Michigan Tech

Office Memo

Office of the Provost and
Senior Vice President for Academic Affairs

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TO: Richard Koubek, President

FROM: Jacqueline E. Huntoon, Provost & Senior Vice President for Academic Affairs

Jacqueline E Huntoon

DATE: April 21, 2022

SUBJECT: Senate Proposal 34-22

Attached is Senate proposal 34-22, “Establishment of a New Graduate Certificate in Fluid Power in Mechatronic Systems,” and a memo stating the Senate passed this proposal at their April 20, 2022 meeting. I have reviewed this memo and recommend approving this proposal.

I concur X do not concur _____ with the provost’s recommendation as stated in this memo.

Richard Koubek, President

4/22/22

Date

Michigan Tech

University Senate

DATE:	April 21, 2022
TO:	Richard Koubek, President
FROM:	Sam Sweitz University Senate President
SUBJECT:	Proposal 34-22
COPIES:	Jacqueline E. Huntoon, Provost & Senior VP for Academic Affairs

At its meeting on April 20, 2022, the University Senate approved Proposal 34-22, "Establishment of a New Graduate Certificate in Fluid Power in Mechatronic Systems". Feel free to contact me if you have any questions.

The University Senate of Michigan Technological University
Proposal 34-22

(Voting Units: Academic)

Establishment of a New Graduate Certificate in Fluid Power in Mechatronic Systems

Submitted by the MMET Department, College of Engineering

1. **Proposal Date:**
   September 22, 2021

2. **Proposing Contacts and Department**
   Contact:
   Dr. John Irwin, Department of Manufacturing and Mechanical Engineering Technology, College of Engineering
   (jlirwin@mtu.edu)
   Committee Members:
   Dr. Aleksandr Sergeyev, Department of Applied Computing, College of Computing
   Dr. Paniz Hazaveh, Department of Applied Computing, College of Computing
   Dr. Nathir Rawashdeh, Department of Applied Computing, College of Computing
   Mr. Kevin Johnson, Department of Manufacturing and Mechanical Engineering Technology, College of Engineering

3. **Sponsor Department Approval**
   At the end of the document

4. **General Description and Characteristics of the Program**

   ### 4.1 General Description of Certificate

   The Departments of Applied Computing in the College of Computing, and Manufacturing and Mechanical Engineering Technology in the College of Engineering, join efforts to introduce three graduate, stackable certificates leading to a Master of Science in Mechatronics. These certificates are: “Industrial Robotics”, “Automation and Controls in Mechatronic Systems”, and “Fluid Power in Mechatronic Systems”. All three certificates include the core courses in the Mechatronics MS degree. These courses are all part of the interdisciplinary MS in Mechatronics.

   ### 4.2 Catalog Description

The Certificate "Fluid Power in Mechatronic Systems" is designed to develop skills and competencies in fluid power, electro-hydraulics, dynamics and kinematics of robotic platforms, and holistic safety related to mechatronic systems.

5. Rationale for Certificate

Many existing jobs will be automated in the next 10 years, and robotics will be a major driver for global job creation over the next five years. These trends are made clear in a study conducted by the market research firm, Metra Martech, "Positive Impact of Industrial Robots on Employment". Many repetitive, low-skilled jobs are already being supplanted by technology. However, a number of studies have found that in the aggregate, the robotics industry is creating more jobs than the number of jobs lost to robots. The rapid growth of robotics and automation, especially during the last few years, its current positive impact and future projections for impact on the United States economy are very promising. Such rapid growth of robotic automation in all sectors of industry will require an enormous number of technically sound specialists with the skills in industrial robotics and automation to maintain and monitor existing robots, enhance development of future technologies, and educate users on implementation and applications. It is critical, therefore, that educational institutions adequately respond to this high demand for robotics specialists by developing and offering appropriate courses geared towards professional certification in robotics and automation.

Fluid power, both hydraulic and pneumatic, systems are integral to the automation that enables robotic applications. For instance, the end effectors of robots are often pneumatically controlled. Large components in automated systems are generally hydraulically controlled to accommodate the high forces and loads. Precision motion control is required in most applications to regulate speed and position, or force and pressure. The dynamics and kinematics of robotic platforms involves analyzing the relation between the joint actuator torques and resulting motion, so that programs can be optimized without exceeding the robot capabilities. Finally, incorporating a safety mindset into the design of automated systems is critical, so that robotics can operate in an environment alongside production workers.

This certificate will prepare students for professional certification in three different fluid power specialist categories. More details are available from the International Fluid Power Society (https://www.ifps.org/certified-fluid-power-specialist). In addition, if a graduate student is a Professional Engineer (PE), or has a degree from an ABET accredited university they can also become a Fluid Power Engineer. The MMET Department is prepared to deliver this curriculum with faculty having multiple years of industry experience in Fluid Power industries. Gifts in FY21 and FY22 from the National Fluid Power Association and the Parker Foundation have been used to develop the Fluid Power curriculum and lab facilities. Private donations have also added to the capabilities for world-class research and teaching of fluid power and motion control. The Fluid Power lab in the EERC has been newly renovated to accommodate Parker, Amatrol and Donald Engineering equipment, and has been updated with instructional technology (see Figure 1).

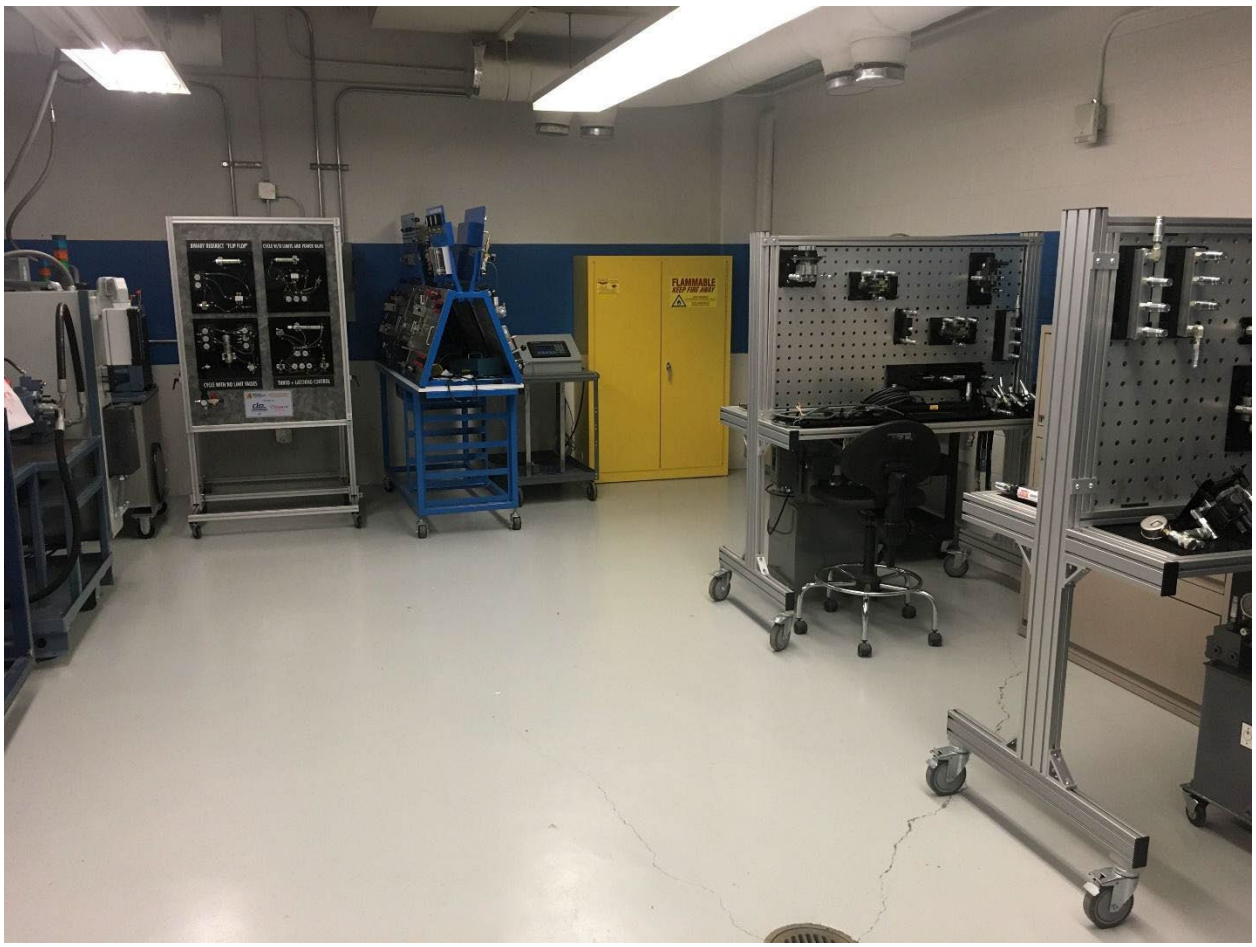

Figure 1: Applied Fluid Power Lab EERC: SB-037

6. Related Programs

There are a variety of certification programs in robotics at undergraduate and graduate levels. Most of the certificates focus on autonomous robotics, forward and inverse kinematics, path planning and optimization algorithms. There are some certificates in fluid power available, but most are at the community college technician level. Many mechanical engineering graduate certificates and degrees include fluid power courses as optional courses. Below is a list of the most recognized institutions with Fluid Power centers and institutes, most offer courses as part of engineering or engineering technology programs. The proposed certificate at Michigan Tech "Fluid Power in Mechatronic Systems" stands out by its specific focus in electro-hydraulic and electro-pneumatic systems and industrial safety.

1. Milwaukee School of Engineering – MSOE Fluid Power Institute
   https://www.msoe.edu/academics/how-we-teach/labs-and-research/engineering/fluid-power-institute/

Since 1962, the Fluid Power Institute™ at MSOE has become a leader in motion control and fluid power education, research and evaluation, distinguishing it as one of the nation's foremost academic fluid power research laboratories. They offer public seminars and events throughout the year for professional development, as well as private and customized seminars. The course offerings include: introduction to Hydraulics for Industry Professionals, Hydraulic Fluids and Contamination Control, Hydraulics Systems Modeling and Simulation for Application Engineers, Electrical Motors, Electrohydraulic Components and Systems, Hydraulic Specialist Certification Review, Electrical Principles and Practices I, and AC/DC Principles. The College of Engineering, ME program includes technical elective courses in Fluid Power Circuits and Fluid Power Modeling.

2. Purdue University – Maha Fluid Power Research Center
   https://engineering.purdue.edu/Maha/education
   This is the largest academic hydraulics lab in the USA encompassing 15,000 square feet of space, where research is conducted on hydraulic pumps, motors, and systems utilizing both computer modeling, and real-world experimentation. The Center hosts the Purdue NFPA Fluid Power Vehicle Challenge student competition team. Purdue is a member of the Center for Compact and Efficient Fluid Power (CCEFP is a National Science Foundation Engineering Research Center), and the Global Fluid Power Society, (GFPS is an international community of institutes for networking in the area of fluid power and fluid techniques). The ME graduate degree program in the College of Engineering, offers a course in Design and Modeling of Fluid Power Systems, and the lab hosts dozens of ongoing projects, both from academia and industry.
3. University of Minnesota - Center for Compact and Efficient Fluid Power
   https://cse.umn.edu/me/research/fluidpower
   This institution is the lead institution for the Center, which has become a catalyst in energizing the fluid power industry and the technology's research community by creating university-industry collaboration. The Center and the Mechanical Engineering Department has three goals related to fluid power: improving energy efficiency; expanding the use of fluid power in transportation; and developing portable, wearable and autonomous fluid-power devices. The College of Engineering offers a course called Fluid Power Control Lab that includes modeling/simulation, system identification, and controller design/implementation. There is a course called Fundamentals of Fluid Power, offered on Coursera, https://www.coursera.org/learn/fluid-power that was developed through a curriculum development grant by the National Fluid Power Association.
4. University of Missouri – Mechanical and Aerospace Engineering
   https://engineering.missouri.edu/academics/mae/
   The College of Engineering offers a course in Hydraulic Control Systems at the undergraduate also cross-listed at the graduate level. This course covers analysis of hydraulic control components and systems. The University is also a member of the Global Fluid Power Society and has been awarded a curriculum development grant by the National Fluid Power Association.

7. Projected Enrollments

Based on the popularity of the courses included in this certificate and the fact that they are part of the MS degree in Mechatronics, we have estimated the following enrollment:

Academic Year	Enrollment
2022-2023	5
2023-2024	10
2024-2025	15
2025-2026	15

8. Scheduling Plans

No change in the regular scheduling of the existing courses is anticipated. MMET will deliver the courses in our regular scheduling plans. Initially, the courses will be delivered on-campus, with the goal of offering later in a blended format. The blended version will be comprised of the theoretical content being offered in the online format, followed by intense training in the laboratories.

9. Curriculum Design

Required Coursework: 10 credits

MET 4377 - Applied Fluid Power (3)
MET 5378 - Advanced Hydraulics: Electro-hydraulic Components & Systems (3)
MET 5400 - Key Factors of Holistic Safety Programs (1)
MET 5800 - Dynamics and Kinematics of Robotics Platforms (3)

Course Descriptions:

MET 4377 - Applied Fluid Power

An introduction to fluid power components and systems. The course includes component selection, circuit design, electrical interfaces, and system troubleshooting and maintenance. A laboratory exposes students to system hardware and circuit simulation techniques for mobile and industrial applications.

Credits: 3.0
Lec-Rec-Lab: (0-2-2)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Class(es): Junior, Senior

MET 5378 - Advanced Hydraulics: Electro-hydraulic Components & Systems

This course covers electro-hydraulic components including solenoid operated valves, proportional valves, and servo valves. Also covered are hydraulic systems including open-loop and closed-loop.

Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall
Pre-Requisite(s): MET 4377

MET 5400 - Key Factors of Holistic Safety Programs

Students learn best industry safety practices with respect to; risk management, lockout/energy isolation, fluid power and electrical symbols, basic circuit design and machine design, and sequence of operation involved with automation controls and mechanical motion.

Credits: 1.0
Lec-Rec-Lab: (0-0-2)
Semesters Offered: Spring

Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate

Pre-Requisite(s): (EET 3373 or EET 5373) and (MET 4377 or MET 5378)

MET 5800 - Dynamics and Kinematics of Robotics Platforms

This course covers the dynamics and kinematics of rigid bodies as the foundation for analyzing the motion of robots. Robotic kinematics is reviewed by analyzing the motion of the robot. The dynamics is reviewed by analyzing the relation between the joint actuator torques and resulting motion.

Credits: 3.0

Lec-Rec-Lab: (0-2-2)

Semesters Offered: Spring

Pre-Requisite(s): MET 2130 or MET 3130

10. Model Schedule Demonstrating Completion Time

The certificate can be completed in three academic semesters.

Spring Semester

MET 4377 - Applied Fluid Power

Fall Semester

MET 5378 - Advanced Hydraulics: Electro-hydraulic Components & Systems

Spring Semester

MET 5400 - Key Factors of Holistic Safety Programs

MET 5800 - Dynamics and Kinematics of Robotics Platforms

11. Library and other Learning Resources

No library or other learning resources are required at this time.

12. Faculty Resumes

The following faculty will be supporting the program.

Kevin M. Johnson PE, Lecturer, Manufacturing and Mechanical Engineering Technology

David M. Labyak Assistant Professor, Manufacturing and Mechanical Engineering Technology

Scott W. Wagner Associate Professor, Manufacturing and Mechanical Engineering Technology

13. Equipment

No additional equipment will be required

14. Program Costs

Initially, there will be no additional costs for offering the certificate. However, as enrollment grows additional instructional resources will be needed.

15. Space

There are no new space requirements.

16. Policies, Regulations, and Rules

Not Applicable

17. Accreditation Requirements

Michigan Tech is accredited by the Higher Learning Commission (HLC). The proposed certificate will meet HLC criteria 3 and 4. The proposed certificate will not seek additional accreditation.

18. Planned Implementation Date

Fall 2022

19. Assessment

Upon successful completion of this certificate, students will be able to do the following:

1. Develop specifications to reduce risks and select safety components.
2. Implement concepts in kinematics and dynamics of robot manipulators.
3. Assess operating principles and design considerations for fluid power electro-hydraulic components and systems.

Approval Process

Department: September 23, 2021
College of Engineering Council: October 14, 2021
Provost's Office and Deans' Council: November 16, 2021
Graduate Faculty Council:
University Senate (Curriculum Policy Committee)