

CONNECTED SYSTEMS

# REQUEST FOR AUTHORIZATION TO IMPLEMENT A MASTER OF SCIENCE IN CONNECTED SYSTEMS ENGINEERING (CSE) AT UNIVERSITY OF WISCONSIN-MILWAUKEE PREPARED BY UW-MILWAUKEE, INDUSTRIAL AND MANUFACTURING ENGINEERING DEPARTMENT

### ABSTRACT

The University of Wisconsin-Milwaukee proposes to establish a Master of Science in Connected Systems Engineering (M.S. CSE), to be offered by the Industrial and Manufacturing Engineering Department, in UWM's College of Engineering and Applied Sciences, in collaboration with UWM's Lubar College of Business and UWM's Connected Systems Institute (CSI). The development of this program responds to the need to prepare students for careers in connected systems in the manufacturing and service industries. According to indeed.com career guide (July 2023), systems engineering jobs promise 10% growth from 2021-2031. The 31-credit program is designed so that students will have a set of core courses that will present the fundamentals of connected systems, followed by a collection of technical electives, which are categorized to emphasize several focus areas. These areas include industrial engineering, manufacturing engineering, robotics and automation, cybersecurity and systems security, data analytics and enterprise resource planning and supply chain. The curriculum will involve the usage of case scenarios from the CSI automated manufacturing testbeds in most of the core courses. The need for this MS program is supported by the number of attendees in the non-credit re-skilling learning pathways offered through the CSI's Manufacturing Workforce Innovation Program (total of 189, between summer 2022summer 2023). The skills learned in these pathways are embodied in the courses included in this new MS program. Feedback from local manufacturing industry leaders (see page 9-10) indicates that such an interdisciplinary MS program will prepare a pipeline of future industry leaders. Considering the recent faculty hires at the Industrial and Manufacturing department and the resources available at the Connected Systems Institute, no additional resources will be required for this program.

# **PROGRAM IDENTIFICATION**

**University Name** University of Wisconsin-Milwaukee

#### **Title of Proposed Academic Degree Program**

Master of Science Connected Systems Engineering

Degree Designation(s)

Master of Science

### Suggested Classification of Instructional Program (CIP) Code

14.2701 – A program that prepares individuals to apply mathematical and scientific principles to the design, development, and operational evaluation of total systems solutions to a wide variety of engineering problems, including the integration of human, physical, energy, communications, management, and information requirements as needed, and the application of requisite analytical methods to specific situations.

### Mode of Delivery: Single Institution, in-person delivery

The degree will offered by the Industrial and Manufacturing Engineering department, with courses coming from the Lubar School of Business, Computer Science Department, School of Information Studies, and Mechanical Engineering. The degree will be based on flexible offerings. The courses are a majority in-person on-campus, with a possibility of some online.

# **Department or Functional Equivalent**

Industrial and Manufacturing Engineering Department

# College, School, or Functional Equivalent

College of Engineering and Applied Sciences

# **Proposed Date of Authorization**

February 2024

# Proposed Term of Implementation:

August 2024

# **PROGRAM INFORMATION**

#### **Program Overview**

The proposed MS program in Connected Systems Engineering is a 31-credit Capstone-based program which will be offered by the Industrial and Manufacturing Engineering Department in the College of Engineering and Applied Sciences, in collaboration with UWM's Connected Systems Institute (CSI) and the Lubar School of Business. This program, the first of its kind in the state of Wisconsin, is designed for graduates with at least a bachelor's degree in engineering and related fields, to reskill or upskill, and gain key knowledge that is necessary for current and future jobs in the manufacturing and service industries. The program entails courses in Industrial Internet of Things (IoT), data acquisition and data analytics, machine learning and artificial intelligence (AI), robotics/automation and digital twins as well as the sustainability in technological advances, taking ethical and social ramifications. Other courses include supply chain, enterprise resource planning and information technology. A unique aspect of this program is that the majority of the hands-on-experiential learning will take place in the state-of-the-art manufacturing testbeds and software that are available in the CSI.

# Projected Enrollments and Graduates by Year Five

This graduate program is being established to attract students from Wisconsin, and mostly from the southeast Wisconsin region (current UWM students in our engineering and related bachelor's degree programs and potential students who are already working and have engineering or related backgrounds such as indicated in the eligibility requirements). According to UWM data, about 85% of UWM graduates start their careers in Wisconsin upon completion of their bachelor's degrees. We envision that this MS program will attract a wide range of graduates, with engineering and related backgrounds, who wish to reskill or upskill in response to the changing job opportunities. We also consider that the program will be attractive to international students. The graduate program will equip students with the knowledge necessary in the current Industry 4.0 era, such as systems engineering, robotics, artificial intelligence (AI) and machine learning, ethics regarding the use and development of technology and information.

Table 1 provides the enrollment and graduation projections, year 1 starting in Fall 2024, with a 3-semester completion for full-time students and 5 semester completion for part-time students. The program is flexible (students are not in cohorts), so students may take as few as 3-4 cr per semester, but for purposes of calculations we assume 10 cr per semester for full-time and 6 cr taken per semester for part-time students. This estimation does not include summer semesters. Because the current MS graduation rate (Industrial and Manufacturing Engineering) is about 95%, the Table has a built-in 90% retention rate, and we assume 75% of the students are expected to be full-time and the other 25% are part-time. At the end of the first five years, about 112 students will have enrolled and 67 students will have graduated. Note, Table 1 tracks enrollment by year rather than by semester. Details on the calculations are provided in the Budget Cost and Revenue Projections Narrative and Spreadsheet.

<b>Table 1: Five-Year Enro</b>	llment and	l Completi	on Project	ions by H	Headcount
					1

Students/Year	Year 1	Year 2	Year 3	Year 4	Year 5
New Students	15	18	22	26	31
Continuing Students	-	8	12	14	17

Total Enrollment	15	26	34	40	48
Graduating Students	-	10	16	19	23

#### **Tuition Structure**

Tuition revenues were calculated based on the Fall 2023 UWM graduate tuition and fees schedule or students enrolled in the College of Engineering and Applied Sciences. In this proposal, we estimate that a full-time student wil be taking 10 credit hours a semester, paying a total of \$6,132 in-state tuition, including \$782 in seg fees. The part-time students wil be taking 6 credit hours a semester, paying a total of \$4,668 in-state per semester, including \$655 in seg fees. A conservative approach has been taken in estimating the cost projections, but we anticipate that a proportion of the students will be paying non-resident rates which are \$12,848 for full-time and \$9,704 for part-time students. A note here is that graduate tuition costs at UWM plateau at 8 credits.

Considering the multi-disciplinary selection of the courses from multiple academic departments, the mode of delivery is diverse; in-person or online. Therefore, in addition to the tuition and segregated fees, students who choose courses with online offerings will incur \$30 per credit for online courses. Also, some courses will be delivered by schools which charge 'master's surcharge fees. For instance, courses taken from the Lubar School of Business will carry an additional \$167.71 per credit. A note here is that these additional costs (online and master's surcharges) do not plateau at 8 credits.

#### **Student Learning and Program Outcomes**

The core objective of this MS in Connected Systems Engineering is to equip students to solve complex and critical system-level problems in the manufacturing and service industries. This overarching goal embodies the mission of the Institute of Industrial and Systems Engineers (IISE), the premier professional organization for systems engineers ("we serve those who solve the complex and critical problems of the world"). Specifically, students graduating from the MS in Connected Systems Engineering program will be able to:

- Understand, analyze, integrate, and validate complex systems.
- Apply and integrate the appropriate data analytical skills and tools to solve industry problems under uncertain conditions.
- Synthesize diverse business models and identify model features that ensure system agility.
- Design coherent industrial system-level solutions using Industry Internet of Things (IIOT) solutions including data analytics, remote sensing and controls, robotics and automation, mixed reality, digital twin and cybersecurity solutions.
- Synthesize, evaluate and apply measurable key performance indices to assess the effectiveness of the proposed system-level solutions.

#### Program Curriculum Requirements

The program is in tandem with the existing master's programs at CEAS (Table 2), in that it consists of 18 credits of required core courses, 3 credits of the capstone completion course, 1 credit of writing effectiveness and 9 credits of elective courses.

Table 2. The General UWM CEAS Non-thesis Capstone MS option credit requirements.

Requirement Description	Credits
A minimum of 18 credits in an approved technical program	18
A minimum of 9 credits of approved electives	9
1 credit of Effective Technical Writing Course	1
A minimum of 3 credits of a capstone project course (or independent	3
study)	

The electives can be selected from a wide variety of courses from several programs in UWM, including Industrial and Manufacturing Engineering, Lubar School of Business, Computer Science, Mechanical Engineering, and the School of Information Studies. As shown in the curriculum (pages 4-6 of this document), the elective courses have been grouped by focus areas, so that a student can select all 9 elective credits from a single focus area if they wish to delve deeper into a focus area. Otherwise, students are free to take a mix of courses from multiple focus areas.

### Table 2: Masters in Connected Systems Engineering Program Curriculum

Academic degree program or major course requirements:

-	Core Courses	22 credits
IND ENG 741	Foundational Technologies for Connected Systems	1 credit
IND ENG 742	Cloud Architecture for Connected Systems	1 credit
BUS ADM 788	Digital Supply Chain Management: Tracking and Tracing	1 credit
IND ENG 540G	Foundations of Systems Engineering	3 credits
IND ENG 555G	Manufacturing Systems Integration	3 credits
IND ENG 715	Data Acquisition and Visualization for Industrial Decision Making	3 credits
IND ENG 716	Engineering Statistical Analysis	3 credits
Bus Adm 811	Process and Workflow Management	3 credits
IND ENG 999	Advanced Independent study towards the capstone design-Capstone Project	3 credits
EAS 701	Effective Academic Writing	1 credits
<b>Technical Electiv</b>	ve Courses (See endnotes below the table)	9 credits
	Industrial Engineering Focus	
Ind Eng 455G	Operations Research I	3 credits
Ind Eng 465G	Operations Research II	3 credits
Ind Eng 475G	Simulation Methodology	3 credits
Ind Eng 550G	Control of Automated Manufacturing Systems	3 credits

Ind Eng 571G Ind Eng 575G Ind Eng 717 Ind Eng 765 Ind Eng 777 Ind Eng 890	Quality Control Design of Experiments Operations Research in Engineering Management Operations Research Methods Scheduling and Realtime Resource Management Advanced Topics in Industrial and Systems Engineering	3 credits 3 credits 3 credits 3 credits 3 credits 3 credits
Ind Eng 550G Ind Eng 572G Ind Eng 587G Ind Eng 751 Ind Eng 890	Manufacturing Engineering Focus: Control of Automated Manufacturing Systems Reliability Engineering Lean Manufacturing Flexible Manufacturing Systems Advanced Topics in Industrial and Systems Engineering	3 credits 3 credits 3 credits 3 credits 3 credits 3 credits
Bus Mgmt 733 Bus Adm 781 Bus Adm 816 Bus Adm 818 Ind Eng 890	<b>Enterprise Resource Planning Focus:</b> Enterprise Simulation Game Enabling Supply Chains with SAP Business Intelligence Technologies and Solutions Information Systems Practicum (*ERP project only) Advanced Topics in Industrial and Systems Engineering	3 credits 3 credits 3 credits 3 credits 3 credits
Ind Eng 590 Bus Adm 781 Bus Adm 782 Bus Adm 783 Bus Adm 787 Bus Adm 789 Ind Eng 890	<b>Digital Supply Chain Management Focus:</b> Global Supply Chains Enabling Supply Chains with SAP Supply Chain Technology and Simulation Modeling and Analytics in Supply Chain Managing Connected Supply Chains Service Operations Management Advanced Topics in Industrial and Systems Engineering	3 credits 3 credits 3 credits 3 credits 3 credits 3 credits 3 credits
Mech Eng 476G Mech Eng 479G Mech Eng 733 Comp Sci 725 Comp Sci 746 Ind Eng 890	Mechatronics/Robotics/Digital Twin Focus Introduction to Robotics Advanced Mechatronics Sensors and Systems Robot Motion Planning Immersive Technologies and 3D User Interfaces Advanced Topics in Industrial and Systems Engineering	3 credits 3 credits 3 credits 3 credits 3 credits 3 credits 3 credits

Comp Sci 711 Comp Sci 715 INFOST 582G	Machine Learning Programming for Machine Learning Introduction to Data Science	3 credits 3 credits 3 credits
	Cybersecurity Focus	
Comp Sci 469G	Introduction to Computer Security	3 credits
INFOST 583G	Survey of Information Security	3 credits
INFOST 695G	Ethical Hacking I	3 credits
INFOST 696G	Ethical Hacking II	3 credits
INFOST 761	Information Privacy	3 credits
INFOST 784	Information Security Management	3 credits
Ind Eng 890	Advanced Topics in Industrial and Systems Engineering	3 credits
<b>Total Credits</b>		31 credits

NOTE: Ind Eng 890: Advanced Topics in Industrial and Systems Engineering. Qualifying topics include Global Supply Chain and Sustainable Technologies: Social and Ethical will count.

# **Eligibility Requirements**

Applicants must meet UWM's <u>Graduate School's mandated admissions requirements</u>. In addition:

1. Applicants should have a baccalaureate degree in engineering or related fields (mathematics, data science, statistics or a natural science) from an accredited college or university.

2. Applications will be reviewed by the Industrial and Manufacturing Engineering Department Faculty Committee to assess academic achievement and ability to do intensive graduate-level work.

# Collaborative Nature of the Program

This Master of Science in Connected Systems Engineering (M.S. CSE) will be offered by the Industrial and Manufacturing Engineering Department, in UWM's College of Engineering and Applied Sciences. Internal collaborators represent departments/schools from which students will take some of the required courses or technical electives. They include UWM's Lubar College of Business, UWM's School of Information Studies, UWM's Department of Mechanical Engineering and UWM's Computer Science Department. In addition, UWM's Connected Systems Institute will provide access to the test-beds, software, personnel time and other resources that students will need for hands-on learning in the courses and capstone projects. External collaborators will include manufacturing and service industries that will provide case projects for the capstone course.

#### Projected Time to Degree:

The estimated time to degree is 3-semesters for full-time students and 5 semester completion for part-time students. This is within the expected timeline for a masters degree

in the College of Engineering and Applied Sciences. In addition, any student enrolled must graduate within 5 years of enrollment, or otherwise request for exemption though the UWM Graduate School.

# **Program Review and Accreditation**

Consistent with all other graduate programs in CEAS, this proposed MS program will be accredited through the Higher Learning Commission (HLC). The HLC together with the internal UWM program review processes will provide the necessary program assessment and review oversight.

# **PROGRAM JUSTIFICATION**

### Rationale and Relation to UWM's Mission

The UW-Milwaukee Select Mission Statement, which can be found at <u>https://uwm.edu/mission/</u> states that:

"To fulfill its mission as a major urban doctoral university and to meet the diverse needs of Wisconsin's largest metropolitan area, the University of Wisconsin–Milwaukee must provide a wide array of degree programs [...]. Fulfilling this mission requires the pursuit of these mutually reinforcing academic goals:

- To develop and maintain high quality undergraduate, graduate, and continuing education programs appropriate to a major urban doctoral university.
- To attract highly qualified students who demonstrate the potential for intellectual development, innovation, and leadership for their communities.
- To further academic and professional opportunities at all levels for women, minority, part-time, and financially or educationally disadvantaged students.
- To promote public service and research efforts directed toward meeting the social, economic, and cultural needs of the state of Wisconsin and its metropolitan areas.
- To provide educational leadership in meeting future social, cultural, and technological challenges."

Among the goals listed in the UWM statement, the MS in Connected Systems Engineering program will also:

- Prepare and graduate a workforce that is ready to lead and contribute inindustry amidst disruptions that are being brought about by a proliferation of technology, and other social-cultural changes.
- Provide academic and professional opportunities at all levels for students from diverse backgrounds.
- To establish and maintain productive relationships with companies locally, regionally, nationally, and internationally.

Though the larger society may be made to believe that AI and automation is "coming for their jobs", we believe that, to the contrary, AI and automation, which are among the disruptive technologies, are not only increasing productivity, but also resulting in new job opportunities. This MS program, which will be skilling a workforce for these new job opportunities, has received the endorsement of the Industrial and Manufacturing Engineering program's Industry Advisory Board, as well as the CSI's academic and industry advisory boards. This new program will enable the current workforce to reskill for job opportunities in systems engineering, with specializations in automation, data analytics, artificial intelligence, digital supply chain and optimization of industry operation.

#### University Program Array

The College of engineering and Applied Sciences provide MS programs in: Civil Engineering/Urban Planning, Computer Science (regular and professional track); Biomedical Engineering; Energy Engineering; Electrical and Computer Engineering; Mechanical Engineering; Industrial Engineering; Manufacturing Engineering, Occupation and Biomechanics Engineering and Materials Engineering. This proposed MS program will increase the overall enrolment in CEAS graduate programs.

### Other Related Programs in the University of Wisconsin-System

Currently there are no programs in the state of Wisconsin that are exactly like the proposed program. There are, however, the following MS programs that are related: UW-Madison offers MS in Sustainable Systems Engineering, MS in Industrial Engineering (Systems Engineering and Analytics), MS in Data Analytics, MS in Design + Innovation, MS in Engineering Management, UW-Platteville offers a general MS in Engineering. The Milwaukee School of Engineering offers an MS in Engineering Management. None of the curriculum in these related programs offer a combination of knowledge areas that our proposed MS program will cover, including: IoT, machine learning, connected systems, multi-echelon inventory optimization, blockchain, robotics, cyber-security, or real-time data analytics.

# Need of Graduates as Indicated by Current Students

The IME department offered a topics course in connected systems (CS) at a U/G level, as a technical elective from Fall 2016 till Spring 2018 (about 20 students per semester). This course served as a precursor to the proposed MS program. The 3-credit CS course encompassed discussions, assignments, and projects in: (1) Emerging technologies that have enabled connectivity and digitization of manufacturing and service industries. (2) Connected systems network and network security, (3) cybersecurity, (4) data management and data flow in connected systems, (5) Predictive analytics and (6) Organizational models and culture. This course was well received by students, who asked for more courses of such flavor. We are currently offering Ind Eng 550, a course that provides skills in the automation of manufacturing systems. This later course has been a dealmaker for some graduates (about 20) in securing job positions. The need for this MS program is also supported by the number of attendees in the non-credit re-skilling learning pathways offered through the CSI's Manufacturing Workforce Innovation Program (total of 189, between summer 2022-summer 2023). The skills learned in these pathways are embodied in the courses included in this new MS program. We believe that given these pointers, and encouragement by our students, we will receive applicants to the MS program from students currently in our engineering B.S. programs, as well as local, regional, and international students. While we understand that in the short term, this new program may increase competition for other MS programs in the

IME department, but we believe that in the long run, this new program, which offers skills that are currently needed in the industry, will increase enrollment in the other existing MS programs, because the new courses in this new MS program will serve as technical electives for the existing MS programs.

#### Need of Graduates as Indicated by Market Demand

Rapid technological changes necessitate reskilling and upskilling of the current engineering workforce. According to the US Bureau of Labor Statistics' projections between 2022-2030, the number of jobs that require STEM- (Science, Technology, Engineering and Mathematics) related skills will grow faster that other employment (<u>Employment in STEM occupations : U.S. Bureau of Labor Statistics (bls.gov</u>)). There are job opportunities on the growth today, that were not in demand a decade ago. These include expert systems engineer, artificial intelligence engineer, cloud architecture engineer, data analyst, among others. Our MS program is geared toward our current students in the Bachelor's degrees and the local and regional workforce with engineering and related backgrounds who wish to gain more knowledge in systems engineering and choose from among the elective focus areas.

A Principal Engineer from Heartland Technology Group, Inc., an engineering employer in the region and industry partner at CSI stated that, "As a leading Wisconsin employer in industrial automation, an advance degree in Industry Internet of Things (IIoT), as proposed by the UW Milwaukee College of Engineering and Applied Sciences, is vital to the growth of our economy. As more industries adopt IIoT technologies to improve efficiency, reduce costs, and transform their operations, the demand for professionals with IIoT skills will grow exponentially. Beyond manufacturing, IIoT is expected to create new jobs in areas like data analysis, system management, and cybersecurity."

Additionally, the Directors of Global Academic Engagement and Advanced Technologies at Rockwell Automation Inc. jointly support the establishment of the MS CSE as follows: "We believe that an interdisciplinary master's program focused on connected systems is a critical step to closing the current industry knowledge gap and preparing a pipeline of future industry leaders. Seeing this outcome was a core reason RA engaged in developing the Connected Systems Institute (CSI) and we fully support the MS program's establishment." Rockwell Automation is a leading employer of UWM's graduates and key industry partner to the UWM IME Department and UWM's CSI. CSI offers several workshops for workforce development, whose contents are embodied in the new MS in Connected Systems Engineering. According to UWM CSI data on attendees, (summer 2022-summer 2023) a total of 181 learners, all of whom are employees from local manufacturing industries, came through some of the non-credit learning pathways offered through the CSI Manufacturing Workforce Innovation Program.

# COST AND REVENUE PROJECTIONS NARRATIVE UNIVERSITY OF WISCONSIN-MILWAUKEE MASTER OF SCIENCE IN CONNECTED SYSTEMS ENGINEERING

#### **PROGRAM INTRODUCTION**

The University of Wisconsin-Milwaukee proposes to establish a Master of Science in Connected Systems Engineering (M.S. in Connected Systems Engineering), to be offered by UWM's College of Engineering and Applied Sciences, in collaboration with UWM's Lubar College of Business and the Connected Systems Institute. The Industrial and Manufacturing Department will serve as the home academic unit for accreditation purposes. The development of this program responds to the need to prepare students for careers in connected systems in the manufacturing and service industries.

This 31-credit program is designed so that students will have a set of core courses that will present the fundamentals of connected systems, followed by a collection of technical electives, which are categorized to emphasize several focus areas. Considering the recent faculty hires at the Industrial and Manufacturing department and the resources available at the Connected Systems Institute, no additional resources will be required for this program.

### Section I – Enrollment

The MS in CSE program is planned to start in Fall 2024. We anticipate 15 students to begin in year 1, and envision a 20% increase in enrollment per year for the initial five years of the degree program (see row 6). We estimate a yearly 90% retention rate (see row 7). Since the program is 31 cr, we estimate that full-time students will take 10 or 11 cr per semester and part-time will take 6 or 7 cr per semester which yields a 3-semester completion, for full-time students and 5 semester completion for part-time students. We assume 75% full-time (graduating in 3 semesters), 25% part-time (graduating in 5 semesters) to calculate (in row 8) the number of graduates each December. Now to calculate the Continuing Student Headcount (row 9), since the spreadsheet is arranged by year rather than semester, we count the students who will be graduating in the middle of that year as 0.5 (Thus, for the year 2 continuing students, you count 0.5 times the number who graduated (of the 90% retained year 1 new students, this is the 75% who were full time) and the part-time students from year 1 who continue all year, that's 25% of the 90% retained year 1 students. For years 3—5, continuing students: first, count 0.5 times the retained parttime students who entered two years prior and are now graduating after 5 semesters (that was 25% of the new students from two years prior with 90% retention); second, it's similar to the year 2 calculation, count 0.5 of the prior year's 75% of students who are graduating after 3 semesters due to being full-time, and then the count of the 25% of the prior year's new students who are continuing on in part-time status). We then list the total student headcount (row 10) for use in Table 1 of the Authorization to Implement document.

For calculating FTE, the full-time students are counted as 1.0 FTE and part-time as 0.5 FTE. For new student FTE (row 11) we again use the estimate of 75% full-time, 25% part-time.

For continuing student FTE (row 12), we use a similar calculation to the headcount of continuing students (row 9) but this time count only as 0.5 FTE each of the part-time students.

At the end of the first five years, about 112 students will have enrolled in the program and 67 will have graduated.

#### **Section II – Credit Hours**

The program requirements consist of 31 total credits, as shown in pages 4-6 of the program description document. This is in tandem with the current UWM CEAS capstone-based MS programs. Of the courses in the listing, only three courses (with an asterisk) are being developed to be offered by Fall 2024. The rest are existing courses in UWM. Considering the array of courses that will be offered by several departments and schools, credits hours will be allocated to the respective generating unit. For the purposes of credit hour calculations, full-time and part-time students are estimated to take 10 and 6 credit hours per semester, thus enabling a 3-semester, and 5-semester time to graduation. This estimation does not include summer semesters. (Of course the program is flexible and students may take as few as 3-4 cr per semester, but the above assumptions were made for purposes of calculation.)

For calculating new credit hours (row 13), we interpreted this as credit hours taken by new students that year, so it's similar to the FTE calculation, instead of counting the full-time (75% of the students) as 1.0 FTE you count them as 10cr, and instead of counting the part-time (25% of the students) as 0.5 FTE you count them as 6 cr.

For calculating 'existing credit hours' (row 14), we interpreted this as credit hours taken that year by continuing students. Thus, these are also similar to the FTE calculations for continuing students, with the 1.0 FTE replaced by 10 cr and the 0.5 FTE for part-time students replaced by 6 cr.

# Section III – Faculty and Staff Appointments

The Industrial and Manufacturing Engineering Department has six faculty members (one non-tenured, five with tenure) and two instructional staff. Though not a requirement for the proposed MS in CSE, we anticipate that should there be additional financial resources at the college level, we may get additional faculty through the cluster hiring process in CEAS. We expect that 0.125 of each faculty and instructional staff's FTE will be dedicated to this program, for a total of 1.0 FTE devoted to the program. On the other hand, a 0.25 FTE is approximated for the administrative staff. None of these are new resources, all are existing staff.

# Section IV – Program Revenues

#### Tuition Revenues

Tuition revenues have been calculated based on the Fall 2023 UWM graduate tuition and fees schedule for graduate students enrolled in the College of Engineering and Applied Sciences (Table 1). The revenue projections have been calculated conservatively, by considering that all students will pay resident tuition rates. We anticipate drawing some non-resident tuition-paying students. As indicated earlier, 75% of new students are anticipated to be full-time, taking 10 credit hours a semester, paying \$5350 in tuition per semester, not including \$782 in seg fees. 25% of new students are anticipated to be full-time, taking 6 credit hours a semester, paying \$3886 in tuition per semester, not including \$655 in seg fees.

For calculating tuition (row 20), it's similar to the FTE calculations for new and continuing students, but added together. So, instead of counting the full-time (75% of the students) as 1.0 FTE you count them as 2\*\$5350 (2 semesters of tuition for 10 cr), and instead of counting the part-time (25% of the students) as 0.5 FTE you count them as 2\*\$3886 (2 semesters of tuition for 6 cr).

# of		Non-	Minnesota w/	Midwest	Segregated
Credits	Resident	Resident	Reciprocity	Rate	Fees*
1	1,006.67	1,846.11	1,532.63	1,341.07	337.88
2	1,738.97	3,417.85	2,790.89	2,407.77	401.39
3	2,471.27	4,989.59	4,049.15	3,474.47	464.90
4	3,203.57	6,561.33	5,307.41	4,541.17	528.41
5	3,935.87	8,133.07	6,565.67	5,607.87	591.92
6	4,668.17	9,704.81	7,823.93	6,674.57	655.43
7	5,400.47	11,276.55	9,082.19	7,741.27	718.94
8+	6,132.77	12,848.29	10,340.45	8,807.97	782.45

Table 1: UWM Fall 2023 Graduate Tuition Schedule for the College of Engineering and Applied Sciences

A \$30 per credit Instructional Technology fee is assessed for any online or hybrid class in addition to the Segregated Fee. There is no credit plateau for the Instructional Technology Fee. The amounts listed on this fee schedule do not include any special course fees or differential tuition that will be charged in addition to the normal tuition and are not included in pricing plateau. Consult the Fall 2023 Schedule of Classes for a complete listing. Differential tuition is defined on the Additional/Differential per credit Charges table available from the Fall 2023 Tuition and Fee Rates page.

If a student enrolls in courses with online delivery, and especially from the Lubar School of Business, the student will incur an instructional technology fee of \$30 per credit for each credit of online delivery. Considering the variety of available technical elective courses, these added online-delivery fees have not been included in the revenue projections. In addition, no tuition increase has been considered in the revenue projections.

#### Program/Course Fees

N/A

<u>Grants/Extramural Funding</u> N/A

Program Revenue (PR) N/A

<u>General Program Revenue (GPR)</u> N/A

### Section V – Program Expenses

### Salary and Fringe Expenses

The total salaries of the current six faculty members and two instructional staff in the department are \$626,796 and \$121,000 respectively. 0.125 of the total salary has been charged to this program as an expense. We have a 0.5 administrative support (shared between two departments), for a 0.5 administrative salary of \$25,000. Similarly, 0.25 of the administrative salary has been charged as an expense to this program. The 5-year projections in the total salaries have incorporated a 3% increase per year.

### Other Expenses

The department will use an eighth of the department's annual S&E allocations (approximately \$1,250) to fund to support annual technology and software needs of the program.

# Section VI – Net Revenue

The net revenues as shown in the cost and revenue projection spreadsheet will be distributed according to the UWM's budget model.

	University of Wisconsin -Milwaukee							
	Cost and Revenue Projections For	MS In Connected Systems Engineering Program						
	Itenis	Projections 2024 2025 2026 2027 2028						
		Year 1	Year 2	Year 3	Year 4	Year 5		
I	Enrollment (New Student) Headcount	15	18	22	26	31		
	Estimated next year rentention of New Student	14	16	20	23	28		
	Graduation count during this year		10	16	19	23		
	Enrollment (Continuing Student) Headcount	0	8	12	14	17		
	Total Headcount	15	26	34	40	48		
	Enrollment (New Student) FTE	13	16	19	23	27		
	Enrollment (Continuing Student) FTE	0	7	9	11	13		
Ш	Total New Credit Hours	135	162	198	234	279		
	Existing Credit Hours	0	71	95	116	138		
111	FTE of New Faculty/Instructional Staff	0	0	0	0	0		
	FTE of Current Fac/IAS	1	1	1	1	1		
	FTE of New Admin Staff	0	0	0	0	0		
	FTE Current Admin Staff	0.25	0.25	0.25	0.25	0.25		
IV	Revenues							
	Tuition	\$149,520	\$259,823	\$328,890	\$392,825	\$467,602		
	Additional Tuition	\$-	\$-	\$ -	\$-	\$-		
	Fees (indicate type)	\$-	\$-	\$-	\$-	\$-		
	Fees (indicate type)	\$-	\$-	\$-	\$-	\$-		
	Program Revenue (Grants)	\$-	\$-	\$-	\$-	\$-		
	Program Revenue - Other	\$-	\$-	\$-	\$-	\$-		
	GPR (re)allocation	\$-	\$-	\$-	\$-	\$-		
	Total Revenue	\$149,520	\$259,823	\$328,890	\$392,825	\$467,602		
v	Expenses							
	Salaries plus Fringes							
	Faculty Salary	\$78,350	\$80,700	\$83,121	\$85,615	\$88,183		
	Instuctional Academic Staff	\$15,125	\$15,579	\$16,046	\$16,527	\$17,023		
	Administrative and Student Support Staff	\$6,250	\$6,438	\$6,631	\$6,830	\$7,034		
	Facilities and Capital Equipment							
	University buildings and space	\$-	\$-	\$-	\$-	\$-		
	Capital Equipment	\$-	\$-	\$-	\$-	\$-		
	Operations	\$-	\$-	\$-	\$-	\$-		
	Other Expenses							
	Other (software and supplies)	\$1,250	\$1,250	\$1,250	\$1,250	\$1,250		
	Other (please list)	\$-	\$-	\$-	\$-	\$-		
	Total Expenses	\$100,975	\$103,966	\$107,048	\$110,222	\$113,491		
	Net Revenue	\$48,546	\$155,857	\$221,843	\$282,604	\$354,112		
Prov	ost's Signature:		Date:					

Provost's Signature:

Chief Business Officer's Signature:

Date: