters are not increased.

Credits passed include progress grades (P). GPA is calculated using all courses, which appear on the graduate transcript.

Appeals and Reinstatements

Because financial aid dollars are applied to the first billing each semester, and the progress status is not determined until semester-end grades are processed, necessary adjustments will appear on a subsequent billing of the semester

following a change of progress status.

If completion of temporary grades (I or X) or other transcript changes (e.g. grade changes) warrant reinstatement, the student should notify the Financial Aid Office before the end of the semester following unsatisfactory progress.

Students not meeting the satisfactory progress requirements because of mitigating or extenuating circumstances may request reinstatement of financial aid by submitting a Satisfactory Progress Appeal Request Form along with the specified documentation. This form can be obtained from the Financial Aid Office or downloaded from the Financial Aid Office website. Appeals should be submitted to the Financial Aid Office no later than Tuesday of the first week of the semester following unsatisfactory progress. If a student's appeal is approved, when appropriate, the full-time semesters will be adjusted allowing continued eligibility.

Financial Aid Refund/Repayment Policy

A tuition/fee adjustment, according to a schedule available in the Office of Student Records and Registration, may be required for students withdrawing from the University. The adjustment will appear on the student's subsequent billing statement. Non-tuition refunds will be prorated according to the week of withdrawal. Withdrawing students must repay any financial aid that exceeds the charges incurred for the term.

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Return of Title IV Funds

Students who completely withdraw from all courses prior to completing more than 60 percent of a semester will have their eligibility for aid recalculated based on the percent of the semester completed. This policy shall apply to all students who withdraw, drop out, or are dismissed from the University and receive financial aid from Title IV funds. The term "Title IV Funds" refers to the following Federal financial aid programs:

Federal Direct Unsubsidized Loan
Federal Direct Subsidized Loan
Federal Perkins Loan.

Title IV aid is earned in a prorated manner on a per diem basis up to and including the 60 percent point in the semester. Title IV funds and all other aid is viewed as 100 percent earned after that time. The percentage of Title IV aid earned shall be calculated as follows:

(Number of days completed by the student)/ (Total number of days in the semester*) = Percent of Title IV aid earned

*The total number of days in the semester includes weekends, but does not include any scheduled breaks of more than five days.

A student's withdrawal date is determined by the University as (1) the date the student began the University's withdrawal process or officially notified the Office of Records and Registration of intent to withdraw; or (2) the midpoint

of the semester for a student who leaves without notifying the University; or (3) the student's last date of attendance at a documented academically related activity.

University's Portion to be Returned—The percentage of Title IV aid unearned (i.e., to be returned to the appropriate program) shall be 100 percent minus the percent earned. Any unearned aid to be returned by the University is the lesser of (1) the entire amount of unearned aid or (2) the total institutional charges multiplied by the percentage of unearned aid. Unearned Title IV aid shall be returned according to the following priority up to the amount received for the semester (1) Direct Unsubsidized Loan; (2) Direct Subsidized Loan; (3) Perkins Loan.

Student's Portion to be Returned—When the total amount of unearned aid is greater than the amount returned by the University from the student's account, the student is responsible for returning unearned aid to the appropriate program(s). The same priority as above would be used. Any loan funds that must be returned by the student will be repaid according to the terms of the promissory note.

Return of Non-Title IV Funds—The portion of state, university and other assistance that must be returned will be calculated based on the particular program's return policy. The student will be billed for any amount due to the University resulting from the return of Title IV and Non-Title IV funds.

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- Provisional/Conditional admit
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- Application procedure
- Application deadlines by department and/or program
- On-Line application log in page
- Download forms to print and send here

General Requirements—To be considered for admission to the Graduate School as a regular student, the applicant must be

- the recipient of a bachelor's degree or its equivalent from an accredited institution (graduates of a 3-year bachelor's program outside the US see the Master's Path option);
- adequately prepared for advanced study in the chosen field of specialization as demonstrated by the previous program of study and the scholastic record; and
- recommended for admission by the head of the program or concentration.

Application Fee

An application fee is required.

Domestic applicants—$40.00 (The Graduate School waives the application fee for McNair Scholars.)

International applicants—$45.00

Employee Admission—Any University employee may enroll in any graduate course, if properly qualified, subject to the approval of the appropriate supervisor. Employees do not pay the application fee.

Currently enrolled MTU graduate students (including non-degree seeking grad students) applying for a different graduate program should fill out a new

Some documents are PDF.

Get Help with PDF here

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application for database purposes, but a second application fee is not necessary.

Provisional/Conditional Admit—The Graduate School does not offer a provisional or conditional admit. Students who wish to take graduate courses prior to full acceptance in a program may apply for non-degree graduate status.

Deferral of enrollment —Enrollment may be deferred for a period of 12 months, for example, from one fall term to the next. Deferral beyond this time is not allowed, and admission will require a new application.

Deadlines—The Graduate School does not have application deadlines; however, some departments do have deadlines. Please see the list here or consult individual departments regarding dates.

Application Procedure

Basic forms are available in the Graduate School and on the Graduate School Website at http://www.admin.mtu.edu/rgs/graduate/apply.html. You may also apply online at https://www.banweb.mtu.edu/pls/owa/bwskalog.P_DispLoginNon. Note, however, that an on-line application is not yet available for non-degree admission. Please download that application here and mail or fax it to the Graduate School.

Materials and forms specific to individual departments are available only from those departments. Please check the website of the department or departments to which you are applying regarding specific requirements they may have. Read the departmental requirements carefully because procedures vary from department to department. (Program links available here.)

Departments whose additional forms are available on the web

- Humanities
- Civil & Environmental Engineering
- Physics

Care should be taken in preparing the statement of purpose as it is quite important in decisions regarding admission.

Steps to Follow:

1. Complete all application forms, on-line and/or paper, and return them to the Graduate School. Distance Learning students should submit application materials to the Sponsored Educational Programs Office.
2. The application fee should be submitted with the application. It is nonrefundable and cannot be credited toward tuition or any other fees. It may be paid by
    - check or money order drawn on a United States institution and made payable to Michigan Technological University,
    - International Postal Money Order, payable in United States currency, made

- Domestic Students
- International Students
- Certification of Finances
- Graduate—Non-Degree Seeking
- Letter of Recommendation Standard Form

payable to Michigan Technological University, or
- credit card (details here).

3. Request that the registrar of each college or university you have attended send official transcripts directly to the Graduate School. Transcripts for course work completed at Michigan Tech will be obtained by the Graduate School. A limited number of graduate courses taken as a graduate student at other universities may be accepted for graduate credit at MTU. Talk with the department to which you are applying.
4. Admissions Tests: The Graduate Record Exam (GRE) is required or encouraged by most departments. In some departments it is required if you wish to be considered for financial assistance. The GMAT is required for admission into programs of the School of Business and Economics. Test results should be sent directly to the Graduate School by ETS. Our code number is 1464.
5. Applicants whose native language is not English must supply results of an English proficiency examination. However, this examination is not required for Distance Learning students applying through a corporate partnered program. Usually, the Test of English as a Foreign Language (TOEFL) is submitted. Although a TOEFL score of 550 (213 on the computer-based test) is recommended by the Graduate School, the applicant should also check with individual departments to determine if a higher TOEFL is required for admission to that department or program. Applicants who have completed a degree in the US may have the TOEFL requirement waived by the Dean of the Graduate School. This requirement may not be waived by departments, programs, or faculty.

Tracking your application status—When your initial application is received by the Graduate School, you will be sent a confirming e-mail with instructions for logging into your web portal. You may check the status of your application at any time via the web portal. Note that departments will generally not review applications until all materials, including letters of reference, have been received.

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- Current Undergraduate Course Listing
- On-Line Courses—Fall 2005

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Nanotechnology

Remote Sensing

Transportation

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- Biological Sciences (MS, PhD)
- Biomedical Engineering (PhD)
- Business Administration (MS)
- Chemical Engineering (MS, PhD)
- Chemistry (MS, PhD)
- Civil Engineering (MEng, MS, PhD)
- Computational Science and Engineering (PhD in Engineering)
- Computer Science (MS, PhD)
- Electrical Engineering (MS, PhD)
- Engineering Mechanics (MS)
- Engineering Physics (PhD)
- Environmental Engineering (MEng, MS, PhD in Engineering)
- Environmental Engineering Science (MS)
- Environmental Policy (MS)
- Forest Ecology and Management (MS)
- Forest Molecular Genetics and Biotechnology (MS, PhD)
- Forestry (MForestry, MS)
- Forest Science (PhD)
- Geological Engineering (MS, PhD)
- Geology (MS, PhD)
- Geophysics (MS)
- Industrial Heritage and Archaeology (MS, PhD)
- Master of Engineering (MEng)
- Materials Science and Engineering (MS, PhD)
- Mathematical Sciences (MS, PhD)
- Mechanical Engineering (MS)
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- Mineral Economics (MS)
- Mining Engineering (MS, PhD)
- Physics (MS, PhD)
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MichiganTech Atmospheric Sciences Program

Atmospheric Sciences

The field of the atmospheric sciences is inherently interdisciplinary. Today's graduate students require a broad understanding of the physical, chemical and biological processes affecting the atmosphere, combined with a thorough understanding of the fundamentals of specific atmospheric systems, in order to contribute to the solution of key atmospheric sciences questions like the following.

- How will atmospheric composition change as human population and emissions grow in the future?
- How will the changing atmosphere affect climate, and what will be the feedbacks through the biosphere, hydrosphere and entire earth system?
- What are the fundamental processes that govern cloud formation in the atmosphere, and how are those processes altered by human activities?
- What is the relationship between fuel combustion and health impacts of air pollution, and how can those health impacts be most cost effectively minimized?
- What new techniques are needed to accurately model the earth-atmosphere system?

The Atmospheric Sciences program at Michigan Tech reflects this need for a combination of breadth and depth. Participating faculty span eight departments and incorporate expertise and research over a range of areas of emphasis. Participating students gain the skills needed to address major atmospheric sciences issues, while also developing a focus in the fundamentals of their home program.

For more information, refer to the links at the top of the page. For information on applying to the program, see the "How to Apply" page.

Michigan Technological University

Atmospheric Sciences Program
808 Dow Environmental Sciences and Engineering Building
1400 Townsend Drive Houghton,
Michigan, 49931 - 1295, USA
Department Phone: 906-487-3202
Department Fax: 1-906-487-2943
Department E-mail: reh@mtu.edu

Atmospheric Sciences brochure (html)

Download brochure (Adobe pdf file format 349 kb)
Download poster (Adobe pdf file format 302 kb)

Participating Departments
Biological Sciences | Chemistry | Computer and Electrical Engineering
Civil and Environmental Engineering
Forest Resources and Environmental Science
Geological and Mining Engineering and Sciences
Mechanical Engineering-Engineering Mechanics | Physics
Michigan Technological University | College of Engineering

Last Update:January 7, 2005
This web site has been optimized for faster internet loading speed, formatted for page-width printing and tested for most platforms and browsers.
If you have any problems or comments, contact the webmaster.
Email Webmaster ehgroth@mtu.edu

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Environmental

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- Biological Sciences (MS, PhD)
- Chemical Engineering (MS, PhD)
- Civil Engineering (MEng, MS, PhD)
- Engineering Physics (PhD)
- Environmental Engineering (MEng, MS)
- Environmental Engineering Science (MS)
- Environmental Policy (MS)
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Information Technology

- Computer Science (MS, PhD)
- PhD in Engineering—Computational Science and Engineering (PhD)

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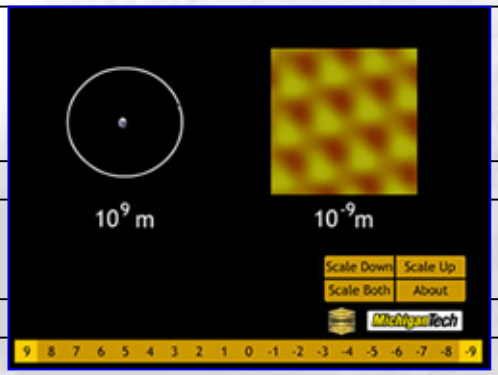
Nanotechnology at Michigan Tech



Michigan Tech's Nanotechnology Animation Gallery

Updated September 6, 2005

NEW Nanotechnology Minor to be offered Fall 2005

NEW institute proposal: Multi-Scale Technologies Institute (MuSTI)

Nano Competition

Second Annual International Nanotechnology Business Idea Competitions Now Accepting Submissions, June 16, 2005

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Remote Sensing Studies

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The Graduate School
1400 Townsend Drive
Houghton, Michigan
49931
Phone: 906.487.2327
Fax: 906.487.2463
e-mail: MTU Grad

Attainment of a graduate degree demonstrates that a person has reached prescribed milestones in the pursuit of knowledge beyond the bachelor's degree. Satisfactory completion of the master's and/or doctoral degree is characterized by a greater level of independent research compared to the undergraduate educational experience. In an age of accelerating development, it is important that degree requirements be completed in a timely manner so the student remains abreast of, and contributes to, new knowledge.

Credit and GPA Requirements

Thirty credits beyond the bachelor's degree are required for most master's programs, though some require more. The distribution of credits among coursework, practicum, and research credits will vary depending on the master's plan chosen. See the departments' websites for detailed information about individual programs.

Thirty credits beyond the master's degree are required for the PhD.

No course numbered below 3000 can be counted toward a graduate degree, with the exception that Peace Corps Master's International students may use 2 credits of language courses below the 3000 level. Courses numbered in the 3000 and 4000 series are intended primarily for upper-division undergraduate students but are available to graduate students for graduate credit with their department's approval, indicated by signature on the degree schedule. Although courses numbered in the 5000 series are intended primarily for graduate students, they are also available to qualified senior students. Courses numbered in the 6000 series are available only to advanced graduate students.

Neither audit, nor continuous enrollment and other pass/fail courses, may be used toward the total number of credits required. The only non-graded credits that count toward a degree are research credits, which are marked satisfactory/unsatisfactory.

Students must maintain an overall 3.0 GPA for all coursework taken as a graduate student. No course in which a grade lower than B (3.0) is received may be used toward a graduate degree without express permission of the Department Chair or Program Director.

Credit Definition

School

Academic advancement by students is measured in terms of semester-hour credits or simply credits. One credit should average 3½ hours of a student's time per week for one semester. Depending on course requirements, these 3½ hours may all be spent in the classroom or laboratory or may be divided between home study and class or laboratory attendance. One hour in class and 2½ hours in individual study is a typical division. Students should multiply the course credits by 3.5 to determine the demands the course will place on their time during a typical week of the semester. For example, in MA5524 Functional Analysis (a 3-credit course with no lab), one would expect to spend 10½ hours per week on the course (3 hours in class and 7½ hours out of class).

Residency Requirements—Academic

Master's students must complete a minimum of two-thirds of the course work in residence at MTU. Thesis credits must be supervised by MTU graduate faculty.

Doctoral students must spend at least four semesters on campus at MTU beyond attainment of a bachelor's degree, or two semesters beyond attainment of a master's degree, in a formal program of study and research under direct supervision of a given program/department. The semesters in residence do not have to be continuous and can include summer terms. In special pre-approved instances, this residency requirement may be waived.

Time Limits

All work for the master's degree must be completed within five calendar years of the first enrollment in the degree program. All work for the PhD must be completed within eight calendar years of the first enrollment in the degree program. Requests for extension must be approved by the advisor, department chair, and Dean of the Graduate School.

Report, Thesis, and Dissertation Guidelines here

Degree-Specific Requirements

The links below provide degree-specific requirements and a timeline for completion of each degree. Please also check with your department, however, since requirements beyond the minimum may vary from department to department or program to program.

- Master of Engineering
- Master of Forestry
- Master of Science

- Master of Science (Professional)
- Master's Path (for students who have completed a three-year bachelor's outside the US)
- Doctor of Philosophy

Last Updated: 20-Sep-2005

Doctor of Philosophy

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The doctor of philosophy degree is a research degree. It is awarded in recognition of demonstrated mastery of subject matter in a chosen field of study and demonstrated competence in the conduct of an individual research investigation that represents a significant contribution to the cumulative knowledge of the field. The program of study and research will be planned and supervised by an Advisory committee. Each candidate's course work and research topic must be approved by the advisory committee as meeting the standards generally associated with the doctoral degree. A minimum of 30 course and/or research credit hours beyond the MS degree (or its equivalent) or a minimum of 60 course and/or research credit hours beyond the bachelor's degree is required. The doctoral student must complete the following:

- If you are a Tech master's student applying to a doctoral program, and substitution of the D1 for a regular application is okay with your department, file an Acceptance into the Doctorate Program form (D1)
- choose an advisor and file a Recommended Advisor form (D2)
- file a Preliminary Program of Study form (D3)
- successfully complete the comprehensive exam and file a report on the Comprehensive Examination form (D4)
- choose an advisory committee and chair and file a Recommend Advisory Committee form (D4a)
- file a Degree Schedule form (D5)
- develop and defend a dissertation plan and file an Approval of Dissertation Proposal form (D6)
- file a Scheduling of Final Oral Examination form (D7) and defend an approved dissertation in an oral exam
- file a Report on the Final Examination form (D8)
- fulfill the campus residency requirement
- submit the corrected, approved dissertation and associated forms
- finish the degree within the prescribed time limit
- Forms are available on-line at http://www.admin.mtu.edu/rgs/graduate/trackingforms.html

In addition to the Graduate School requirements, which are described below, individual

departments may have higher standards. Students are expected to know their department's requirements.

Grades—All grades must be B (3.0 on a 4.0 scale) or better in the major subject area. The department chair can approve no more than 6 credits of BC (2.5) or C (2.0) in a cognate department. The student must maintain a cumulative grade point average of 3.0 or better to remain in good standing.

Campus Residency Requirement— Doctoral students must spend at least four semesters on campus at MTU beyond attainment of a bachelor's degree, or two semesters beyond attainment of a master's degree, in a formal program of study and research under direct supervision of their major advisor. The semesters in residence do not have to be continuous and can include summer terms. In special pre-approved instances, this residency requirement may be waived.

Time Limit—Comprehensive examinations must be taken within five years of entry and two terms before the final oral defense, and all requirements must be completed within eight years from the time of a student's first enrollment in the doctoral program.

Modern Language Requirement—There is no University-wide language requirement for doctoral degrees. Individual departments or programs may require a foreign language. Each academic department or program is responsible for establishing standards and examination procedures where a foreign language is required. Doctoral students should consult with their advisory committee concerning departmental regulations.

Advisory Committee

During the student's first semester of residence, an Advisor will be chosen to assume initial responsibility for the direction of the student's educational program and to hold meetings as needed to fulfill this responsibility. It is also possible that other members of the advisory committee will be chosen at the same time as the advisor. The advisor and committee, consisting of at least two members of the graduate faculty in addition to the advisor, will be appointed by the chair of the major department or program with the approval of the dean of the Graduate School and filed on the D2 and D4a forms. This committee, with the addition of a fourth, external member, will often become the Examining Committee (see "Oral Examination" below).

Preliminary Program of Study—Initially the Advisory Committee will meet with the student and prepare a program of course study and research work that will lead to the doctoral degree. This program must be filed in the Graduate School office during the second

term of residence on the Preliminary Program of Study form (D3). Subsequent changes in the program can be made by the advisory committee and will appear on the final Degree Schedule form (D5). The Graduate School office must be notified in writing of any significant changes affecting the time required for obtaining the degree.

Proficiency Examinations—Exams may be scheduled as necessary by the department or program to assist in planning students' study programs or to determine the advisability of students continuing in the doctoral program.

Comprehensive Examination

A comprehensive examination will be given to determine the general knowledge appropriate to the student's program and the student's ability to use this knowledge. This examination will be a written examination, although it may be oral in part if recommended by the Advisory Committee, but it must be given no later than five years after enrollment. It is recommended that the comprehensive exam be given after about two years of doctoral study and following completion of all course work required by the Advisory Committee. The examination will be given after the applicant has completed any modern language requirement and at least two terms prior to scheduling the final oral examination.

The examination will be prepared and administered by the major department or program with the cooperation of the Advisory Committee. Satisfactory performance on the comprehensive examination will be regarded as an indication that no additional formal course work is needed, although the student may take additional course work. Any member of the graduate faculty may attend the oral examination as an observer.

Final Degree Schedule—Upon satisfactory completion of the comprehensive examination, a final Degree Schedule form (D5) must be filed in the Graduate School office and approved prior to scheduling a final oral examination. This Degree Schedule should include all course work taken since the last previous degree to be applied to the doctoral degree. It must be approved by the Advisory Committee as meeting the standards associated with the doctor of philosophy degree.

Dissertation

The research study undertaken as part of the doctoral degree program will be presented in the form of a dissertation that can be made a permanent acquisition of the library, along with an expanded abstract, not exceeding 350 words. Any classified or proprietary material that cannot be made available to the public is not acceptable as a dissertation. Completing the dissertation includes approval of the dissertation proposal, preparing the dissertation

according to guidelines, and filing the completed (and successfully defended) dissertation.

The dissertation will be written and prepared under the supervision of the chair of the Advisory Committee according to discipline-specific writing requirements. Publication guidelines are found in Publishing Your Dissertation (UMI Dissertations Publishing). The Graduate School Office sends this booklet to students when the final Degree Schedule (D5) has been received. A completed draft of the dissertation must be approved by the Advisory Committee two weeks prior to the final examination.

After the dissertation has been satisfactorily defended, recommended or other appropriate editorial changes in the dissertation should be made with the approval of the Advisory Committee chair.

The appropriate number of copies of the corrected version of the dissertation, one with the original signatures, must be submitted to the Graduate School Office. Two will be bound for placement in the J. R. Van Pelt Library. The third, accompanied by the required form, attachments, and payment, is for submission to UMI Dissertations Publishing for microfilming and inclusion in Dissertation Abstracts International. If the student prepares appropriately, the UMI submission can be done electronically.

Oral Examination

At a public final oral examination, primarily concerning the research and doctoral dissertation, the candidate should justify the validity of the methods and conclusions contained in the dissertation and should be familiar with the import of the particular investigations reported in the dissertation relative to the larger body of existing knowledge. The examination may be given any time after a period of two academic terms following the successful completion of the comprehensive examination and upon completion of the dissertation in a satisfactory form. The student's examination results must be reported to the Graduate School office on the D8.

The Examining Committee will be appointed by the dean of the Graduate School in consultation with the department chair. The committee will consist of at least four members of the graduate faculty. At least one of these will be from a cognate department or program. For interdisciplinary programs, "cognate" should be interpreted to mean a department other than those departments represented in the program or area of concentration. A person external to MTU may be appointed as an ad hoc member of the Graduate Faculty to serve as the external (cognate) examiner. Additional external examiners who are not graduate faculty may be appointed by a nomination memo to, and approval by, the dean.

The examination will be scheduled, by filing the Scheduling of Final Oral Examination form (D7) with the dean of the Graduate School, in consultation with the chair of the Advisory Committee. The date of the examination must be at least two weeks following the approval of the completed draft of the dissertation by the Advisory Committee. A copy of the completed dissertation draft must accompany the D7 when it is filed in the Graduate School office. Copies of the completed draft must be distributed to any new members of the Examining Committee at least two weeks prior to the scheduled examination date.

Timeline to Degree—PhD

First reconcile this suggested chronology with your department's requirements. The sequence may not be the same as written here. Take this timeline to a meeting with your advisory committee to make sure your goals are consistent with their expectations.

Date	Done	
During the first semester of residence or soon thereafter		
		[For internal applications from Master's program only] D1, Acceptance into the Doctoral Program*—completed by your department's graduate program coordinator, perhaps after a preliminary exam.
		Make sure the GSO has *official* final transcripts showing proof of your previous degrees (if not from MTU).
		Get a Social Security Number if you will be a GRA or GTA, or otherwise working.
		Fill out a Patent, Research, and Proprietary Rights form in your department office.
		Inform the Office of Student Records and Registration of any changes in your status, address, student identification number, etc.
During the second semester of residence		
		D2, Recommended Advisor—Your department chair/graduate program coordinator appoints an advisor to meet with you and prepare a program of courses and research work. If at any time you wish to change advisors, it should be approved by the department chair and reported to the GSO. Arrange a meeting with your advisor to work on the D3 and plan your degree path.

		D3, Preliminary Program of Study—Traditionally, this work contract is a list of all courses you have completed since you received your BS and any additional courses your committee says you should take. Subsequent changes in course selections or anticipated completion date can be made on the D5. If credit transfers are necessary, use the Transfer Credits form.
		Proficiency Examination—if required by department
		Modern Language Requirements—if required by department
As work goes on		
		If your research involves animal subjects, human subjects, or recombinant DNA you must obtain approval from the appropriate administrative review committee(s). Applications for approval(s) may be found on the Research web site. If you need further assistance, please contact the Research Compliance Administrator by phone 906-487-3403.
		At least 2 semesters prior to scheduling the final oral examination and no more than five years after beginning your doctoral program, you will be given a written comprehensive exam (and perhaps an oral exam) after you have completed any modern language requirement. Satisfactory performance on the comprehensive exam usually indicates that no additional course work is needed, although you have the option of taking more.
		D4, Report on the Comprehensive Examination—Some departments hold this form until the oral section of the exam. Please note that fails as well as passes must be reported to the Graduate School on the D4.
		D4-A, Recommended Advisory Committee—Your department chair/ graduate program coordinator appoints an advisory committee of graduate faculty members to meet with you and prepare a program of research work. Any changes in the membership of this committee should be approved by the department chair and reported to the GSO. Arrange a meeting with your committee to work on D5 and plan your research path.
		D5, Degree Schedule—The GSO can start verifying your grades immediately. Your copy will be returned attached to the University Microfilms booklet on preparing your dissertation for publication.
The Dissertation		

		D6, Approval of Dissertation Proposal—This should be a simple statement of your research goal and plan of attack. (This is sometimes the oral part of the comprehensive exam.)
		At least 6 weeks prior to your defense, send the dissertation draft to your advisory (three-member) committee.
		D7, Scheduling of Dissertation Defense—due in the GSO with a copy of your best dissertation draft at least two weeks before the defense date but after the examining committee has approved your draft and signed the back of the D7. The examining (defense) committee must be comprised of at least four graduate faculty members, including at least one from a cognate department. Non-MTU members of your committee must be preapproved by the dean of the Graduate School. Your copy of the signed form will be returned with instructions on how to complete your degree.
		Dissertation Defense—Take your **D8, Report on Dissertation Defense**, to the defense for signatures. Your advisor/department may hold the signed form for up to one week following the defense; research grades will not be changed until this form is in the GSO.
		Submission of Dissertation—After the defense, make corrections as directed and get the new original dissertation signed. Determine whether you are submitting a CD for printing and binding or a fully linked ETD. Convert the file to the appropriate electronic format. If you are NOT submitting an ETD, you will need to print one complete copy for submission to UMI. Read the paperwork attached to your copy of the signed D7 carefully for other details related to completing your degree and submitting your dissertation. Bring your dissertation invoice, UMI dissertation copy unless submitting to UMI electronically, UMI forms, and payment receipt to the GSO. You can usually receive a certification letter immediately if all your degree requirements are complete.
		The Goal: Graduation—no more than eight years after starting the doctoral program. Your transcript will indicate degree granted by the 4th week of the next semester. If you have left a valid address, your diploma will be mailed to you about 90 days after semester end.
		Be sure the GSO and your advisor are aware of your commencement plans at the beginning of the commencement semester.

* All these forms can be sent to the GSO by your department's graduate secretary via campus mail. Copies of signed forms will be returned to you and the department. Be sure to keep a file of your paperwork.

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Master of Engineering

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The Graduate School
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Fax: 906.487.2463
e-mail: MTU Grad School

The Master of Engineering degree is intended to be a terminal professional degree where the candidate demonstrates advanced ability in course work and with an advanced engineering design project, or practicum. The master of engineering student must do the following:

- file a preliminary Degree Schedule form
- choose an advisor and advisory committee
- complete a written and oral report on a practicum
- file a final Degree Schedule form
- fulfill the campus residency requirement
- finish the degree within the prescribed time limit
- file a successful practicum report form.
- Forms on-line at http://www.admin.mtu.edu/rgs/graduate/trackingforms.html

In addition to the Graduate School requirements, which are described below, individual departments may have higher standards. Students are expected to know their department's requirements. Currently, there are master of engineering degrees in civil engineering and in environmental engineering, as well as a non-departmental master of engineering administered through the office of the dean of engineering.

Grades—All grades must be B (3.0 on a 4.0 scale) or better in the major subject area. The department chair can approve no more than 6 credits of BC (2.5) or C (2.0) in a cognate department. The student must maintain a cumulative GPA of 3.0 or better in all courses taken as a graduate student.

Campus Residency Requirement—A minimum of one-half of the course work credits must be taken in residence at MTU. (Note that this is inconsistent with the general requirement that 2/3 of the course work be taken in residence. See Senate Proposal 5-98.)

Time Limit—All work required for the Master of Engineering degree must be completed within five calendar years of the first enrollment in the degree program.

Advisor—Initially the advisor may be the department's graduate coordinator, but as soon as possible, and by the end of the first semester in residence, a permanent advisor should be chosen. This MTU graduate faculty member advises the student on course selection

and choice of practicum experience. The advisor is an important factor in the graduate student's timely and successful completion of his or her program of study.

Advisory Committee—The Advisory Committee is nominated by the chair of the major department, usually in consultation with the advisor, and approved by the College of Engineering. At least two of the three examiners must be members of the graduate faculty and at least one of the graduate faculty members must be from outside the major department.

Degree Schedule—The Proposed Degree Schedule and Work Plan form (MEng1), available from the College of Engineering and on the Grad School "forms" web page, is used to list all the courses that the student will use for the Master of Engineering degree. The completed form must be approved by the student's advisor and department, the College of Engineering, and the Graduate School office during the first semester of enrollment.

The Final Degree Schedule form (MEng2), available from the College of Engineering and on the Grad School "forms" web page, must be filed during the first week of the second term in residence. It lists all the courses applied to the Master of Engineering degree, gives the advisory committee membership, provides an abstract of the practicum, and is endorsed by the student, the advisor, the department chair, the associate dean of engineering, and the dean of the Graduate School.

Changes in the Final Degree Schedule—Any changes must be approved. The chair of the major department must send a memo to the dean of the Graduate School.

Course Work —Courses taken must meet certain requirements, described below, and they must be approved by the advisor and the department chair. Courses taken while an undergraduate at Michigan Tech may be used for graduate degree credits if the Senior Rule form (available from the department secretary) has been appropriately filed. Courses taken while a post-grad may be used on the Degree Schedule with departmental approval. The minimum requirements are as follows:

Course work	26–28 credits
Practicum	2–4 credits
Total (minimum)	30 credits
Distribution of course work credit	

5000–6000 series (minimum)	12 credits
3000–4000 level (maximum)	14 credits

Master of Engineering Practicum—The practicum is an advanced independent study for students in the master of engineering program. The student in consultation with the advisor develops and executes a project demonstrating capabilities in problem solving, communication, and decision making. The practicum can be completed on campus or at the site of a Michigan Tech corporate partner. Students must submit a written report and make an oral presentation related to their project to their Advisory Committee.

The successful on-campus oral presentation will be evaluated by the committee on the MEng3 form, Report on Practicum.

Timeline to Degree—Master of Engineering

First reconcile this suggested chronology with your department's requirements. The sequence may not be the same as written here. When you consult your advisor for your degree schedule, take this timeline to the meeting so you and your advisor are in agreement on your plans.

The degree will be granted at the end of the semester in which all courses have been satisfactorily completed and forms MEng1, MEng2, and MEng3 have been submitted and approved.

Date	Done	Task
		Enrolling for the first time— If you do not have a faculty advisor to help you choose courses, consult with Dr. Sheryl Sorby, Associate Dean of Engineering.
		Make sure the GSO has official final transcripts showing proof of your previous degrees if they are not from Michigan Tech.
		Fill out the Patent, Research, and Proprietary Rights form in your department office.

		If your research involves animal subjects, human subjects, or recombinant DNA, you just obtain approval from the appropriate administrative review committee(s). Applications for approval(s) may be found on the Research Website. If you need further assistance, please contact the Research Compliance Administrator by phone 906.487.3403.
		Inform the Office of Student Records and Registration of any changes in your status, address, student identification number, expected graduation date, etc.
		MEng1, Proposed Degree Schedule and Work Plan*—This form is due early in the first semester and is prepared in cooperation with your advisor. It establishes preliminary plans for your course work and nominates a committee to complete your advising and practicum report.
		MEng2, Final Degree Schedule—This form is due in the first week of your second term of enrollment. After you submit your Final Degree Schedule, you will receive a signed copy in return that includes Graduate School forms to help you finish your degree. All your grades in the courses used must be B or better in your major subject, and your cumulative GPA must be 3.0 or higher.
		Set up an appointment with your committee to report on your practicum.
		MEng3, Report on Practicum—This form is due when you have completed your practicum, including the oral presentation to your committee.

		The Goal: Graduation—no more than five calendar years after you started graduate school. Your graduation date is the end of the term in which you complete all degree requirements. Your transcript will not indicate your degree until about four weeks after the next term begins. Your diploma will be mailed to you about 90 days after the term ends if you have completed and submitted your Life After MTU form. You may request a degree certification letter as soon as your degree is completed.

* All these forms can be sent to the GSO by your department's graduate secretary via campus mail. Copies of signed forms will be returned to you and the department. Be sure to keep a file of your paperwork.

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Master of Forestry

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Program Regulations

The program of study for each student will be planned and supervised in accordance with existing University and School policies. The student's Advisory Committee (which includes the student's Advisor) must insure that each M.F. candidate's course work meets the standards of a Master's program. A minimum of 30 course work credit hours beyond the bachelor's degree is required, as well as an oral examination. The proposed Master of Forestry will have completely specified course work requirements.

Master of Forestry (Plan B and Plan C)

The Master of Forestry (M.F.) degree program will be Plans B and C only, and will be directed at students who want a course work-only professional degree or who may be interested in working on a small project with a report. Students in this program will most likely lack a forestry background at the Bachelors level, and would find the Master of Forestry degree more appropriate than any of the other options within the School. The structure of this program is significantly different from our present Master of Science in Forestry and from the proposed Master of Science Degree programs in Forest Ecology and Management, Applied Ecology, and Forest Molecular Genetics and Biotechnology. In addition to a Bachelors degree, students applying for this program are expected to have had 1 semester of Chemistry, and 1 semester of Elementary Statistics. The curriculum for Plan C is listed below. Students completing plan B may choose to take 2-6 research credits in lieu of the required course work listed below, upon consultation with their advisor. Curriculum:34 credits, depends on previous course work (at a minimum 30 credits)

Fall Semester (11 credits)

FW5510 Measuring Forest Resources & Vegetation of North America (4 cr)

FW3020 Forest and Landscape Ecology (3 cr)

FW3330 Soil Science (4 cr)

Spring Semester (13 credits)

FW3110 Natural Resource Policy (3 cr)

FW3540 Remote Sensing/GIS (4 cr)

FW4130 Biometrics (2 cr)

FW5080 Advanced Forest Economics and Finance (3 cr) **NEW COURSE**

FW5800 Master's Graduate Seminar (1 cr)

Fall Semester (10 credits)

FW5510 Special Topics in Natural Resources (1 cr)

FW5700 Graduate Field Forestry (7 cr)

FW5760 Graduate Tropical Forestry (2 cr)

Advisory Committee

The student's Graduate Advisory Committee should be appointed by the second semester of residence. The Advisory Committee will consist of at least four members, including one member designated as Chair. The chair is the student's graduate advisor. The Chair must be a member of the School of Forest Resources and Environmental Science and the MTU Graduate School faculty. At least one member of the Advisory Committee must be from outside the School. The Advisory Committee must approve the report (Plan B), and the necessary course work to successfully complete the project. The student's Advisor is responsible for ensuring the report (Plan B) is within the capability of the student and can be completed within a reasonable period of time. The Advisor and the Advisory Committee are responsible for ensuring the report (Plan B) and course work (Plans B and C) fall within the Masters program selected by the student and the student's Advisor. The role of the Advisory Committee for Plan C students is to help the student choose course work, keep track of the student's progress in his/her course work, and to test the student's knowledge on his/her course work at the student's oral defense.

General Procedures

A plan of work showing the courses to be taken, the topic of the report (Plan B), and the report format (Plan B) will be prepared by the student with his/her Advisor. The student's Advisory Committee will review the course work (Plans B and C) and design of study (Plan B) by the end of the second or third semester in residence. For a plan B Masters, the study plan must be presented to the student's Advisory Committee no later than the end of the second semester in residence. A copy of the approved study plan will be given to all committee members once approved by the Advisory Committee.All graduate students are required to be enrolled each academic term following entry into the Masters program until completion of all degree requirements. A full-time student on an assistantship must enroll in a minimum of 9 credit hours per semester and not more than 12 credit hours each semester. During the summer, a full-time student on an assistantship must enroll for one credit hour.All Masters students will go through an oral defense. The oral defense for Plan B Masters students will focus around the student's report and their course work. Early in the student's last semester, a draft of the report should be submitted to the student's Advisor. Following review and revisions by the Advisor, the report should be submitted to the student's Advisory Committee at least two weeks before the scheduled oral examination. Plan B students must give a scheduled oral presentation before their defense. The oral defense for Plan C students will focus on their course work. All work required for the M.F. degree must be completed within five years after first registering for classes.

Grades

All grades must be B (3.0 on a 4.0 scale) or better in the major subject area. The Associate Dean of the School of Forest Resources and Environmental Science can approve no more than six credits of C (2.0) in a cognate department. The student must maintain a cumulative grade point average of 3.0 or better.

The master's degree demonstrates advanced ability. The master's student must complete the following:

- choose an advisor and file a Recommended Advisor form (M2-GSO)
- file a Degree Schedule form (M4)
- complete the coursework requirements
- complete an oral examination
- fulfill the campus residency requirement
- finish the degree within the prescribed time limit
- submit an approved document in plans A & B
- Forms are available on-line at http://www.admin.mtu.edu/rgs/graduate/trackingforms.html

Advisor

Initially the advisor may be the department's graduate coordinator, but as soon as possible, and no later than the end of the second term in residence, a permanent advisor should be chosen. This MTU graduate faculty member advises the student on course selection. The advisor is an important factor in the graduate student's timely and successful completion of the program of study.

Degree Schedule

The Degree Schedule form (M4) is used to list all the courses that are to be applied to the degree requirements, including those yet to be taken. The completed M4 should be submitted in the term prior to the defense term. It must be approved before the defense is scheduled.

The courses listed on the M4 must meet certain requirements, described in each option below, and they must be approved by the advisor and the department chair. Courses taken while an undergraduate at MTU may be used for graduate degree credits if the Senior Rule form (available from the department secretary) has been appropriately filed. Courses taken while a post-grad may be used on the Degree Schedule with departmental approval.

Plan B: Report Option (Not offered by all departments)—This plan requires a report describing the results of an independent study project. Of the minimum total of 30 credits, at least 24 must be earned in course work other than the project.

Course work	24 credits

Report	2–6 credits
Total (minimum)	30 credits
Distribution of course work credit	
5000–6000 series (minimum)	12 credits
3000–4000 level (maximum)	12 credits

Plan C: Course Work Option (Not offered by all departments)—This plan requires the minimum 30 credits be earned through course work.

Distribution of course work credit	
5000–6000 series (minimum)	18 credits
3000–4000 level (maximum)	12 credits

Oral Examination

Examination by and approval of a faculty committee is required for awarding a master's degree. This committee will examine the general professional knowledge, course work, and (in plans A and B) the written documents of each master's candidate. The defense is scheduled and the committee nominated via the Scheduling of Final Oral Examination form (M5), which must be in the Graduate School office two weeks prior to the defense date.

Examination Committee—Must be nominated by the chair of the major department, usually in consultation with the advisor, and approved by the dean of the Graduate School. At least three of the four examiners must be members of the graduate faculty and one of the graduate faculty must be from outside the major department.

Thesis or Report

Distribute copies to the Examining Committee at least two weeks prior to the examination date.

Defense—Must be scheduled and the committee nominated via the Scheduling of Final Oral Examination form (M5). The committee's written evaluation must be filed on the Report on Oral Examination form (M6). The student must be enrolled to defend.

Timeline to Degree

First reconcile this suggested chronology with your department's requirements. The

sequence may not be the same as written here. When you consult your advisor for your degree schedule, take this timeline to the meeting so you and your advisor are in agreement on your plans.

Date	Done	Task
		Enrolling for the first time—Get into course work under the direction of your departmental graduate coordinator.
		Make sure the GSO has official final transcripts showing proof of your previous degrees (if they are not from MTU).
		Fill out Patent, Research, and Proprietary Rights form in your department office.
		Get a Social Security Number if you will be getting a GRA or GTA, or otherwise working.
		Start looking for a **faculty advisor** for research projects; she/he should be chosen **by the end of the second term** in residence—your department will have its own way of handling this. **File an M2-GSO form**.
		If your research involves animal subjects, human subjects, or recombinant DNA, you must obtain approval from the appropriate administrative review committee(s). Applications for approval(s) may be found on the Research web site. If you need further assistance, please contact the Research Compliance Administrator by phone 906-487-3403.
		Inform the Office of Student Records and Registration of any changes in your status, address, student identification number, expected graduation date, etc.
		During the semester prior to your defense (or earlier), complete the **M4, Degree Schedule*** in consultation with your advisor—if there are problems, you have a term in which to correct them. Because it is approved by your advisor/coordinator and your department chair, any changes must also have their approval. If credit transfers are necessary, use the Transfer Credits form.

		At least two weeks prior to your defense, complete **M5, Schedule of Oral Examination**, in consultation with your whole committee. This names your four-member examining committee and schedules your oral examination. (Check departmental policy on choosing your committee.)
		At least two weeks prior to your defense, distribute readable copies of the thesis/report to the examining committee.
		Oral Examination—Faculty and students will be invited to hear at least your presentation. It is wise to attend a few of these early in your tenure at Tech. Some departments also require a couple of preliminary seminars during your research. The examination for the course work option varies with the programs allowing this option. Take your **M6, Report on Oral Examination**, to the exam for signatures. (Your advisor/department may retain your M6 for up to one week following the defense while you make corrections; research grades are not changed until the M6 is in the GSO.
		Submission of final document (Plan A & B)—Make corrections as indicated by your committee. Get the new original signed. Plan B report: 1 copy to the GSO, in a sturdy binder suitable for archiving in the Library. (Your advisor/department may want more copies.) Plan A thesis: The Graduate School requires the approved copy converted to . pdf and saved on CD. Instructions for payment and submissions are on the invoice and Heckman bindery form you will receive when you defend.
		The Goal: Graduation—no more than five calendar years after you started Graduate School. When you have completed your degree requirements, you can usually receive a certification letter immediately. Your transcript will indicate degree granted by the 4th week of the next semester. Your diploma will be mailed to you about 90 days after the term ends. Leave a valid address with the Graduate School.
		Be sure the GSO and your advisor are aware of your commencement plans at the **beginning** of the commencement semester.

* All these forms can be sent to the GSO by your department's graduate secretary via campus mail. Copies of signed forms will be returned to you and the department. Be sure to keep a file of your paperwork.

Last Updated: 1-jul-05

Master of Science

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Houghton, Michigan 49931
Phone: 906.487.2327
Fax: 906.487.2463
e-mail: MTU Grad School

The master's degree demonstrates advanced ability, usually in both course work and research. The master's student must complete the following:

- choose an advisor & file a Recommended Advisor form (M2-GSO)
- file a Degree Schedule form (M4)
- complete one of three option plans: Note that plans B and C are not offered by all departments.

  plan A—thesis and course work
  plan B—report and course work*
  plan C—course work only*

- complete an oral examination
- fulfill the campus residency requirement

  (Distance Learning students must document time on campus.)
- finish the degree within the prescribed time limit
- submit an approved document in plans A & B
- Forms are available on-line at http://www.admin.mtu.edu/rgs/graduate/trackingforms.html

In addition to the Graduate School requirements, which are described below, individual departments may have higher standards. Students are expected to know their department's requirements.

Master's Path Program—See additional details about program requirements here.

Grades—All grades must be B (3.0 on a 4.0 scale) or better in the major subject area. The department chair can approve no more than 6 credits of BC (2.5) or C (2.0) in a cognate department. The student must maintain a cumulative grade point average of 3.0 or better in all courses taken as a graduate student in order to remain in good standing.

Campus Residency Requirement—A minimum of two-thirds of the course work credits, i. e., non-research credits, must be taken in residence at MTU. Thesis credits must be supervised by MTU graduate faculty.

Time Limit—All work required for the master of science degree must be completed within five calendar years of the first enrollment in the degree program.

Advisor

Initially the advisor may be the department's graduate coordinator, but as soon as possible, and no later than the end of the second term in residence, a permanent advisor should be chosen. This MTU graduate faculty member advises the student on course selection and choice of research topic and supervises the research experience. The advisor is an important factor in the graduate student's timely and successful completion of the program of study.

Degree Schedule

The Degree Schedule form (M4) is used to list all the courses that are to be applied to the degree requirements, including those yet to be taken. The completed M4 should be submitted in the term prior to the defense term. It must be approved before the defense is scheduled.

The courses listed on the M4 must meet certain requirements, described in each option below, and they must be approved by the advisor and the department chair. Courses taken while an undergraduate at MTU may be used for graduate degree credits if the Senior Rule form (available from the department secretary) has been appropriately filed. Courses taken while a post-grad may be used on the Degree Schedule with departmental approval.

Changes in the Degree Schedule—Any changes must be approved. The chair of the major department must send a memo to the dean of the Graduate School requesting changes.

Options

For plans A or B, the scope of the research topic for the thesis or independent project should be defined in such a way that a full-time student could complete the requirements for a master's degree in twelve months or three semesters following the completion of course work by regularly scheduling graduate research credits. The thesis or report must be prepared in a style appropriate to the discipline. Following the defense the corrected Plan A thesis, as approved by the committee, is submitted to the Graduate School office as a .pdf file on CD for printing and binding. A single paper copy of the corrected and approved Plan B report is submitted to the Graduate School. The J. Robert Van Pelt Library archives all master's reports and theses. Plan C coursework papers are not submitted to the Graduate

School and are not retained by the Van Pelt Library.

Plan A: Thesis Option—This plan requires a research thesis prepared under the supervision of the advisor. The thesis describes a research investigation and its results. The minimum requirements are as follows:

Course work (minimum)	20 credits
Thesis research	6–10 credits
Total (minimum)	30 credits
Distribution of course work credit	
5000–6000 series (minimum)	12 credits
3000–4000 level (maximum)	12 credits

Plan B: Report Option (Not offered by all departments)—This plan requires a report describing the results of an independent study project. Of the minimum total of 30 credits, at least 24 must be earned in course work other than the project.

Course work	24 credits
Report	2–6 credits
Total (minimum)	30 credits
Distribution of course work credit	
5000–6000 series (minimum)	12 credits
3000–4000 level (maximum)	12 credits

Plan C: Course Work Option (Not offered by all departments)—This plan requires the minimum 30 credits be earned through course work.

Distribution of course work credit	
5000–6000 series (minimum)	18 credits
3000–4000 level (maximum)	12 credits

Oral Examination

Examination by and approval of a faculty committee is required for awarding a master's

degree. This committee will examine the general professional knowledge, course work, and (in plans A and B) the written documents of each master's candidate. The defense is scheduled and the committee nominated via the Scheduling of Final Oral Examination form (M5), which must be in the Graduate School office two weeks prior to the defense date.

Examination Committee—Must be nominated by the chair of the major department, usually in consultation with the advisor, and approved by the dean of the Graduate School. At least three of the four examiners must be members of the graduate faculty and at least one of the graduate faculty must be from outside the major department.

Thesis or Report

Distribute copies to the Examining Committee at least two weeks prior to the examination date.

Defense—Must be scheduled and the committee nominated via the Scheduling of Final Oral Examination form (M5). The committee's written evaluation must be filed on the Report on Oral Examination form (M6). The student must be enrolled to defend.

Timeline to Degree

First reconcile this suggested chronology with your department's requirements. The sequence may not be the same as written here. When you consult your advisor for your degree schedule, take this timeline to the meeting so you and your advisor are in agreement on your plans.

Date	Done	Task
		Enrolling for the first time—Get into course work under the direction of your departmental graduate coordinator.
		Make sure the GSO has official final transcripts showing proof of your previous degrees (if they are not from MTU).
		Fill out Patent, Research, and Proprietary Rights form in your department office.
		Get a Social Security Number if you will be getting a GRA or GTA, or otherwise working.

		Start looking for a **faculty advisor** for research projects; she/he should be chosen **by the end of the second term** in residence—your department will have its own way of handling this. **File your M2-GSO form** with the Graduate School.
		If your research involves animal subjects, human subjects, or recombinant DNA, you must obtain approval from the appropriate administrative review committee(s). Applications for approval(s) may be found on the Research web site. If you need further assistance, please contact the Research Compliance Administrator by phone 906-487-3403.
		Inform the Office of Student Records and Registration of any changes in your status, address, student identification number, expected graduation date, etc.
		During the semester prior to your defense (or earlier), complete the **M4, Degree Schedule*** in consultation with your advisor—if there are problems, you have a term in which to correct them. Because it is approved by your advisor/coordinator and your department chair, any changes must also have their approval. If credit transfers are necessary, use the Transfer Credits form.
		At least two weeks prior to your defense, complete **M5, Schedule of Oral Examination**, in consultation with your whole committee. This names your four-member examining committee and schedules your oral examination. (Check departmental policy on choosing your committee.)
		At least two weeks prior to your defense, distribute readable copies of the thesis/report to the examining committee.
		Oral Examination—Faculty and students will be invited to hear at least your presentation. It is wise to attend a few of these early in your tenure at Tech. Some departments also require a couple of preliminary seminars during your research. The examination for the course work option varies with the programs allowing this option. Take your **M6, Report on Oral Examination**, to the exam for signatures. (Your advisor/department may retain your M6 for up to one week following the defense while you make corrections; research grades are not changed until the M6 is in the GSO.

		Submission of final document (Plan A & B)—Make corrections as indicated by your committee. Get the new original signed. Plan B report: 1 copy to the GSO, in a sturdy binder suitable for archiving in the Library. (Your advisor/department may want more copies.) Plan A thesis: The Graduate School requires the approved copy converted to . pdf and saved on CD. Instructions for payment and submissions are on the invoice and Heckman bindery form you will receive when you defend.
		The Goal: Graduation—no more than five calendar years after you started Graduate School. When you have completed your degree requirements, you can usually receive a certification letter immediately. Your transcript will indicate degree granted by the 4th week of the next semester. Your diploma will be mailed to you about 90 days after the term ends. Leave a valid address with the Graduate School.
		Be sure the GSO and your advisor are aware of your commencement plans at the **beginning** of the commencement semester.
* All these forms can be sent to the GSO by your department's graduate secretary via campus mail. Copies of signed forms will be returned to you and the department. Be sure to keep a file of your paperwork.		

Last Updated: 2-sep-05

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Master's Path Program – for students who have completed a three-year bachelor's program outside the US

Background

Some colleges and universities outside the US are moving to a three-year bachelor's degree and a five-year master's degree. After obtaining the three-year degree in their home country, many students would like to go abroad to pursue a high-quality master's degree, gain international experience, and perfect their English. The Michigan Tech Master's Path Program allows students to pursue a master's degree directly, rather than requiring they first complete a bachelor's program at a US institution. The Master's Path Program is offered in twenty-three disciplines in the sciences, engineering, forestry, communications, social sciences, and business.

Application Process

Students apply for graduate admission using the international forms, specifying "Master's Path." Applications must be approved by both the department chair and by the Graduate School.

- Suggested minimum admissions criteria
- Completion of recognized three-year degree in appropriate area
- Statement of purpose, application fee, official transcripts
- Three letters of reference
- Adequate academic achievement in pursuit of the three-year degree
- GRE/general test results, if required by department,
- Proof of English proficiency TOEFL (at least 550 written or 213 computer-based) or ILETS (a score comparable to TOEFL requirements)

Master's Path Curriculum

Students who hold a 4-year bachelor's degree are required to take at least 30 semester credits beyond the bachelor's for their master's degree. Students entering the Master's Path Program with a 3-year bachelor's degree will be required to take additional credits

depending on their preparation in the chosen field of study. The transcript of each accepted student is reviewed by the departmental graduate committee, which delineates the specific course requirements needed for completion of the master's degree.

Based on the specific MTU degree program, the student's focus, and the transcript review, a set of bridge courses, required in addition to the 30 credits, is defined. Courses on the student's transcript that have been taken beyond the requirement of their 3-year bachelor's degree may be evaluated for transfer into the master's curriculum. Bridge courses are integrated into the Master's Path curriculum, which is normally completed within 24 months. Students typically will take a mix of graduate and bridge courses during their first one or two semesters. Students in the Master's Path Program may take an hourly, salaried job on campus during their first term of residence, provided it does not slow progress toward their degree. (A limited number of hourly research, teaching, and service jobs are available.) Following the successful completion of their first term, they may, at the discretion of their advisor, be eligible for a research and/or teaching stipend.

Brochure describing the program here.
Master's Path course planning form here.

Last Updated: 29-mar-05

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Last Updated: 14-Apr-2005

Affiliated Programs & Agreements - Draft

MTU currently partners with a variety of other institutions to enhance and expand opportunities for graduate education. These opportunities include distance learning, exchange and transfer of credits, options for transferring in "graduate option" credits, and joint support and research arrangements. We invite other institutions to read through these agreements and propose similar or complementary affiliations. Contact Dr. Marilyn Vogler, Assistant Dean of the Graduate School, for information.

Northland College (transfer of graduate option credits)

Ford Motor Company (partnered distance learning)

Southern University A&M College (exchange term and transfer of credits)

Kettering (joint support and research)

John Deere (partnered distance learning)

MIGS (Michigan Graduate Schools transfer of credits)

Mayo (partnered distance learning)

Universidad del Turabo

Academic and Conduct Policies

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All members of the University community—students, faculty, staff, and administrative officers—are jointly involved in maintaining moral and social patterns of acceptable conduct. All students are expected to exhibit behavior which is indicative of good citizenship; when they fail to do so, they are expected to accept responsibility for conduct that may be incongruent with University community standards. The University reserves the right to discipline any student for violation of any rule, ordinance, or law, or for any conduct damaging to the University, by such means as it considers suitable, including dismissal.

Refer to the MTU Code of Community Conduct (available at http://www.sa.mtu.edu/dean/judicial/policies/code/), and to document links at the bottom of this page for more information on disciplinary procedures and specific policies.

Academic Integrity

Academic integrity and honesty are central to a student's education. Ethical conduct in an academic context will be carried forward into a student's professional career. Academic honesty is essential to a community of scholars searching for and learning to seek the truth. Anything less than total commitment to honesty undermines the efforts of the entire academic community. Both students and faculty are responsible for insuring the academic integrity of the University.

In their academic work, students are expected to maintain personal academic integrity; to treat all academic exercises as work to be conducted without consultation or collaboration with others unless otherwise instructed; to ask faculty to clarify any aspects of permissible or expected cooperation on any assignment; and to report any cheating activity. Please note that use of "scoop" material (old exams) is prohibited unless specifically authorized by the instructor.

Students found guilty of academic dishonesty can receive a sanction ranging from academic integrity warning to expulsion.

Definitions of academic dishonesty, including plagiarism, cheating, fabrication, and facilitating academic dishonesty, can be found in the Academic Integrity Policy booklet.

Copies of the policy can be obtained from the Office of Student Affairs and from chairs of academic departments or on the web at http://www.studentaffairs.mtu.edu/dean/judicial/policies/academic_integrity.html.

Computer Use Policy

MTU considers access to computer resources to be a privilege granted on the condition that each member of the University Community uses these resources responsibly, and in accord with professional and university standards. This section describes MTU's computer resources, the responsibilities assumed by users of the system, the services provided to support and assist users, and professional and university standards that must be observed.

Computer and network facilities are provided for educational, research and administrative use. All access and use of University computing resources and services is presumed to be consistent with University rules and regulations, including University personnel policies, faculty and student codes of conduct and departmental policies and procedures. All use is also subject to the University's Conflict of Interest and Intellectual Property policy and procedure. Use of Michigan Technological University's computers and networks for non-MTU-related business purposes or personal gain without authorization is prohibited.

Individuals who are provided access to MTU's computer facilities and to the campus-wide communication network assume responsibility for appropriate use of these resources. The University expects individuals to be responsible in the use of computers and networks. Those who use wide-area networks (such as the Internet) to communicate with others or to connect to computers at other institutions are expected to abide by the rules of the remote systems and networks as well as those for MTU's systems. In addition to being a violation of University rules, certain computer misconduct is prohibited under Michigan Laws. Act 53 of the Public Acts of 1979 of the State of Michigan (as amended by Act 326 of 1996), states "An act to prohibit access to computers, computer systems, and computer networks for certain fraudulent purposes; to prohibit intentional and unauthorized access, alteration, damage, and destruction of computers, computer systems, computer networks, computer software programs, and data; and to prescribe penalties." In addition, individuals may be held responsible for misuse which occurs by allowing their account to be accessed by a third party.

Individuals must consult their department System Administrator or other designated individual prior to any activity that might threaten the security or performance of University computers and networks. Failure to do so may result in disciplinary action. An individual who may have unintentionally or inadvertently participated in or caused such an

event, must notify the System Administrator as soon as possible.

MTU computer and network facilities have tangible value. Consequently, attempts to circumvent accounting systems or to use the computer accounts of others will be treated as forms of attempted theft. Refer to http://www.cec.mtu.edu/cacsec/info/cup_approved.html.

FERPA

The Family Educational Rights and Privacy Act (FERPA) affords students certain rights with respect to their education records. Questions about FERPA may be directed to Michigan Technological University, Office of Student Records and Registration, 1400 Townsend Drive, Houghton, MI 49931-1295. The complete policy is available on the Office of Student Records and Registration website at http://www.admin.mtu.edu/em/students/policies/privacy.php

Directory Information—Michigan Technological University, Houghton, Michigan, hereby by public notice, and in order to comply with Section 438 of Public Law 93-380 designates the following student information as public or "directory information": student name, local address, telephone number, hometown, e-mail address, age, major field of study, participation in officially recognized activities and sports, weight and height of athletic team members, attendance dates, degrees and awards received, and most recent previous school attended.

Withholding Disclosure—Currently enrolled students may withhold disclosure of the above information, except name and verification of enrollment status, under the Family Education Rights and Privacy Act of 1974, by submitting written notification to the Office of Student Records and Registration within two weeks of the start of classes for any semester. Such notification will prevent disclosure to non-University personnel.

Records Request—Requests for review of a record other than grades should be made in writing to the Graduate School office.

Intellectual Property and Trademark Licensing

All graduate students are required by Board of Control policy to sign the MTU Proprietary Rights Agreement which establishes the ownership and disposition of intellectual property developed at MTU. The Office of Corporate Services provides assistance to inventors (including graduate student inventors) in the patenting, commercialization, and ultimate

licensing of technologies developed at Michigan Tech. This assistance can involve direct support for patenting the technology and identification of potential commercialization partners or licensees. Invention Disclosures on any new technologies should be submitted to Corporate Services for review and possible patent application. In some cases, the rights will be returned to the inventor(s).

Corporate Services handles the licensing of MTU technologies (intellectual property) as well as logos/trademarks.

Corporate Services is also responsible for licensing the use of the MTU logo, which is a registered trademark. Any use of the MTU logo/trademark should first be approved by Corporate Services. The office maintains a list of licensed vendors who are authorized to use and reproduce the logo and a specification sheet of approved MTU logos. The office also handles the approval and licensing of new vendors and logo uses.

Michigan Residency

The governing board at each university in Michigan has the authority to determine residency classification guidelines for admission and tuition purposes. Therefore, residency guidelines may vary from school to school and are independent of guidelines used by other state authorities to determine residency for purposes such as income and property tax liability, driving and voting.

A resident student is defined as a student domiciled in the State of Michigan. Dependent students must have the same residency as their parents. Independent students must have a physical presence in Michigan. Students who enroll in the University as nonresidents shall be so classified throughout their attendance as students unless residency reclassification is granted. Continuously enrolled nonresident students are not eligible for reclassification.

Students who believe their residency status has changed since their first enrollment may seek an evaluation of their status. Contact the Office of Student Records and Registration —487-2319. MTU alumni who were Michigan residents as undergraduates will retain that residency status for tuition purposes, regardless of current address.

Scientific Misconduct Procedures

A major goal of the University is the furthering of research. The University upholds the scientific method in the conduct of research and is committed to the ethical conduct of research by its faculty, staff, and students.

A requirement of valid experimental observation or theoretical deduction is that the data and/or the conditions of obtaining the data and results can be verified, either by scrutiny of accurate records made at the time of experimentation or by repetition of the experiments or theoretical deduction.

Conduct inconsistent with the ethical conduct of research and which is considered scientific misconduct includes

- Serious deviation from commonly accepted practices in the scientific community in proposing, conducting or reporting research, such as fabrication, plagiarism, falsification, deception, misrepresentation, or arbitrary selection of data;
- Plagiarism or other appropriation of the work of another individual and presenting it as if it were one's own or without credit to the originator as is required by commonly accepted practices in the scientific community;
- Material failure to comply with funding agency (federal, state, or private, and so on,) requirements that uniquely relate to the conduct of the research; and
- Retaliation against a person who, acting in good faith, has reported or provided information about suspected or alleged misconduct.

Faculty, staff, and students involved in scientific misconduct or false accusations of such conduct may be subject to University disciplinary procedures.

Possible University sanctions may include, but are not limited to, sending a letter of reprimand, setting special conditions on research activities, requiring special certifications or assurances of compliance, dismissal from degree programs and/or termination of employment. Any termination of employment shall occur in a manner consistent with existing applicable University policies on employment practices and academic tenure. The University may impose limitations or special reviews on the research activities or expenditures of affected individuals.

For further information, see appendix F of the Faculty Handbook at http://www.admin.mtu.edu/admin/prov/facbook/appf/fapp.htm.

Sex Discrimination / Sexual Harassment

Michigan Tech is committed to providing a fair and responsible environment for all of its students. Federal and state law prohibit discrimination in the use of educational facilities because of gender. Discriminatory treatment on the basis of one's status as cited in the Michigan Tech Equal Opportunity statement (see page 27) is prohibited. Title VII of the Civil Rights Act expressly prohibits sexual harassment. According to the MTU Sexual

Harassment Policy, unwelcome sexual advances, requests for sexual favors, and other verbal and physical conduct of a sexual nature constitute sexual harassment when submission is either explicitly or implicitly a basis for academic advancement (e.g., for better grades, advancement in an academic program); or when submission or rejection affects the targeted person's employment (e.g., their evaluation, advancement, salary); or when the conduct has the purpose or effect of unreasonably interfering with the targeted person's work performance or learning environment; or when it creates an intimidating, hostile, or offensive work, academic, or residential living environment. For information on the University's sexual discrimination policies, see the MTU Student Handbook, "Rules" section (Code of Conduct, Sexual Harassment, Sexual Misconduct) or contact the Office of Affirmative Programs—487-3310.

- MTU Policy on Sex Discrimination/Sexual Harassment
- MTU Policy on Discrimination/Harassment
- MTU Complaint Procedures

Michigan Tech's Sexual Misconduct Policy for students is found at http://www.sa.mtu.edu/dean/judicial/policies/sexual_misconduct.html

Substance Abuse

The University encourages and promotes an environment where healthy life-style choices can be made every day by the students, faculty, and staff. Students may take advantage of the substance abuse assessment and counseling available to them through Counseling Services. MTU is committed to following the guidelines of the Drug-Free Schools and Community Act of 1988. The Drug and Alcohol Policy may be found at.

MTU recognizes that substance abuse has a detrimental effect on the University's goals and objectives. It affects the intellectual, social, physical, and moral growth and development of the individual and the campus community. To reduce the effects that substance abuse promotes, Michigan Tech expects each person to accept the responsibility for their own choices and behavior. The University will intervene in any substance abuse-related behaviors that have a negative effect on any segment of the University community or violate any city, state, or federal law. For more explicit information, refer to the brochure on Policy and Procedure Concerning Drugs and Alcohol, or the MTU Student Handbook.

Maintaining Active Status

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Please understand the difference between registration and enrollment. When you sign up for particular courses, you are **registering**. After you register, you will be charged tuition and fees. When you pay those tuition and fees, you have confirmed your **enrollment**.

CONFIRMING YOUR ENROLLMENT IS REQUIRED, NECESSARY, & ESSENTIAL EVERY TERM YOU REGISTER FOR COURSES, INCLUDING CONTINUOUS ENROLLMENT COURSES OR COOP CREDITS. **THIS IS YOUR RESPONSIBILITY!**

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Steps to Confirm Enrollment

- MTU is no longer mailing paper bills. You may retrieve your bill via the web at http://www.admin.mtu.edu/acct/ [click Student On-line Bill].
- You must process your bill even if you have a zero ($0.00) or credit balance. If you have a zero or credit balance, click the button at the bottom of the page to confirm enrollment.
- You may pay your bill on the web by credit card (Visa, Mastercard, and Discover are accepted). Credit card payments may not be brought or phoned in to the Cashier's window.
- If you do not confirm your enrollment (process your bill) by the due date, you will be assessed a late fee of $50. If your bill is not processed by the first Wednesday of classes, your courses and/or research credits will be dropped, and you will be charged a late fee of $100. All fees must be paid before your schedule can be

reinstated. This will not be paid by whoever is supporting you.

- If you get a bill for full tuition and have been told you'll be supported, verify with the cashier whether your support has been added by your department. If your support has been processed by your department, you can pay just the fees you owe (approximately $135).
- If your support has not been processed, contact your department immediately. DO NOT HOLD YOUR BILL BEYOND THE DUE DATE WAITING TO HEAR FROM YOUR DEPARTMENT.
- You may arrange a deferred payment with Accounts Receivable if you can't pay the bill in full by the due date.

Registration

To be enrolled, students are required to register each semester during the dates specified in the University Academic Calendar. Enrollment requires selecting classes, verifying course data, acquiring the combined billing statement, and making the applicable payment by the due date. Registration is confirmed when the billing statement is processed by the Cashiers' office. Distance Learning students register through Sponsored Educational Programs.

Although every effort is made to ensure that the Time Schedule Booklet is accurate at the time of printing, unforeseen circumstances or low enrollments may cause the cancellation of some section(s) or course(s). Michigan Tech also reserves the right to change the days, times, rooms, and/or instructors of section(s) or course(s) as deemed necessary.

Registration Changes

Dropping and adding credits may impact your bill. Changes to your registration should be made by the second Wednesday of the semester and, subject to the allowable maximum, students may make the following changes in their schedules: adding or dropping classes, changing credits on variable-credit courses, section changes, pass-fail versus letter-grade option changes, and audit versus letter-grade option changes.

Students may drop courses through the end of the third week of a semester without a grade being reported. From the beginning of the fourth week through the end of the eighth week of a semester, courses dropped will be indicated by a grade of W (late drop) on the transcript.

Full-Time Status

All graduate students, including Distance Learning students, who are using University services must be enrolled for at least one course or at least one credit of graduate

research. Graduate students supported by teaching, research, or administrative assistantships or by fellowships must be registered as full-time students and must complete a certain number of credit hours each term in which they receive support (further information for students on assistantships). Full-time enrollment may also be required by insurance companies, your lending institution, and/or the Immigration and Naturalization Service.

A graduate student is considered full time during the academic year for all support, visa, and financial aid purposes if s/he enrolled for 9 or more credits (credits may be of any type: coursework or research, audit or graded, undergraduate or graduate, any department including PE). A student is considered half-time if s/he is enrolled for 5-8 credits. Before you sign up for fewer credits, be sure you're not jeopardizing your visa status, loans, fellowships, insurance, your department standing, and so on.

(Recent changes noted by brown text)

A student taking fewer than 9 credits is considered full time at Michigan Tech if any **one** of the following applies:

1. Student is enrolled in a course that carries full-time status regardless of the number of credits, e.g., co-op (UN5000). For a list of these courses click here;
2. Last term (completion) has been certified:
    a. **Must be recorded with GSO by the end of the previous term.**
    b. M4/D5 has been filed
    c. Advisor affirms in writing that student will complete the degree during the term.
    d. Students who have certified a "Documented Final Term" but do not complete the degree in that term must back-enroll for additional credits to bring their total to 9 if they were required to be full time for support, visa, or financial aid purposes. Source of original support will be billed (self, project, department).
3. Full time (progress) has been certified:
    a. **To be used ONLY when circumstances dictate dropping to below 9 credits following the last official drop/add day AND when advisor does not recommend replacing the dropped credits with a different COURSE.** (Adding additional research credits to maintain full-time status is not necessary.)
    b. Student must consult with advisor about decision to drop credits.

c. Advisor must affirm in writing that student is making adequate progress to degree.
d. Must be recorded with GSO in a timely fashion, generally prior to the actual change in registration

4. Student is dual-enrolled for credits at Tech and an affiliated university and (1) the total credit enrollment equals or exceeds 9 credits, or (2) the student meets criteria 2 [last term] above. An affiliated university is one with whom MTU has a formal written agreement for exchange and/or dual enrollment of students. Enrollment at the affiliated university must be documented through the student's home department at Michigan Tech and the Graduate School.

Summer term enrollment of 1 credit of research or one course is considered full time.

Graduate students supported by teaching, research, or administrative assistantships or by fellowships must be registered as full-time students and must complete a certain number of credit hours each term in which they receive support. In both master's and doctoral programs, research credits may, but need not, be included for the purpose of determining whether the minimum criteria have been met.

Continuous Enrollment

Having begun a graduate program, students must be enrolled every fall and spring semester until they complete the degree. "Completing" a degree means turning in ALL THE PAPERWORK as well as the REVISED AND EDITED report, thesis, or dissertation. In general, graduate students are not required to register for summer term in order to fulfill the continuous enrollment policy. However, those graduate students who have summer financial support, who are completing their degree during summer term, or who are using University facilities or faculty time must register for summer term.

Also, students must be enrolled for one full credit the term of their final oral examination. Students who defend, but are not able to complete corrections must be enrolled each fall and spring term until all revisions are approved and the paperwork is turned in. Students turning in paperwork during summer must be enrolled summer term as well. In all cases, if a student must be enrolled during terms following the defense term, **and is no longer on campus**, enrollment in UN5952 is sufficient.

Continuous enrollment may be satisfied by being enrolled in

- regular course(s)
- research credits

- Co-op
- UN5951, UN5952, or UN5953, as appropriate.

If a non-summer term is missed and a waiver of continuous enrollment was not granted by the Graduate School office, the student becomes inactive. Students who become inactive must apply for readmission and pay the continuous enrollment fee for each semester missed before returning to active status.

Waiver of Continuous Enrollment

A waiver of continuous enrollment status will remain available only for those students who for demonstrable extenuating circumstances will be making NO progress to degree during a given term. Waivers will be strictly limited to one term except in the most serious of situations. All waivers must be approved by the Dean of the Graduate School.

The “no progress” designation means NO use of campus facilities (e-mail, library, labs, computers, etc.) and NO use of faculty time.

Continuous Enrollment Courses

UN5951: Graduate Status - Maintenance of Continuous Enrollment

00 credits (fee only, $100)

1. Meets continuous enrollment requirement for graduate students needing "time out" for special circumstances and for programs with inactive terms
2. No access to advisor's time or campus facilities
3. Enrollment includes e-mail and library privileges

UN5952: Report, Thesis, Dissertation - Independent Writing & Revision

.25 credits (billed at regular tuition rate)

1. Meets continuous enrollment requirement for graduate students engaged in writing report, thesis, or dissertation
2. Open only to students who have completed all course and credit requirements
3. Limited access to advisor's time
4. No access to labs and other campus facilities
5. Enrollment includes e-mail and library privileges
6. NOTE: This course differentiates between students who are not engaging the advisor’s time (UN5951) and those who are (UN5952). Because the advisor must

grant permission to register, all involved will understand that the student is actively involved in writing the report/thesis/dissertation and will be making limited demands on the advisor's time. (At the standard 1 cr. = 1 hour contact, .25 cr. comes out to about 1 hour / month.)

UN5953: Terminal Graduate Registration

.75-1.0 variable credits (billed at regular tuition rates)

1. Meets defense-term enrollment requirement for graduate students defending report, thesis or dissertation
2. Open only to students returning from enrollment in UN 5951/5952
3. Allows decision late in the term to defend and complete
4. Late enrollment after the billing due date carries standard late fee; no waivers granted
5. Variable credit assigned to bring total term enrollment to minimum 1.0 credits
6. Computer lab access is not included; if campus computing facilities are necessary for post-defense revision, the BCF will need to be paid as well.

Readmission

Any University graduate student whose enrollment is interrupted for one or more non-summer semesters or who has been dismissed or requested to withdraw must apply for readmission. The application for readmission should be submitted well in advance of the beginning of the term in which the student wishes to resume his or her degree program.

Students returning after failing to maintain continuous enrollment must

1. apply for readmission and have the application approved
2. pay a readmission fee equivalent to the cost of having maintained continuous enrollment, calculated at the total cost of enrolling in UN5951 each non-summer term the student has not been active. This fee may not be waived.

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Paperwork that Must be on File in the Graduate School

Please be sure your graduate school file contains an official final transcript from your previous college and your signed, witnessed "Patent, Research, and Proprietary Rights Agreement," which is available on the Web at http://www.admin.mtu.edu/rgs/graduate/KeepingOnTrackForms/PatentFormt.pdf.

If your final transcripts do not include degree granted, then an official proof-of-degree is also required. Transcripts are not considered official unless they are sent directly to the Graduate School by the degree-granting institution or are received in a stamped, sealed envelope issued by the institution. MTU graduates do not have to request or pay for their transcripts—the GSO has access to them.

Various forms are used to inform the GSO of your progress through your degree program. They also serve as a kind of work contract between you and your advisor/committee, confirming that you're on the right track. These forms are on the Web at http://www.admin.mtu.edu/rgs/graduate/trackingforms.html. They should be filed in a timely fashion per instructions on each form and/or the timeline to your degree found in the degree requirements. There is also a summary of when forms are due at http://www.admin.mtu.edu/rgs/graduate/KeepingOnTrackForms/SubmissionSchedule.pdf.

Contact Us

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Fax: 906.487.2463
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Transfer and Sr. Rule Credits

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Transfer Credits

A limited number of course credits taken as a graduate student at other colleges or universities may be accepted for graduate credit at MTU. If these credits were taken before enrollment at MTU, a request for transfer credit should be made during the student's first term on campus. Transfer of credits taken after enrollment at MTU must be approved in advance of course registration. Courses intended primarily for undergraduates and courses used toward a prior degree are not transferable. The number of credits accepted depends on an evaluation by the major department and the dean of the Graduate School. In no case may the total number of transfer credits exceed 1/3 of the required non-research course credits. Link to Transfer approval request form.

Special agreements regulate the transfer of credits among Michigan graduate schools and the use of credits taken prior to completion of an undergraduate degree at MTU and at Northland College.

- Michigan Intercollegiate Graduate Studies (MIGS) Program
- Senior Rule
- Northland College Graduate Credit Option

MIGS

Graduate Students who are in good standing in a degree program are eligible to elect courses at several graduate schools in Michigan with the approval of both Host and Home faculty. This program for guest scholars enables graduate students to take advantage of unique educational opportunities throughout the state. Contact the MTU Graduate School office for a list of participating Universities and MIGS liaison officers.

Procedures:

1. The Student and Academic Advisor decide if the course(s) are appropriate to the program of study and are not available at the Home University (MTU).
2. The advisor discusses the plan with appropriate faculty members at the Host University.
3. The Host department is consulted to ensure that space is available for enrollment.

4. MIGS application is filled out, and returned with the Academic Advisor's signature to the MTU Graduate School office.
5. Signature from Liaison Officer (Nancy Byers-Sprague) is obtained and the application is forwarded to the Host University for completion.
6. Once the admission has been approved by the Host Department, the MIGS Liaison Officer at the Host University issues admissions documents, registration instructions, and forwards a copy of the letter to the MTU Graduate School.
7. After completing the course(s), the student is responsible for arranging to have two (2) official transcripts sent to the MTU Graduate School.
8. The student should also contact that office to indicate that a transcript isbeing sent for posting on the academic record as MIGS graduate credit.

Fees: Students on a MIGS enrollment pay tuition and other fees normally charged by the Host University for the services rendered.

Residency Status: It is the same as at the Home University.

Credit: All credit earned under a MIGS enrollment will be accepted by a student's Home University as if offered by that University.

Grades: Grades earned in MIGS courses will be applied toward the Home University grade point average.

Part-Time: A student may combine a part-time enrollment at the Home University with a part-time MIGS enrollment with approval if the student's academic advisor.

Fellowships: MIGS participation does not necessarily modify fellowship commitments made by a Home University for a given period. Therefore, specific arrangements for individual cases should be negotiated with the appropriate officials.

Enrollments: Enrollments are limited to six (6) credit hours for master's or specialist degree students or nine (9) credit hours for doctoral degree students.

Transcripts: The student is responsible for arranging to have transcripts certifying completion of work under a MIGS enrollment forwarded to the Home University.

Senior Rule

An MTU senior with a satisfactory undergraduate record may apply for permission to take courses for graduate credit while completing the bachelor's degree requirements. Permission to take classes should be obtained from the chair of the major undergraduate department and the chair of the prospective graduate department. A student so enrolled and carrying 6 credits or more in 5000- or 6000-level courses may carry no more than 16 credits of course work per semester.

After the Senior Rule form has been submitted and approved, senior rule students may elect to have these credits appear on their graduate transcripts and be applied toward an advanced degree, in which case the designated credits will not be used to calculate the undergraduate GPA. This decision is irrevocable and must be made prior to the awarding of the undergraduate degree. The accumulation of senior rule credits does not constitute admission to a graduate program. The student must officially apply for admission to the Graduate School. If the student is admitted to a graduate program at MTU, these courses may be used on the graduate degree schedule provided the normal degree schedule approvals are obtained.

Northland College – Graduate Credit Option

An agreement between Michigan Tech and Northland College allows students at Northland to use up to twelve credits obtained while enrolled at Northland College towards a graduate degree at Michigan Technological University. Details of the Graduate Credit Option are here.

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Quarter to Semester Conversion

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Quarter to Semester Conversion Master's Program Requirements*	Master of Science			Master of Engineering
	Plan A	Plan B	Plan C	
	Course Work and Thesis	Course Work and Report	Course Work	Course Work and Practicum
	Q/S	Q/S	Q/S	Q/S
Min. coursework credits (total)	30/20	36/24	45/30	39/26
Min grad (5000-level) credits	18/12	18/12	27/18	21/12
Max undergrad (4000-level) credits	18/12	18/12	18/12	21/14
Practicum credits	—	—	—	3–6/2–4
Research credits†	9–15/6–10	3–9/2–6	—	—
Minimum total credits	45/30	45/30	45/30	45/30

*Semester credits apply to degrees completed after August 28, 2000.

†Research credits may also be used as continuous enrollment credits for those who leave before completing their degrees.

As always, departments can have special, more-stringent requirements, so check with your department coordinator before completing your M4 degree schedule. Departments may require more credits, may limit your out-of-department credits, may require specific courses, and so on.

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Good Standing & Grading Policy

Good Standing

In order to remain in good standing, you must maintain an overall 3.0 GPA for all graded courses taken while a graduate student. In addition, students are expected to consistently receive a grade of "P" (progress) in research credits. Students whose overall graduate GPA falls below 3.0 or who receive a grade of "Q" (unsatisfactory) in research credits will be sent a notification of academic probation. After receiving this notification, graduate students must meet with their advisor and/or graduate program director as soon as possible to plan a course of action for resolving the situation.

All courses used on your degree schedule must be graded, that is not pass/fail, audit, or satisfactory/unsatisfactory.

All courses used on your degree schedule must have B or better grades. However, at your department's discretion, 6 credits of BC/C grades may be used toward your degree if they are not in your major department.

Grades in courses that are not on your degree schedule will not affect your standing except as they affect your overall GPA. Graduate students are allowed to repeat courses in which they have received less than a "B." The old grade stays on the academic record, but is exempted from computation of the overall GPA.

Courses which are needed for background or breadth but will not be used on the degree schedule may be audited or taken pass/fail so as not to affect GPA.

Grading Policies

Grades are assigned in accordance with University procedures. A grade of A, AB, or B must be obtained in each course used for credit toward a graduate degree with the exception that a total of 6 credits taken in cognate departments may carry a grade of BC or C, if approved by the chair of the major department. Graduate students must maintain a minimum 3.0 cumulative GPA in all course work taken while in graduate status.

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Grading System & Grade Points

The grades awarded by the University are:

A	Excellent	4.00 grade points/credit
AB	Very good	3.50 grade points/credit
B	Good	3.00 grade points/credit
BC	Above average	2.50 grade points/credit
C	Average	2.00 grade points/credit
CD	Below average	1.50 grade points/credit
D	Inferior	1.00 grade points/credit
F	Failure	0.00 grade points/credit
I	Incomplete (no grade points per credit)—Given only when a student is unable to complete a segment of the course because of circumstances beyond the student's control. It must be made up by the close of the next three semesters in residence or the incomplete grade becomes a failure (F). An I grade may be given only when approved in writing by the department chair. At graduation, an I grade is considered an F grade in computing the final GPA.	
X	Condition (no grade points per credit)—Given only when the student is at fault in failing to complete a segment of a course, but in the judgment of the instructor does not need to repeat the course. The X grade becomes a failure (F) if it is not made up within the next semester in residence. An X grade is computed into the GPA as an F.	
M	Missing grade—See instructor for clarification.	
W	Late Drop (no credit, no grade points)—From the beginning of the fourth week through the end of the eighth week of a term, course drops will be indicated by a grade of W on a student's transcript. For the remainder of a term, special late drops for graduate students (also indicated by a W) will only be issued by the dean of the Graduate School to correct errors in registration or events of catastrophic impact beyond a student's control, such as serious personal illness, serious accidents, emergency hospitalization, and so on.	

N	No grade (no credit, no grade points)—Given when a student officially withdraws from the University after the regular drop period, passing the subject. In these cases, the registrar notifies the instructor that the student has withdrawn from the University and should receive an N grade if passing as of the date of withdrawal. The student's grade form will come to the instructor at the end of the course in the normal manner. The instructor will enter the appropriate grade, N or F, thus notifying the registrar.
P	Progress—(no credit, no grade points) Should be used with 5000- or 6000-level research courses where projects carry over for more than one semester. May also be used for approved 3000- or 4000-level project courses.
Q	Inadequate Progress (no credit, no grade points)—Should be used with 5000- or 6000-level research courses where projects carry over for more than one semester. May also be used for approved 3000- or 4000-level project courses.
Cr	Credit—Given by advanced placement or examination.
S	Satisfactory (credit given, no grade points)—Given for courses taken under the Pass-Fail option. A grade of S is given for performance equal to a letter grade of A, AB, B, BC, or C. Also indicates successful completion of research courses as evidenced by a successful defense of report, thesis, or dissertation.
E	Effort Unsatisfactory (no credit, no grade points)—Given for courses taken under the Pass-Fail option. A grade of E is given for performance equal to a letter grade of CD, D, or F.
Note: Audit Option—Courses are typically taken for audit by students wishing to refamiliarize themselves with the material. A course taken as an audit may be taken at a later date for credit subject to the approval of the student's committee. Changes to audit option must be approved by the instructor. Be certain to find out what the instructor requires of you in an audit; it often is more than simply sitting in class.	
V	Satisfactory audit (no grade points or credit)—Given for courses taken under the audit option.
U	Unsatisfactory audit (no grade points or credit)—Given for courses taken under the audit option.

Grade Reports & Transcripts

Students may access their semester-end grades through the Office of Records and Registration Website http://www.admin.mtu.edu/em/. Follow the “Student” tab. Access to the Website requires that the student provide both an ID number and a PIN number. Grades are mailed to the student only upon request.

Disputed Grades

A student having an error in a final course grade should contact the instructor and the registrar as soon as possible but no later than one month after the beginning of the next semester. Graded student work (exams, papers, homework, and so on,) that has not been returned to the student should be retained by the instructor of record for at least one month after the beginning of the next semester or until existing disputes have been resolved.

Official Transcripts

Students or alumni may request official transcripts of their academic records from the Office of Student Records and Registration at no charge. Write a brief letter and fax it to 906-487-3343 or mail it to

Office of Student Records and Registration
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295

The letter must include the exact address where each transcript should be sent and also contain your

- Full name and any former names
- Social Security Number (for verification purposes only)
- Graduation date or the year you last attended MTU
- Address and telephone number
- Signature

Unofficial Transcripts

Unofficial transcripts are available through the Office of Student Records and Registration Website at http://www.admin.mtu.edu/em/. (Follow the Students tab.)

Dear _____,

The Office of Student Records & Registration calculates each student's Grade Point Average (GPA) at the end of each term. According to their records, your overall graduate GPA following the posting of _____ term grades is __XXX___. Because your GPA is below 3.0, you have been placed on academic probation under the terms of the following Graduate School policy:
In order to remain in good standing, you must maintain an overall 3.0 GPA for all courses taken while a graduate student. Students whose overall graduate GPA falls below 3.0 are placed on academic probation.

Graduate students receiving any kind of financial assistance are required to maintain, at the end of each term, a cumulative Grade Point Average (GPA) of at least 3.0. Failure to do so will result in the student being placed on academic probation and may result in the loss of funding. After receiving notification of probation, graduate students must meet with their graduate program director as soon as possible to plan a course of action for resolving the situation.

I have notified your advisor and/or program director of your status, but it is your responsibility to make an appointment to meet with her/him as soon as possible to discuss this matter. There are several possibilities you need to consider.

If you believe the calculation is in error, your program director can help you determine whether or not it is correct; if it is not, s/he can help you get it corrected.

If your GPA is temporarily below 3.0 because you have received an 'X' grade, you need to discuss your plans for completing the course(s) with your advisor and the instructor of the course(s).

If your GPA is temporarily below 3.0 because you received an 'I' long enough ago that it has rolled over to an 'F', you need to discuss your plans for completing the course(s) with your advisor and the instructor of the course(s).

If your GPA has fallen below 3.0 because of grades other than these, you should work with your program director and/or your advisor to develop a plan for improving your GPA and returning to good standing. Please remember that courses in which you receive a grade lower than "B" (B/C, C, D, F) may not be counted toward your degree without special permission of your department and thus should probably not be used on your degree schedule. You may, however, retake any course in which you receive a grade lower than "B".

If you have questions, you may contact me at 7-2813 or at mjvogler@mtu.edu. We want to do whatever we can to assist you in being successful in your degree program.

Sincerely,

Dr. Marilyn Vogler
Assistant Dean of the Graduate School

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Dismissal, Change of Status, and Grievance

- Failure to Meet Academic Standards and/or Make Progress to Degree
- Conduct Violations

If for any reason the faculty concludes that a student is not meeting the expected academic and/or progress standards, the Dean of the Graduate School, on the advice of the student's Advisory Committee and the Department Chairperson, may require the student to withdraw. The following procedure will be followed:

Dismissal—The Advisory Committee meets with the student and provides the student with the reasons which indicate, in their professional judgment, that progress in course work, research, or other requirements has not been satisfactory and that completion of the degree program is not likely. The student is given one week to reply orally or in writing. The Committee evaluates the student's reply and subsequently forwards a written recommendation to the Department Chairperson with a copy going to the student.

Having heard the student's reply, the Committee must file a recommendation whether it subsequently determines dismissal or change of status is warranted or not.

Change of Status—In lieu of dismissal of a doctoral student, the Committee may recommend transfer to the MS program if they judge that the student is likely to successfully complete that degree program. In this case, a written recommendation for a change of status is sent to the Department Chairperson with a copy to the student.

If the recommendation is for dismissal or change of status, the Department Chairperson evaluates the Advisory Committee's recommendation and discusses the recommendation with the student. If the Department Chairperson agrees with the recommendation and is satisfied that the student understands the basis for the recommendation and has had an opportunity to reply, a letter recommending dismissal or change of status is sent to the Dean of the Graduate School, together with the supporting documentation.

If the Dean of the Graduate School is satisfied that there is a basis for dismissal or change of status and that the student has been afforded due process, the Dean writes a letter to the student on behalf of the University terminating or changing the student's status in the

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Graduate School.

Grievance Procedures Following Dismissal or Change of Academic Status

Following receipt of a letter of dismissal or change of status from the Dean of the Graduate School, the student has two weeks to appeal the dismissal. If the student wishes to appeal, the student should write a letter to the dean explaining the specific reasons for reinstatement. The dean will review the case and notify the student of the disposition of the case. In general, reinstatement will be granted only in cases where either the intent of the procedure was not followed or where there are additional, extenuating circumstances that affected the student's performance and were unknown at the time of the initial recommendation to the Dean of the Graduate School.

Conduct Violations—Graduate students are held to the same ethical and conduct standards as all Michigan Tech students. Conduct violations under the Code of Community Conduct or Academic Integrity Policy will be handled in accordance with these respective policies and procedures, including notification by Student Judicial Affairs of disciplinary sanctions, requirements, and conditions.

In cases involving suspension, expulsion for conduct violations under the Code of Community Conduct or Academic Integrity Policy through the Dean of Students/Office of Student Judicial Affairs, the student shall follow the appeal procedures set forth in the Code of Community Conduct or Academic Integrity Policy, whichever is applicable.

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Extenuating Circumstances

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Late Drops / Withdrawal

Courses dropped and withdrawals processed between the beginning of the fourth week and the end of the eighth week of the semester will be indicated by a grade of W on the transcript. After the end of the eighth week of the semester W grades will not be given without the approval of a late drop request. A graduate student may request a late drop and/or late withdrawal from the Graduate School office, which will consider those requests that involve circumstances beyond the student's control.

University Withdrawal

If you terminate your course work during the semester, it is important that you be formally withdrawn. A form for withdrawal is available in the Office of Student Records and Registration or from the Assistant Dean of the Graduate School. Letting the Graduate School know of your plans before the fact helps ensure a smooth withdrawal-readmission process. You may do this in person, over the phone, through the mail or by fax or e-mail.

Failure to withdraw formally may result in "F" grades and in payment of tuition and fees which otherwise might be avoided. Students supported by an assistantship, must notify their department and/or advisor of their decision to withdraw as early as possible. Students who plan to return at a later time to complete the degree should register for one of the continuous enrollment courses (UN5951 or UN5952) to replace the dropped credits. Students may continue to enroll in UN5951 or UN5952 without special permission other than the standard instructor's permission for enrolling in the course. Enrollment will not be automatic, but must be initiated by the student.

A student who drops all classes and does not register for a continuous enrollment course will be withdrawn from school as of the date classes were dropped and will have to apply for readmission before returning to the graduate program.

Medical Withdrawal of Graduate Students

Medical Withdrawal is an umbrella term covering all cases in which a graduate student steps out of "progress" enrollment in a course of study during or between terms for medical reasons. There will be no distinction made in the student's record between

mental and physical illness or between cases initiated by the University and cases initiated by the student. Neither is there a distinction in the procedures for withdrawal or eventual return to study.

A written request for approval of medical withdrawal is to be prepared and forwarded to the Assistant Dean of the Graduate School. The request should cite the reason for the request, documentation from a physician and/or MTU's Counseling Services as to the necessity of the withdrawal, and signatures from the student's advisor and/or graduate coordinator that s/he is aware of the request. The advisor's signature is an indication only of awareness, not of approval or disapproval. Approval or disapproval of the request lies with the Assistant Dean of the Graduate School, who may consult with the Dean of the Graduate School, with right of appeal to the Dean of Students.

Upon approval of the request by the Assistant Dean of the Graduate School, all research, coursework, or co-op credits in which a student is currently enrolled will be dropped without penalty. The student will be enrolled in UN5951 for the current term at no additional expense and will thus remain on active status for the remainder of the term in which the medical withdrawal took place. The student may continue to enroll in UN5951 without special permission other than the standard instructor's permission for enrolling in the course. Enrollment will not be automatic, but must be initiated by the student.

Before the student may return to "progress" enrollment (a "progress" continuing enrollment course, co-op, coursework, or research credits) documentation from a physician verifying that the student is safely able to return to campus will be required. A written request to return to progress enrollment should be forwarded to the Assistant Dean of the Graduate School at least two weeks before the beginning of the term in which the student wishes to return. The physician's documentation must be sent directly to the Assistant Dean, who will consult with appropriate campus offices and persons before granting the student permission to enroll.

Late Drop Request Procedure

In order to have a request for a late drop approved, you must have clearly extenuating circumstances that prohibit you from completing a course.

1. You must make a written request to the Assistant Dean of the Graduate School explaining the circumstances necessitating a late drop. As well as justification for the late drop, your written request must include your name, student identification number, and the course(s) you wish to drop. After reviewing your request, the assistant dean will schedule an appointment to meet with you.

2. In the meeting, the assistant dean will request documentation to substantiate the extenuating circumstance. It could include, for example, hospital or doctor receipts, the recommendation of the instructor of the course to be dropped, or the recommendation of a counselor from Counseling Services.
3. The day after the meeting, you must check back to learn the preliminary decision. If preliminary approval is given, you will receive two “Comment Slips”—one for the instructor of the class and one for your academic advisor.
4. The two comment slips must be returned to the Graduate School office. Some faculty will send them through campus mail; others will give them to you to return.
5. A final decision will be made after both comment slips are returned. If final approval is granted, a grade of “W” will appear on your grade report and transcript.

Last Updated: 01-Jul-2005

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Questions?

Contact Us

The Graduate School
1400 Townsend Drive
Houghton, Michigan 49931
Phone: 906.487.2327
Fax: 906.487.2463
e-mail: MTU Grad School

Graduation, Degree Certification & Commencement

A help sheet with procedures, dates, and deadlines for the current term can be found at http://www.admin.mtu.edu/rgs/graduate/pubs.html.

Graduation

You must remain enrolled until the end of the semester in which you complete all degree requirements. You graduate in a given semester if you have completed all degree requirements, including grade changes, before the first day of the next semester. You won't officially graduate, however, until the end of the term, so your degree won't be on your transcript until approximately the fourth week of the next term. Your diploma will be mailed to you about 90 days after the end of your graduation term.

Degree Certification

Provisional Certification

The Graduate School will issue a letter of Provisional Certification if requested by the student. The student must have completed all the requirements for an advanced degree, including depositing copies of the thesis, dissertation, or report in the Graduate School office.

Official Certification

The Graduate School office authorizes and mails the diplomas within approximately 90 days of the end of the term in which the student finishes. It is important to keep the Graduate School informed of current addresses. A replacement diploma costs $35.

The Board of Control receives and approves the list of degree recipients at its next regular meeting after the end of the term. That meeting date is the conferral date for the degrees, but the effective date is the end of the term in which the student finishes.

Commencement Ceremony

Michigan Tech has commencement at the end of fall and spring semesters. Commencement information is mailed to all eligible students about two months before the ceremony, generally in mid-March and early October. Any graduate student is eligible to participate in the nearest UPCOMING commencement if

(1) The student's advisor has signed the "Request to Participate in Commencement Prior to Final Submission of Documents" affirming his/her confidence that the student will defend, correct and submit to the Graduate School, their thesis/report/dissertation and all final paperwork prior to the official end date of the FOLLOWING semester.

(2) The Graduate School receives this form with the advisor's signature prior to the process that initiates printing of commencement materials (about one month before commencement).

You may also defer participation to a later commencement by notifying the GSO via the LAM form or via phone or e-mail.

Please confirm your commencement plans with the GSO at the beginning of the term in which you intend to participate in commencement. Students who leave campus before commencement should keep the Graduate School office informed of their commencement plans and their current address.

Your name will appear in only one commencement program, either the commencement for which you are first eligible, or a later one if deferral is requested in a timely manner.

Last Updated: 01-Jul-2005

Members of the Graduate Faculty

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A

Duane L. Abata

Adjunct Graduate Faculty

Dean of Engineering and Technology, Northern Arizona University

PhD, University of Wisconsin-Madison

Engines, combustion, engine dynamics

John H. Adler (jhadler@mtu.edu)

Chair and Professor of Biological Sciences

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Structure-function interactions of lipids, particularly sterols and steroids, as hormones, components of biological membranes, and as defense compounds in higher plants, algae, and fungi

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German and Austrian literature from 1880 to the present, critical theory, intercultural communication, humanities research methods, rhetoric of difference, exile studies, Thomas Mann

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General physics

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Soil compaction, cold weather construction, computer methods, dynamic properties of soils, aggregate properties,

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Capillary flow, interfacial transport phenomena, fuel cells, phase-change heat transfer, microgravity fluid physics

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Continuum mechanics, applied math, composite materials, novel theories in elasticity, Upper Bound Analysis

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PhD, University of North Dakota, Grand Forks

Psychology and law (eyewitness memory, credibility assessment, field sobriety testing); normative parent/child

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Heat transfer, thermodynamics, I.C. engines, torque converters, cavitation, wireless telemetry

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B

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Aquatic resources

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Signal transduction in the musculoskeletal system

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Experimental vibration of noise and vibration with an emphasis on development of specialized digital signal processing solutions

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Photochemical and free radical reactions (abiotic and biotic) in the environment including the role of metals and metal-organic complexes in these processes, development of molecular probes to examine these processes in both biological and environmental systems, interfacial reactions and redox chemistry in natural waters, optical properties and the remote sensing of seawater constituents

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Survey and marketing research, branding (especially in Estonia), student satisfaction and student performance

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Biochemistry and molecular biology of proteins; structure and function of nitrate reductase utilizing recombinant expression systems and site-directed mutagenesis; lignin-specific O-methyltransferases from woody species

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Polymer solutions, polymer phase transitions, polymer membranes, polymer reaction engineering, polymer foams, mathematical modeling, block copolymers, polymer reactive processing, paints and coatings

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Heterogeneous nucleation of ice, physics and chemistry of thin films, physics and chemistry of aerosol particles/ cloud condensation nuclei

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General area of pathogenic infectious microbiology with research projects relating to microbial toxic production, synergistic interactions between pathogens, and the host immune response to infection

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Operating systems, languages and compilers for parallel and distributed computers

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Landscape ecology, ecological modeling, forest microclimate, ecosystem analysis, conservation biology

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Supercritical fluid extraction, electroanalytical

chemistry, process analytical chemistry

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Wireless ad hoc networks & sensor networks, cross-layer network design, wireless network security,

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Visiting Assistant Professor, School of Forest Resources & Environmental Science

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Wetland ecology, ecosystem ecology, global change biology, restoration ecology

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Automotive safety

Khashruzzaman Choudhury

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Development of bioactive ceramic materials and their processing and evaluation from a materials science and a biological perspective

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Plant-wide control, process modeling, neural networks, fuzzy set control

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PhD, Queen's University, Belfast, UK

Engine performance modeling, exhaust emissions, catalyst systems, engine noise reduction

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Adjunct Associate Professor of Biological Sciences

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Autonomic regulation of human cardiovascular function; exercise, and aerospace physiology

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Social context and writing, writing pedagogy, post-modern theory, technical communication

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Adjunct Prof. of Chemical Engineering;

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Solid-state structure and point defect chemistry; Raman spectroscopy; EXAFS and XANES; battery electrode structure, esp. nickel electrodes

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Adjunct Graduate Faculty

Phd, Louisiana State University

Assistant Professor of Mechanical Engineering, Southern University and A&M College

Advanced engineering materials research including modeling material behavior, microstructural and property characterization & performance study; engineering education

Thomas R. Crow

Adjunct Professor of Forestry

US Forest Service, Rhinelander, Wisconsin

PhD, University of Minnesota

Old-growth forest ecosystems, landscape ecology, ecosystem management, biological biodiversity

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Herbert H. Dow Chair for Chemical Process Safety; Professor of Chemical Engineering

PhD, University of Illinois—Urbana

Chemical process safety

Allan Curran

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Vice President, ThermoAnalytics, Inc.

PhD, Stanford

Development of software that autonomously produces simulation parameters from geometric and functional descriptions of vehicle components

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Top

D

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CAPP, cost conscious planning, resourced-based manufacturability evaluation

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Industrial sociology, social change, world-system studies,
deviant behavior, sociological theory, sociology of organizations

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MS, University of Alaska Fairbanks
Volcano monitoring, eruption cloud and thermal anomalies using satellite data and ash dispersion models

Paul V. Desanker

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Landscape ecology, ecological modeling

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Civil infrastructure materials, cement and concrete

microstructure, supplementary cementitious materials, and utilization of industrial residuals

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Bone mechanics, cellular mechanotransduction, fluorescent imaging, osteoporosis, bone, metabolism in black bears

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Experimental and theoretical studies of the behavior of nonmethane organic substances in the atmosphere

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research survey approach, statistics

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Machining process modeling, cutting mechanics, machine dynamics, mechanistic modeling techniques

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G

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Composition studies, theories of visual representation, and popular culture

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Unmanned robotic vehicles, image and signal processing, target acquisition modeling and simulation

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Biotic and abiotic controls on below ground carbon allocation. Carbon cycling and storage in forests. Response of forest nutrient cycling to anthropogenic disturbances, especially fire. Plant-soil interactions and the effects of tree species on soil carbon cycling and nutrient supply

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Remote sensing of volcanoes, lava flow cooling & emplacement, strombolian activity, funarolic activity

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Protein/lipid isolation characterization, microbial physiology, microorganism isolation/characterization, bioremediation,

Thiobacillus ferrooxidans growth/physiology, applications to bioleaching

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Professor of ME-EM

DSc, New Mexico State University

Heat transfer, fluid mechanics, turbo machinery, aerocoustics, solar energy, energy conservation

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PhD, University of California-Berkeley

History and theory of rhetoric, composition studies, rhetoric of philosophy

Top

M

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Associate Professor of Remote Sensing, School of Forest Resources and Environmental Science,

Associate Professor of Computational Science & Engineering

PhD, University of Wisconsin-Madison

Remote sensing, digital image processing, aerial photography and interpretation, and geographic information systems

Gordon A. Maclean

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Remote sensing, digital image processing, geographic information systems

Carol A. Maclennan (camac@mtu.edu)

Associate Professor of Anthropology, Department of Social Sciences

PhD, University of California-Berkeley

Political ecology, anthropology of industry (mining and sugar),

Hawaii and the Pacific, Southwestern US, and democracy

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Assistant Professor of Mechanical Engineering-Engineering Mechanics

PhD, University of Illinois, Urbana-Champaign

Modeling and simulation of failure and deformation of multifunctional materials, biomimetics, multiscale analysis, dynamic fracture

Daniel G. Makagon

Adjunct Graudate Faculty

Assistant Professor, Dept of Comminication, DePaul Univ

PhD, University of South Florida

Communication, cultural studies, ethnography, audio documentary, media studies, rhetorical theory, rhetorical criticism, urban studies, community

Patrick E. Martin (pem-194@mtu.edu)

Professor of Archaeology, Department of Social Sciences

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Historical archaeology, industrial archaeology, eastern U.S. prehistory

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North American prehistory, quantitative methods, aboriginal technologies

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PhD, Purdue University

Construction engineering, linear scheduling, warranties, performance-based specifications, safety

William J. Mattson

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Chief Insect Ecologist, USDA Forest Service

PhD, University of Minnesota

Forest entomology, plant/herbivore interactions and global climate change, Nutritional and physiological ecology, and Ecology of invasive species

Laurent M. Matuana

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Wood composites, recycling (utilization of waste and recycled wood fibers and thermoplastics in the manufacture of wood fiber/plastic composites); wood adhesives, surface sciences and adhesion; wood physics and mechanics and foaming

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Professor of Geological Engineering and Sciences,

Professor of Civil and Environmental Engineering, Professor of Computational Science & Engineering

PhD, University of North Carolina-Chapel Hill

Multi-phase fluid flow and contaminant transport in porous media, experimental and computational hydrogeology. Groundwater flow and transport modeling, fate and remediation phase of non-aqueous liquids in groundwater, mathematical optimization of groundwater remediation, groundwater flow in arid regions, and waste treatment process models

Jean Mayo (jmayo@mtu.edu)

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Distributed systems, operating systems

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Low temperature alteration, clay mineralogy, mineral chemistry

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Processing of particulate and composite shapes, mechanical alloying, material/process interactions in metallic alloys, aluminum metal matrix composites

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Michigan Molecular Institute, Midland

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Chemistry

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Assessing social attitudes and values, behavior in large and small groups,

quantitative social analysis, small program outcome evaluation

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Historical archeology, industrial archeology

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Large-scale computation

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Applied microeconomics theory, game theory, public sector economics

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Computational fluid dynamics and fluid mechanics

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Biological processes, sustainability, engineering in developing world

Donald E. Mikkola (demikkol@mtu.edu)

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Structure-property-processing relationships, deformation and strengthening mechanisms, intermetallics, shape memory alloys, composites, materials characterization with diffraction and microscopy

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Grinding, precision engineering, microelectromechanical systems

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Mechanical behavior of materials

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Computer security, security protocols, reliability-fault detection and tolerance, high-performance design

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Composite materials, experimental stress analysis, nanomechanics

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International and labor economics

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Industrial engineering, metrology and computer simulation

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Electronic and photonic heterostructures, wafer-bonding, X-ray diffraction analysis

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Transients in electrical power systems, nonlinear dynamics and chaos theory, magnetic materials and saturation of transformers, computer simulation, power system protection, power quality

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Polymer rheology, melt-flow instabilities, block copolymers

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Professor, School of Forest Resources and Environmental Science

Professor of Silviculture

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Silviculture, forest soils, wetlands

Andrew Muhammad

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Assistant Professor, Department of Economics and Finance, Southern University and A&M College

Phd, University of Florida

Trade policy and theory, applied econometrics, economic impact anaylsis

and applied microeconomics

Amlan Mukherjee (amukherj@mtu.edu)

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Planning and decision making in construction management using situational simulations,

information visualization, transportation infrastructure management, simulations of complex systems,

system dynamics, expert novice cognition (especially among construction managers)

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Sol-gel processing, surface science, environmental engineering

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Mechanism of signal tranduction in living cells, metabolism of inositol

phosphates and phytic acid, biochemistry and molecular biology of

inositol phosphates metabolizing enzymes including phytases

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Combustion, alternative fuels including hydrogen, IC engines and after treatment systems

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Dislocation physics

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Silviculture, forest vegetation dynamics, tree ecophysiology

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Phase-change, condensing flows, heat transfer, fluid mechanics

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Medieval and Elizabethan literature, British fantasy literature, theater history

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Bio-heat transfer, biological effects of radio frequency radiation, human comfort and thermoregulation, heat pipe applications

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Economics of public utilities and other regulated industries, engineering economy, capital budgeting, and benefit cost studies, industrial economics, change management, operations management.

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Gamma ray busts, gravitational lensing, cosmology,

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Extractive metallurgy, hydrometallurgy, bio-processing of metals, waste management, particle separations

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Music history and criticism, role of arts in society

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Artificial intelligence, planning, reasoning under uncertainty

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Computer architecture, programming languages

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Biomass energy production, biochemical treatment processes, landfill technology,

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Clive Oppenheimer

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Volcanic gas emissions, especially sulfur dioxide

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Economics, international forestry

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Network strategies, sensemaking, decision-making, strategy-making, loosely coupled networks

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Software measurement, software engineering

Top

P

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Forest soils, long-term site productivity

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Modeling of materials

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Data-dependent systems modeling, forecasting, computer control

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Fermentation, Biotransformation Process Development at Cambrex, Molecular Biology Techniques

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Dynamics; linear and nonlinear control; robotics; flexible,

multibody dynamic modeling and control; real-time parallel processing; fault detection and isolation

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Vibrations, dynamics, finite elements

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Computer Architecture, Human-Computer Interaction, and Domain Specific Languages

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Linear and nonlinear systems and control, stochastic

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Public health, environmental data analysis, air pollution source identification, educational design

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Computational modeling of nano-electronic devices, electron transport theory, theoretical modeling of molecular self assembly, surface physics, optical and magnetic properties of nano-scale materials, spectroscopic (NQR) properties of molecular and solid state systems

Barry M. Pegg (bpegg@mtu.edu)

Associate Professor of Literature

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The literature of polar exploration: as literature, as a record of the response of cultures to terrain, and as a record of the interaction of those cultures; the relative ethical, utilitarian, and representational values of fiction and nonfiction

Karol I. Pelc (kipelc@mtu.edu)

Professor of Technology Management, School of Business and Economics

PhD (electronics), University of Uppsala, Sweden; PhD(economics), Technical University of Wroclaw

Poland Engineering management, management of innovation and technology

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Chair, Geological and Mining Engineering and Sciences

Professor of Geophysical Engineering

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Petroleum geophysics, well logging, seismology, induced seismicity

Warren F. Perger (wfp@mtu.edu)

Associate Professor of Electrical and Computer Engineering and of Physics,

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Optical and infrared properties of energetic materials, atomic theory, electromagnetics

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PhD, Swiss Federal Institute of Technology

Air & Water Quality

Matthew C. Peterson

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Weather forecasting, impacts of solar activity and geomagnetic storm on communication systems and satellites; influence of long-range transport of pollutants on the composition of the global atmosphere

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Wildlife management and ecology, animal behavior, and population dynamics

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Operations research, harvest scheduling, optimal bucking, and financial decision making

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High temperature deformation and fracture, super plasticity, computer-aided education in phase transformations/ microstructure

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Probability, statistics, optimization, operations research,

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Fracture of brittle materials, high temperature

deformation, solidification of ceramics, plasma spray processing

Mark R. Plichta (mrplich@mtu.edu)

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PhD, Michigan Technological University

Phase transformations and microstructural stability in metals and ceramics, electron microscopy

Stephen Pluhacek

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Contemporary European philosophy; ancient philosophy

Christopher N. Plummer (cplummer@mtu.edu)

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MFA, University of Illinois

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Computer science education, instruction level parallelism,

parallel computer architectures

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Combustion, sprays, engines, computational fluid dynamics, high speed photography,

alternative fuels, turbulence, and aerodynamics

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Book history and narration

Fred J. Prata

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Leader, Remote Sensing Team: CSIRO Division of Atmospheric Science

PhD, University of Oxford

Physics of atmospheric radiative transfer with specific

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Ceramic processing, behavior and characterization, wave propagation in solids, impact phenomena

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Forest ecology, landscape ecology, ecosystem science, global change, conservation and management of natural resources

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Financial economics, corporate finance, asset pricing

R

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Forest stand dynamics, growth, and yield; mathematical modeling, quantitative analysis; resource assessment

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Glacial geology, remote sensing, geographic information systems

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History of technology (general); histories of water power, the engineering profession in America, and iron mining

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Forest pathology, mycology, forest microbiology, mycorrhizae, wood decay and preservation

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Image and signal processing, atmospheric and adaptive optics, pattern recognition, remote sensing

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Volcanology, geochemistry, remote sensing, volcano/atmosphere interactions, global change

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Austempering of gray and ductile irons, microsegregation

and its effects on structure-property relationships in ductile cast irons, ausforming-austempering of ductile cast iron,

structure-property relationships in cast and heat treated alloys

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Wood engineering, composite wood material, molded wood composites, structural adhesives, construction sealants

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Interdisciplinary relations across literature, science and technology; the essay (Latin-American, French, English); literary, critical, and linguistic theory; translation and intercultural communication

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PhD, Colorado State University

Snow and ice engineering, hydrology, hydraulics of ice-covered rivers

Kimberly Anne Sawchuk

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Cultural study of science and technology with a specialization in feminist debates; new media art and its engagement with issues of biotechnology

Timothy J. Scarlett (scarlett@mtu.edu) http://www.ss.mtu.edu/people/scarlett.htm

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Historical and Industrial Archaeology; Mormons and the American Intermountain West; Ecobiography and Landscape Studies; Globalization

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Management and silviculture of northern forests and wetlands, sustainable forestry and timber harvesting systems, renewable energy

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Statistical signal and image processing, remote sensing, estimation and detection theory, electron microscopy

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Incubators, incubation process, technological development of technology-based entrepreneurial ventures, university technology transfer, biotech-pharmaceutical alliances

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Electron structure of polymers

Bruce E. Seely (bseely@mtu.edu)

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Transportation history, especially development of American highways; history of engineering and engineering education; industrial archaeology; American iron and steel industry; societal implications of nanotechnology

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Interprocessor communication algorithms, massively parallel computers, and interconnection networks

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Technical communication, rhetoric of science and technology, environmental rhetoric, feminist science studies

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Computers and their effects on writers, writing processes, and written text; the socio-political, economic, and ideological issues connected with technology use in educational settings

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Theory and practice of communication technologies and their use in English studies curricula

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Modal analysis, computer-aided engineering, kinematics

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Forest ecology, regeneration ecology of hardwoods and conifers

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Environmentally-conscious process design, optimization, environmental biotechnology, life-cycle assessment of products and processes

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Theories of visual representation, film theory, gender studies, twentieth-century French literature and cinema

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Cultural studies, communication theory, technology and culture, environment and culture, art and culture

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Computer networks, computer security

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Powder metallurgy processing, influence of porosity on mechanical and physical properties of crystalline solids

David E. Smith

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Automated planning and scheduling with emphasis on methods for dealing with time and concurrency, resources, uncertainity, and over-subscription in planning problems relevant to NASA missions

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Techno poetics, new media and technical communications, composition studies

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Risk perception & estimation, Internet learning & courseware, Applied statistical methodology

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Molecular basis for male-determination in non-Drosophila Diptera; cloning and analysis of gene-enzyme systems; transposable elements as agents in eucaryotic speciation; biochemical population genetics and systematics

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Power harvesting, vibration control, smart structures, structural health monitoring, non-contact damping

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Clinical immunology, medical parasitology, urology, body fluid analysis, clinical laboratory core concept integration and application

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PhD, Indiana University

Environmental and energy policy, global climate change

Jon A. Soper

Professor Emeritus of Electrical Engineering

PhD, University of Michigan

Applied electromagnetics, Antennas, Microwave & RF Networks

Sheryl A. Sorby (sheryl@mtu.edu)

Associate Dean of Engineering

Chair, Department of Engineering Fundamentals

Professor of Civil and Environmental Engineering

PhD, Michigan Technological University

Structural analysis, experimental stress analysis, engineering computation, engineering graphics and spatial visualization

Patricia J. Sotirin (pjsotiri@mtu.edu)

Associate Professor of Communication

PhD, Purdue University

Organizational communication, feminist studies, and qualitative methodologies

William S. Sottile II (sottilew@state.mi.us)

Adjunct Professor of Biological Sciences

PhD, University of Georgia

Clinical and Public Health Microbiology

Orhan Soykan

Adjunct Assistant Professor Biomedical Engineering and Electrical and Computer Engineering

Medtronics Inc., Minneapolis, Minnesota

PhD, Case Western Reserve

Implantable devices, biosensors, molecular medicine

Mark Spalding

Adjunct Graduate Faculty

Research Scientist, Dow Chemical Company

PhD, Purdue University

Polymer processing with special expertise in rotational equipment design

William J. Sproule, PE, (wsproule@mtu.edu)

Professor of Civil and Environmental Engineering

PhD, Michigan State University

Transportation planning, traffic engineering and safety, airport planning and design, public transit, automated people movers, hockey history

Suzanne A. Stephens (sastephe@mtu.edu)

Associate Professor of Fine Arts

PhD, Miami University, Ohio

Improvisation work in theatre and as communication aids, interpersonal communication and small group work, interpersonal exploration

Laurence G. Stevens

Adjunct Professor of Chemistry

Consultant and Retired VP, Indium Corporation

PhD, Wayne State University

Inorganic chemistry

Douglas R. Stinson

Adjunct Graduate Faculty

Professor of Computer Science, University of Waterloo, Canada

PhD, University of Waterloo

Cryptography, networks and distributed systems, algorithms and computational complexity, construction of combinatorial structures with applications in computer science and cryptography

Charles J. Stivale

Adjunct Graduate Faculty

Professor of French, Wayne State University

PhD, University of Illinois, Urbana – Champaign

Literary and cultural topics in 19th and 20th century French studies; the work of Gilles Deleuze and Felix Guattari; Cajun music and dance

Shari Stockero (stockero@mtu.edu)

Director, First Year Math, Mathematical Sciences

MA, Western Michigan University

Mathematics education, specifically the professional development of pre-service and practicing teachers

David H. Stone (dstone@mtu.edu)

Associate Professor of Electrical and Computer Engineering

PhD, Michigan State University

Lasers, photonics and wireless communication

Andrew J. Storer (storer@mtu.edu)

Associate Professor, School of Forest Resources and Environmental Science

PhD, University of Oxford, England

Forest insect ecology, insect/fungus/plant interactions, impacts of exotic species on forest ecosystems, interactions among fire, insects and diseases, urban forest health, chemical ecology

Allan A. Struthers (struther@mtu.edu)

Professor of Mathematics

PhD, Carnegie-Mellon University

Applied mathematics, continuum mechanics, nonlinear optics, solutions, constitutive theory, phase transitions

Ghatu Subhash (subhash@mtu.edu)

Professor of Mechanical Engineering

Adjunct Professor of Materials Science and Engineering

PhD, University of California-San Diego

Dynamic behavior, experimental mechanics, nanomaterials, ceramics, fracture, wave propagation

Bryan H. Suits (suits@mtu.edu)

Professor of Physics

PhD, University of Illinois

Nuclear magnetic resonance

John W. Sutherland (jwsuther@mtu.edu)

The Richard and Elizabeth Henes Chair, Professor of Mechanical Engineering

PhD, University of Illinois-Urbana/Champaign

Environmental issues in design and manufacturing, manufacturing processes and systems, quality engineering

Lawrence L. Sutter (llsutter@mtu.edu)

Associate Professor of Civil Engineering Technology

Adjunct Associate Professor of Civil and Environmental Engineering

PhD, Michigan Technological University

Materials characterization, electron microscopy, concrete and cement, industrial residual re-use

Douglas J. Swenson (dswenson@mtu.edu)

Associate Professor of Materials Science and Engineering

PhD, University of Wisconsin-Madison

Thermodynamics and phase diagram modeling, diffusion and solid-state reaction kinetics and the application of these principles to the solution of materials problems

Top

T

Jindong Tan (jitan@mtu.edu)

Assistant Professor of Electrical and Computer Engineering

PhD, Michigan State University

Computer engineering, mobile robotics

Franz X. Tanner (tanner@mtu.edu)

Associate Professor of Mathematics, Associate Professor of Computational Science & Engineering

PhD, University of Illinois at Urbana-Champaign

Applied mathematics, computational reacting multiphase flows, scientific computing, optimal control

Caroline M. Taylor (cmtaylor@mtu.edu)

Assistant Professor of Chemistry

PhD, University of Chicago

Theoretical and computational chemistry, physical chemistry, molecular dynamics simulation, electronic structure, soft condensed matter, materials science, nanoscience, biophysics

Jerry Taylor (jdtaylor@mtu.edu)

Associate Professor, School or Technology

JD, T.M. Cooley Law School

Mediation-boundary law land development law

Duane M. Thayer

Professor Emeritus/Research Professor of Materials Science & Engineering

MS, Michigan Technological University

Fine particle flotation, Fine particle characterization, Reclamation of metallurgical and chemical wastes

Martin J. Thompson (mthomps@mtu.edu)

Assistant Professor of Chemistry

PhD, Arizona State University

Biochemistry and Chemical Biology

Richard A. Thompson

Adjunct Graduate Faculty

PhD, University of Maryland

Analytical chemistry

Gerry Tian (ztian@mtu.edu)

Associate Professor of Electrical Engineering

PhD, George Mason University

Signal processing for wireless communications, ultra-wideband communications, wireless sensor networks, digital communication systems, statistical array and signal processing

Vladimir D. Tonchev (tonchev@mtu.edu)

Professor of Mathematics

DMSc, Bulgarian Academy of Sciences; PhD, University of Sofia, Bulgaria

Algorithms, computing, coding theory, cryptography, combinatorics, finite geometry

Bela Torok (bela.torok@umb.edu)

Adjunct Graduate Faculty

Faculty in Chemistry Dept., University of Massachusetts - Boston

Ph.D., Jozsef Attila University, Hungary

Catalysts for asymmetric synthesis immobilization of chiral

ligands on polymer or inorganic supports

Carl C. Trettin

Adjunct Assistant Professor of Forestry

Oak Ridge National Laboratory

PhD, North Carolina State University

Ecology and management of forested wetlands

Chung-Jui Tsai (chtsai@mtu.edu)

http://forest.mtu.edu/faculty/tsai/

http://biotech.mtu.edu

Associate Professor of Forest Biotechnology, Director of Biotechnology Research Center

PhD, Michigan Technological University

Functional genomics, metabolic engineering, phenylpropanoid

metabolism, wood formation, genetic transformation

Roger M. Turpening (roger@mtu.edu)

Research Professor of Geophysical Engineering

PhD, University of Michigan

Petroleum seismology, borehole seismology (VSP, RVSP, x-well)

Top

U

Graham Underwood

Adjunct Professor of Biological Sciences

PhD, University of Sussex, Colchester, UK

Environmental Microbiology

Ram K. Upadhyay

Adjunct Graduate Faculty

Senior Research Engineer, GE Global Research Center

PhD, Cornell University

Polymer processes - injection molding, thermoforming, extrusion and compression molding; manufacturing

processes for carbon-reinforced materials; ceramic powder injection molding; process control

Noel R. Urban, (nurban@mtu.edu)

Associate Professor of Civil and Environmental Engineering

PhD, University of Minnesota

Biogeochemistry, surface water quality, wetlands, impacts of human activities on the environment

Eugenijus Urnezius (urnezius@mtu.edu)

Assistant Professor of Chemistry

PhD, Case Western Reserve University - Cleveland, Ohio

Organometallic and inorganic chemistry, metallopolymers, ligand design, material chemistry

Donald R. Uzarski

Adjunct Graduate Faculty

Civil Engineer, U.S. Army Engineer Research and Development Center

PhD, University of Illinois

Railroad Engineering

Top

V

Madhukar Vable (mavable@mtu.edu)

Associate Professor of Engineering Mechanics

PhD, University of Michigan

Computational mechanics

James W. Vallance (james@fuego.civil.mcgill.ca)

Research Assistant Professor of Geology

PhD, Michigan Technological University

Volcanic hazards, debris flows, geomorphology, mechanics of granular materials

Thomas J. Van Dam, PE, (tvandam@mtu.edu)

Associate Professor of Civil and Environmental Engineering

PhD, University of Illinois

Pavement analysis, design, and management; transportation

materials; characterization of bituminous mixtures and cementitious mixtures

Charles D. Van Karsen (cdvankar@mtu.edu)

Associate Professor of ME-EM

MS, University of Cincinnati

Experimental vibration, structural dynamics

Chelley M. Vician (cvician@mtu.edu)

Associate Professor of Information Systems, School of

Business and Economics

PhD, University of Minnesota

Technology mediated learning, group support systems, computer mediated communication, and information systems adoption

Carl R. Vilmann, PE (crvil@mtu.edu)

Associate Professor of Engineering Mechanics

PhD, Northwestern University

Fracture mechanics and finite elements

Stanley J. Vitton, PE, (vitton@mtu.edu)

Associate Professor of Civil and Environmental Engineering

Adjunct Associate Professor of Geotechnical Engineering

PhD, University of Michigan

Geotechnical engineering, soil and rock dynamics, aggregate research, geological hazards analysis

Marilyn Jo Vogler (mjvogler@mtu.edu)

Assistant Dean of the Graduate School

PhD, Michigan Technological University

Gender and language, feminist theory, persistence in graduate education, dissertation practices

John A. Vucetich (javuceti@mtu.edu)

Research Assistant Professor of Forestry

PhD, Michigan Technological University

Demographic and genetic aspects of population biology

Leah M. Vucetich (lmvuceti@mtu.edu)

Research ASsistant Professor (School of Forest Resources and Environmental Science)

PhD, Michigan Technological University

Genetic properties of animal populations

Top

W

Craig Waddell (cwaddell@mtu.edu)

Associate Professor of Rhetoric

PhD, Rensselaer Polytechnic Institute

Examining and facilitating public participation in deliberative decision-making on such issues as environmental protection, neighborhood/community enhancement, and global poverty relief; and the relationship of the following to this end: classical rhetoric; risk communication; journalism; qualitative research methods

Christa L. Walck (cwalck@mtu.edu)
Dean, School of Business and Economics and
Professor of Organizational Behavior, School of Business and Economics
PhD, Harvard University
Organizations and the natural environment, organizational theory, cross-cultural management

Charles Wallace (wallace@mtu.edu) http://www.cs.mtu.edu/~wallace/
Assistant Professor, Computer Science
Ph.D., University of Michigan
Software engineering, requirements analysis, usability engineering, formal methods,
parallel computing, programming languages, computer science education

Hao (Howard) Wang (wangh@mtu.edu)
Assistant Professor, Materials Science and Engineering>
PhD, University of Pennsylvania
Structure and dynamics in soft materials; carbon-nanotube/polymer composites; biomimetic lipids systems; phase transformations and morphology in polymers; polymer thin films, surfaces and interfaces; scattering methods

Zhenlin Wang (zlwang@mtu.edu)
Assistant Professor, Computer Science
PhD, University of Massachusetts, Amherst
Optimizing compilers and high performance architectures

Robert O. Warrington (row@mtu.edu)
Dean of Engineering, Professor of Mechanical Engineering
PhD, Montana State University, Bozeman
Micromanufacturing, microtransport processes, laser-based micromachining, heat transfer

Melissa S. Waters
Adjunct Graduate Faculty
Associate Professor of Economics, Southern University and A&M College
PhD, Louisiana State University
Applied Econometrics, applied microeconomics, economics of houshold behavior

David W. Watkins, (dwatkins@mtu.edu) http://www.cee.mtu.edu/~dwatkins/index.html
Associate Professor of Civil and Environmental Engineering
PhD, University of Texas at Austin

Water resources planning and operations, watershed management, hydrologic statistics, decision theory

I. Matthew Watson (watson@mtu.edu)

Research Assistant Professor of Geological and Mining

Engineering and Science

PhD, Cambridge University - Cambridge, UK

Remote detection of volcanic plumes using satellite- and

ground-based multi-spectral sensors

Corey E. Weaver (cweaver3@ford.com)

Adjunct Assistant Professor, MEEM

PhD, University of Michigan Tech University

Christopher R. Webster (cwebster@mtu.edu)

Assistant Professor, School of Forest Resources and Environmental Science

PhD, University of Wisconsin

Quantitative ecology, forest management, silviculture

Robert S. Weidman (weidman@mtu.edu)

Associate Professor of Physics

PhD, University of Illinois

Electronic structures of solids

Klaus J. Weinmann (kjweinma@mtu.edu)

Professor Emeritus, Research Professor of Mechanical Engineering

PhD, University of Illinois-Urbana/Champaign

Plasticity, materials processing

Michael S. Wertheim (wertheim@mtu.edu)

Professor Emeritus of Physics

PhD, Yale University

Theory of fluids

Calvin L. White (cwhite@mtu.edu)

Professor of Materials Science and Engineering

PhD, Michigan Technological University

Interfaces, interfacial segregation, interfacial fracture, materials joining, intermetallic compounds

Dennis O. Wiitanen, PE (wiitanen@mtu.edu)

Professor of Electrical and Computer Engineering

PhD, University of Missouri-Rolla

Computer applications to power systems, distribution systems, power system modeling, properties of insulating materials

John G. Williams (jgwillia@mtu.edu)
Professor of Chemistry
Adjunct Professor of Mechanical Engineering
PhD, Melbourne University, Australia
Plastics and composites, processing science of composites, crack propagation in glass resins, relaxation properties in polymers

R. Christopher Williams (rwilliam@iastate.edu)
Adjunct Assistant Professor of Civil and Environmental Engineering
Associate Professor Department of Civil, Construction, and Environmental Engineering, Iowa State University
PhD, Purdue University
Pavement analysis, design, and management; transportation materials; characterization of materials; construction materials specifications

John A. Witter
Adjunct Professor of Forest Entomology
University of Michigan
PhD, University of Minnesota
Forest entomology and acid rain

James R. Wood Jr. (jrw@mtu.edu)
Professor of Geology
PhD, Johns Hopkins University
Geochemistry, environmental geology, diagenesis, petroleum geology

Ramakrishna Wusirka (wusirika@mtu.edu)
Assistant Professor of Biological Science
PhD, University of Pune
Molecular biology, genomics & bioinformatics

Albert S. Wylie, Jr. (aswylie@mtu.edu)
Adjunct Assistant Professor, Geological & Mining Engineering & Science
Geologist, Cabot Oil and Gas Corp
PhD, Michigan Technological University
Petroleum reservoir characterization and exploration, mineralogy, sedimentology, petrology

Anne Frances Wysocki (awysocki@mtu.edu)
Associate Professor of Visual and Digital Communication and
Director of GTI Education/Director of Writing Programs, Humanities
PhD, Michigan Technological University
Visual communication and culture, technologies of visual communication, visual rhetoric,

image/word relationships, interactivity and design

X

Zhiyong Xu (zhxu@mtu.edu)
Research Scientist, Institute of Materials Processing
PhD, Michigan Technological University
FTIR investigation of cement hydration kinetics, reuse of industrial solid wastes in concrete, microwave reactor design and application

Top

Y

Song-Lin (Jason) Yang (slyang@mtu.edu)
Professor of Mechanical Engineering-Engineering Mechanics
PhD, University of Florida
Computational fluid dynamics, heat transfer

Yoke Khin Yap (ykyap@mtu.edu) http://www,phy.mtu.edu/faculty/Yap.html
Assistant Professor of Physics
Adjunct Assistant Professor of Materials Science and Engineering
PhD, Osaka University, Japan
Experimental materials physics, nanoscience, and laser physics

William L. Yarroch (wlyarroc@mtu.edu)
Associate Professor of Education
PhD University of Wisconsin-Madison

Byeng Dong Youn (bdyoun@mtu.edU)
Assistant Professor of Mechanical Engineering-Engineering Mechanics
PhD, University of Iowa
Engineering design, reliability and quality engineering, durability (fatigue) analysis,
statistical information technology, design sensitivity analysis

Charles T. Young, PE (ctyoung@mtu.edu)
Associate Professor of Geophysics
PhD, University of Wisconsin-Madison
Exploration geophysics, electrical and electromagnetic
geophysics, geophysical signal analysis, ground-penetrating radar, environmental geophysics

Dae S. Young (dsyoung@mtu.edu)

Associate Professor of Mechanical Engineering

PhD, University of Utah

Mining engineering, rock mechanics, geostatistics

Heather Lynne Youngs (hlyoungs@mtu.edu)

Assistant Professor of Biochemistry, Biological Sciences

PhD, Oregon Health and Science University

Plant biochemistry and molecular biology, enzymology and kinetics, bioremediation

Top

Z

Seyed A. Zekavat (rezaz@mtu.edu)

Assistant Professor of Electrical Engineering

PhD, Colorado State University

Wireless communications, statistical modeling, radar systems and theory

Shuanglin Zhang (shuzhang@mtu.edu)

Assistant Professor of Mathematics

PhD, Peking University, Beijing

Bioinformatics, statistical genetics, nonparametric function estimation, wavelets

Top

Last Updated:
09-Sep-2005

Graduate Course Descriptions Effective Fall 2005

Business

BA 5200 - Information Systems
Focuses on management of IS/IT within the business environment. Topics include IT infrastructure and architecture, organizational impact of innovation, change management, and human-machine interaction. Class format includes lecture, discussion, and integrative case studies.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 1200

BA 5290 - Special Topics in IS/IT
IS/IT 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; Must be enrolled in one of the following Level(s): Graduate

BA 5300 - Accounting
This class covers the collection, reporting and analysis of financial information with emphasis on the use of that information to support decision making.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 2300

BA 5390 - Special Topics in Accounting
Accounting topics of interest to students and faulty.
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 Level(s): Graduate

BA 5400 - Finance
Explores the theory and practice of finance and capital markets. Topics include role of the financial manager and goals of the firm, financial mathematics, valuation of assets, cost of capital, project evaluation, capital structure, forecasting, financing vehicles, special topics in finance.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 3400 or EC 3400

BA 5490 - Special Topics in Finance
Finance 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; Must be enrolled in one of the following Level(s): Graduate

BA 5610 - Operations and Quality Management
Applications and case studies focusing on contemporary issues in operations and quality management to include lean manufacturing practices, ERP, quality and environmental management systems/standards, Six Sigma, statistical process control, and other current topics.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 2110

BA 5690 - Special Topics in Operations & Systems Management
Operations and systems management 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; Must be enrolled in one of the following Level(s): Graduate

BA 5700 - Management & Organizational Behavior
Discusses managing effectively within the environmental context of the organization. Topics include corporate culture, managing in a global environment, planning and strategy, organizational structure, human resources management, managing change, leadership, motivation, communication, conflict management, and teamwork.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
Pre-Requisite(s): BA 3700

BA 5710 - Business Strategy
Introduces students to a repertoire of strategies that have been found useful in the creation of competitive advantage: cost leadership, business model differentiation, vertical integration, diversification, globalization, mergers and acquisitions, tacit collusion, alliance, and flexibility-agility-adaptability strategies.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 3700

BA 5720 - Entrepreneurship I - Launching Entrepreneurial Ventures
Focuses on the development of new technology-based businesses. Topics include creativity, screening technological opportunities, analyzing markets, testing business concepts, protecting intellectual property, strategy development, entrepreneurial team selection, securing financing, and developing a business plan.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BA 5730 - Entrepreneurship II - Growing and Managing New Ventures
Focuses on growing new technology-based businesses. Topics include building an effective entrepreneurial team, ethics and social responsibility, financial planning/reporting, working capital management, growth marketing, product/process development, raising capital, managing change and development, and planning for succession.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BA 5750 - Strategic Managerial Processes
Introduces students to advanced topics in strategic change, strategy formation, and strategy implementation through a review of organization theories and processes. Course materials are applied to specific projects through individual specialized strategic management research projects.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 3700

BA 5790 - Special Topics in Management
Management 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; Must be enrolled in one of the following Level(s): Graduate

BA 5800 - Marketing
The course will provide an integrated approach to marketing management. Uses a modeling and case analysis approach to develop strategic marketing thinking.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 3800

BA 5890 - Special Topics in Marketing
Marketing 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; Must be enrolled in one of the following Level(s): Graduate

BA 5990 - Special Topics
Business topics of interest to students. Study is under the guidance of a faculty member.
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 Level(s): Graduate

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Biomedical Engineering

BE 5000 - Graduate Research
Includes the study of an acceptable biomedical engineering problem and the preparation of a report or thesis.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5100 - Cell and Tissue Mechanics
Focuses on mechanical behavior and adaptation of musculoskeletal tissues including material properties, viscoelasticity, fatigue and failure. Includes the role of mechanical forces in the development, growth and adaptation of musculoskeletal tissues; cell biology and cellular mechanotransduction.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BE 3750

BE 5300 - Advanced Polymeric Biomaterials
A specialized study of polymers used in biomedical engineering. Topics include: Processing-structure-properties relationships for polymer fibers and composites, degradation of polymers, and medical applications for composite biomaterials.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5400 - Bio-Heat and Mass Transfer
Explores principles of heat transfer and mass transfer as they relate to problems and applications in biology, medicine and related fields.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

BE 5440 - Genetic Engineering and Molecular Medicine
Molecular medicine and its applications in genetic engineering will be discussed following a quick review of genetics and cell biology as well as the human disease mechanisms. In vivo, in vitro and ex vivo treatments utilizing genetically engineered

products, allogeneic and autologous cell transplantation experiments will be discussed.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5500 - Biomedical Materials
An overview of biomaterials in three basic classes: metals, ceramics, and polymers. Topics include biomaterials used in special medical applications (such as tissue replacement, absorbable and non-absorbable sutures, and soft tissue replacements) as well as discussion of tissue, body, and blood response to implants (bio-compatibility).
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BL 2020 and BL 2021 and MY 2100

BE 5660 - Advanced Active Implants
Implantable devices which are actively delivering therapy and acting as monitoring tools will be covered. Emphasis will be on the component level design and system level integration. Each student will design an implantable device and demonstrate its feasibility with theoretical methods learned in the class. Students will also review existing designs and will reverse engineer them from patents and product brochures for presentation.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5700 - Advanced Biosensors
This course introduces the student to biosensor development and applications. It provides an understanding of biological components, immobilization techniques, transducers, and fabrication methods. In particular, microfabrication and nanofabrication techniques will be discussed.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5750 - Bioapplications of Nanotechnologies
The prospect of bioapplications of nanotechnologies, selected topics including nanodevices for biosensor and drug delivery, biocompatibility and toxicity of nanomaterials, nanostructured polymers for tissue engineering, design and operation of medical nanorobots, ethics and societal impacts of nanobiotechnology, etc.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5800 - Advanced 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 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: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5900 - Biomedical Engineering Topics
Biomedical engineering courses will be offered as professional electives dependent upon the interest of the faculty.
Credits: variable to 6.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 5940 - Introduction to Tissue Engineering
Explore the application of engineering principles toward the construction/reconstruction of human tissue. Fundamental biological principles involved in tissue engineering are reviewed from an engineering perspective with examples of engineered tissues such as blood vessels, skin, liver, cartilage and bone.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

BE 6000 - Doctoral Research
Includes the study of an acceptable biomedical engineering problem and the preparation of a report or thesis.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BE 6900 - Biomedical Engineering Topics
Biomedical engineering courses will be offered as professional electives dependent upon the interest of the faculty.
Credits: variable to 6.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Biological Sciences

BL 5030 - Molecular Biology
Molecular biology of gene structure, expression and regulation. Molecular techniques and their application to biotechnology and genomes are covered.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5040 - Electron Optical Methods of Analysis I: Principles and Techniques for Biologists
Hands-on course focusing on use of transmission electron microscopes. Topics include sample preparation for biology, transmission electron optics, specimen-beam interactions, operating parameter choices, image formation and processing. Successful completion of course is the prerequisite to becoming a certified operator, MTU Electron Optics Facility. (This is a half semester course.)
Credits: 2.0
Lec-Rec-Lab: (0-3-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5050 - Electron Optical Methods of Analysis II: Principles and Techniques for Biologists
Hands-on focusing on the use of transmission electron microscopes. Topics: sample preparation for biology, transmission electron optics, specimen-beam interactions, operating parameter choices, image formation and processing. Successful completion of course is the prerequisite to becoming a certified operator in the MTU Electron Optics Facility. (This is a half

semester course)
Credits: 2.0
Lec-Rec-Lab: (0-3-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5060 - Biological Ultrastructure
Microscopical investigations of biological specimens with transmission and scanning electron, scanning tunneling, and atomic force. Basic laboratory techniques include fixation and embedding, ultrathin sectioning, critical point drying, sputter coating. Also includes advanced cytochemical, cryo- and high-resolution techniques.
Credits: 4.0
Lec-Rec-Lab: (0-2-6)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BL 5040 or BL 5050

BL 5150 - Advanced Plant Physiology
Comprehensive study of metabolic activities and growth processes of plants. Emphasizes water relations and growth at the submicroscopic, microscopic, and macroscopic levels. Prerequisite: a course in plant physiology.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5160 - Plant Biochemistry and Molecular Biology
Biochemical principles underlying central processes unique to plants, including photosynthesis and symbiotic nitrogen fixation. Also covers fundamentals of plant molecular biology including transformation of plants and regulation of gene expression. Background required: one year of biochemistry and a course in plant physiology.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5170 - Plant Cell & Development
Cellular, molecular processes involved in plant development. In-depth study of the structure and function of the plant cell as related to plant development. Such topics as control of iterative growth, cellular basis of form, cell differentiation, competence, determination and coordination of development. Background required: course in biochemistry and in plant physiology.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5200 - 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
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BL 3210 or BL 3310

BL 5250 - Immunological Toxicology
Covers current topics in immunology and toxicology, including lymphokines, lymphocyte interactions, immune network theory,

acquired and genetic immune defects, immunization of animals, characteristics of antibodies, immunoassays, and production of monoclonal antibodies.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5340 - Special Topics in Biology
A discussion of recent developments in the biological sciences. Recent offerings have included population genetics, taxonomy of aquatic insects, herpetology, bryology, fungi, and lichens.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5350 - Special Topics in Physiology
A discussion of recent developments in physiology. Recent offerings have included respiratory physiology, renal physiology, clinical cardiology, and neurophysiology.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5360 - Special Topics in Biochemistry
A discussion of recent developments in the field of biochemistry. Topics taught recently include steroid biochemistry, immunology, and metabolic control theory.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5370 - Special Topics in Microbiology
A discussion of recent developments in the field of microbiology. Topics taught recently include bacterial genetics, industrial microbiology, and advanced microbial ecology.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5380 - Special Topics in Ecology
A discussion of recent developments in the field of ecology. Topics taught recently include systems ecology, ecology of Great Lakes fisheries, ecology of algae, aquatic macrophytes, and world ecosystems.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5390 - Special Topics in Clinical Laboratory Science
A discussion of recent developments in clinical laboratory science.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5400 - Special Topics in Plant Sciences
A discussion of recent developments in plant science. Topics may include biotechnology, physiology, systematics, phylogenetics, biochemistry, and molecular genetics.
Credits: variable to 10.0; Repeatable to a Max of 10
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5431 - Population Ecology
The distribution and abundance of organisms, including theoretical, laboratory, and field studies of factors limiting population growth. Examines biological limitations, including competition, predation, parasitism, and disease.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5451 - Aquatic Ecology
Integrated coverage of flowing and standing fresh water environments, including biological, physical, and chemical factors and their interactions. Applied aspects include biological responses to stress, fisheries, and the management of aquatic systems. Emphasizes the fundamentals of aquatic systems and fieldwork on local environments.
Credits: 4.0
Lec-Rec-Lab: (0-3-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5460 - Advanced Ecology: Ecosystems
Comparison of ecosystem structure and processes with emphasis on lakes. Stresses critical reading of recent journal literature.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5500 - Graduate Seminar in Biological Sciences
Analysis, evaluation, and synthesis of primary scientific literature on a specific topic in recitation/discussion format.
Credits: 1.0; Repeatable to a Max of 4
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5501 - Graduate Research Seminar Ecology/Environmental
Seminar is designed to facilitate critical discussions of student research projects at various stages of their development. The presenter will provide an overview or seminar on their project and research goals, which will establish the foundation for the discussion thereafter.
Credits: 1.0; May be repeated
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

BL 5520 - Satellite Limnology
Provides an overview of historical, current applications of satellite remote sensing in limnologic research, including remote sensing of lake surface temperatures and ice, application of satellite image analysis for evaluating water quality variables (e.g., suspended solids and chlorophyll), development of a new lake, ocean color algorithms, and review of satellite instrument capabilities.
Credits: 3.0
Lec-Rec-Lab: (0-2-2)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5680 - Bryology
Emphasizes the broad aspects of bryology, including physiology, ecology, development, taxonomy, and evolution with an ecological theme that is fortified with laboratory examination of structures and field identification of bryophyte species,

communities, and adaptations.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5681 - Field Bryology
A field course in the identification of mosses, liverworts and hornworts. Field trips will include various sites in the Keweenaw Peninsula. This intensive course will be taught as one week of field trips in the Keweenaw Peninsula.
Credits: 1.0
Lec-Rec-Lab: (0-0-3)
Semesters Offered: Summer
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

BL 5750 - Advanced Ecology: Communities
Discussion of factors that determine plant and animal species distribution, abundance, and diversity. Emphasis on theoretical concepts involves critical reading of recent literature.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 5990 - Masters Research in Biological Sciences
An original investigation in biology that culminates in a thesis.
Credits: variable to 15.0; Repeatable to a Max of 15; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

BL 6990 - Doctoral Research in Biological Sciences
An original investigation in theoretical or experimental biology, or both, and submission of a dissertation in partial fulfillment of the requirements for the PhD degree.
Credits: variable to 45.0; Repeatable to a Max of 45; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer

Civil & Environmental Engrg

CE 5101 - Advanced 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: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CE 3101

CE 5102 - Advanced Concrete Materials
Properties and applications of portland cement and portland cement concrete. Includes cement production, chemistry and hydration, concrete admixtures, and the properties of fresh and hardened concrete. Presents concrete microstructure and durability. Other topics include high-strength and high early-strength concrete, fiber-reinforced concrete, and advanced cement-

based materials.
Credits: 3.0
Lec-Rec-Lab: (0-2-2)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CE 3101

CE 5190 - Special Topics in Civil Engineering Materials
Advanced study of materials related topics, including discussions of recent research developments at an advanced level.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer

CE 5201 - Advanced Structural Analysis
Energy methods in structural analysis. Elastic buckling of beams, beam-columns, and frames, including numerical methods for buckling analysis. Introduction to finite element analysis, including one- and two-dimensional elements.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4201

CE 5202 - Finite Element Analysis
Introduction to the use of finite element methods in structural analysis. Covers the finite element formulation, 1- and 2-D elements, including isoparametric elements, axisymmetric analysis, plate and shell elements, dynamics, buckling, and nonlinear analysis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 4201

CE 5211 - Advanced Reinforced Concrete Design
Advanced topics in behavior of reinforced-concrete structures and relationships with element design. Code requirements, reasoning behind theoretical and experimental studies for understanding structural behavior, and applications to design. Other topics include deep beams, corbel design, and yield-line analysis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 4211

CE 5212 - Prestressed Concrete Design
Theory of prestressed and post-tensioned members. Covers analysis and design of prestressed concrete beams, slabs, box girders, and bridge girders by elastic and ultimate strength methods. Precast and cast-in-place system construction techniques will be included.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 3201

CE 5221 - Advanced Structural Steel Design
Critical analysis of behavior of steel and thin- walled metal structural elements. Introduction to basic concepts of structural

stability. P-delta effect as used in structural design. Torsional behavior of prismatic beams, including St. Venant and warping torsion. Torsional buckling.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4221

CE 5231 - Advanced Timber Design
Design of glulam members, including tapered beams, tapered and curved beams, and arches. Covers use of timber connectors as well as design of wood shear walls and diaphragms.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4201 and CE 4231

CE 5241 - Structural Dynamics I
Free and forced vibration of undamped and damped single degree of freedom systems. Generalized coordinates and Rayleigh's method. Multiple degree- of-freedom systems, including shear buildings and frames. Frequency response analysis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4201

CE 5242 - Structural Dynamics II
Earthquake engineering and advanced dynamic analysis. Includes time history response of multiple degree-of-freedom systems, seismicity, equivalent static force method, modal analysis, base isolation, soil-structure interaction, and an introduction to random vibrations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 5241

CE 5243 - Probabilistic Analysis and Reliability in Civil Engineering
Basic probability and statistics, including random variables, moments, probability distributions, and regression analysis. Also examines time-to-failure analysis, capacity/demand reliability analysis, first-order reliability methods, Monte Carlo simulation, and system reliability in a civil and environmental engineering context.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): MA 3710

CE 5250 - Special Topics in Structural Engineering
Advanced study of structural engineering topics, including discussions of recent research developments at an advanced level. Topics might include loading analysis, advanced topics in steel design, composite materials for structures, and behavior of a variety of reinforcements for concrete applications.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5332 - Productivity Planning and Improvement

Analysis of current trends in productivity, factors that affect productivity, and techniques to identify and improve areas of low productivity.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Pre-Requisite(s): and BA 3700) or (BA 3610 CE 3332

CE 5337 - Project Delivery Systems
A study of project delivery, from feasibility through design and construction, focusing on the three contemporary systems: general contracting, design-build, and construction management.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Class(es): Graduate
Pre-Requisite(s): CE 3331

CE 5338 - Project Management and Administration
Exploration of the essential elements of project management and construction administration for the design and construction industry. This includes project planning, organization, budgeting, monitoring, control, life cycle, organizational structure and characteristics, and responsibilities of project managers.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Class(es): Graduate
Pre-Requisite(s): CE 3331

CE 5390 - Special Topics in Construction Engineering
Advanced study of construction engineering topics including discussion of recent research developments.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer

CE 5401 - Advanced Pavement Design
Advanced analysis, behavior, performance, and structural design of highway and airport pavements. Focuses on mechanistic characterization of pavement structures and approaches used to characterize existing structures for the purpose of rehabilitation. Subjects include advanced materials characterization, mechanistic modeling, nondestructive testing, and pavement rehabilitation. Also includes airport pavement design and rehabilitation.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 4401

CE 5402 - Highway Design
Advanced highway design, including horizontal and vertical alignment, cross-section elements, super elevation, and other road design topics. Includes extensive use of highway design computer software with a complete roadway design project using software.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring

Pre-Requisite(s): CE 3401

CE 5403 - Pavement Management Systems
Principles of pavement management, including inventory, condition assessment, needs determination, and budget analysis. Emphasis on field condition assessment techniques. Presents database design to illustrate data handling techniques and introduces several software packages.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring

CE 5404 - Transportation Planning
Introduction to urban transportation planning, travel characteristics, demand forecasting techniques, corridor studies, traffic impact studies, and public transit planning and operations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring

CE 5405 - Environmental Impacts of Transportation
Introduction to environmental legislative and regulatory history. Understanding of the basic elements of environmental impact analysis for transportation facilities. Topics include noise, air quality, wetlands, cultural, historic, community, and socioeconomic aspects, and public participation techniques.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall

CE 5406 - 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

CE 5407 - Advanced Airport Planning and Design
Airport capacity and delay analysis, terminal and ground access planning, security, environmental aspects, noise and land use planning, airport management and operations. Includes extensive use of airport computer simulation software packages.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
Pre-Requisite(s): CE 5406

CE 5408 - Public Transit
An introduction to public transit, user characteristics, management, transit modes, data collection and surveys, planning, operations, scheduling, transit finances, and future trends.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand

Restrictions: Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

CE 5410 - Intelligent Transportation Systems
Introduction to ITS, concepts, technologies, activities, and deployment issues. Topics include advanced traffic management, traveler information systems, commercial vehicle operations, vehicle control systems, ITS applications in public transit, and rural ITS.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
Pre-Requisite(s): CE 4402

CE 5490 - Special Topics in Transportation Engineering
Topics of special interest in transportation engineering.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

CE 5501 - Environmental Process Engineering
Review of mass transfer, kinetics, reactor design, and mathematical modeling principles. Includes illustration by application to several important natural systems and environmental engineering unit processes. Mathematical models of selected environmental engineering systems are developed and solved using PCs.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5502 - Biological Treatment Processes
Application of kinetics, reactor theory, and microbiology to modeling and design of aerobic and anaerobic wastewater treatment systems. Topics include activated sludge process models and application of these models to process design and operation.
Credits: 3.0
Lec-Rec-Lab: (0-2-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CE 4502

CE 5503 - Physical-Chemical Treatment Processes
Advanced theory, fundamentals, and application of physical and chemical processes employed in design and operation of drinking water treatment systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CE 5501

CE 5504 - Surface Water Quality Modeling
Mathematical models are applied in the solution of water quality management problems. The spatial and temporal variation of conservative and reactive substances is simulated in lakes, rivers, and embayments. Kinetic representations of natural phenomena are developed, including mass transport, biogeochemical cycling of nutrients and toxics and food web dynamics.
Credits: 3.0

Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 4505

CE 5505 - Atmospheric Chemistry
Study of the fundamental processes that govern tropospheric and stratospheric composition, with applications to tropospheric ozone, atmospheric fate of organic compounds, atmospheric radiation and climate impacts, acidic deposition, and stratospheric ozone, and to atmospheric gas-phase measurements.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 4504 or CE 4501

CE 5506 - Air Quality Modeling
Mathematical tools for the analysis of air quality issues at the indoor, local, and regional scales. Introduces statistical and deterministic methods. Provides hands-on experience with state-of-the-science air quality models from U.S. EPA and engineering consulting firms.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4504

CE 5507 - Sorption and Biological Processes
Fundamental principles and modeling of some important physical and biological fate processes that govern the transport, persistence, and/or degradation of organic and inorganic pollutants in natural or engineered systems. Topics include sorption to soils/sediments, biodegradation of organic chemicals, bioavailability, and engineered remediation.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5508 - Biogeochemical Processes
To define what constitutes sustainable human activities, one must understand linkages among physical, chemical, and biological structures and processes that comprise our biosphere. Examine interactions between physical, chemical, and biological processes on earth; model these interactions; and identify areas where knowledge is insufficient for modeling.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 4501

CE 5509 - Environmental Organic Chemistry
Investigation of factors controlling the environmental fate, distribution, and transformation of organic xenobiotic molecules. Thermodynamics and kinetics of chemical partitioning among air, water, sediment, and organic phases. Transformations examined include hydrolysis, oxidation-reduction, photochemistry, and "organism-assisted" reactions. Structure-activity relationships and estimation techniques are presented with a goal of modeling environmental impacts.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4501 or CH 3510

CE 5510 - Practical Applications and Analytical Techniques for Environmental Measurements
Develop methods and skills for laboratory work required for experimental research in environmental engineering. Topics include laboratory safety, quality control/quality assurance, purchasing, and use of analytical equipment. Students select one or more of the following topics for specialized study: GC, AA, carbon analysis, HPLC, UV/Visspectroscopy, liquid scintillation counting.
Credits: variable to 3.0
Semesters Offered: Summer
Restrictions: Permission of instructor required

CE 5511 - Air Quality and the Built Environment
Investigates the complex interaction between the engineered environments in developed and developing nations and air quality. Major topics include: air pollutant health impacts and epidemiology, indoor air quality, urban design and air quality, infrastructure and air quality, and atmospheric sustainability.
Credits: 3.0
Lec-Rec-Lab: (0-2-1)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

CE 5560 - Advanced Topics in Air Quality Engineering
Advanced study of topics related to atmospheric chemistry and/or modeling the transformation and transport of atmospheric pollutants.
Credits: variable to 4.0; Repeatable to a Max of 8
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

CE 5561 - Advanced Topics in Biological Processes
Advanced study of biological processes associated with natural and engineering systems.
Credits: variable to 4.0; Repeatable to a Max of 8
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

CE 5562 - Advanced Topics in Physical-Chemical Processes
Advanced study of physical and chemical processes that occur in natural and engineered systems.
Credits: variable to 4.0; Repeatable to a Max of 8
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

CE 5563 - Advanced Topics in Surface Water Quality Engineering
Advanced topics related to understanding the biogeochemistry of surface waters (lakes, rivers, wetlands) and the mathematical modeling of those systems.
Credits: variable to 4.0; Repeatable to a Max of 8
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

CE 5590 - Special Topics in Environmental Engineering
Advanced study of environmental engineering topics including discussion of recent research developments.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer

CE 5610 - Civil and Environmental Engineering Systems Analysis
Operations research theory with application to civil and environmental engineering problems. Decision theory and optimization techniques, including linear programming, nonlinear programming, and dynamic programming. Computer based applications will be included.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall
Pre-Requisite(s): MA 2150 or MA 2160

CE 5660 - Hydrology II
Advanced hydrology aimed at a more thorough understanding of the individual components of the hydrologic cycle. Includes physical hydrology, hydrometeorology, stochastic hydrology, and remote sensing applications.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CE 3620

CE 5661 - GIS Applications
Application of a Geographical Information Systems (GIS) to hydrologic modeling. While the application centers on hydrologic modeling, the experiences gained are applicable to a wide variety of situations. Learn the processes of obtaining, manipulating, and generating data via ArcInfo and ArcView.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CE 3620

CE 5664 - Water Resources Modeling
Application of fundamental principles to develop mathematical models of water resources systems. Includes application of numerical methods, programming to develop simple water resources models, and application of state-of-the-art models for hydrology and river analysis.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CE 3620

CE 5665 - Sediment Transport
Basin 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: Fall
Pre-Requisite(s): CE 3620

CE 5666 - Water Resources Planning and Management
Economic and environmental aspects of water use. Topics include flood damage reduction, water demand and hydrologic forecasting, water supply planning, and water resource systems operation.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): CE 3620 and (EC 3402 or ENG 3402 or EC 3400)

CE 5668 - Cold Regions Hydrology
Analysis of the effects of fresh water ice and snow engineering projects. Topics include snow hydrology, formation, melt, transport distribution, and loading; ice formation, mechanics, bearing capacity, hydraulic effects on rivers, ice jams, and ice control.
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, Sophomore, Junior
Pre-Requisite(s): CE 3620

CE 5690 - Special Topics in Water Resources
Advanced study of water resources topics including discussion of recent research developments.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer

CE 5810 - Advanced Soil Mechanics
Provides advanced studies in the topics of soil compressibility and soil strength. Develop advanced procedures for determining stress distribution and stress changes from a fundamental basis. Students are strongly advised to take CE5820 concurrently.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 3810

CE 5820 - Geotechnical Engineering Laboratory
Hands-on experimental lab course intended to develop understanding of soil behavior and the subtle variables that influence testing results. Tests studied include cyclic and monotonic triaxial drained and undrained strength, triaxial and one-dimensional compression, and as-compacted vs. long-term behavior of fill materials.
Credits: 3.0
Lec-Rec-Lab: (0-1-4)
Semesters Offered: Fall
Pre-Requisite(s): CE 3810

CE 5830 - Advanced Geotechnical Engineering
Applies soil mechanics to the design of foundations and earth-retaining structures. Proper input parameters are stressed, and elements include the design of conventional retaining walls, reinforced earth walls, caissons, piles, shallow foundations, de-watering systems, and the support of temporary excavations.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 5810 and CE 5820

CE 5840 - Frozen Ground Engineering
Stresses the problems and their solutions in seasonally frozen ground. Topics include definition of detrimental frost action, frost susceptibility criteria, mechanism of frost action, frost-resistant design, and the use of insulation. Studies both pavements and light building foundations. Take field trips during the spring thaw period.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 3810

CE 5850 - Stability of Earth Structures
Studies the analysis and design of earth cuts, earth embankments, and gravity dams. Topics include field compaction of soil, compacted properties, fluid flow through the soil, and slope stability procedures. Requires a field trip to an RCC dam and an analysis of its water pressure and movement records.

Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): CE 3810

CE 5860 - Fundamentals of Soil Behavior
Develop an understanding of the factors determining and controlling the engineering properties of a soil. Topics include crystal structure and surface characteristics, soil mineralogy, soil formation, rock weathering, soil composition, soil water, clay-water electrolyte systems, soil structure and stability, volume change behavior, and strength and deformation behavior.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 3810

CE 5890 - Special Topics in Geotechnical Engineering
Advanced study of geotechnical engineering topics including discussion of recent research developments.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5920 - 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 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5930 - 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 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5990 - Civil Engineering Graduate Seminar
Detailed study and group discussions of current literature and graduate research projects related to the broad field of civil engineering. Topics will be combined to address the student's area of interest, including construction, environmental, geotechnical, structures, transportation, and water resources. External speakers discuss current related issues.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5991 - Environmental Engineering Graduate Seminar I
Presentations and discussion of current literature and research related to the broad field of environmental engineering.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall

CE 5992 - Environmental Engineering Graduate Seminar II
Presentations and discussion of current literature and research related to the broad field of environmental engineering.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)

Semesters Offered: Spring

CE 5993 - Field Engineering in the Developing World
Study of applying appropriate and sustainable engineering solutions and technology in the developing world. Concepts of sustainable development are covered. Topics are drawn from several areas of engineering, including water supply/treatment, wastewater treatment, materials, solid waste, construction, and watersheds.
Credits: 2.0
Lec-Rec-Lab: (0-1-2)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5994 - International Civil & Environmental Engineering Field Experience
Field work and reporting from students in the Peace Corps Master's International Program in Civil & Environmental Engineering.
Credits: 1.0; May be repeated
Lec-Rec-Lab: (0-0-2)
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CE 5995 - International Engineering Master's Research
An original investigation in theoretical or experimental engineering and submission of a thesis or report in partial fulfillment of the requirements of the Master of Science degree conducted while in the Peace Corps Master's International Civil & Environmental Engineering program.
Credits: variable to 9.0
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Major(s): Civil Engineering, Environmental Engineering

CE 5998 - Engineering Design Practicum
Advanced independent study for students in the Master of Engineering program. In consultation with student's advisor, develop and execute a project demonstrating capabilities in problem solving, communications, and decision making. The practicum can be done on campus or at the site of a Michigan Tech corporate partner.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 5999 - Master's Research
Study of an acceptable civil or environmental engineering problem and preparation of a report or thesis.
Credits: variable to 10.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CE 6999 - Doctoral Research
Original research leading to the preparation of a dissertation in partial fulfillment of the requirements for the PhD degree.
Credits: variable to 10.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Civil Engineering, Environmental Engineering, Engineering - Environmental

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Chemistry

CH 5210 - Analytical Separations
Covers theory and applications of modern gas chromatography, high performance liquid chromatography, and ion chromatography as well as instrumentation for these techniques. Studies trace organic analysis and environmental problems.
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

CH 5220 - Physical Methods of Analysis
Electrochemical methods, including potentiometry, voltammetry, chronopotentiometry, and electrolysis; electrochemistry in nonaqueous media; mechanisms of electrode processes. Analytical applications of atomic spectroscopy, nuclear magnetic resonance, and mass spectrometry.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 5310 - Advanced Inorganic Chemistry
Covers the organometallic chemistry of the transition elements, beginning with a historical overview of the subject, as well as basic ideas in complex and transition metal chemistry.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Pre-Requisite(s): CH 4320

CH 5410 - Advanced Organic Chemistry I
Advanced study of mechanistic organic and physical organic chemistry intended to bring the student to the level of current research activity. Topics may include methods for determining organic reaction mechanisms, chemical bonding as it applies to organic compounds, structure-reactivity relationships, molecular rearrangements, and molecular orbital theory.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 5420 - Advanced Organic Chemistry II
Advanced study of organic reactions and synthetic organic chemistry intended to bring the student to the level of current research activity. Topics may include retrosynthetic analysis and synthesis design, synthons, protecting groups, and analysis of syntheses from recent literature.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 5509 - Environmental Organic Chemistry
Investigation of factors controlling the environmental fate, distribution, and transformation of organic xenobiotic molecules. Covers thermodynamics and kinetics of chemical partitioning among air, water, sediment, and organic phases. Transformations examined include hydrolysis, oxidation reduction, photochemistry, and "organism-assisted" reactions. Structure-activity relationships and estimation techniques are presented with a goal of modeling environmental impacts.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CE 4501 or CH 3510

CH 5510 - Classical and Statistical Thermodynamics
Principles of classical chemical thermodynamics from the viewpoint of Gibbs and DeDonder; principles of applications of statistical mechanics to thermodynamics, including the properties of gases, liquids, electrolytic solutions, solutions of high polymers, and other systems of chemical interest.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CH 3520

CH 5520 - Chemical Kinetics
An advanced study of chemical reaction rates, including methods of analysis of reaction rate data and the theory of rate processes.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CH 3520

CH 5530 - Molecular Spectroscopy
An introduction to molecular spectroscopy and molecular structure. Topics include infrared and Raman spectroscopy, electronic spectroscopy, fluorescence, phosphorescence, and resonance techniques.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CH 3520

CH 5540 - Applications of Group Theory in Chemistry
The predictive power of group theory in chemistry is developed through theory and detailed applications. Emphasizes group theoretical applications to molecular orbital theory, orbital symmetry, ligand field theory, and vibrational spectroscopy.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CH 3520

CH 5550 - Solid State Chemistry
Introduces principles of solid state chemistry and the application to produce compounds with the desired physical and chemical properties. Discusses reactivity, preparation techniques, structure, impurity or dopant effects, phase transformations, electric and magnetic properties, and point defect chemistry.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CH 3520

CH 5560 - 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: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): CH 3520

CH 5570 - Biophysical Chemistry
A discussion of experimental techniques and applications of physical chemistry principles to the study of the structure, dynamics, and chemical reactions of proteins, nucleic acids, and other biopolymers.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CH 3520

CH 5810 - Magnetic Resonance Spectroscopy
Considers the physical interactions of importance to magnetic resonance spectroscopy. Illustrates these principles by selected, modern experimental techniques. Emphasizes on spin 1/2 particles.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CH 3521

CH 5900 - Chemistry Seminar
Graduate seminar in chemistry.
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 Level(s): Graduate

CH 5990 - Graduate Research in Chemistry
An original investigation in chemistry for students seeking an MS degree.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 6290 - Special Topics in Analytical Chemistry
Discussion of current research developments at an advanced level. A list of possible topics might include chromatography, magnetic resonance, surface analysis, mass spectrometry, or environmental analysis.
Credits: variable to 3.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 6390 - Special Topics in Inorganic Chemistry
Discussion of recent developments in inorganic chemistry.
Credits: variable to 3.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Pre-Requisite(s): CH 4320

CH 6490 - Special Topics in Organic Chemistry
Advanced study in special areas of organic chemistry. Topics could include organic synthetic methods, production and reactions of enolate ions, heterocyclic, carbohydrate, bioorganic, or free-radical chemistry.
Credits: variable to 3.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 6510 - Current Topics Seminar - Physical Chemistry
A weekly discussion between graduate students and faculty of current research and literature topics in physical chemistry. Required for all graduate students in physical chemistry.
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 Level(s): Graduate

CH 6590 - Special Topics in Physical Chemistry
A discussion of recent research developments at an advanced level. Topics could include atomic and molecular structure, kinetic theory of gases, solid-state chemistry, thermodynamics, electrochemistry, and molecular spectroscopy.
Credits: variable to 3.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 6690 - Special Topics in Polymer Science
Advanced study in special areas of polymer science. Topics could include thermal analysis, polymer surface science, advanced polymerization processes, scaling laws, etc. Some topics may include a laboratory component.
Credits: variable to 3.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CH 6790 - Special Topics in Biochemistry
Advanced study in special areas of biochemistry and molecular biology. Topics could include bioorganic chemistry, signal transduction or transcriptional control.
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, Sophomore, Junior

CH 6800 - Current Topics in Graduate Chemistry
Discussion of recent topics in chemistry at a graduate level.
Credits: variable to 3.0; Repeatable to a Max of 12
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CH 6990 - Chemistry Doctoral Research
Laboratory research in preparation of the PhD thesis. Requires permission of the student's advisory committee and the graduate faculty.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Chemical Engineering

CM 5100 - Appl Mathematics for CM
The solution to basic equations for momentum, mass, and heat transfer by use of separation of variables, numerical methods, and other mathematical techniques.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5200 - Advanced CM Thermodynamics
Emphasis in phase equilibria and related concepts, such as molecular or statistical thermodynamics, nonideal fluids and solids.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5300 - Advanced Transport Phenomena
Single- and multi-component mass, energy, and momentum transport. Derivation and use of the general transport equations for Newtonian and non-Newtonian flows, convective flows, and mass transport in flowing systems. Applications to complex systems.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CM 5100

CM 5310 - Laboratory Safety
Provides the technical and cultural background necessary to operate and manage a safe Laboratory.
Credits: 1.0
Lec-Rec-Lab: (1-0-0)
Semesters Offered: Fall

CM 5400 - Adv Reactive Systems Analysis
An analytical study of various aspects of chemical reactor behavior, such as multiple steady-states, dynamics, stability, and control. Also covers transport phenomena in packed beds of solids and mathematical modeling of packed-bed reactors.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5500 - Theory and Methods of Research
Discusses modern methods of research. Topics could include statistical analysis, presentation of data, modern experimental methods, or oral presentation skills.
Credits: 2.0
Lec-Rec-Lab: (1-0-2)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5650 - Heterogeneous Catalysis
A survey of theories of catalytic activity of solids with examples drawn from reactions of industrial importance.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5670 - Advanced Process Design
Problems and lectures in plant design. Course content will vary according to particular needs of the students involved.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5680 - Adv Chemical Process Control
Analysis and design of digital and sampled control systems; use of z-transform and time-domain methods. Study of nonlinear feedback systems, stability criteria, and state-space methods. Design using optimal control. Multivariable and adaptive control system concepts as applied to chemical processes.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CM 5700 - Advanced Polymer Rheology
Exploration of advanced nonNewtonian constitutive equations and nonlinear polymer behavior. In-depth analysis of rheological constitutive equations and their applications. Model studied include the convected-Maxwell Rouse, and Doi-Edwards models as well as more recent models.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CM 4650

CM 5710 - Coal Preparation
Geology, petrography, mining, and preparation of coal. Covers topics such as coal-water-fuels, transportation, economics, and environmental considerations.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand

CM 5730 - Control of Process Streams
Sampling statistics, on-line sensors, serial and parallel interfacing, artificial intelligence, and fuzzy logic applied to minerals and materials processing operation.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand

CM 5900 - Special Topics in CM
A discussion of chemical engineering topics of current interest not included in regular graduate courses.
Credits: variable to 3.0
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CM 5950 - Advanced Special Projects
This is a course for graduate students who wish to do extensive work on projects or topics not directly related to their thesis topic and not covered in one of the graduate courses.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CM 5990 - MS Research
An original investigation of a chemical engineering problem.
Credits: variable to 15.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer

CM 6990 - Doctoral Research
An original investigation in theoretical or applied chemical engineering or both, and submission of a dissertation in partial fulfillment of the requirements for the PhD degree.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer

Computer Science

CS 5090 - 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: Fall, Spring, Summer
Restrictions: Permission of department required

CS 5091 - Master's Seminar in Computer Science
From time to time, depending on student demand, a seminar will be offered on advanced topics in current computer science research.
Credits: variable to 3.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: On Demand
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

CS 5131 - Compiler Optimization
This course emphasizes the design and implementation of low- and high-level compiler optimizations. Topics include control- and data-flow analysis, traditional compiler optimization, global register allocation, instruction scheduling, dependence analysis, memory-reuse analysis and loop transformations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall, Spring
Pre-Requisite(s): CS 4131

CS 5311 - Computation Theory
Turing machines, recursive functions, register machines, parallel computational models, bounds of complexity, NP-completeness, and P-Space completeness.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4311

CS 5321 - Advanced Algorithms
Topics include algorithms for complex data structures, amortized analysis, and NP-completeness. Application areas include approximation algorithms, network flow, combinatorics, string matching, and parallel algorithms. Additional topics as time permits.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CS 4321

CS 5331 - Parallel Algorithms

Emphasizes the principles used in the development of algorithms for parallel computers, including programming paradigms, implementation, analysis, and performance evaluation. Considers algorithms in the areas of scientific computation and nonnumeric processing as well as software tools for performance visualization and debugging.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4431 and CS 4321

CS 5411 - Advanced Operating Systems
Advanced concepts in operating systems. Topics include real-time and multiprocessor scheduling, I/O, modern file systems, and performance analysis. Also requires a substantial implementation project.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4411

CS 5431 - Advanced Computer Architecture
An in-depth study of various aspects of parallel processing, with an emphasis on parallel architectures. The course has an analytical focus and investigates models of various aspects of the design and analysis of parallel systems. Topics include simple uniprocessor/multiprocessor performance models, pipelining, instruction-level parallelism, and multiprocessor design issues.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4431 or (EE 3173 and EE 3175)

CS 5441 - Distributed Systems
Covers time and order in distributed systems; mutual exclusion, agreement, elections, and atomic transactions; Distributed File Systems, Distributed Shared Memory, Distributed System Security; and issues in programming distributed systems. Uses selected case studies.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4411

CS 5461 - Mobile Networks
Mobile network issues including routing and mobility management strategies in ad hoc networks, sensor networks, and personal area networks such as Bluetooth.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4461

CS 5611 - Computer Graphics: Advanced Rendering and Animation
Topics include polygonal objects, parametric curves and surfaces, lighting models, shadows and textures, ray-tracing techniques, radiosity methods, volume rendering, and animation.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): CS 4611

CS 5621 - Computer Graphics: Geometric Modeling and Processing
Design concepts in geometric modeling. Topics include representation of shapes for solids and surfaces; shape modeling, including parametric curves and surfaces such as Bezier, B-spline, and NURBS curves and surfaces; implicit curves and surfaces; surface intersection, blending, and offsetting; applied computational geometry; and the design of robust geometric algorithms.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): CS 5611 and MA 2330

CS 5632 - Computer Graphics: Scientific and Data Visualization
Covers the fundamental concepts in the field of scientific, engineering, biomedical, and information visualization. Emphasizes the representation of scalar, vector, and tensor fields; data sampling and resampling; reconstruction using multivariate, multivalued finite elements, surfaces, volumes and functions on surfaces; and volumetric rendering techniques.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): (MA 2320 or MA 2321 or MA 2330) and CS 5611

CS 5711 - Advanced Software Engineering
This course surveys current research in software engineering. Topics include both the technical aspects of software development (e.g. requirements modeling/analysis, design, verification) and issues pertaining to software process and project management (e. g. measurement, risk analysis, team organization).
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CS 4711 and CS 4712

CS 5811 - Advanced Artificial Intelligence
Course topics include current topics in artificial intelligence including agent-based systems, learning, planning, use of uncertainty in problem solving, reasoning, and belief systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CS 4811

CS 5911 - Advanced Numerical Analysis
Topics include linear and nonlinear systems, interpolation, function approximation, numerical integration and differentiation, fast fourier transform, ODEs and PDEs, eigenvalue calculation, and unconstrained optimization.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall

CS 5990 - Master's Research in Computer Science
The study of an acceptable computer science problem and the preparation of a thesis
Credits: variable to 9.0; Repeatable to a Max of 99; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CS 5999 - Master's Reading and Research in Computer Science
Individual reading and research on current topics in computer science.
Credits: variable to 9.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CS 6090 - 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: Fall, Spring, Summer
Restrictions: Permission of department required

CS 6091 - Doctoral Seminar in Computer Science
Seminar covers advanced topics in current Computer Science research for doctoral degree candidates. Offered according to student demand.
Credits: variable to 3.0; May be repeated
Semesters Offered: On Demand
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

CS 6461 - Advanced Computer Networks
Most advanced research issues in computer networks will be discussed. Topics include overlay networks, anonymity, distributed denial of service, and security in a sensorized universe. With term project students will experience a full cycle of typical research activities in networking.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CS 4461

CS 6621 - Computer Graphics: Contemporary Modeling and Design Research Topics
An in-depth study of recent developments in computer graphics, geometric modeling and visualization, with an emphasis on polyhedron simplification, refinement, surgery, multiresolution representations and geometric compression. In addition, this course will also cover the blossoming principle, scatter data interpolation and approximation d surface subdivision schemes.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Permission of instructor required
Pre-Requisite(s): CS 5611

CS 6990 - Doctoral Research in Computer Science
The study of an acceptable computer science problem and the preparation of a dissertation.
Credits: variable to 9.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CS 6999 - Doctoral Reading and Research in Computer Science
Individual reading and research on current topics in Computer Science for doctoral degree candidates.
Credits: variable to 9.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

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Computational Science & Engr

CSE 5091 - Computational Science and Engineering Seminar
From time to time, depending on student demand, a seminar will be offered on current topics in computational science and engineering.
Credits: variable to 3.0; May be repeated
Semesters Offered: Fall, Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CSE 5200 - Computational Genomics
Topics include introduction to molecular biology, DNA sequence assembly, fast database searching, sequence alignment, and gene recognition.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CSE 5311 - Computation Theory
Turing machines, recursive functions, register machines, parallel computational models, bounds of complexity, NP-completeness, and P-Space completeness.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CS 4311

CSE 5321 - Advanced Algorithms
Topics include algorithms for complex data structures, amortized analysis, and NP-completeness. Application areas include approximation algorithms, network flow, combinatorics, string matching, and parallel algorithms. Additional topics as time permits.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CS 4321

CSE 5331 - Parallel Algorithms
Emphasizes the principles used in the development of algorithms for parallel computers, including programming paradigms, implementation, analysis, and performance evaluation. Considers algorithms in the areas of scientific computation and nonnumeric processing as well as software tools for performance visualization and debugging.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CS 4321 and CS 4431

CSE 5711 - Advanced Software Engineering
Surveys current research in software engineering. Topics include both the technical aspects of software development (e.g. requirements modeling/analysis, design, verification) and issues pertaining to software process and project management (e.g. measurement, risk analysis, team organization).
Credits: 3.0
Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CS 4711 and CS 4712

CSE 5811 - Advanced Artificial Intelligence
Current topics in artificial intelligence including agent-based systems, learning, planning, use of uncertainty in problem solving, reasoning, and belief systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): CS 4811

CSE 5900 - Computational Linear Algebra
Computational methods for solving systems of linear equations. Presents background in linear algebra theory and computational techniques. Typical topics include finite element methods, conjugate gradient methods, other iterative methods, and direct methods. Emphasizes modern computational approaches.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CSE 5911 - Advanced Numerical Analysis
Topics include linear and nonlinear systems, interpolation, function approximation, numerical integration and differentiation, fast fourier transform, ODEs and PDEs, eigenvalue calculation, and constrained optimization.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

CSE 6090 - Special Topics in Computational Science and Engineering
Special topics in Computational Science and Engineering offered on occasion based on student and faculty demand and interest.
Credits: variable to 4.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required

CSE 6091 - Computational Science and Engineering Seminar
From time to time, depending on student demand, a seminar will be offered on current topics in computational science and engineering.
Credits: variable to 3.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

CSE 6131 - High-Level Program Analysis and Optimization
Covers the use of high-level program analysis to transform code with deep memory hierarchies and vector and parallel features. Topics include dependence analysis, memory-hierarchy analysis, loop transformations and code generation strategies for high-performance computer architectures.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): CS 4131

CSE 6990 - Doctoral Research
By arrangement with the instructor directing the PhD dissertation.
Credits: variable to 9.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

CSE 6999 - Doctoral Reading and Research
Individual reading and research on current topics in computational science and engineering.
Credits: variable to 9.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

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Economics

EC 5000 - Microeconomics
The study of consumer demand theory of the firm, market structure, and industrial performance. Emphasizes establishment of an analytic framework for evaluating public policy.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): EC 3002

EC 5010 - Macroeconomics
The study of the determinants of the level of income, employment, the rate of inflation, economic growth, and cyclical variations in the economy, including considerations of the rationale for monetary and fiscal policy and their impact on the business community.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): EC 3003

EC 5300 - Managerial Economics
Economic analysis of the operation of a business. Topics include optimization, demand theory and forecasting, production/cost analysis, market structure and strategic behavior, risk analysis, antitrust policy and regulation of safety and the environment, and international management.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): EC 3001 or (EC 2002 and EC 2003)

EC 5400 - Advanced Engineering Economics
Presents and demonstrates procedures and quantitative techniques used in capital budgeting and project evaluation and selection for industry. Topics include cash flow analysis, decision methods, risk and uncertainty, cost of capital, taxes and depreciation, and forecasting market variables. Topics presented with study problems, applying spreadsheet programs.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)

Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): BA 3400 or EC 3400

EC 5600 - Natural Resource and Environmental Economics
Supply and use of renewable and depletable natural resources, including minerals, energy, agriculture, forests, fisheries, wildlife, and water. Efficient management of private and common property resources and environmental issues and concerns. Efficiency, market failures, benefit-cost analysis, and policy analysis. No credit if a student has previous credit for EC4610.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

EC 5610 - Economics of Nonfuel Minerals
Economics of the nonfuel minerals industries: market analysis, market structure, international trade issues, policy analysis, role of minerals in society, supply, demand, markets, and foreign trade for important minerals, effects of government policies on the minerals industries. No credit if a student has previous credit for EC4600.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Fall
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

EC 5620 - Energy Economics
Examines social and private problems in the supply, distribution, and use of energy resources and the energy industries. Studies production, allocation, and environmental and social problems of petroleum, natural gas, coal, nuclear, electricity, and various alternative energy sources. No credit if a student has previous credit for EC4620.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

EC 5900 - Special Topics
Economic topics of interest to students or independent study in economics under the guidance of a faculty member.
Credits: variable to 4.0; Repeatable to a Max of 8
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

EC 5999 - Graduate Research
Under the guidance of a faculty member, students will read, conduct research, and prepare a report, paper, or thesis.
Credits: variable to 15.0; Repeatable to a Max of 15; Graded Pass/Fail Only
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

EC 5999D - Graduate Research
Under the guidance of a faculty member, students will read, conduct research and prepare a report, paper or thesis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Education

ED 5100 - College Teaching
Covers course preparation, educational testing and evaluation, understanding theories and processes of student learning, developing assignments, instructional strategies (discussions, lecturing, collaborative learning, cases/simulations, etc.), using instructional technologies, motivating students, the roles of the teaching assistant, and using institutional resources for student development.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

ED 5110 - Educational Psychology
Review of psychological principles as they relate to human learning. Covers factors in school that contribute to the emotional, psychological stability of the developing child: assessing students' capabilities, setting educational objectives for the child, classroom practices, procedures, teachers' behavior and their relationship to different types of students. All four components of the Early Block must be taken concurrently.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Co-Requisite(s): ED 5210, ED 5310

ED 5210 - Principles 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. All four components of the Early Block must be taken concurrently.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Co-Requisite(s): ED 5110, ED 5310

ED 5310 - Graduate Seminar in Education
Introduction to contemporary issues in teacher education. Synthesis of clinical experiences with the psychological foundations of learning and foundations of education courses. Requires a term project. This course is one component of the Teacher Education Early Block. Requires admission to teacher education program. All four components of the Early Block must be taken concurrently.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Co-Requisite(s): ED 5110, ED 5210

ED 5410 - Educational Field Experience
Observation, tutoring and classroom teaching in an area elementary school classroom. This course is one component of the Teacher Education Early Block. Requires admission to teacher education program. All four components of the Early Block need to be taken concurrently.
Credits: 1.0
Lec-Rec-Lab: (0-0-3)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

Co-Requisite(s): ED 5110, ED 5210

ED 5420 - Mentoring Student Teachers
Classroom mentoring, support and supervision of student teachers. Emphasis on helping student teachers improve skills in assessment, planning, classroom management.
Credits: 1.0; Repeatable to a Max of 6
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Permission of department required

ED 5500 - Special Studies in Educational Psychology
Individual or group studies of specially selected issues or problems in educational psychology. Credit may be granted for scholarly work under the supervision of departmental-approved, authorized University faculty members that results in an acceptable scholarly product—research reports, curricula, computer program, or other.
Credits: variable to 6.0; 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, Junior

ED 5510 - Special Studies in Educational Technology
Individual or group studies of specially selected issues or problems in educational technology. Credit may be granted for scholarly work under the supervision of departmental-approved, authorized University faculty members that results in an acceptable scholarly product—research reports, curricula, computer program, or other.
Credits: variable to 6.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required

ED 5520 - Special Studies in Middle and Secondary Methods
Individual or group studies of specially selected issues or problems in middle and secondary school methods. Credit may be granted for scholarly work under the supervision of departmental-approved, authorized University faculty members that results in an acceptable scholarly product-research reports, curricula, computer program, or other.
Credits: variable to 6.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required

ED 5530 - Special Studies in Elementary and Middle Methods
Individual or group studies of specially selected issues or problems in elementary and middle schools methods. Credit may be granted for scholarly work under the supervision of departmental-approved, authorized University faculty members that results in an acceptable scholarly product-research reports, curricula, computer program, or other.
Credits: variable to 6.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required

ED 5540 - Special Studies in Education I
Individual or group studies of specially selected issues or problems in education. Credit may be granted for scholarly work under the supervision of departmental-approved, authorized University faculty members that results in an acceptable scholarly product-research reports, curricula, computer program, or other.
Credits: variable to 6.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required

ED 5550 - Special Studies in Education II
Individual or group studies of specially selected issues or problems in education. Credit may be granted for scholarly work, under the supervision of departmental-approved, authorized University faculty members that results in an acceptable scholarly product-

research reports, curricula, computer program, or other.
Credits: variable to 6.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required

ED 5560 - Ecology of Isle Royale for Educators
K-12 teachers participate in a field-based camping experience on Isle Royale National Park, exploring basic ecological concepts regarding the interraletedness of plants, animals, gelogy, climate, and human influences on Isle Royale. Prepares teachers to help students understand interrelationships, energy distribution in ecosystems and change over time.
Credits: 3.0
Lec-Rec-Lab: (0-1-6)
Semesters Offered: Summer
Restrictions: Permission of department required
Pre-Requisite(s): ED 5561(C)

ED 5561 - Ecology of Isle Royale Practicum for Educators
Teachers will implement a one-two week teaching unit based on their experiences in ED5560 and assess its impact on learning in their classroom.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: On Demand
Restrictions: Permission of department required
Pre-Requisite(s): ED 5560(C)

ED 5600 - Independent Study in Education
Through an independent study, gain additional insights to relevant topics in education and research. Students must work directly with select faculty to develop a structured line of study on select educational topics.
Credits: variable to 6.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required

ED 5601 - Special Content Studies in Education
Educators' Science and Mathematics Institute Series Courses. Intensive institutes designed to help elementary, middle and high school educators integrate important concepts in math and science into classroom teaching units. New content areas are designed each year to address the needs of participating teachers.
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: Fall, Spring, Summer

ED 5602 - Special Applications in Education
Educators' Science and Mathematics Institute Series Practicums. Practical application following special content studies during which elementary, middle and high school teachers implement and evaluate a teaching unit that they designed for their own classroom inspired by the previous content course. A mandatory teachers' forum provides opportunity to share ideas with other participating teachers
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: Fall, Spring

ED 5603 - Special Topics in Education
Teachers' Earth Science Institute Courses. Utilizes mineral science and mineral processing to enhance the teaching of science in middle and high school. Teachers will be involved in hands-on, discovery- based activities that integrate concepts in math, physics, and chemistry with elements of social sciences.
Credits: variable to 9.0; Repeatable to a Max of 9

Semesters Offered: Spring, Summer

ED 5620 - Professional Development for Educators: Teaching Earth Science
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of earth science. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5630 - Professional Development for Educators: Teaching Life Sciences
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of teaching life science. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5640 - Professional Development for Educators: Teaching Environmental Science
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of environmental science. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5641 - Global Change Institute for Teachers
This course will provide teachers with the skills necessary to engage middle/high school students in real-world study of global climate change and its effects on ecosystems. National Content Standards for mathematics, and life, earth, and physical sciences will be addressed.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: Summer

ED 5650 - Professional Development for Educators: Teaching Physical Science
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of physical science. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5660 - Professional Development for Educators: Teaching Mathematics
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of mathematics. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5665 - Professional Development for Educators: Teaching Computer Science
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of computer science. Up to 4 credits in ED5620-ED5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4

Semesters Offered: On Demand

ED 5670 - Professional Development for Educators: Teaching Technology
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of technology. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5680 - Professional Development for Educators: Teaching Social Studies
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of social studies. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5690 - Professional Development for Educators: Teaching Language Arts
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of language arts. Up to 4 credits in ED5620-5695 may be applied to the M.S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5695 - Professional Development for Educators: Teaching Business
A course for the professional development of professional K-12 educators. Topics address ideas, trends, and applications in the teaching and learning of business. Up to 4 credits in ED5620-5695 may be applied to the M. S. in Applied Science Education.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

ED 5700 - Science Education Research
In-depth study of education research methods pertaining to classroom practice, curriculum standards, and program evaluation. Course will include an opportunity to design research to answer questions relevant to classroom teaching and learning. Equivalent to ED 5701 plus ED 5702.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall
Pre-Requisite(s): ENG 5100

ED 5701D - Science Education Research Methods
Study of research methods in science education. Issues of research design, program evaluation, and data presentation will be addressed.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Class(es): Graduate

ED 5702D - Action Learning and Action Research
A form of systematic inquiry conducted by teacher researchers to gain insight into how students learn. Use of scientific research projects to teach science in secondary schools. Developing students as communities of science learners.
Credits: 1.0

Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Class(es): Graduate

ED 5710 - Measurement and Evaluation in Education
Survey of measurement and evaluation techniques as they apply to K-12 curriculum. Reviews teacher-made tests and standardized tests. Emphasizes designing and use of quality measurement tools in the classroom.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

ED 5730 - Science Learning Materials, Inquiry and Assessment
Examination of learning materials that enable inquiry-based learning as prescribed by National Science Education Standards. Assessment techniques to measure this type of learning will be considered. Equivalent to ED 5731 plus ED 5732.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Spring
Pre-Requisite(s): ED 5700

ED 5731D - Science Learning Materials and Inquiry
Inquiry, as described by the National Science Education standards, will serve as the focus of a survey of learning materials, particularly those that are internet-based. Identification, selection, and evaluation of source materials for teaching science.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Class(es): Graduate

ED 5732D - Assessing Science Learning
A survey of alternative and authentic assessment techniques for ensuring consistency, reliability, and fairness in evaluating science learning. Assessment planning techniques reviewed will use both national and state standards as guides to measure outcomes.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Class(es): Graduate

ED 5740 - Connecting Michigan Science Benchmarks and Research
Current research and classroom practice will be examined using the Michigan Mathematics and Science Benchmarks. Objective is to further understanding of how goals can promote higher levels of learning. Equivalent to ED 5741 plus ED 5742
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall
Pre-Requisite(s): ED 5700 and (ENG 5200 or ENG 5300)

ED 5741D - Michigan Benchmarks
An examination of the Michigan Mathematics and Science Benchmarks from the standpoint of national goals, standardized assessment, and classroom practice.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Class(es): Graduate

ED 5742D - Research Trends and Classroom Practice
An exploration of the major issues and applicable research results that apply to the teaching and learning of secondary science and mathematics.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Class(es): Graduate

ED 5810 - Advance Methods of Teaching Science, Math, and Computer Science
Application of learning and instructional theories to the teaching of science, mathematics, and computer science. Emphasizes methods of materials used to teach early adolescents. Taught from the perspective of science/math/computer science teachers. Lab offers opportunities to refine instructional techniques. Admission to teacher education required.
Credits: 4.0
Lec-Rec-Lab: (0-3-3)
Semesters Offered: On Demand
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate
Co-Requisite(s): ED 5910
Pre-Requisite(s): ED 5110 and ED 5210 and ED 5310 and ED 5410

ED 5900 - Graduate Research in Education
Students will conduct a research project/report as a capstone to an approved plan of study. The student should present a project plan to their education advisor for approval, conduct whatever work is necessary for the project, prepare a final report at the conclusion of the project, and defend the project/report in an oral presentation.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ED 5700

ED 5910 - Teaching Internship
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. Completion of MTTC Basic Skills Test. See department for application deadlines.
Credits: 12.0
Lec-Rec-Lab: (0-0-36)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Co-Requisite(s): ED 5810
Pre-Requisite(s): ED 5110 and ED 5210 and ED 5310 and ED 5410

Electrical Engineering

EE 5200 - Advanced Methods in Power Systems
Advanced analysis and simulation methods for load flow, symmetrical components, short circuit studies, optimal system operation, stability, and transient analysis. Application of commonly used software reinforces concepts and provides practical insights.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s):

Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 4222

EE 5220 - Transient Analysis Methods
A study of transient behaviors and their analysis and prediction. Addresses analytical methods and their numerical implementation, switching and lightning surges, short circuits, and non-linear effects. Includes computer simulations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 4222

EE 5223 - Power System Protection
Real-time monitoring and protection of modern power systems. Secure and reliable operation of radial and grid systems. Protection of transmission lines, buses, generators, motors, transformers, and other equipment against disturbances.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring

EE 5224 - Power System Protection Lab
Theory-based application of software and hardware used for power system protection. Fault simulations, protective relay settings and coordination, and test operation of relays under static, dynamic, and transient conditions.
Credits: 1.0
Lec-Rec-Lab: (0-0-2)
Semesters Offered: Spring
Pre-Requisite(s): EE 5223(C)

EE 5230 - Power System Operations
Study of advanced engineering and economic algorithms and analysis techniques for the planning, operation, and control of the electric power system from generation through transmission to distribution.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5240 - Computer Modeling of Power Systems
Topics include modeling and computer methods applied to electrical power systems, matrix formulations, network topology and sparse matrix data structures, loadflow, short- circuit and stability formulations, constrained optimization methods for loadflow and state estimation, and time-domain simulation methods for transient analysis.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering
Pre-Requisite(s): EE 5200

EE 5250 - Distribution Engineering
Modeling and analysis of electrical distribution systems; load characteristics, load modeling, unbalanced three-phase overhead

and underground line models, and distribution transformers. Analysis of over current protection, voltage drop, and power quality.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering
Pre-Requisite(s): EE 4221

EE 5290 - Selected Topics in Power Systems 1
Selected topics of current interest.
Credits: variable to 4.0; May be repeated
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5410 - 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
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 3140

EE 5420 - Electromagnetic Systems Engineering
Theory and application of microwave circuits such as filters, couplers, and transmission lines. Includes use of numerical modeling and applications to radar systems.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 5410

EE 5430 - Electronic Materials
A study of the physical principles, operational characteristics, models, and basic applications of selected solid-state devices.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

EE 5440 - Laser Types, Laser Design, Modeling Techniques, and Nonlinear Optics
Survey of laser types and analysis of the common physical and engineering principles, including energy states, inversion, gain, and broadening mechanisms. Design issues include resonators, packaging, cooling, pulsed power, and safety. Students will construct computational model that predicts laser performance. Nonlinear optics and selected applications also covered.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 3140

EE 5450 - Modeling of IC Interconnects
Techniques of modeling phenomena associated with metallic integrated circuit interconnections will be presented. These include parasite elements, propagation delays, crosstalk and electromigration induced failure. Optical and superconducting interconnections will also be reviewed.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5460 - Solid State Devices
A study of the physical principles, operational characteristics and models and basic applications of solid state devices such as p-n junctions, metal- semiconductor junctions and transistors.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

EE 5470 - Semiconductor Fabrication
Graduate level introduction to the science and engineering of semiconductor device fabrication.
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

EE 5480 - Advanced MEMS
This course will cover advanced topics dealing with MEIXIS technologies, transduction mechanisms, and microfabricated sensors and actuators and is a continuation of EE4240/MY4240
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, Junior
Pre-Requisite(s): EE 4240 or MY 4240

EE 5500 - Statistical Signal Processing
Focuses on the application of statistical techniques to the study of random signals and noise. Includes random processes in continuous and discrete time and space, second-order properties of random processes, the interaction of random processes with linear systems, parameter estimation, and the design and implementation of statistical signal-processing algorithms.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5510 - Information Theory and Coding
Definition of information and a study of its properties. Channel capacity and error-free communication over noisy channels. Covers encoding, decoding, and encrypting systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5520 - Fourier Optics
Analysis and modeling of diffraction effects on optical systems, emphasizing frequency-domain analytic and computational approaches. Presents wave propagation, imaging, and optical information processing applications.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 3190

EE 5521 - Detection & Estimation Theory
Detecting and estimating signals in the presence of noise. Optimal receiver design. Applications in communications, signal processing, and radar.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering
Pre-Requisite(s): EE 5520

EE 5522 - Digital Image Processing
Image formation, enhancement, and reconstruction. Applications in medical imaging, computer vision, and pattern recognition.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering
Pre-Requisite(s): EE 3190

EE 5530 - Wireless Digital Communication
Detailed study of modulation, transmission, detection and demodulation in wireless digital networks. Emphasizes doppler shift, multipath, beamsteering and current topics.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5540 - Statistical Optics
Study of the effects of randomness in optical systems. Covers coherence theory, photon statistics, wave propagation, and imaging through random media. Presents analytic and computational approaches.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5550 - Optical Information Processing
Geometric and wave optics. Optical devices with applications in imaging, beamforming, and optical communication systems.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)

Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering, Physics

EE 5560 - Multi-user Detection
Demodulation of mutually interfering digital streams of information that occur in areas such as wireless communications and high-speed data transmission. Design and analysis of receivers for multi-access channels, with focus on fundamental models and algorithms. Topics include optimal multiuser detection and the optimal attainable performance in Gaussian multiuser channels, suboptimal linear multiuser detection, blind and adaptive methods, multiuser receiver for multiple-antenna reception, and the performance measure of asymptomatic multiuser efficiency.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering
Pre-Requisite(s): EE 5520

EE 5570 - Communication Networks
System architectures. Data link control, error correction, and protocol analysis. Message delay, Markov processes, queuing, delays in statistical multiplexing, multiple users with reservations, limited service, priorities. Network delay, traffic flows, throughput analysis. Multiple access networks.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering
Pre-Requisite(s): EE 5500(C)

EE 5580 - Wavelet and Spectral Analysis
Fourier analysis, wavelet transforms and time-frequency analysis. Applications in signal and image processing.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering

EE 5610 - Linear Optimal Control I
Performance analysis in multi-input, multi-output (MIMO) linear feedback systems including internal stability, principle gains and cost functions. Analysis of MIMO systems with random inputs. Stability and performance robustness analysis using singular values and structured singular values. Introduction to the calculus of variations and optimal control. The linear quadratic regulator, the stochastic regulator and their properties.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 5310(C)

EE 5620 - Linear Optimal Control II
Linear, mean-square estimation and Kalman filtering. Optimal estimation for colored plant and measurement noise. Linear quadratic Gaussian optimal control, loop transfer recovery and tracking system design. H-infinity optimal control mu-synthesis. Controller order reduction via pole-zero truncation and balanced truncation.
Credits: 3.0

Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 5610

EE 5710 - Current Topics in Computer Engineering I
Current topics in computer engineering suitable for both computer specialists and non-specialists.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5711 - Mathematical Techniques for Computer Engineering
Mathematical theory and methods frequently used in computer engineering research and development. Picks up where undergraduate courses usually stop. Includes selected topics from formal logic, theorem proving, probability, statistics, modeling and simulation. Contains a significant programming component.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Pre-Requisite(s): MA 2320 and MA 3520 and (MA 3710 or MA 3720) and CS 2141

EE 5715 - Linear Systems Theory and Design
Overview of linear algebra, Modern Control: state-space based design of linear systems, observability, controllability, pole placement, observer design, stability theory of linear time-varying systems, Lyapunov stability, optimal control, Linear Quadratic regulator, Kalman filter, Introduction to robust control.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): EE 4261 or MEEM 4700 or MA 4330

EE 5720 - Current Topics in Computer Engineering II
Current topics in computer engineering suitable for both computer specialists and non-specialists.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5722 - Computer Networks
Focuses on the fundamental network architecture concepts and the core design principles and issues in the emerging communication/data networks. The course sysematically gives students the complete picture of data and computer networks.
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): (MA 3710 or MA 3720) and EE 2150

EE 5723 - Computer and 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: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): EE 2150 and (MA 3710 or MA 3720)

EE 5725 - Mobile Robotics & Multi-Robot Systems
Introduction to mobile robotics and multi-robot systems. Introduce spatial description, mobil robot locomotion, kinematics, localization and mapping, motion planning and navigation. Topics in multirobot systems include biological inspirations, control structure, inter-robot communication, learning in multi-robot systems, and modeling and analysis.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): (EE 3160 or EE 4261) and (MA 3710 or MA 3720) and (CS 1129 or CS 2141)

EE 5726 - Embedded Sensor Networks
Introduces the concepts of wireless snesor networks. Topics include sensor network coverage and sensor deployment, time synchronization and sensor node localization, network protocols, data storage and very, collaborative signal processing. Introduce sensor network programming network reliability and tolerance.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): (CS 4461 or EE 4272 or EE 5722) and (EE 3170 or EE 3173) and (CS 1129 or CS 2141)

EE 5731 - Real-Time and Embedded Systems
Theory and practice of building real-time embedded systems with sensors and actuators with real-time operating systems (RTOS) to obtain hard-real-time behavior. The lab class puts theory into practice.
Credits: 4.0
Lec-Rec-Lab: (3-0-2)
Semesters Offered: On Demand
Pre-Requisite(s): EE 3173 and EE 4261

EE 5751 - Verilog HDL Design
Use of Verilog Hardware Description Language (HDL) to model, simulate, and synthesize combinational and sequential digital hardware systems. Emphasis is on developing Verilog models of encryption and authentication cryptographic algorithms.
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, Junior
Pre-Requisite(s): EE 2171

EE 5752 - Digital Storage Technologies
Digital Storage Technologies including solid state memory devices, magnetic and optical disks will be covered. The usage of the available technologies in a microprocessor system memory hierarchy will be explored using architectural simulation tools.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following Level(s): Graduate; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
Pre-Requisite(s): EE 3173 and EE 3175

EE 5755 - Fault-Tolerant Systems
Covers both the theory and the practice of how to design, model, evaluate, and implement reliable systems out of unreliable components. Includes: Fault Models, Redundancy Management, Agreement, Consensus, Voting, Clock synchronization and reliable broadcast. Material is reinforced with real-world case studies.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): CS 3421 and CS 4411 and (EE 3175 or EE 5910)

EE 5772 - Parallel Computer Organizations
The range of multiprocessor computer architecture (CMP & SMP to Deep Blue to Beowulf Clusters) will be examined in conjunction with the communication protocols necessary to enable operation of these machines. Focus of this course will be on the hardware implementation rather than programming techniques or algorithms.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Class(es): Senior
Pre-Requisite(s): EE 3173 and EE 3175

EE 5778 - Digital Arithmetic Algorithms and Architecture
High speed implementations for common digital arithmetic and number crunching functional units will be examined and explained. A variety of SIMD ISA extensions (MMX, 3dNOW, SSE) will be covered together with their compatibility with standard floating point functional units and area impact.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Class(es): Senior
Pre-Requisite(s): EE 3173 and EE 3175

EE 5805 - Directed Study in Electrical & Computer Engineering
Directed study on a topic mutually agreed upon by the student and the instructor.
Credits: variable to 3.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5900 - Special Topics in Electrical Engineering
Special topics in electrical engineering selected by the student and approved by his/her advisor and the faculty member who will approve the study.
Credits: variable to 5.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5920 - Power Systems Seminar

An analytical study of any current high-level problem or series of problems associated with the advance of knowledge in power systems.
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 Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5940 - Electrophysics Seminar
An analytical study of any current high-level problem or series of problems associated with the advance of knowledge in electrophysics.
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 Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5950 - Signals and Systems Seminar
An analytical study of any current high-level problem or series of problems associated with the advance of knowledge in signals and systems.
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 Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 5970 - Computer Engineering Seminar
An analytical study of any current high-level problem or series of problems associated with the advance of knowledge into computer engineering.
Credits: 1.0; Repeatable to a Max of 2
Lec-Rec-Lab: (1-0-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Computer Engineering, Electrical Engineering

EE 5990 - Thesis Research in Electrical Engineering
Study of some acceptable electrical engineering problem and preparation of a thesis.
Credits: variable to 10.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

EE 5991 - Project Research in Electrical Engineering
Study of some acceptable electrical engineering problem and preparation of a report.
Credits: variable to 6.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

EE 5992 - Practical Experience in Electrical Engineering
A collaboration with industry on some acceptable electrical engineering task and preparation of a report.
Credits: variable to 4.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required

EE 6210 - Power System Dynamics and Stability

A study of the dynamic behavior of power systems. A review of synchronous machine modeling, system dynamic equations, and method of analysis. Examines overall system behavior via small signal and transient stability and energy functions. Also studies voltage stability and non-linear effects.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering
Pre-Requisite(s): EE 5200

EE 6290 - Selected Topics in Power Systems 2
Selected topics of current interest.
Credits: variable to 4.0; May be repeated
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 6460 - CMOS Devices
An in-depth treatment of field-effect devices.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): EE 5460

EE 6480 - Thin Films
Material science of thin films
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

EE 6900 - Advanced Topics in Electrical Engineering
Advanced topics in electrical engineering selected by the student and approved by his/her advisor and the faculty member who will approve the study.
Credits: variable to 5.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 6920 - Advanced Seminar in Power Systems
An in-depth study of any problem or series of problems of current importance associated with the advancement of knowledge in power systems.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 6940 - Advanced Seminar in Electrophysics
An in-depth study of any problem or series of problems of current importance associated with the advancement of knowledge in electrophysics.
Credits: 1.0

Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 6950 - Advanced Seminar in Signals and Systems
An in-depth study of any problem or series of problems of current importance associated with the advancement of knowledge in signals and systems.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Electrical Engineering, Electrical Engineering

EE 6990 - Doctoral Research
Original research leading to the preparation of a dissertation in partial fulfillment of the requirements for the PhD degree.
Credits: variable to 15.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required

Engineering Fundamentals

ENG 5100 - The Engineering Process
This course introduces the engineering problem solving and design processes. Students will learn about the engineering profession and will complete a design/build/test project.
Credits: 4.0
Lec-Rec-Lab: (0-3-2)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

ENG 5101 - Introduction to Engineering for Educators I
Course is aimed at inservice teachers to provide them with an introduction to the engineering profession.
Credits: 2.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

ENG 5102 - Introduction to Engineering for Educators II
Course aimed at inservice teachers to provide them with further exposure to engineering applications in math and science.
Credits: 2.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ENG 5101

ENG 5200 - Engineering Applications in the Physical Sciences
This class will show how engineers use principles from the physical sciences to solve problems and design systems. Key concepts will be linked to the Michigan Curriculum Frameworks for precollege education.
Credits: 4.0
Lec-Rec-Lab: (0-3-2)
Semesters Offered: Summer

Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ENG 5100

ENG 5201 - Introduction to Engineering in the Physical Science I
Course aimed at inservice teachers to provide them with exposure to engineering applications in the Physical Sciences.
Credits: 2.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

ENG 5202 - Introduction to Engineering in the Physical Sciences II
Course aimed at inservice teachers to provide them with further exposure to engineering applications in the Physical Sciences.
Credits: 2.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ENG 5201

ENG 5300 - Engineering Applications in the Earth Sciences
This course will show how engineers use principles from the earth sciences to solve problems and design systems. Key concepts will be linked to the Michigan Curriculum Frameworks for precollege education.
Credits: 4.0
Lec-Rec-Lab: (0-3-2)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ENG 5100

ENG 5301 - Introduction to Engineering in the Earth Sciences I
Course aimed at inservice teachers to provide them with exposure to engineering applications in the Earth Sciences.
Credits: 2.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

ENG 5302 - Introduction to Engineering in the Earth Sciences II
Course aimed at inservice teachers to provide them with further exposure to engineering applications in the Earth Sciences.
Credits: 2.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ENG 5301

ENG 5510 - 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
Pre-Requisite(s): UN 2002

ENG 5520 - Sustainable Futures II
Covers sustainability in developed and developing countries. Topics include policy analysis, regulatory impact & cost benefit analyses, trade & markets, laws & regulations, international disasters, GIS applications, green manufacturing, and evolution of environmental policy in U.S. and other countries.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring

ENG 5530 - Graduate Colloquium in Sustainability
Introduces students to general and specific issues related to sustainability. Topics include review and discussion of historical readings that define the movement towards sustainability, international issues related to sustainable development, corporate leadership, consumption, and societal issues.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring

ENG 5900 - Engineering Internship for Educators
Students will work in an industry or research internship during summer months with an engineer. At the conclusion of the internship, students will write a paper regarding how they will apply what they have learned in their pre-college classroom.
Credits: variable to 6.0
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): ENG 5100

ENG 5998 - Engineering Design Practicum
An advanced independent study for students in the Master of Engineering program. In consultation with his/her advisor, the student develops and executes a project demonstrating capabilities in problem solving, communications, and decision making. The practicum can be completed on or off campus.
Credits: variable to 4.0; Repeatable to a Max of 4
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering

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Forest Resources & Env Science

FW 5020 - Indentification & Biology of Forest Vegetation
Emphasis will be placed on survival and regeneration strategies of forest vegetation. Includes systematic study of the major forest vegetation types of North America. An independent project component may be required.
Credits: 2.0
Lec-Rec-Lab: (1-0-3)
Semesters Offered: Fall

FW 5024 - Advanced Wood Preservation
Covers mechanisms of fungal degradation of wood; chemistry and formulation of modern wood preservatives used worldwide; and environmental aspects of wood preservation.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)

Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): FW 4024

FW 5030 - Forest Measurement & Assessment
Techniques used to measure a wide range of forest ecosystem attributes. Includes overstory and understory vegetation measurement and land measurement. Emphasis will be placed on statistically based sampling designs. An independent project component may be required.
Credits: 2.0
Lec-Rec-Lab: (1-0-3)
Semesters Offered: Fall

FW 5050 - Current Topics in Forest Biotechnology
Current topics in forest biotechnology. Could include micropropagation of young and old trees, anther culture, genetic engineering via agrobacterium and biolistics, and environmental concerns about the commercial use of forest biotechnology. Aspen and larch are used for labs, focusing on sterile technique, micropropagation, and genetic engineering.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5068 - Advanced Wood Composites
In-depth analysis of the influence of material and processing parameters on the physical and mechanical properties of wood composite products. Applied surface sciences. New developments and special topics.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5070 - Developmental and Ecological Genetics
Course will provide current knowledge on signal perception, transduction and response pathways in higher eukaryotes with most examples primarily from but not limited to plants in a lecture and colloquium format. Topics will cover major developmental pathways, and molecular bases of adaptation to biotic and abiotic factors.
Credits: 3.0
Lec-Rec-Lab: (1-2-0)
Semesters Offered: Fall
Pre-Requisite(s): BL 5030

FW 5080 - Gene Profiling Analysis
Advanced training in modern molecular techniques with an emphasis on gene expression analysis. Discussion of various gene profiling methods and their applications. Hands-on laboratory exercises and data analysis.
Credits: 2.0; Graded Pass/Fail Only
Lec-Rec-Lab: (0-1-3)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

FW 5085 - Functional Genomics and Biotechnology
Fundamentals and practical applications of functional genomics tools in biological research. Topics include transcript profiling, regulation of gene expression, mechanisms of gene silencing, genetic transformation, and high throughput DNA microarray and metabolic profiling technologies.
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

FW 5088 - Forest Finance & Economics
Financial analysis and economic theory applied to forestry project analysis and selection, focusing on prices. Covers risk, regional economics, taxation, auctions, and non-market valuation. Applies operations research and statistical concepts to solve resource use problems. Includes critical evaluation of published literature.
Credits: 3.0
Lec-Rec-Lab: (2-0-2)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5089 - Tools of Bioinformatics
Computer applications in molecular biology. Hands-on experience with using popular computer programs for DNA, RNA and protein sequence analysis, database management, data editing, assembly, and organization, multiple sequence comparisons, protein structural analysis, evolutionary relationships of genes, use of Internet for data retrieval, comparison and analysis.
Credits: 4.0
Lec-Rec-Lab: (2-1-2)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5100 - Advanced Terrestrial Ecology
Structure and function of terrestrial ecosystems. Roles of ecotypic variation, animals, natural disturbance, biological diversity, management, and global change on plant community dynamics and ecosystem processes.
Credits: 4.0
Lec-Rec-Lab: (3-0-2)
Semesters Offered: Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

FW 5110 - Advanced Natural Resource Policy
Covers advanced concepts related to policy and natural resources. Offers a survey of natural resource policies and organizations special attention to natural forest policies. State and federal levels of policy making 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: (2-1-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

FW 5115 - Restoration Ecology
Study the tools, challenges, and philosophical underpinnings associated with ecological restoration. Restoration of forest grassland communities (plant and animal) will be discussed.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5120 - Ecophysiology of Forest Productivity
Examines how changes in resource availability and environment affect forest productivity through ecological and physiological responses expressed at molecular, whole plant, and ecosystem scales. Topics include carbon acquisition, carbon loss, nutrient acquisition, growth and allocation, forest hydrology and net ecosystem productivity.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5130 - Forest Vegetation Dynamics
Investigation of how trees grow and interact in a variety of stand structures from a functional standpoint at both the tree- and stand-level. These principles will be used to test the use of silvicultural management tools for meeting a variety of objectives. Linkages will be made between stand development patterns and management options, with an emphasis on disturbance ecology.
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): FW 3020 or FW 3010 or BL 3400 or FW 3012

FW 5150 - Advanced Natural Resource Policy Analysis
This course focuses on student performance and understanding of advanced natural resource policy analysis related to federal land management decision making.
Credits: variable to 3.0; Repeatable to a Max of 3
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): Sch of Forest Res & Envir Sci

FW 5160 - Operations Research in Natural Resource Management
Forestry applications of operations research methods. Includes linear, mixed integer, separable, and dynamic programming and their application to renewable resource management and wood products manufacturing situations. Emphasizes problem formulation and case studies.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Pre-Requisite(s): FW 4150

FW 5221 - Advanced Wetland Science
Advanced study in wetland ecology concentrating on theoretical and technological advances. Readings will pertain to major topics in wetland ecology: hydrology, soils, vegetation, biogeochemistry, and ecological characteristics of different wetland types.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5350 - Soil Biology
Ecology of soil microorganisms and fauna and their roles in soil organic matter decomposition and nutrient cycling.
Credits: 4.0
Lec-Rec-Lab: (3-1-0)
Semesters Offered: Spring
Pre-Requisite(s): FW 3330 or BL 3210

FW 5376 - Advanced Forest and Environmental Resource Management
Application of forest and environmental management practices and topical investigations 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: variable to 4.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor and department required; Must be enrolled in one of the following Level(s): Graduate

FW 5400 - Advanced Conservation Biology
This course examines the biology that underlies our attempts to conserve genetic, species, and community diversity. Discussion will include current issues from the primary literature and applications to student research projects.
Credits: 4.0
Lec-Rec-Lab: (4-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5410 - Analysis of Natural Resource Data
Theory, application, and interpretation of quantitative methods for the analysis of ecological data, including techniques used in developing and using quantitative management tools.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MA 5701

FW 5411 - Applied Regression Analysis
Regression as a tool for the analysis of forest and environmental science data. Topics include multiple linear, curvilinear and non-linear regression, hierarchial and grouped data and mixed-effects models. Emphasis is placed on application of tools to real-world data.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5510 - Special Topics in Natural Resources
Independent study of a specific area of natural resources.
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5550 - Geographic Information Systems for Resource Management
Use of geographic information systems (GIS) in resource management. Studies various components of GIS in detail, as well as costs and benefits. Laboratory exercises use ArcMap, ArcView, and ArcInfo software packages to solve resource management problems.
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, Junior
Pre-Requisite(s): MA 2720 or MA 2710 or MA 3710

FW 5560 - Digital Image Processing: A Remote Sensing Perspective
Presents the theory and quantitative procedures of digital image processing using remotely sensed data. Emphasizes image acquisition, preprocessing, enhancement, transformation classification techniques, accuracy assessment, and out-products. Discusses linkages to GIS. Also covers evaluating applications of the technology to current resource management problems via peer-reviewed literature.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: Spring
Restrictions: Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

FW 5600 - Advanced Insect Ecology
An advanced examination of insects as a highly successful group of organisms which are involved in a myriad of interactions in terrestrial and aquatic ecosystems. This course will include study of some of the unique mechanisms that insects have evolved to overcome challenges facing them in different environments.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5641 - Global Change Institute for Teachers
This course will provide teachers with the skills necessary to engage middle/high school students in real-world study of global climate change and its effects on ecosystems. National Content Standards for mathematics and life, earth and physical sciences will be addressed.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Summer

FW 5700 - Graduate Field Forestry
For graduate students without an undergraduate degree in forestry or a closely related field. Covers field skills in mapping/GPS work, forest diseases and insects, wildlife, timber harvesting, natural resource inventory, and silviculture.
Credits: 8.0
Lec-Rec-Lab: (3-0-15)
Semesters Offered: Fall

FW 5701 - Graduate Field Applied Ecology
Field skills in mapping/GPS work, forest diseases and insects, wildlife, vegetation geomorphology, natural resource inventory and silviculture for graduate students without an undergraduate degree in environmental science or a closely related degree.
Credits: 8.0
Lec-Rec-Lab: (3-0-15)
Semesters Offered: Fall

FW 5710 - Trees in Agricultural Systems
Farm systems analysis and the role of trees in tropical farming systems. Also covers specific material on soil conservation and tropical crops.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

FW 5720 - International Forestry Seminar
Seminar for students who have completed FW5730. Synthesizes field work in a theoretical framework. Covers macro aspects of development theory.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): FW 5730

FW 5730 - Field Work in International Forestry
Field work and reporting from students in the Peace Corps Loret Miller Ruppe Masters International Program in Forestry.

Credits: 1.0; May be repeated
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

FW 5740 - Overseas Research
An introduction to conducting research overseas. Covers scientific methods, ethics, and responsibilities in other cultures, social research, and research development.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

FW 5760 - Graduate Tropical Forestry
Fundamental ecological processes in tropical forests, traditional use including tenure, current problems and solutions to those problems.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5770 - Rural Community Development Planning and Analysis
Context, analysis, and monitoring of development processes of rural communities in tropical countries.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

FW 5800 - Master's Graduate Seminar
Presentation by students of current forest resource- related problems and research. Some instruction on presentation skills.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5810 - Research Methods in Natural Resources
Overview of science and scientific research, research problem selection, study plan and proposal preparation, with literature review and scientific hypothesis testing. Students prepare a proposal or paper on their individual research and go through a peer review of their proposal/ paper.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 5850 - Effective Grantsmanship Workshop
Ability to write successful grant application is an important part of graduate education. Students will learn basic techniques of grant writing for federal, industrial, and international funding agencies and will submit a well-organized proposal for peer review in the class.
Credits: 1.0
Lec-Rec-Lab: (1-0-0)
Semesters Offered: Fall
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

FW 5998 - Forest Resources and International Forestry Master's Research

An original investigation in theoretical or experimental natural resources and submission of a thesis or report in partial fulfillment of the requirements of the Master of Science degree conducted while in a Peace Corps program.
Credits: variable to 9.0
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): Sch of Forest Res & Envir Sci

FW 5999 - Forest Resources and Environmental Science Master's Research
An original investigation in forest science, ecology, and forest molecular genetics that culminates in a Master's degree.
Credits: variable to 15.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 6800 - Doctoral Graduate Seminar
A seminar course in which current forest resource related problems and research are presented by students in the class. Some instruction on presentation skills.
Credits: 1.0; Repeatable to a Max of 2
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 6980 - Graduate Teaching
Development of teaching skills through assisting in instruction. Students gain experience in course organization, lecture and laboratory instruction, and laboratory preparation.
Credits: variable to 4.0; Repeatable to a Max of 4; Graded Pass/Fail Only
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

FW 6999 - Forest Resources and Environmental Science Doctoral Research
An original investigation in theoretical or experimental natural resources and submission of a dissertation in partial fulfillment of the requirements of the PhD degree.
Credits: variable to 15.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Geolog. & Mining Engrg & Sci.

GE 5001 - Intercultural Natural Hazards Communication in Latin America
Perception of risk and hazards in Latin American cultures. Available technology for mitigation and its practicality and perception. Working effectively with hazard agencies. How to measure mitigation effectiveness. Indigeous and European over prints in Latin American life.
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

GE 5040 - Evolution of Structures in Deformed Rock
How rocks deform on a microstructural to hand specimen scale. Topics include dislocations, work hardening and recovery processes, annealing and recrystallization, slipsystems, preferred orientation mechanisms, and foliation development, with independent project on selected topic.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)

Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5050 - Structural Analysis and Interpretation
Analysis of deformed rock structures from hand specimen to outcrop and map scales. Topics include mechanics of cleavage development and folding, shear zones and vorticity, strain measurement, style group analysis, overprinting relationships, mapping and hemispherical projection techniques.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5100 - Advanced Geomorphology and Glacial Geology
In-depth study of surficial processes that shape landforms and determine the composition and character of the Earth`s surface. Processes studied include glacial, flovial, wind, mass movement, and wave action. Emphasizes the role of past and present climate. In-depth report and presentation on two separate topics required.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): GE 2000

GE 5110 - Sequence Stratigraphy
The study of sedimentary rocks interpreted as a series of packages separated by time-significant surfaces. Also examines the processes controlling generation of the time-significant surfaces (eustasy, tectonics, and sediment supply).
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5120 - Basin Analysis
The evolution of sedimentary basins is influenced by the tectonic mechanisms that initially form the basin, the sediments that are deposited in the basins (composition and environments), and post-depositional processes (thermal, hydrologic, chemical and tectonic) that modify the basin fill. Course examines sedimentary basins as a record of past events.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5130 - Geology of the National Parks: Field Experience
A two-week, field-based course taught in National Parks Course requires a project and special assignments. Lab fee costs dependent upon location.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5140 - Paleoclimatology
This course will investigate the geologic evidence of global climate and the mechanisms that are interpreted to produce climate change.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand

GE 5150 - Advanced Natural Hazards
Exploration of how to develop comprehensive plans to mitigate the impact of natural hazards on humans. Requires a project and report.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5180 - Volcanology
Volcanoes and how they work. Volcanic products, their recognition, and significance. Applies chemistry, physics, and fluid mechanics in a volcanological context.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5185 - Special Topics in Volcanology
A special offering class devoted to an advanced topic in volcanology of topical interest, such as Megaeruptions, Convergent Plate Boundary volcanism or Volcanic Landslides. The class will be built around lectures from 6 different universities, linked via videoconferencing.
Credits: 2.0; May be repeated
Lec-Rec-Lab: (1-1-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Major(s): Geological Engineering, Geology, Geophysics; May not be enrolled in one of the following Class(es): Freshman, Sophomore

GE 5187 - Volcanological Field Seminar
Field Seminars of 1-3 weeks to volcanological sites of interest. These are offered in association and following GE5185. The field seminars are complemented by the preceding semester's classes, which examine the broad context of the field events. The two classes may be taken together as 4 credits or separately.
Credits: 2.0; May be repeated
Lec-Rec-Lab: (0-0-6)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Major(s): Geological Engineering, Geology, Geophysics; May not be enrolled in one of the following Class(es): Freshman, Sophomore

GE 5190 - Volcanic Hazards
Historic and current volcanic hazards and crises are studied including roles of scientists and engineers, public responses, impacts of volcanic emissions, medical aspects, the use of technology to mitigate the hazards, and the potential impacts of global scale events.
Credits: 3.0
Lec-Rec-Lab: (2-0-1)
Semesters Offered: Fall
Restrictions: Permission of instructor required; Must be enrolled in one of the following Class(es): Graduate

GE 5200 - Advanced Geochemistry
Elements of modern geochemistry, including aqueous solutions, isotopes, age dating, etc., with an emphasis on concepts and quantitative methods. Project and report required.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5210 - Advanced Applied Geochemistry
Monitoring techniques, collection of field data, processing, and analysis of geochemical data to study near-surface environmental systems. Project and report required.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5220 - Aqueous Geochemistry
Introduction to quantitative methods in aqueous geochemistry with emphasis on calculation of aqueous equilibria relevant to natural systems such as carbonate equilibria.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5270 - Volcanic Clouds
Synthesis of recent advancements in volcanic cloud research along with theoretical background and practical experience in the study, understanding and remote sensing of volcanic clouds. Techniques covered are also applicable to other atmospheric phenomena although volcanic ash, gas and aerosol remote sensing is the main focus.
Credits: 4.0; Repeatable to a Max of 8; Graded Pass/Fail Only
Lec-Rec-Lab: (2-0-6)
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

GE 5300 - Clay Mineralogy and X-ray Diffractometry
The identification of clay minerals using X-ray diffractometry methods. Reviews clay mineral structures, chemistry, and physical properties and demonstrates applications in diagenesis, petroleum geology, weathering/soils, and sedimentation.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5400 - Global Geophysics and Geotectonics
Plate tectonics and the internal structure of the earth using information from seismology, geomagnetism gravity, and heat flow. A term project/report is required.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): (MA 3150 or MA 3160) and PH 2200 and (GE 2000 or GE 2200)

GE 5405 - Geophysics for Archaeology
Principles and practice of non-invasive archaeological geophysics (remote sensing) such as magnetometry, ground penetrating radar and resistivity. Data interpretation will involve basic computation, contouring, three-dimensional visualization programs, interpretation and archaeological significance. Activities include fieldwork, data analysis and presentation, and short reports. The mathematical content of the class will be minimal.
Credits: 3.0
Lec-Rec-Lab: (2-0-1)
Semesters Offered: Fall

GE 5415 - Matlab for Geosciences

Matlab programming as applied to graphing single and multiple one-dimensional data sets, contouring two- dimensional data sets, slice and movie presentations of three-dimensional data sets, loading data, convolution, cross and autocorrelation and frequency analysis, specialized computations for geophysics and geology.
Credits: 3.0
Lec-Rec-Lab: (2-0-1)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Major(s): Applied Geophysics, Geological Engineering, Geology; May not be enrolled in one of the following Class(es): Freshman, Sophomore

GE 5450 - Potential Field Theory in Gravity and Magnetic Applications
The fundamentals of potential theory and the application to gravity and magnetic studies of the crust and lithosphere. Topics include Newtonian & magnetic potential, magnetization, regional gravity fields, the geomagnetic field, forward & inverse modeling. Fourier-domain modeling and transformations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MA 3160 and PH 2200 and GE 3040

GE 5500 - Paleomagnetism and Environmental Magnetism
Origin and interpretation of the natural remanent magnetism in rocks and its use in deciphering the geologic past. Applications studied are plate tectonic movements, environmental change, stratigraphic correlation, and the earth's magnetic field.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): GE 2000

GE 5600 - Advanced Reflection Seismology
Principles and application of reflection seismic techniques. Includes acquisition, data processing, and 2D/3D data interpretation. Project and report required.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5610 - Quantitative Reservoir Characterization
Develop and integrate several aspects of reservoir characterization using data from actual oil and gas fields. The various aspects include well logs, seismic data, production data, and geologic/outcrop inference. Geostatistical routines and integrated software suites.
Credits: 3.0
Lec-Rec-Lab: (1-2-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5650 - Special Topics in Petroleum Geology
The study of current topics in petroleum geology. Research papers and reports are required.
Credits: variable to 4.0; Repeatable to a Max of 8
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5760 - Advanced Engineering Evaluation of Mineral Deposits
Analysis and design of programs to explore and evaluate various types of mineral deposits. An integrated project includes factors

such as geological characteristics, economics, regulations, and environmental impact. Requires an independent project on an approved topic.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5770 - Mineral Deposit Exploration Models
Systematic study of the characteristics, distribution, and origin of economic metallic and nonmetallic mineral deposits, and the development of models for exploration with emphasis on selected deposits. Laboratory stresses the study of mining districts and development of exploration and genetic models.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): GE 2300 and GE 2310

GE 5780 - Exploration and Environmental Geochemistry
Application of geochemical data collection and analysis to the exploration of metallic and nonmetallic mineral deposits and evaluation of environmental consequences of extraction.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): GE 3200

GE 5800 - Mathematical Modeling of Earth Systems
Introduction to numerical techniques for mathematical modeling of various earth-system phenomena, including groundwater flow, heat transfer, and atmospheric transport. Numerical techniques covered include finite-difference, finite-element, collocation, and characteristic methods. Students write their own mathematical models. Prerequisite: experience in programming computer languages such as FORTRAN.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5810 - Flow and Transport in Subsurface Systems
Analysis of fluid flow in geologic materials, including groundwater flow, solute and contaminant transport, heat flow, and petroleum movement. Develops fundamental transport equations and numerical methods for solving these equations.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5850 - Advanced Groundwater Engineering and Remediation
Computer modeling and other advanced topics in the analysis hydrological systems, contaminant transport and fate, and subsurface remediation systems.
Credits: 3.0
Lec-Rec-Lab: (0-2-3)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Class(es): Graduate

GE 5900 - Geological Engineering Seminar

Seminar course dealing with geological subjects of current interest.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5910 - Geology Seminar
Seminar course dealing with geology subjects of current interest.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5920 - Geophysics Seminar
Seminar course dealing with geophysics subjects of current interest.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 5930 - Special Topics in Geological Engineering
Study and discussion of geological engineering topics.
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

GE 5940 - Special Topics in Geology
Study and discussion of geology topics.
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

GE 5941 - Special Topics in Mineralogy
The study of special topics in mineralogy using the Seaman Mineral Museum.
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 Level(s): Graduate

GE 5950 - Special Topics in Geophysics
Study and discussion of geophysics topics.
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

GE 5960 - Special Topics in Mining Engineering
Study and discussion of mining engineering topics.
Credits: variable to 9.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

GE 5994 - International Geological Practicum
Geological field work outside of the U.S. used by Peace Corps Master International students during their field assignments. May be used repeatedly up to 12 credits.
Credits: 1.0; Repeatable to a Max of 12

Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Major(s): Geological Engineering, Geology, Geophysics

GE 5998 - International Geology Master's Research
An original investigation in theoretical or experimental natural geological hazard mitigation and submission of a thesis or report in partial fulfillment of the MS degree conducted while in the Peace Corps Program.
Credits: variable to 9.0
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering

GE 5999 - Master's Graduate Research
Research of an acceptable geological engineering, mining engineering, geology, or geophysics problem and preparation of a thesis.
Credits: variable to 15.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE 6999 - Doctoral Graduate Research
Original research of an acceptable geological engineering, mining engineering, geology, or geophysics problem and preparation of a PhD dissertation.
Credits: variable to 15.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Humanities

HU 5001 - Proseminar in Rhetoric and Technical Communication
An introduction to the issues, goals, and scholarly methods across the disciplinary areas represented in the Rhetoric and Technical Communication Program.
Credits: 1.0; Repeatable to a Max of 5
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5002 - Rhetoric, Composition and Literacy Studies
This course considers key theoretical, pedagogical, and historical issues and events that have linked the fields of rhetoric, composition, and literary studies.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5003 - Technical Communication and Technology Studies
This course considers key historical, pedagogical, and theoretical issues in technical communication, scientific communication, and technology studies. Considerable attention is paid to the practice and critique of technical communication and technology in academic and non-academic settings.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5004 - Communication in Cultural Contexts
This course considers key issues in how cultural contexts and processes of communication affect representation, understanding, and practice.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5005 - Knowledge and Inquiry in the Humanities
This course considers a range of methods, methodologies, and approaches to research that inform scholarship in RTC program. Approaches may include qualitative, ethnographic, quantitative, rhetorical, feminist, historigraphic, hermeneutic, literary, and interpretive methods.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5010 - Organizational Communication
Theoretical review of the role of communication in organizations. Emphasizes critical interpretive approaches.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5011 - Technology, Culture and Communication
Examines philosophical and theoretical concepts for understanding the cultural role of technology such as causality, determinism, progress, identity, agency, articulation, assemblage, social space, control, and change.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5012 - Communication Theory
Traces the development of communication theories. Emphasizes interactions among theoretical, political, historical, and socio-cultural factors.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5020 - Composition Theory
An introduction to such issues in composition theory as the relationships of thought to language, of spoken to written language, of reading to writing, of writing to learning, and of process to product.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5021 - Literacy Theory and Research
A study of the social, cultural, and ideological implications of literacy practices using a variety of historical, theoretical, and ethnographic accounts.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5030 - Linguistic Analysis
The study of linguistic theories and methods for analyzing oral, written, and/or electronic texts. Topics may include how societies construct and are constructed through language; gender, ethnicity, power, class, and region in sociolinguistic variation; theories of discourse; pragmatics; semantics; and methods, ethics, and coding in data collection and analysis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5040 - Reading Literature
An introduction to theoretical perspectives on the reading of literature in the context of considerations of particular literary texts. Will also include some discussion of the reading of nonliterary texts.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5050 - Intercultural Communication
A critical examination of cross-language and cross-cultural equivalences and differences through the study of acculturation, values, traditions, role expectations, perceptions, stereotypes, and gender issues as well as other verbal and nonverbal problems and issues of communication. Emphasizes the dimensions of communication within a comparative cultural context.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5060 - Issues in Social, Political, and Legal Philosophy
An introduction to diverse issues in social, political and legal philosophy. Topics may include the justification of social and political institutions, liberalism and its critics, democracy and consent, analysis of basic political and legal concepts, the nature of law and legal interpretation, critical evaluation of legal practices and theories.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5070 - History and Theory of Rhetoric I
History and theory of rhetoric, focusing on ancient times but extending into the Middle Ages.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5071 - History and Theory of Rhetoric II
History and theory of rhetoric, focusing on modern times but extending back to the Renaissance.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)

Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5080 - Computer Applications in Technical Communication
An examination of how industry and educational institutions employ computers to create, design, and distribute information. Emphasizes such topics as interactive computer-assisted instruction, computerized telecommunications, word processing, document design, and graphics.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5081 - Writing Applications in Technical Communication
A writing-intensive course focusing on special writing assignments for professional technical communicators, such as company annual report narratives and internal magazine articles, especially articles focusing on scientific and technical research.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5090 - Writing Literary Nonfiction
Writing and editing nonfiction for publication in Blue Ice Anthology, a general interest journal published in the Department of Humanities. Course includes study of theory and techniques of literary nonfiction
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5091 - Writing for Publication
Practice in writing to the requirements of professional publications and in identifying the rhetorical considerations of writing for different publications.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5092 - Grammar and Editing for Professionals
An examination of the text-based decisions professional editors make as they prepare manuscripts for publication. Through practice on real documents, students obtain strategies for text editing, acquire a professional vocabulary for communicating effectively with authors, and sharpen their grammar and proofreading skills.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5100 - Qualitative or Quantitative Humanistic Research
Course addresses qualitative or quantitative methods. Field methods in the humanities include the three foundations of qualitative methods; participant observation, interviews, and cultural text analysis. Quantitative methods of inquiry include philosophical foundations of empirical research, structure of quantitative inquiry, modes of observation, and data analysis. Students conduct preliminary research projects.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5110 - Backgrounds of Critical Theory
Study of major critical theories that have influenced contemporary theories such as feminist theory, postmodern theory, cultural studies, critical pedagogy, and discourse theory. Focuses on primary texts in Marxist theory, structuralism, poststructuralism, and phenomenology, and introduces students to the challenges of reading theoretical texts and texts in translation.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5111 - Critical Perspectives on the Environment
Philosophical, rhetorical, literary, or cultural studies approaches to the environment. Topics may include environmental communication and advocacy; environmental ethics, law, and philosophy; environmental literary texts; etc.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5112 - Critical Perspectives on Science and Technology
Philosophical, rhetorical, literary, or cultural studies perspectives on science and technology. Topics may include philosophy of science, philosophy of technology, rhetoric of science, rhetoric of technology, etc.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5113 - Cultural Studies
Introduction to the theoretical history, methods, and practice of cultural studies. Includes the influence of literary humanism, Marxism, structuralism, subcultural studies, feminism, postmodernism, articulation theory, Deleuze and Guattari.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5114 - Introduction to Visual Representation
A critical survey of selected theoretical, philosophical, and methodological issues that inform various disciplinary perspectives on the study of the visual, such as sociology, film and television theory, communication, and art history.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5115 - Literacy, Technology, Society and Education
Examines the linkage between technology and literacy in the U.S. and the ways in which this linkage has been established in public schools, workplace programs, or university settings.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5116 - Rhetorics of Difference/Alterity
A critical examination of discourses, theories, and representations of otherness or difference according to race, gender, sexuality, class, age, nationality, ethnic background, and other socio-cultural categories. May include discussion of issues of self-representation within and among groups, the rhetorics of exile or diaspora, colonial and postcolonial constructions of identity.

Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5117 - Theories of Language
Study of major theories of language that have influenced contemporary work on discourse, language, and literacy. Focuses on language theorists from one or more of a variety of disciplines, such as philosophy, linguistics, literary studies, psychology, anthropology, and rhetoric.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5118 - Theories of Pedagogy
Contemporary theories of pedagogy that influence current approaches to teaching writing, including feminist pedagogy, critical pedagogy, liberatory pedagogy, and psychological and developmental approaches to pedagogy.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5900 - Independent Study
Guided research under the direction of a member of the graduate faculty. Open to advanced master's students in RTC only. Students must meet with their supervising instructor and receive approval of their study plan from the Director of RTC before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5901 - Directed Reading
Directed reading in a focused area under the direction of a member of the graduate faculty, open to advanced MS students in RTC. Students must file a plan of study and receive approval from the supervising faculty and the Director of RTC before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5902 - Internship
Work experience under the direction of a member of the graduate faculty, for advanced MS students. May be conducted on or off campus. Work off campus requires additional direction by an off-campus supervisor. Students must receive approval from their supervising instructor and the Director of RTC before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5931 - Oral, Written and Visual Communication Pedagogies
A study of pedagogical techniques, technologies, evaluation, and assessment. Topics may include practical strategies and theories of rhetorical analysis, reflective speaking practices, critical visual design, and composition. GTAs in the RTC program in their first year of teaching are required to enroll in two consecutive semesters of this course.
Credits: 2.0; Repeatable to a Max of 4

Lec-Rec-Lab: (0-1-1)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5932 - Practicum in Teaching Technical Communication
GTAs who teach undergraduate classes in technical and scientific communication meet weekly to discuss strategies for teaching the course, to read pertinent material, and to develop policy. Veteran GTAs mentor GTAs new to the course.
Credits: 2.0; Repeatable to a Max of 4
Lec-Rec-Lab: (0-1-1)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5933 - Practicum in Modern Language Pedagogy
Discussion and development of effective pedagogical practices and reading of research, scholarship, and theory of modern language pedagogy. GTAs will observe modern language classes regularly and reflect on their own and others' practices. Required of all GTAs in the RTC program in their first year of language teaching at MTU.
Credits: 2.0; Repeatable to a Max of 4
Lec-Rec-Lab: (0-1-1)
Semesters Offered: Fall, Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 5990 - Thesis
Individual research or scholarship under the direction of a graduate faculty advisor. Open to students in the master's program in rhetoric and technical communication. Students must meet with their advisors before registering.
Credits: variable to 10.0; Repeatable to a Max of 10; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 5991 - Special Projects
Individual projects under the direction of a graduate advisor. Open to master's students in RTC only. Students must meet with their advisors before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 6001 - Special Topics in RTC
The study of special topics within or across the areas of rhetoric, technical communication, and the humanities.
Credits: variable to 3.0; Repeatable to a Max of 9
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6010 - Special Topics in Communication
In-depth examination of topics in communication.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6020 - Special Topics in Composition
In-depth examination of theoretical perspectives on composing. May include discussion of current-traditional, expressivist, social constructionist, and postmodern perspectives.
Credits: 3.0; Repeatable to a Max of 9

Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6040 - Special Topics in Literature
Advanced study of topics in American, British, and world literature.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6050 - Special Topics in Modern Languages and Literatures
Advanced study of topics in modern languages and literatures. May include intercultural studies of non-English literature and film around an integrated theme; the study of non-English fiction and non-fiction with attention to theoretical and critical approaches; or more applied studies such as language for special purposes, second-language acquisition, and translation.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6060 - Special Topics in Philosophy
Advanced study of selected topics in philosophy. Possible topics include philosophy of literature, philosophy of mind, continental European philosophy, analytic philosophy, theories of truth, philosophical issues in cognitive science, and contemporary feminist philosophy.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6070 - Special Topics in Rhetoric
Advanced study of special topics in rhetorical theory or history, such as women in rhetorical history, the sophists, non-Western rhetorics, Aristotelian rhetoric, cultural backgrounds to the history of rhetoric, and rhetorical criticism.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6080 - Seminar in Technical Communication
May include study of the theoretical backgrounds of technical communication, the history of technical communication, rhetoric of technical communication, technical communication program administration, and technical communication pedagogy.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6110 - Special Topics in Contemporary Critical Theories
Study of particular contemporary theoretical perspectives that are influential in rhetoric and technical communication research. Topics might include cultural studies, theories of representation, feminist theory, marxist theory, postmodern theory, or intensive study of influential individual theorists.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6111 - Special Topics in Gender Studies
An inquiry into the ways in which gender is constituted within and affects rhetorical, representational, and communicative processes, situations, and structures.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6112 - Special Topics in New Media
A study of the design and evaluation of interactive texts on the computer, with emphasis on critical and theoretical issues raised by the visuality, shifting word-image ratio, and interactivity possible on computer screens.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6114 - Special Topics in Visual Representation
A critical examination of selected topics in visual representation, with an emphasis on the theoretical, industrial, cultural, international and national, and aesthetic contexts that inform an understanding of particular visual media. May include such topics as genre studies, reception theory and theories of spectatorship, gender and visual representation, etc.
Credits: 3.0; Repeatable to a Max of 9
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

HU 6900 - Independent Study
Guided research under the direction of a member of the graduate faculty. Open to advanced doctoral students in RTC only. Students must meet with their supervising instructor and receive approval of their study plan from the Director of RTC before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 6901 - Directed Reading
Directed reading in a focused area under the direction of a member of the graduate faculty, for advanced PhD students in RTC. Credit varies according to the nature of the reading. Students must file a plan of study and receive approval from the supervising faculty and the Director of RTC before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 6902 - Internship
Work experience under the direction of a member of the graduate faculty, for advanced PhD students. May be conducted on or off campus. Work off campus requires additional direction by an off-campus supervisor. Students must receive approval from their supervising instructor and the Director of RTC before registering.
Credits: variable to 6.0; Repeatable to a Max of 6
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

HU 6990 - Doctoral Research
By arrangement with the instructor directing the PhD dissertation

Credits: variable to 10.0; Repeatable to a Max of 10; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Rhetoric & Tech Communication

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Mathematical Sciences

MA 5201 - Combinatorial Algorithms
Basic algorithmic and computational methods used in the solution of fundamental combinatorial problems. Topics may include but are not limited to backtracking, hill-climbing, combinatorial optimization, linear and integer programming, and network analysis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5211 - Discrete Optimization
Optimization problems (traveling salesman, minimal spanning tree, linear programming, scheduling, etc.), simplex algorithm, primal-dual algorithms, complexity, matching, weighted matching, spanning trees, matroid theory, integer linear programming, approximation algorithms, branch-and-bound, local search, polyhedral theory.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall

MA 5221 - Graph Theory
Review of basic graph theory followed by one or more advanced topics which may include topological graph theory, algebraic graph theory, graph decomposition or graph coloring.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MA 5301 or MA 4209

MA 5222 - Design Theory
Methods for the construction of different combilateral structures such as difference sets, symmetric designs, projective geometries, orthogonal latin squares, transversal designs, steiner systems and tournements.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): and MA 5301 MA 4209

MA 5231 - Error-Correcting Codes
Basic concepts, motivation from information transmission, finite fields, bounds, optimal codes, projective spaces, duality and orthogonal arrays, important families of codes, MacWilliams' identities, applications.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 5301

MA 5232 - Cryptography
Classical cryptography, public key systems, signature schemes, key exchange, authentication codes, secret sharing schemes, protocols.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): MA 5221

MA 5301 - Finite Groups and Finite Fields
Basic theory of finite groups (subgroups, normality, homomorphisms, abelian groups, cyclic groups, commutators, order, cosets, index, conjugacy, simple groups, Sylow Theorems), basic theory of finite fields (prime fields, irreducible polynomials, galois groups, trace), families of groups defined over finite fields (linear groups).
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MA 4310

MA 5302 - Rings and Modules
A continuation of MA5301. Topics include rings and fields, ideal theory, polynomials, Galois theory, modules, and linear operators.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): MA 5301

MA 5330 - Topics in Linear Algebra
A graduate-level study of fundamental ideas in linear algebra and its applications. Reviews basic operations, block computations, vector spaces and decompositions, operators, eigenvalue problems, canonical forms, generalized inverses and singular value decompositions, functions of matrices, and applications.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5401 - Real Analysis
A graduate-level study of the Lebesgue integral including its comparison with the Riemann integral; the Lebesgue measure, measurable functions and measurable sets. Integrable functions, the monotone convergence theorem, the dominated convergence theorem, and Fatou's lemma.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5405 - Complex Variables
The Cauchy-Goursat theorem; the argument principle and winding numbers; the Riemann mapping theorem; conformal mappings and application in hydrodynamics; Poisson's formula and the Dirichlet problem for harmonic functions; analytic continuation; infinite products; the gamma and zeta functions, and the distribution of primes.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5504 - Mathematical Modeling
Construction, analysis, and testing of mathematical models (continuum, discrete, deterministic, or stochastic). Possible models include acoustical, biological, chemical, dynamical, ecological, economics, electromagnetics, financial, geological, mechanical, medical, metallurgical, optical, process, robotics, systems, thermal, material (solid, liquid, gas, plasma, multiphase) dynamics.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5510 - Ordinary Differential Equations I
First order equations, general theory of linear equations, constant coefficient equations, matrix methods, singular points, infinite series methods, plane autonomous systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): and MA 4330 MA 4450

MA 5524 - Functional Analysis
Metric spaces, Banach spaces, Hilbert spaces, fundamental convergence and mapping theorems, spectral theory, weak topologies and weak compactness, unbounded operators and their adjoints, fixed point theorems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): (MA 4330 or MA 4610) and MA 4450

MA 5531 - Asymptotic and Perturbation Methods
Addresses asymptotic expansions for integrals, method of steepest descent, stationary phase, etc.; asymptotic expansions for differential equations, regular perturbation methods, Linstedt-Poincare expansions, multiple scales, and averaging, singular perturbation methods, matched asymptotic expansions, composite expansions, etc.; specific applications in mechanical vibrations, boundary layer heat transfer, and fluid flows.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5532 - Bifurcation and Stability Theory
Study of the branching of solutions to nonlinear problems and their stability. Employs asymptotic and functional and analytic techniques to study stationary (steady) and Hopf (time-periodic) bifurcations. Analyzes specific applications in elastic buckling, Benard convection, hydrodynamic stability, and chemical reaction-diffusion systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5545 - Applied Integral Equations
Linear integral equations of the first and second kind, Fredholm theory with applications, Hilbert-Schmidt theory with applications, computational methods for approximate solutions of integral equations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5548 - Mathematical Continuum Mechanics
Langrangian and eularian coordinate systems, stress and strain in elastic, viscoelastic, and plastic materials. Constitutive equations, viscosity, balance laws of fluid and solid mechanics, elasticity, Euler equations, and Navier-Stokes equations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5565 - Partial Differential Equations
Theory of partial differential equations. Covers classification, appropriate boundary conditions and initial conditions, PDEs of mathematical physics, characteristics, Green`s functions, and variational principles.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): and MA 4330 MA 4450

MA 5626 - Numerical Approximation Theory
Analysis and design of algorithms (for the numerical solution of industrial and financial problems) using the following bodies of theory: difference calculus and interpolation, summation calculus and quadrature, function approximation and data representation, linear and nonlinear optimization, and mathematical programming.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): MA 3520 or MA 3521 or MA 3530 or MA 3560 or MA 4630

MA 5627 - Numerical Linear Algebra
Analysis and design of algorithms for the numerical solutions of linear systems of equations using direct and iterative methods; eigenvalue problems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): or MA 4630 MA 4330

MA 5628 - Numerical Ordinary Differential Equations
Analysis and design of algorithms for the numerical solutions of ordinary differential equations.
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 or MA 4630

MA 5629 - Numerical Partial Differential Equations
Analysis and design of algorithms for the numerical solution of partial differential equations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): MA 4630 or MA 5628 or MA 4515

MA 5630 - Numerical Optimization

Numerical solution of unconstrained and constrained optimization problems and nonlinear equations. Topics include optimality conditions, local convergence of Newton and Quasi-Newton methods, line search and trust region globalization techniques, quadratic penalty and augmented Lagrangian methods for equality-constrained problems, logarithmic barrier method for inequality-constrained problems, and Sequential Quadratic Programming.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 4330 or MA 4610 or MA 4630 or MA 5627

MA 5640 - Computational Fluid Dynamics
Topics include equations of continuum mechanics, principles and applications of numerical methods to discretize equations, stability and error analysis, linear and nonlinear solvers, boundary conditions, incompressible and compressible flows, transient and stationary flows, pre- and post-processing, and applications.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Permission of instructor required

MA 5701 - Statistical Methods
Introduction to design, conduct, and analysis of statistical studies, with an introduction to statistical computing and preparation of statistical reports. Topics include design, descriptive, and graphical methods, probability models, parameter estimation and hypothesis testing.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 5711 - Mathematical Statistics I
Review of distribution theory and transformation theory of random variables. Topics include sufficiency; exponential and Bayesian models; estimation methods, including optimality theory; basics of confidence procedures and hypothesis testing, including the Neyman-Pearson framework.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): and MA 4760 and MA 4770 MA 4450

MA 5712 - Mathematical Statistics II
Optimal tests and decision theory. Other topics may include regression and analysis of variance, discrete data analysis, nonparametric models.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 5711

MA 5721 - Stochastic Processes
Markov chains and their stationary distributions; Markov processes; second-order processes, including Gaussian processes and Brownian motion; differentiation and integration of second-order processes, white noise, and stochastic differential equations.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): MA 3710

MA 5731 - Linear Models
A unified development of linear statistical models that includes the following topics: matrices and quadratic forms, normal and chi-square distribution theory, ordinary and generalized least squares modeling, estimability, estimation and tests of hypothesis.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 4710 and MA 4720 and MA 4760 and MA 4330

MA 5740 - Advanced Sampling Methods
Runs concurrently with MA 4740 and covers the same topics as MA 4740, but students meet an additional one hour per week to prove results and discuss advanced topics. Students cannot receive credit for both MA 4740 and MA 5740.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: On Demand
Pre-Requisite(s): MA 5701 and MA 4770

MA 5750 - Statistical Genetics
Application of statistical methods to solve problems in genetics such as locating genes. Topics include basic concepts of genetics, linkage analysis and association studies of family data, association tests based on population samples (for both qualitative and quantitative traits), gene mapping methods based on family data and population samples.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall

MA 5761 - Computational Statistics
Introduction to computationally intensive statistical methods. Topics include resampling methods, Montes Carlo simulation methods, smoothing technique to estimate functions, and methods to explore data structure. This course will use the statistical software S-plus.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall, Spring
Pre-Requisite(s): MA 4770(C)

MA 5791 - Categorical Data Analysis
Structure of 2-way contingency tables. Goodness-of-fit tests and Fisher's exact test for categorical data. Fitting models, including logistic regression, logit models, probit and extreme value models for binary response variables. Building and applying log linear models for contingency tables.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring

MA 5901 - Teaching College Mathematics I
Survey key issues in undergraduate mathematics education, including course preparation, assessment, student learning, developing assignments, instructional strategies, technology, motivating students and institutional resources. The lab involves practical training in the computer algebra system used in the mathematics lab.
Credits: 3.0
Lec-Rec-Lab: (0-2-1)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Major(s): Mathematics; May not be enrolled in one of the following Class

(es): Freshman, Sophomore, Junior

MA 5903 - Introduction to Scientific Programming
Topics include program control, input/output, data structures, procedural and modular programming, and floating point arithmetic. Emphasis on techniques and structures for computational mathematics. Requires programming assignments and projects.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand

MA 5980 - Special Topics in Mathematics
Special topics in mathematics.
Credits: variable to 12.0; Repeatable to a Max of 48
Semesters Offered: Fall, Spring, Summer

MA 5999 - Graduate Research in Mathematics
Original investigation in theoretical, or applied mathematics, and submission of a thesis in partial fulfillment of the requirements for the master's degree in mathematics.
Credits: variable to 12.0; Repeatable to a Max of 48; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

MA 6200 - Advanced Topics in Discrete Mathematics
Reflects the current research interests of the discrete mathematics faculty. Topics may include but are not limited to finite fields, permutation groups, projective geometries, design theory, graph theory, coding theory, probabilitistic methods, extremal set theory, and combinatorial matrix theory.
Credits: variable to 12.0; Repeatable to a Max of 48
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 6201 - Finite Geometrics
Introduction to finite geometrics and its links to groups and codes. Topics include projective and affine geometries over finite fields, geometric description of error-correcting codes, bilinear forms and their groups (the classical groups, geometric algebra), group geometries (Dynkin diagrams, projective planes, generalized quadrangles), coordinatization of projective planes.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 5301

MA 6301 - Permutation Groups and Enumeration
Introduction to finite groups, permutations and their applications. Covers a review of finite group theory (Lagrange's theorem, simple groups, p-groups, Sylow theorems), permutation groups (Burnside's lemma, orbit formula, primitivity, t-fold transitivity, linear groups, the Mathieu groups). Applications include Polya theory (counting group orbits) and its use in chemistry, construction of combinatorial designs.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 5301

MA 6302 - Algebraic Curves and Algebraic Codes
Introduction to the theory of algebraic curves, equivalent algebraic function fields (main theorems Riemann-Roch theorem and

Hasse-Weil theorem) and the construction of error-correcting codes from algebraic curves with finite fields of constants.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): MA 5301

MA 6700 - Advanced Topics in Statistics
Topics may include but are not limited to experimental designs, methods of quality improvement, discrete data analysis, regression analysis, sampling theory, multivariate methods, resampling methods, statistical computing, integral and measure theory, stochastic processes, asymptotic methods, optimization, modeling, nonparametric and parametric statistics.
Credits: variable to 12.0; Repeatable to a Max of 48
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MA 6701 - Probability
Review of discrete probability, probability measures, random variables, distribution functions, expectation as a Lebesgue-Stieltjes integral, independence, modes of convergence, laws of large numbers and iterated logarithms, characteristic functions, central limit theorems, conditional expectation, martingales, introduction to stochastic processes.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): MA 3720 and MA 4450

MA 6980 - Special Topics in Mathematics
Special topics in mathematics.
Credits: variable to 12.0; Repeatable to a Max of 48
Semesters Offered: Fall, Spring, Summer

MA 6999 - Mathematical Sciences Doctoral Research
Taken in partial fulfillment of the doctoral thesis requirement.
Credits: variable to 12.0; Repeatable to a Max of 48; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

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Mechanical Eng. - Engrg. Mech.

MEEM 5110 - Fund of Mechanics/Elasticity
Covers development of Cartesian tensors and indicial notation applied to vector analysis; analysis of stress, principal stresses, invariants, strain tensors, material derivatives, and continuity equations; basic conservation laws and constitutive relationships; the theory of elasticity, including 2-D problems in plane stress/strain, stress functions, and 3-D problems with polar symmetry.
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, Junior
Pre-Requisite(s): MEEM 2150 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

MEEM 5120 - Plasticity and Viscoplasticity
Plastic stress-strain laws, yield criteria, flow rules, work hardening, flexure and torsion of bars, boundary-value problems, thick cylinders, spheres, discs, general 3-D, residual stresses, limit analysis, plane strain, slip line theory.

Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5110

MEEM 5150 - Advanced Mechanics of Matls
A critical study of the basic concepts of stress, strain, and constitutive laws of solids, the physical significance of principle stresses, stress deviator and octahedral stress. Covers failure theories; two-dimensional elasticity theory; mechanics of sub-micron structures; torsion of prismatic bars, thick pressure vessels; special topics in beam theory; elements of elastic stability.
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, Junior
Pre-Requisite(s): MEEM 2150

MEEM 5160 - Experimental Stress Analysis
Review of elastic stress-strain relationships. Covers theory and use of resistive strain gages, strain gage circuits, rosette analysis, static and dynamic strain measurement; discusses other current strain measuring techniques; introduces photoelasticity, Moire, and other optical techniques.
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): MEEM 2150

MEEM 5170 - Finite Element and Variational Methods in Engineering
Variational concepts and Euler-Lagrange equations and the application of these concepts in formulating boundary value problems and approximate methods, including finite-element method. Development of finite element methodology for problems in engineering.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 5175 - Failure of Materials in Mechanical Design - Theory and Design
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. A research/design project will be required. Cannot receive credit for both MEEM4170 and MEEM5175.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering

MEEM 5180 - Mechanics of Composite Matls
Introduces engineering properties and advantages of fibrous composites, the governing equations of mechanics of anisotropic, laminated materials. Develops micromechanics methods for predicting the elastic properties of the composite and classical lamination theory, including hygrothermal effects, and applies them to stress and failure analysis of composite structures.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5110

MEEM 5185 - Advanced Engineering Biomechanics
Engineering mechanics applied to the human body in health and disease on 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. No credit for both MEEM4180 and MEEM5185.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 2150 and MEEM 2700

MEEM 5200 - Advanced Thermodynamics
A study of the principles of thermodynamics, including fundamental concepts and introduction of the analytical treatments of the first, second and combined first and second laws of thermodynamics. Topics include irreversibility, availability (exergy), thermodynamic relations, mixtures, chemical reactions, and chemical equilibrium.
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, Junior
Pre-Requisite(s): MEEM 2200

MEEM 5205D - Comp Methods in Thermal Sci (Distance Program)
Introduces computational methods used to solve thermodynamic, fluid mechanic, and heat transfer problems. Discusses theoretical and practical aspects. Modern computational tools are used to reinforce principles and introduce advanced topics in thermodynamics, fluid mechanics, and heat transfer.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Pre-Requisite(s): MEEM 3230

MEEM 5210 - Advanced Fluid Mechanics
Develops control volume forms of balance laws governing fluid motion and applies to problems involving rockets, pumps, sprinklers, etc. Derives and studies differential forms of governing equations for incompressible viscous flows. Some analytical solutions are obtained and students are exposed to rationale behind computational solution in conjunction with CFD software demonstration. Also covers qualitative aspects of lift and drag, loss of stability of laminar flows, turbulence, and vortex shedding.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3210

MEEM 5230 - Advanced Heat Transfer
Advanced topics on conduction, convection, radiation, and heat exchangers are covered. Emphasis is on problem formulation, and exact solutions, with some coverage of empirical results and computational techniques.
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, Junior
Pre-Requisite(s): MEEM 3230

MEEM 5240 - Comp Fluid Dynamics for Engg
Introduces finite-difference and finite-volume methods used in solving fluid dynamics and heat transfer problems. Covers numerical grid generation, turbulence modeling, and application to some selected problems.
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, Junior

MEEM 5250 - Internal Combustion Engines II
Advanced topics in internal combustion engines with emphasis on CI operation, modeling of engines, modeling of combustion processes, tribology, second law applications, and other topics of current interest.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 4220

MEEM 5260 - Advanced Engine Laboratory
Experimental studies of the effect of operating and design variables on the performance, efficiency, and exhaust emission of internal combustion engines.
Credits: 3.0
Lec-Rec-Lab: (0-1-4)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 4220

MEEM 5270 - Advanced Combustion
The objective is to understand basic combustion processes through detailed analysis. Introduces both analytical and modern experimental methods. Emphasizes liquid fuel combustion, flame propagation, and critical phenomena of ignition and extinction.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering
Pre-Requisite(s): MEEM 4240

MEEM 5280 - Phase-Change & Two-Phase Flows
Considers two-phase flow patterns for air-water, condensing, and boiling flows in the context of interface conditions (surface tension, etc.) and interfacial instabilities that lead to interfacial waves, droplet formation, etc. The course emphasizes development of model equations. Relevant experimental data leading to pressure drop correlations, interfacial shear model, etc., are discussed. The model equations and empirical correlations are used to estimate solutions of problems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3230

MEEM 5401 - Design for Reliability
Emphasizes the importance of reliability in design, covering basic concepts of series, parallel, standby and mixed systems. Uses conditional probability and multimodefunctions as methods for problem solution. Considers derating and reliability testing.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3501

MEEM 5404D - Mechanism Syn/Dynamic Modeling (Distance Program)
Student 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
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3502(C)

MEEM 5405D - Intro to the Finite Element Method (Distance Program)
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: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3502 and (MA 2320 or MA 2321 or MA 2330) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

MEEM 5408 - Design Automation
Students learn fundamental theories and techniques used in mechanical CAD software development. Useful to all students using CAD software in their research and students specializing in design. Basic software engineering, math topics, geometry, solid modeling, design knowledge, design manipulation, and internet will be covered.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 5443 - Kinematics
Students apply kinematic synthesis techniques in the design and analysis of mechanical systems and special purpose cams. They develop synthesis software to link to commercial dynamic packages, optimizing simple mechanisms and mechanical systems.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3502

MEEM 5602D - Process and Product Design and Improvement
Introduces value-engineering tools for product development and total quality management. Topics include systems engineering fundamentals, quality function deployment, experimental design, robust engineering, failure mode and effects analysis, and

engineering problem-solving techniques.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Campus(s): Extended University Programs

MEEM 5605D - Metal Forming Processes (Distance Program)
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: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 2500 and MEEM 2150

MEEM 5610 - Advanced Machining Processes
Covers mechanics of 2-D and 3-D cutting and their extension to commonly used processes such as turning, boring, milling, and drilling. Topics include force modeling, surface generation, heat transfer, tool life and dynamics.
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, Sophomore, Junior
Pre-Requisite(s): MEEM 2500

MEEM 5615 - Advanced Metal Forming
Introduces fundamentals of plasticity theory and applies to the analysis of deformation processes. Processes considered are forging, extrusion, wire drawing, bending, deep drawing, and stretch forming. Emphasizes sheet metal formability.
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, Junior
Pre-Requisite(s): MEEM 3502 or MEEM 2150

MEEM 5625 - Precision Manuf and Metrology
Presents theory and practice involved in the manufacturing and measuring of precision components. Topics include precision machining processes, precision machine/mechanism design, and dimensional metrology. Addresses current manufacturing challenges in the bearings, optics, and microelectronics industries.
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): MEEM 3502 and MEEM 3700

MEEM 5640 - 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. No credit for both MEEM4640 MEEM5640.
Credits: 3.0
Lec-Rec-Lab: (0-2-2)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

Pre-Requisite(s): MEEM 3502(C)

MEEM 5645 - Numerical Analy Manuf Proc
Nonlinear FEM and BEM analyses, modeling of bulk forming processes, sheet forming processes, machining processes, casting processes, grinding of ceramics.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 2500

MEEM 5650 - Advanced Quality Engineering
Stresses the concepts and methods for 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; Monte Carlo simulation, multi-variate situations; and computer-based workshops. No credit for both MEEM4650 and MEEM5650.
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, Junior
Pre-Requisite(s): MA 3710

MEEM 5653 - Life-cycle Engineering
Familiarizes students with the principles and techniques of life-cycle engineering. These techniques include design reviews, re-engineering, cost/benefit analysis, value engineering and design for "X." Upon completion, students should be adept at weighing the costs and benefits of product design decisions as they apply to a product from concept to retirement. Credit may not be received for both MEEM 4653D and MEEM 5653.
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
Pre-Requisite(s): MEEM 4900

MEEM 5660 - Data Based Modeling & Control
System modeling and analysis from observed data for computer-aided design and manufacturing, providing differential equation models. Computer routines for modeling, forecasting with accuracy assessment and minimum mean-squared error control. Underlying system analysis, including stability and feedback interpretation, periodic and exponential trends. Uses illustrative applications to real-life data, including team projects.
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, Junior

MEEM 5670 - Experimental Design in Engg
Review of basic statistical concepts. Models for testing significance of one or many factors. Reducing experimental effort by incomplete blocks, and Latin squares. Factorial and fractional factorial designs. Response surface analysis for optimal response.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall, Summer
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

MEEM 5680 - Optimization I
Provides introductory concepts to optimization methods and theory. Covers the fundamentals of optimization, which is central to any problem involving engineering decision making. Provides the tools to select the best alternative for specific objectives.
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, Junior

MEEM 5685 - Environmentally Responsible Design and Manufacturing
Examines impact of engineering and, in particular, design/manufacturing decisions on the environment. Topics include sustainability; energy/material flows; risk assessment, life cycles, manufacturing process waste streams, product design issues, including disassembly/post-use product handling; techniques for pollution prevention. Requires course project. Credit may not be received for both MEEM4685 and MEEM5685.
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, Junior

MEEM 5700 - Dynamic Meas/Signal Analysis
Assessment of measurement system requirements: transducers, conditioners, and displays of dynamic measurands. Time-, frequency-, probabilistic-, and correlative-domain approaches to dynamic signal analysis: sampled data, discrete Fourier transforms, digital filtering, estimation errors, system identification, calibration, recording. Introduction to wavelet analysis. All concepts reinforced in laboratory and simulation exercises.
Credits: 4.0
Lec-Rec-Lab: (0-3-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MA 4520

MEEM 5701 - Intermediate Dynamics
Intermediate study of several topics in engineering dynamics, including three-dimensional kinematics and kinetics, generalized coordinates, Lagrange's equation, and Hamilton's principle. Uses computer-aided dynamic simulation tools for analyzing dynamic systems.
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, Junior
Pre-Requisite(s): MEEM 2700

MEEM 5702 - Analytical Vibroacoustics
First in a series of two courses on vibro-acoustics to provide a unified approach to study noise and vibration. Emphasizes interaction between sound waves and structures. Presents advanced vibration concepts with computational tools. Discusses wave-modal duality.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3700

MEEM 5703 - Exp Methods Vibro-Acoustics
Covers operating data measurement and analysis, including multisource ODS. Includes signature analysis and order tracking; modal theory, modal scaling. FRF estimators; multiple input excitation techniques; parameter estimation methods; sound

measurements and acoustic intensity; sound quality; field data acquisition, DAT; binaural recording and playback with equalization.
Credits: 4.0
Lec-Rec-Lab: (0-3-3)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5702 and MEEM 4701

MEEM 5710D - NVH and Sound Quality (Distance Program)
Noise Vibration and Harshness (NVH) is an important design consideration in the automotive, appliance, and machine tool industry. This course presents the fundamental concepts of noise and vibration measurement, modeling, and control. Lectures are supported with hands-on testing and analysis.
Credits: 3.0
Lec-Rec-Lab: (0-2-2)
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3700

MEEM 5715 - Linear Systems Theory and Design
Overview of linear algebra, Modern Control; state-space based design of linear systems, observability, controllability, pole placement, observer design, stability theory of linear time-varying systems, Lyapunov stability, optimal control, Linear Quadratic regulator, Kalman filter, Introduction to robust control.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 4700 or EE 4261 or MA 4330

MEEM 5990 - Special Topics
Study of selected subjects related to mechanical engineering or engineering mechanics.
Credits: variable to 6.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

MEEM 5999 - Graduate Research
Research/investigation on a topic related to mechanical engineering or engineering mechanics leading to the submission of a thesis or report in partial fulfillment of the requirements for the master's degree.
Credits: variable to 15.0; Repeatable to a Max of 30; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Mechanical Eng-Eng Mechanics, Engineering Mechanics, Mechanical Engineering

MEEM 6000 - Graduate Seminar
Presentations/seminars on issues related to mechanical engineering and engineering mechanics. May include invited speakers from industry, government labs, and academe.
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 Level(s): Graduate

MEEM 6120 - Hi Strain Rate Behav of Matl
Covers stress-strain response of high strain rates, constitutive models, microstructural changes, wave propagation. Uses

experimental methods to obtain dynamic response, dynamic fracture, adiabatic shear banding.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 2150

MEEM 6130 - Engineering Fracture Mechanics
Development of the stress and deformation fields present near the tips of cracks. Uses elasticity solutions, plasticity corrections, and numerical methods in modeling these fields. Introduces fracture criteria and explains the various parameters used to develop these criteria.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5110

MEEM 6140 - Theory of Plates and Shells
A study of classical theory of plates and shells with applications. Includes solutions of plates and shells of various shapes; limitations and validity of classical theory; and variational methods.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 6230 - Conduction
Fundamental aspects of conductive heat transfer applied to steady-state and transient conditions. Studies multidimensional conduction problems with exact and approximate solutions techniques.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5230

MEEM 6240 - Convective Heat Transfer
An introduction to flow and boundary layer theory for forced and natural convection heat and mass transfer. Includes derivation and application of the equations for conservation of mass, energy, and momentum; dimensional analysis and correlation of experimental results.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5230

MEEM 6250 - Radiative Heat Transfer
Fundamentals of thermal radiation for black, gray, nongray, diffuse, and specular surfaces. Includes radiation combined with conduction and convection at boundaries; properties for radiation in absorbing, emitting, and scattering media; and the engineering treatment of gas radiation in enclosures.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand

Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5230

MEEM 6401 - Engg Design Optimization
Covers mathematical optimization methods useful for engineering design optimization. Includes classical methods as well as new techniques. Emphasizes practical applications and the selection of optimization methods for the solution of specific problems in design.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 6670 - Data Dependent Systems
Modeling of systems from multiple series of observed data. Includes interpretation and characteristics of vector difference-equation models; impulse response functions and modal analysis; spectrum analysis of the contribution of various system components to the measured responses; application to process control and design.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 4660 or MEEM 5660

MEEM 6680 - Optimization II
Provides advanced concepts to optimization theory and methods with an emphasis on engineering problems. Covers design and manufacturing optimization problems in all engineering disciplines. Provides various optimization methods, including unconstrained/constrained optimization, multiobjective optimization, and stochastic optimization.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 5680

MEEM 6701 - Advanced Acoustics
Advanced concepts in acoustics with emphasis on modeling of sound sources, sound interaction with solid structures, transmission and radiation of sound. Discusses numerical acoustics, statistical energy analysis, and sound quality concepts. Provides beneficial background in basic vibrations and noise control.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 6702 - Nonlinear Sys Analy & Control
Studies nonlinear systems from perspective of analysis/control system design. Explores fundamental properties of nonlinear differential equations in addition to describing functions, phase plane analysis, stability/instability theorems. Develops and applies control system design approaches for nonlinear systems, including feedback linearization, quantitative feedback theory, sliding mode control, and backstepping.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 6703 - Advanced Vibrations

Free and forced vibration of continuous systems with applications to strings, shafts, beams, plates and membranes. Problems formulated using Hamilton's principle and Lagrange's equations. Approximate methods of solution include the Rayleigh-Ritz method and Galerkin's method.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MEEM 3700

MEEM 6705 - Advanced Dynamics
Systematic study of principles of mechanics from a modern perspective. Includes rates of change of position and orientation; angular velocity and acceleration; linear velocity and acceleration; generalized coordinates and velocities; properties of distributed mass; generalized active and inertia forces for holonomic and nonholonomic systems; potential energy, kinetic energy, and virtual work.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MEEM 6990 - Special Topics
Study of selected subjects related to mechanical engineering or engineering mechanics.
Credits: variable to 6.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

MEEM 6999 - Doctoral Research
Research/investigation on a topic related to mechanical engineering or engineering mechanics leading to the submission of a dissertation in partial fulfillment of the requirements for the PhD degree.
Credits: variable to 15.0; Repeatable to a Max of 90; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Materials Science & Engrg

MY 5000 - Materials Science and Engineering
Concepts of crystallography and crystal structure. Designed for students without a degree in materials science and engineering. Covers microstructural development as related to phase diagrams, kinetics of phase transformations, diffusion and materials processing. Relationship of properties to microstructure and processing. No degree credit given to students with materials undergraduate degrees.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5100 - Thermodynamics and Kinetics I
Solution thermodynamics and application to phase equilibria. Driving force for phase transformations. Chemical thermodynamics applied to materials processing. Corrosion and oxidation of metals. Applications to engineering situations.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5110 - Thermodynamics and Kinetics II
The kinetics of liquid-to-solid and solid-to-solid phase transformations. Diffusion-controlled phase transformations, including nucleation, growth, coarsening, spinodal decomposition, eutectic and eutectoid transformations, cellular transformations, and massive transformations. Martensitic transformations.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MY 5100

MY 5200 - Advanced Scanning Electron Microscopy
Basic design and operating principles of scanning electron microscope (SEM) with discussions on interactions of electrons with solids and resulting signal production, for analysis of heterogeneous materials using X-ray microanalysis, and applications to surface science. Includes practical training on advanced operation of SEM and FE-SEM (FE=field emission)* instruments with an emphasis on the production of high resolution images and quantitative X-ray analysis of specimen composition based on real and virtual standards. (*if available)
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5250 - Transmission Electron Microscopy
Practical aspects of materials characterization by transmission electron microscopy.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5260 - Crystallography & Diffraction
Crystallographic concepts and diffraction analyses in materials science.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5400 - Mechanical Behavior of Materials
Elasticity and plasticity in solids. Dislocation interactions and strengthening mechanisms. High temperature deformation. Low and high temperature material forming operations. Fracture processes in materials.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5430 - Electronic Materials
A study of the physical principles, operational characteristics, models, and basic applications of selected solid-state devices.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5460 - Solid State Devices
A study of the physical principles, operational characteristics and models and basic applications of solid state devices such as p-n junctions, metal-semiconductor junctions and transistors.

Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

MY 5470 - Semiconductor Fabrication
Graduate level introduction to the science and engineering of semiconductor device fabrication.
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

MY 5480 - Advanced MEMS
This course will cover advanced topics dealing with MEIXIS technologies, transduction mechanisms, and microfabricated sensors and actuators and is continuation of EE4240/MY4240.
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, Junior
Pre-Requisite(s): EE 4240 or MY 4240

MY 5480D - Advanced MEMS
This course will cover advanced topics dealing with MEMS technologies, transduction mechanisms, and microfabricated sensors and actuators and is continuation of EE4240/MY4240.
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, Junior
Pre-Requisite(s): MY 4240D or EE 4240D

MY 5550 - Solid Surfaces
The performance, durability, and stability of composites, coatings, films, advanced ceramics, implants, and nano-technological products rely on the understanding, control and manipulation of surfaces and interfaces. This course provides both a fundamental and practical introduction to the concepts and theories of solid surfaces and solid-liquid interfaces. The capillary effects, electrical aspects of interfaces, and adsorption at materials surfaces, with their practical applications and consequences, are emphasized.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5580 - Introduction to Scanning Probe Microscopy
Students will learn basics of design and fundamental physics behind the scanning probe microscopy techniques. The lectures will also discuss analysis of the solid surfaces regarding roughness, topography, composition, heterogeneity, and adhesion properties using atomic force microscopy (AFM). Artifacts associated with inappropriate conditions in atomic AFM imaging will be discussed as well. Training in the operation of the AFM instrument and exploration of its capability during the laboratory sessions will complement the lectures.
Credits: 2.0
Lec-Rec-Lab: (1-0-3)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5600 - Powder Processing

Processing of metal and ceramic powders into bulk products. Powder manufacture and characterization, compaction, sintering, pressure-assisted consolidation to full density. Emphasis on principles underlying consolidation 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, Junior
Pre-Requisite(s): MY 2100

MY 5610 - Materials Recycling: Processing and Utilization
Methods for materials recycling is the emphasis. Topics include the recycling of materials for steel, aluminum, automobile, foundry, glass, plastics, energy, construction, and other industries. Background of the industry, characteristics of materials, materials flow, and the processing and utilization methods to recycle the materials are presented.
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

MY 5620 - Soft Materials
An introduction to basic concepts, interactions, structures, and properties in soft materials. Topics include polymers, liquid crystals, colloids, surfactants and lipids, polymeric nano composites, and bio materials.
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, Sophomore, Junior
Pre-Requisite(s): MY 2100

MY 5750 - Bioapplications of Nanotechnologies
The prospect of bioapplications of nanotechnologies, selected topics including nanodevices for biosensor and drug delivery, biocompatibility and toxicity of nanomaterials, nanostructured polymers for tissue engineering, design and operation of medical nanorobots, ethics and societal impacts of nanobiotechnology, etc.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5900 - Graduate Seminar
Graduate student presentations at departmental seminars.
Credits: 1.0; May be repeated
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 5990 - MS Thesis Research
Fundamental and applied research in metallurgical and materials engineering. Taken by graduate students in partial fulfillment of the MS thesis requirements.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 6100 - Computational Materials Science and Engineering
Computational and analytical techniques applied to materials science and engineering problems. Develops student facility with modern computational techniques.
Credits: 3.0

Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 6110 - Advanced Topics in Materials Processing
Advanced treatment of various unit operations of materials processing. Operations may include deformation processing, powder and particulate technology, solidification processing, thermomechanical processing, optimum process selection, etc.
Credits: variable to 4.0; May be repeated
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 6200 - Advanced Topics in Materials Characterization
Advanced concepts in materials characterization. Specific course content is tailored to meet the interests of the students and faculty.
Credits: variable to 4.0; May be repeated
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 6400 - Advanced Topics in Mechanical Behavior of Materials
Advanced concepts in mechanical behavior of materials. Specific course content is tailored to meet the interests of the students and faculty.
Credits: variable to 4.0; May be repeated
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 6460 - CMOS Devices
An in-depth treatment of field-effect devices.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): MY 5460

MY 6480 - Thin Films
Material Science of thin films.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

MY 6990 - PhD Thesis Research
Fundamental and applied research in metallurgical and materials engineering. Taken by graduate students in partial fulfillment of the PhD thesis requirements.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

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Physics

PH 5010 - Graduate Journal Club
Presentation and discussion of current issues in physics and recent research by departmental faculty and others. One credit in

journal club is required for all graduate degrees in physics.
Credits: 1.0
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5090 - Special Topics in Physics
The subject matter may vary from term to term and year to year depending on the needs of advanced students.
Credits: variable to 3.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5110 - Classical Mechanics
Lagrangian methods, symmetries and conservation laws, variational formulation, small oscillations, Hamilton's equations, contact transformations, Poisson brackets, Hamilton-Jacobi theory, Lorentz-invariant formulation.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5210 - Electrodynamics I
Electrostatics and magnetostatics, boundary value problems, multipoles, Maxwell's equations, time-dependent fields, propagating wave solutions, radiation.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): PH 5320

PH 5211 - Electrodynamics II
Scattering and diffraction, special relativity, relativistic particle dynamics, Lorenz transformation, 4-vectors, transformation of fields, charges and currents, Thomas precession, retarded potentials, radiation from moving charges.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): PH 5210

PH 5250 - Atomic and Molecular Physics
An introduction to modern atomic, molecular, and optical physics. Special topics covered are cw field-atom interactions including atomic trajectory manipulation, laser theory, saturation spectroscopy, resonance fluorescence, quantum computing and Bose-Einstein condensation in atom traps.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): PH 3210 and (PH 4211 or PH 5210) and (PH 3411 or PH 5410)

PH 5310 - Statistical Mechanics
Ensembles, partition functions and distributions, thermodynamic potentials, quantum statistics, ideal and nonideal gases, interacting systems. Applications may include classical and quantum liquids, phase transitions and critical phenomena, correlation functions, linear response and transport theory, or other topics.

Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5320 - Mathematical Physics
Partial differential equations of physics, separation of variables, boundary value problems, Sturm-Liouville theory, Legendre and Bessel functions, inhomogeneous partial differential equations, Green's functions. Fourier series, Fourier and Laplace transforms, complex variables, evaluation of integrals by contour integration, linear algebra, matrix methods with emphasis on numerical applications.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5410 - Quantum Mechanics I
Study of the postulates of quantum mechanics framed in Dirac notation, the Heisenberg uncertainty relations, simple problems in one dimension, the harmonic oscillator, the principles of quantum dynamics, rotational invariance and angular momentum, spherically symmetric potentials including the hydrogen atom, and spin.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5411 - Quantum Mechanics II
Continuation of PH5410. Includes the study of symmetries and their consequences, the variational method, identical particles, the Hartree-Fock approximation time-independent perturbation theory, time-dependent perturbation theory, diatomic molecules with applications to H2+, many-body perturbation theory, and the Dirac equation.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): PH 5410

PH 5450 - Introduction to Relativity
An introduction to the ideas and results of general relativity, including a review of special relativity. Discusses applications to the properties of massive objects and cosmology.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5510 - Theory of Solids
Free electron theory, Bloch's theorem, electronic band structure theory, Fermi surfaces, electron transport in metals and semiconductors. Lattice vibrations and phonons, other topics as time permits.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): PH 5320 and PH 5410

PH 5520 - Materials Physics
Materials classification and structures; phase diagrams; lattice imperfections; quasiparticles; boundaries and interfaces;

mechanical, electronic, optical, magnetic and superconducting properties of materials.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5530 - Selected Topics in Nanoscale Science and Technology
Presentation and discussion of selected topics in nanoscale science and engineering. Topics include growth, properties, applications, and societal implication of nanoscale materials. Evaluation: attendance and assignment.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

PH 5610 - High Energy Astrophysics
An introduction to the ideas and results of astrophysics and high energy physics.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5630 - Imaging Systems
An introduction to the theory, technology, and methods associated with imaging systems. Topics include telescopes and astronomical imaging, microscopes, aerial cameras and remote sensing instruments, and image recording technologies.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5910 - Atmospheric Physics
Concepts in atmospheric physics. Covers radiative transfer, atmospheric thermodynamics, cloud physics, and remote sensing and imaging of Earth.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5920 - Scientific Instrument Fabrication
Project-oriented introduction to scientific instrument design and machine shop techniques. The course introduces proper use and application of shop machinery, including lathe, drill press, band saw, mill, torch, and woodworking tools. Instrument design, bench layout, and drafting standards are included as well as laboratory safety training.
Credits: 2.0
Lec-Rec-Lab: (0-0-4)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5950 - Graduate Electronics for Scientists
A graduate-level, laboratory-based course in electronics for scientists. Covers foundations of analog electronics, including DC circuits, RCL filters, timers and tank circuits, diodes, FETs, OP Amps, and power circuits. Digital circuitry includes gates, counters, registers, D/A and A/D conversion, and microcontrollers.
Credits: 3.0
Lec-Rec-Lab: (0-0-6)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH 5999 - Master's Research
Master's-level research conducted under the direction of a graduate faculty advisor.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor and department required; Must be enrolled in one of the following Level(s): Graduate

PH 6510 - Advanced Solid-State Physics
Electron-electron interactions solids, lattice dynamics, transport, optical properties of solids, superconductivity.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): PH 5510

PH 6999 - Doctoral Research
Independent research conducted in partial fulfillment of the requirements for the PhD degree. Scheduled by arrangement.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor and department required; Must be enrolled in one of the following Level(s): Graduate

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Social Sciences

SS 5010 - Directed Study
Directed readings or research conducted under the direction of a member of the graduate faculty. Students must meet with their supervising instructor and receive approval of their study plan before registering.
Credits: variable to 4.0; Repeatable to a Max of 9
Semesters Offered: Fall, Spring
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

SS 5100 - Global Environmental Systems
Survey of literature that connects global biological and physical processes with human adaptations, interventions and social systems. Study of range of human systems adapted to living in and with the environment. Topics include energy balance and transfer in the earth environment, ecosystems and energy flow, human intervention into geomorphological processes.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5200 - Environmental Decision Making
Group practicum in environmental decision making. Focuses on facilitating the decision making process associated with a community-based environmental concern or policy choice. Past projects include efforts to facilitate public participation in developing a forest management plan and participating in a review of the Torch Lake Area of Concern.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5300 - Environmental Policy and Politics
An overview of environmental policymaking and politics in the U.S. Emphasizes policies regarding air and water pollution, toxics and hazardous waste. Discussion of rulemaking, enforcement, and administration of laws by EPA. Investigation of

environmental politics on national and community levels, with focus on social movements and citizen participation.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5350 - Environmental Policy Analysis
The role of economic analysis in environmental policy, including a detailed review of the major tools that are used at the federal, state, regional, and local levels. Special emphasis on benefit-cost analysis and comparative risk analysis.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): SS 5300

SS 5400 - Sociology of the Environment
Provides students with an introduction to basic sociological concepts as they apply human relationships to the environment. Topics include social values, organizations, norms, ideologies, and political systems. Themes will include the relationship of expertise to lay knowledge, public participation, and urban-rural relationships.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5405 - Geophysics for Archaeology
Principles and practice of non-invasive archaeological geophysics such as magnetometry, ground penetrating radar, and resistivity. Data interpretation will involve basic computation, computer and hand contouring, three-dimensional visualization programs, interpretation and archaeological significance. Activities will involve fieldwork, work on data, and short reports. The mathematical content of the class will be minimal.
Credits: 3.0
Lec-Rec-Lab: (2-0-1)
Semesters Offered: Fall

SS 5500 - IA Proseminar-I: History of Technology
Provides a basic introduction to work in the history of technology. Students must also register for SS5501.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5501 - IA Proseminar II: Industrial Communities
A graduate seminar covering the main components of anthropological studies of industrial communities. Introduces the methods and approaches of this field through reading and discussion of selected articles and case studies. Students must also register for SS5500.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5502 - IA Proseminar III: Historical Archaeology
Graduate seminar covering the essential elements of historical archaeology through reading and discussion of selected articles and case studies. Students must also register for SS5503.
Credits: 2.0

Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5503 - IA Proseminar IV: Material Culture Studies
Graduate seminar covering the basic elements of material culture studies through readings, discussion, and projects. Students must also register for SS5502.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5510 - 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
Pre-Requisite(s): UN 2002

SS 5600 - Industrial Archaeology
Directed readings and lectures in industrial archaeology using wide range of material from the historical engineering and archaeology literature. Central focus is on regional case studies. Students complete a substantial directed research project.
Credits: 4.0
Lec-Rec-Lab: (4-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5700 - Archaeological Field Methods
Practical experience in methods and techniques of field archaeology. Background readings followed by participation in site survey, testing, excavation, and record keeping. Students involved in ongoing research projects in upper Great Lakes Region. Offered with SS 3210. Graduate students complete independent project in addition to regular work. Recommended SS2020.
Credits: variable to 8.0; Repeatable to a Max of 16
Semesters Offered: Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5800 - Documentation of Historic Structures
Principles and practice of survey and documentation of historic structures. Techniques include reconnaissance survey, in-depth survey, measured drawings, architectural photography, primary research, and written descriptions. Students use survey and documentation to analyze historic structures.
Credits: 4.0
Lec-Rec-Lab: (4-0-0)
Semesters Offered: Fall
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5900 - Heritage Management
Introduces the current field of heritage management; the legislation that underwrites its practice; the articulation of federal, state, and local governmental activity; the evolving philosophies of archaeologists and historic preservationists operating in the public interest; parallels on the international scene; and the impacts of heritage tourism.
Credits: 4.0
Lec-Rec-Lab: (4-0-0)

Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5990 - Graduate Research
Individual research work leading towards master's thesis or project. Open by arrangement to students in master's programs in the Department of Social Sciences.
Credits: variable to 10.0; Repeatable to a Max of 15; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 5998 - Peace Corps Fellows Off Campus Masters Research
Work related research credit for Peace Corps Fellows students who are off campus in partial fulfillment of Masters degree requirements.
Credits: variable to 9.0; Repeatable to a Max of 12
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Sciences & Arts; Must be enrolled in one of the following Major(s): Environmental Policy

SS 6010 - Special Topics in Industrial Heritage
Examines themes or topics related to studies of industrial heritage. May include such topics as advanced cultural resource & heritage management and tourism; industrial heritage field methods; international dimension of industrial heritage; government policy. May be repeated.
Credits: variable to 6.0; Repeatable to a Max of 12
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 6020 - Special Topics in Industrial History
Examines themes or topics related to the study of industrial history of technology. Topics may include global history of industrialization; theoretical models of industrial evolution; and social history of technology and work. May be repeated.
Credits: variable to 6.0; Repeatable to a Max of 12
Semesters Offered: On Demand
Restrictions: Must be enrolled in one of the following Level(s): Graduate

SS 6500 - Independent Study/Directed Reading
Independent study or directed reading with appropriate faculty at the graduate level.
Credits: variable to 9.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate

SS 6600 - PhD. Dissertation Research
Fundamental and applied research in industrial heritage, industrial archeology, and history of technology. Taken by graduate students in partial fulfillment of the PhD thesis requirements.
Credits: variable to 9.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of instructor required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Social Sciences

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University Wide

UN 5000 - Cooperative Education - Graduate
Offered by each participating college or school-the graduate -level cooperative education course. Requires advisor approval,

registration with the Office of the Graduate School, acceptability by a recognized employer. Student must have completed one full-time semester on the MTU campus.
Credits: variable to 12.0; May be repeated
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

UN 5001 - Responsible Conduct of Research
This course explores ethical and policy issues arising during the conduct of research: authorship practices, animal/human subjects, scientists as citizens, scientific misconduct, data sharing/secrecy, intellectual property, technology transfer, social and ethical implications of genetic technologies, conflict of interest, and mentoring.
Credits: 1.0; Graded Pass/Fail Only
Lec-Rec-Lab: (1-0-0)
Semesters Offered: Summer
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore

UN 5951 - Graduate Status - Maintenance of Continuous Enrollment
Meets continuous enrollment requirement for graduate students needing "time out" for special circumstances and for programs with inactive terms. No access to advisor's time or campus facilities; does include e-mail and library privileges.
Credits: 0.0; Repeatable to a Max of 97; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

UN 5952 - Report, Thesis, Dissertation - Independent Writing & Revision
Meets continuous enrollment requirement for graduate students engaged in writing report, thesis, or dissertation. Open only to students who have completed all course and credit requirements. Limited access to advisor's time. No access to labs and other campus facilities. Enrollment includes e-mail and library privileges.
Credits: 0.3; Repeatable to a Max of 97; Graded Pass/Fail Only
Lec-Rec-Lab: (0-.25-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

UN 5953 - Terminal Graduate Registration
Meets defense-term enrollment requirement for graduate students defending report, thesis or dissertation. Open only to students returning from enrollment in UN 5951/5952. Late enrollment after the billing due date carries standard late fee; no waivers granted. Variable credit assigned to bring total term enrollment to minimum 1.0 credits. Computer lab access is not included.
Credits: 1.0; Graded Pass/Fail Only
Lec-Rec-Lab: (0-1-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): UN 5951(C) and UN 5952(C)

UN 5990 - 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

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