The University Senate of Michigan Technological University
Proposal 67-21

Establishment of a New Graduate Certificate in Profit-Increasing Strategies in Chemical Processing

Submitted by: Department of Chemical Engineering

1. **Proposal Date:** October 12, 2020

2. **Proposing Contacts and Department:**

   Dr. Jeana Collins, Department of Chemical Engineering, jeanac@mtu.edu
   Dr. Tony Rogers, Department of Chemical Engineering, tnrogers@mtu.edu
   Dr. Kurt Rickard, Department of Chemical Engineering, karickar@mtu.edu

3. **Sponsor Department Approvals:** Approved on October 7, 2020

4. **General Description and Characteristics:**

   4.1 General Description of Certificate

   The Graduate Certificate in Profit-Increasing Strategies in Chemical Processing would prepare students to design new processes, retrofit existing processes for capacity expansion and more flexible operations, and implement process (chemistry) modifications. The certificate would cover all three aspects essential to the design of chemical processes: process simulation or mathematical modeling, process economics, and process automation and control.

   The certificate would consist of three courses (total 9 credit hours) and is intended to provide advanced skills in all aspects of process design. The primary intended audience is chemical engineers practicing in the chemical manufacturing and/or petrochemical industry who are engaged in the process design function. It can also serve practicing engineers who have transitioned into the process design role after working in different functions for several years. Finally, entry-level process engineers would benefit from an awareness of the operational flexibility and economic benefits afforded by modular automation principles.

   4.2 Catalog Description

   Intended for chemical engineers, this certificate provides advanced skills in chemical process design for the chemical manufacturing and/or petrochemical industry. The first two courses provide advanced process simulation and economic analysis skills, which are used in a systems approach to optimize the entire operation. The third course builds on the skills acquired in the first two courses. This course focuses on developing dynamic models of processes, advanced control configuration and methods, and stability and performance analysis of controlled processes.

5. Rationale for Certificate:

The commercial viability of a chemical process rests on three pillars – (i) economics, (ii) a quantitative description relating operating parameters to product characteristics, and (iii) process automation to control and run the plant at desired operating conditions. Simulation of chemical processes provides a quantitative description of both the steady-state and the transient behavior, which is critical in designing a suitable control and automation strategy. Modern modular control strategies permit maximum utilization of capital equipment, reuse of software automation code for similar applications, and standardization of equipment purchases. This certificate would provide in-depth training on integrating these three pillars of a chemical process into a systems approach.

The intended audience of this certificate includes (i) graduate students, (ii) industrial practitioners engaged in process engineering, design, and/or control, and (iii) chemical engineering seniors.

6. Related Programs:

To the best of our knowledge, there are no certificates such as that described here that are targeted towards training engineers practicing in the chemical process industry.

7. Projected Enrollments:

It is anticipated that ~ 5 students from our non-thesis MS program would enroll in this certificate. Michigan Tech has a tradition of offering a strong set of two design courses as part of the capstone design sequence. Non-thesis MS students would greatly benefit from participating in this certificate, since they have had very little exposure to such an extensive process simulation, design, and economics analysis.

Engineers practicing in the chemical process industry (including the petrochemical industry) would be ideal candidates for this certificate. Most U.S. universities do not provide in-depth training in these topics. MTU alumni would be helpful in spreading the word.

Semester	On-campus Enrollment	Online Enrollment
Fall 2021	5	10
Fall 2022	5	15
Fall 2023	5	20
Fall 2024	5	25
Fall 2025	5	25

8. Scheduling Plans:

No change in the regular scheduling of the existing courses is anticipated. The three courses will be offeredthrough remote instruction (available either synchronously or asynchronously depending on a person's work schedule, both options available), beginning fall 2021, as described below.

9. Curriculum Design:

Required Coursework: 9 credits

Course One:	CM 4855	Chemical Process Analysis and Design I (3)
Course Two:	CM 5860	Capital Investment Projects in the Chemical Industry (3)
Course Three:	CM 5XXX	Chemical Process Dynamics and Automation (3)

Course Descriptions:

CM 4855 - Chemical Process Analysis and Design I

Capstone technical and economical evaluations of processes and unit operations. Applications of cost estimation, energy efficiency, and economic evaluation techniques. Students model a facility, address safety and environmental concerns, identify process improvements, reduce energy/utility consumption, estimate manufacturing profit, and recommend a course of action.

CM 5860 – Capital Investment Projects in the Chemical Industry

Process and project design principles applied to realistic problems, including project evaluation and management. Problems include safety, environmental, and operability constraints. Emphasizes the profit motive in industry and the role of the chemical engineer.

CM 5XXX – Chemical Process Dynamics and Automation

This course provides theoretical and practical knowledge needed to design, select, evaluate, and manage today's complex control systems and advanced control strategies. On-line plant simulation software is used with actual data acquisition systems to collect and analyze data for the design of control systems.

10. Model Schedule Demonstrating Completion Time

The certificate is designed to be completed in three semesters. CM5XXX may also be taken as the first course in the sequence.

Fall Semester

CM 4855 (3 credits) – course one

Spring Semester

CM 5860 (3 credits) – course two. This course has CM4855 as a prerequisite.

Summer Semester (Track A + B)

CM 5XXX (3 credits) – course three. The rationale for offering this course in summer is that the course instructor will need extra time to develop the course; offering it for the first time in summer will provide that extra preparation time. In the future, it is possible this course could be offered in fall or spring, with logistics issues carefully resolved, but the first several offerings are intended for summer.

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.

Dr. Jeana Collins, Department of Chemical Engineering
https://www.mtu.edu/chemical/department/faculty/collins/

Dr. Tony Rogers, Department of Chemical Engineering
http://www.mtu.edu/chemical/department/faculty/rogers/

Dr. Kurt A Rickard, Department of Chemical Engineering
https://www.mtu.edu/chemical/department/faculty/rickard/

13. Equipment

No additional equipment will be required.

14. Program Costs

Initially, offering the Certificate will not incur additional costs to Michigan Tech, but as enrollment grows additional instructional resources in the form of GTAs and a UniSim network license will be needed. Michigan Tech full-time faculty may or may not receive extra remuneration to teach a summer course such as CM5XXX, based on their fall and spring workload assignments.

15. Space

There are no new space requirements.

16. Policies, Regulations, and Rules: Not applicable

17. Accreditation Requirements

The proposed certificate will meet HLC criteria 3 and 4. The proposed certificate will not seek additional accreditation.

18. Planned Implementation Date

Fall 2021

19. Learning Objectives

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

- Define the scope of realistic industrial problems and perform process simulation, economic evaluation, and process optimization using computational tools
- Design advanced process control strategies to optimize performance of dynamic unit operations

Approval Process

Departmental Graduate Committee: August 2020
Department: October 7, 2020
College of Engineering: November, 2020
Graduate School
Provost's Office and Deans' Council
Approved by the Senate:
Approved by the President:

Michigan Tech

— Course Add Proposal —

PLEASE COMPLETE THIS FORM IN RED

A guide for completing this form is located at http://www.mtu.edu/registrar/faculty-staff/course-proposal/

1) Course Information

Is this a **half-semester course proposal?** ☐ Yes ☒ No

NOTE: All half-semester courses must follow rules set in Faculty Senate Proposal 4-00. See Senate website for details: http://www.sas.it.mtu.edu/usenate/propose/03/10-03.htm

Course Prefix/Number *(i.e. MEEM 2110)*: CM 5860

Course Title *(abbreviated; used on transcript - Up to **30** characters including spaces)*

Chemical Plant Investments

Alternative Title for Catalog *(Up to **100** characters including spaces)*

Capital Investment Projects in the Chemical Industry

2) Credits

Number of credits assigned to this course 3

OR

Range of credits if **variable** ☐ to ☐ *(Number of credits to be taken in a given semester)*

3) Schedule

Contact Hours per Week *(Lec & Rec: 1 credit =1 contact hour; Lab: 1 credit =1-3 contact hours. (i.e. a 3-credit course may be 2 contact hours of lecture or recitation and up to 3 contact hours of lab OR 1 contact hour of lecture or recitation and up to 6 contact hours of lab)*

Lecture	Recitation	Lab
2		2

OR

Research Course? ☐ Yes ☐ No

OR

Special Topics Course? ☐ Yes ☐ No

4) Additional Credits

May students receive **additional credits** by taking and passing this course more than once?

☒ No

☐ Yes, for a maximum of _____ credits. *(Must be a multiple of the course credits, i.e. Research or Special Topics)*

☐ Yes, for an unlimited number of credits. *(i.e. Music, Varsity sports, etc.)*

5) Pass/Fail

Will this course be offered as a **pass/fail option ONLY**? *(grade of S or E)* ☐ Yes ☒ No

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6) Cross/Dual Listed Course

Cross Listed: Is there an identical course offered in a different subject? ☐ Yes ☒ No

If yes, what is the other subject and course number? _____

Dual Listed: Is there a course offered at a different level? ☐ Yes ☒ No

If yes, what is the other course number? _____

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7) Equivalent Course: Does this course replace a dropped course with no change in course content for degree requirements, prerequisites, and repeating purposes? ☐ Yes ☒ No

If yes, what is the subject and course number of the dropped course? _____

8) Corequisites and Prerequisites

Corequisites are courses that are **REQUIRED to be taken at the SAME TIME** as this course (courses MUST be offered during the same term):

Required corequisite course(s):

_____

_____

Prerequisites are courses that are **REQUIRED to be taken PRIOR** to enrollment in this course.
Select appropriate box and use parentheses where needed.

Required prerequisite course(s):

1 CM 4855 Process Analysis and Design I

☐ And ☐ Or 2 _____

☐ And ☐ Or 3 _____

☐ And ☐ Or 4 _____

☐ And ☐ Or 5 _____

☐ And ☐ Or 6 _____

A **concurrent prerequisite** is a defined prerequisite course (from list above) that **MAY** be taken **EITHER** simultaneously in the same semester **OR** in a prior semester. Indicate below applicable courses.

Concurrent prerequisite course(s):

_____

_____

_____

9) Catalog Course Description

The traditional catalog style description for a course is limited to **350 characters including spaces**. If course is proposed as a half-semester course, please include that information in the description. **Please refer to the Course Proposal Guide for examples and suggestions on developing a course description.**

Process and project design principles applied to realistic problems, including project evaluation and management. Problems include safety, environmental, and operability constraints. Emphasizes the profit motive in industry and the role of the chemical engineer.

10) Registration Restrictions

- If permission is **always required** for registration purposes (a student cannot enter the course without department or instructor signature), please select the appropriate permission.

Do not select unless EVERY STUDENT must get "SIGNED INTO" the class.

☒ Department **OR** ☐ Instructor

- Students who register for this course may be restricted by their **College/School OR** their **Major**. Please indicate if any college or major restrictions should be applied to this course. If there are no restrictions please indicate in the check box provided.

☐ **No College/School Restrictions**

Colleges/Schools who MAY NOT enroll (EXCLUDE)

-OR-

Colleges/Schools who MAY enroll (INCLUDE)

☐ **No Major Restrictions**

Majors that MAY NOT enroll (EXCLUDE)

all except chem. engg.

-OR-

Majors that MAY enroll (INCLUDE)

Chemical Engineering

-- Restrictions continued on next page --

- A restriction may also be placed on **Class Standing** (freshman, sophomore, junior, senior, graduate). Please indicate if any class restrictions should be applied to this course. If there are no restrictions please indicate in the check box provided.

☐ **No Class Restrictions**

Class of students who MAY NOT enroll (EXCLUDE)

freshman, sophomore, junior

-OR-

Class of students who MAY enroll (INCLUDE)

senior, graduate

11) Semester(s) Offered

☐ Fall ☐ Spring ☐ Summer *(Check all that apply)*

OR ☐ On Demand

If offered in a specific semester, will the course be offered only in alternate years? ☐ Yes ☐ No

If yes, what will be the starting academic year? *(i.e. 2014-15 or 2015-16)* Spr 22

12) General Education

Is this course being proposed for General Education? ☐ Yes ☐ No

Proposal forms are available at: http://www.mtu.edu/registrar/faculty-staff/course-proposal/.

13) Course Computing Lab and Expendables Fees

DO NOT RECORD FEE INFORMATION HERE. Submit new course fee information on the New Course Fees Form available at: http://www.mtu.edu/registrar/faculty-staff/course-proposal/.

14) Course Learning Objectives (Required)

Upon successful completion of this course, students will be able to:

1. Apply process and project analysis, design, evaluation, and management skills
2. Define an appropriate scope, design and cost a project, and perform an economic evaluation of open-ended projects
3. Perform computer simulations of plant scale processes

15) Degree Programs which this course will affect

List the degrees, minors, and certificates in which this course will be required or used as an elective: ***

Degree Program(s):
BS in Chemical Engineering
MS in Chemical Engineering
PhD in Chemical Engineering
Graduate Certificate in "Profit-Increasing Strategies in Chemical Processing"

***** Be sure to adjust the appropriate degree audits in sections 7 and 8 in your department's binder.**

***16)* Course Rationale** *(Required)*

This advanced process design course builds on the basic undergraduate Chemical Process Analysis and Design I (CM 4855) course. This course allows students to develop a mastery of topics such as discounted cash flow investment analysis, comparing investment options, investment risk analysis, and decision tree analysis. Proficiency with a "toolbox" for design engineers will be developed that includes advanced skills in process simulation.

This course will provide a strategic capability to students which is lacking in most chemical engineering programs across the U.S.

17) Faculty Contact

Faculty proposing this course *(please print)*: Name _Dr. Tony Rogers_

Email _tnrogers@mtu.edu_

DID YOU USE RED INK TO COMPLETE THIS FORM?

IF NOT, PLEASE HIGHLIGHT YOUR ANSWERS SO NOTHING IS MISSED IN PROCESSING.

Michigan Tech

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Course Prefix/Number *(i.e. MEEM 2110)*: CM 5XXX

Course Title *(abbreviated; used on transcript - Up to **30** characters including spaces)*

Process Dynamics & Automation

Alternative Title for Catalog *(Up to **100** characters including spaces)*

Chemical Process Dynamics and Automation

2) Credits

Number of credits assigned to this course 3

OR

Range of credits if **variable** ☐ to ☐ *(Number of credits to be taken in a given semester)*

3) Schedule

Contact Hours per Week *(Lec & Rec: 1 credit =1 contact hour; Lab: 1 credit =1-3 contact hours. (i.e. a 3-credit course may be 2 contact hours of lecture or recitation and up to 3 contact hours of lab OR 1 contact hour of lecture or recitation and up to 6 contact hours of lab)*

3		
Lecture	Recitation	Lab

OR

Research Course? ☐ Yes ☐ No

OR

Special Topics Course? ☐ Yes ☐ No

4) Additional Credits

May students receive **additional credits** by taking and passing this course more than once?

■ No

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Will this course be offered as a **pass/fail option ONLY**? *(grade of S or E)* ☐ Yes ☒ No

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Dual Listed: Is there a course offered at a different level? ☐ Yes ☒ No

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---

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Prerequisites are courses that are **REQUIRED to be taken PRIOR** to enrollment in this course.
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Required prerequisite course(s):

1_____

☐ And ☐ Or 2_____

☐ And ☐ Or 3_____

☐ And ☐ Or 4_____

☐ And ☐ Or 5_____

☐ And ☐ Or 6_____

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This course provides theoretical and practical knowledge needed to design, select, evaluate, and manage today's complex control systems and advanced control strategies. On-line plant simulation software is used with actual data acquisition systems to collect and analyze data for the design of control systems.

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Colleges/Schools who MAY NOT enroll (EXCLUDE)

-OR-

Colleges/Schools who MAY enroll (INCLUDE)

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Majors that MAY NOT enroll (EXCLUDE)

all except chem. engg.

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Majors that MAY enroll (INCLUDE)

Chemical Engineering

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- A restriction may also be placed on **Class Standing** (freshman, sophomore, junior, senior, graduate). Please indicate if any class restrictions should be applied to this course. If there are no restrictions please indicate in the check box provided.

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Class of students who MAY NOT enroll (EXCLUDE)

freshman, sophomore, junior

-OR-

Class of students who MAY enroll (INCLUDE)

senior, graduate

11) Semester(s) Offered

☐ Fall ☐ Spring ■ Summer *(Check all that apply)*

OR ☐ On Demand

If offered in a specific semester, will the course be offered only in alternate years? ☐ Yes ■ No

If yes, what will be the starting academic year? *(i.e. 2014-15 or 2015-16)* summer 2022

12) General Education

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13) Course Computing Lab and Expendables Fees

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14) Course Learning Objectives (Required)

Upon successful completion of this course, students will be able to:

1. Use process data for stability analysis and modeling of chemical processes.
2. Apply advanced control technology to control chemical processes.

15) Degree Programs which this course will affect

List the degrees, minors, and certificates in which this course will be required or used as an elective: ***

Degree Program(s):
BS in Chemical Engineering
MS in Chemical Engineering
PhD in Chemical Engineering
Graduate Certificate in "Profit-Increasing Strategies in Chemical Processing"

***** Be sure to adjust the appropriate degree audits in sections 7 and 8 in your department's binder.**

***16)* Course Rationale** *(Required)*

This advanced process control course builds on the basic undergraduate Process Control course (CM 3310) and introduces the students to the real world control problems and strategies used to implement automation and control of complex chemical processes.

Senior-level Unit Operations Laboratory courses chemical engineering students hands-on experience in the process automation and control. This course would enrich students' learning by providing a strong underpinning for the basis of control in industrial systems.

17) Faculty Contact

Faculty proposing this course *(please print)*: Name Dr. Kurt Rickard

Email karickar@mtu.edu

DID YOU USE RED INK TO COMPLETE THIS FORM?

IF NOT, PLEASE HIGHLIGHT YOUR ANSWERS SO NOTHING IS MISSED IN PROCESSING.