Agendum
Oakland University
Board of Trustees Formal Session
June 28, 2024

BACHELOR OF SCIENCE IN ENGINEERING DEGREE IN MECHATRONICS AND ROBOTICS ENGINEERING
A Recommendation

1. **Division and Department:** Academic Affairs, School of Engineering and Computer Science, Department of Electrical and Computer Engineering.

2. **Introduction:** Oakland University proposes a new Bachelor of Science in Engineering (BSE) degree in Mechatronics and Robotics Engineering. The new major expands upon the strengths of existing coursework, research activity, and degree programs in the Department of Electrical and Computer Engineering as well as in the other departments in the School of Engineering and Computer Science. Its distinguishing features include: (1) a curriculum of the program satisfies the latest ABET accreditation criteria for engineering programs; (2) the program was developed in close collaboration amongst all departments in the School of Engineering and Computer Science and draws on courses and expertise from each; (3) the program is designed as an "umbrella" program that allows the selection of course work in several area of specializations within the mechatronics and robotics fields; and (4) the program offers the option of choosing one of six available major-dependent concentration that equip graduates with specialized expertise that is seeing rapidly growing demand in Southeast Michigan and nationally.

3. **Previous Board Action:** None.

4. **Budget Implications:** The primary source of funding for the program will be undergraduate tuition. The program is expected to generate a net income for the University from its first year of operation. Tuition revenue is expected to reach a steady state with 60 students by the fifth year of the program's operation. Salary expenses include a full-time faculty member and three graduate assistants. Operating expenses include marketing expenses for this new program. The proforma budget is included as Attachment B. The budget implication for this new program is minimal because it is mostly based on coursework and expertise already available within the School of Engineering and Computer Science.

5. **Educational Implications:** The proposed program will introduce two new courses that relate to robot operating systems and autonomous vehicle systems. These courses serve as foundation courses for the program. In addition, the offering frequency of six existing courses will be increased to ensure efficient degree progress and student success.

6. **Personnel Implications:** To manage the anticipated teaching load arising from the introduction of the two new courses, the program will necessitate the hiring of a full-time faculty member at the assistant professor level starting from the second year of its operation. Additionally, the annual hiring of three graduate assistants will be essential to supervise increased student enrollment and offering frequency of labs associated with the program.

7. **University Reviews/Approvals:** The proposed program has been reviewed by the School of Engineering and Computer Science Faculty Assembly, the University Committee on Undergraduate Education, the Oakland University Senate, and the Executive Vice President for Academic Affairs and Provost.

8. **Recommendation:**

WHEREAS, the BSE in Mechatronics and Robotics Engineering degree program is consistent with the objectives contained in Oakland University's Institutional Priorities; and

WHEREAS, the BSE in Mechatronics and Robotics Engineering degree program will build on the academic and research strengths of the School of Engineering and Computer Science and provide new educational and community engagement opportunities; now, therefore, be it

RESOLVED, that the Board of Trustees authorizes the School of Engineering and Computer Science to offer the BSE in Mechatronics and Robotics Engineering; and, be it further

RESOLVED, that the Executive Vice President for Academic Affairs and Provost will complete annual reviews of the BSE in Mechatronics and Robotics Engineering degree program to evaluate academic quality and fiscal viability to determine whether the program should continue.

9. **Attachments:**

A. Proposal for the BSE in Mechatronics and Robotics Engineering degree program.

B. Proforma budget for the BSE in Mechatronics and Robotics Engineering degree program.

Recommended on 6/19, 2024
to the Board for Approval by

Ora Hirsch Pescovitz, M.D.
President

Reviewed by

Joshua D. Merchant, Ph.D.
Chief of Staff and
Secretary to the Board of Trustees

Program Degree Proposal

Bachelor of Science in Engineering in Mechatronics and Robotics Engineering

Requested Program Implementation Term: Fall 2024

Department of Electrical and Computer Engineering (ECE)
Date Approved 09/15/2023

School of Engineering and Computer Science (SECS) Faculty Assembly
Date Approved: 09/29/2023

University Committee on Undergraduate Instruction (UCUI)
Date Approved: 12/05/2023

SECS Dean
Date Approved: 01/09/2024

University Senate
Date Approved: 04/18/2024

Board of Trustees
Date Approved: 06/28/2024

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ABSTRACT

The world is transforming at an unprecedented pace, driven by advancements in automation, mobility, artificial intelligence, and robotics. To stay competitive and provide our students with the skills necessary to succeed and serve our local and national industry, OU needs to offer an undergraduate program in Mechatronics and Robotics Engineering. Our existing successful MS program in this field provides a strong foundation for this program. In addition, we have worked with three other departments in SECS (Mechanical, Industrial and Systems Engineering, Computer Science and Engineering) to put together this proposal for a program that brings together course work, research, and student activities already "happening" at OU in the area of mechatronics and robotics to the forefront through the attractive and current program we are proposing in this document. The curriculum for the proposed program leverages the existing expertise and established courses from the Electrical and Computer Engineering, Industrial and Systems Engineering, and Mechanical Engineering Departments. The new resource needs are limited due to the existing infrastructure already in place and it is therefore time for us to offer a BSE in Mechatronics and Robotics to our constituents.

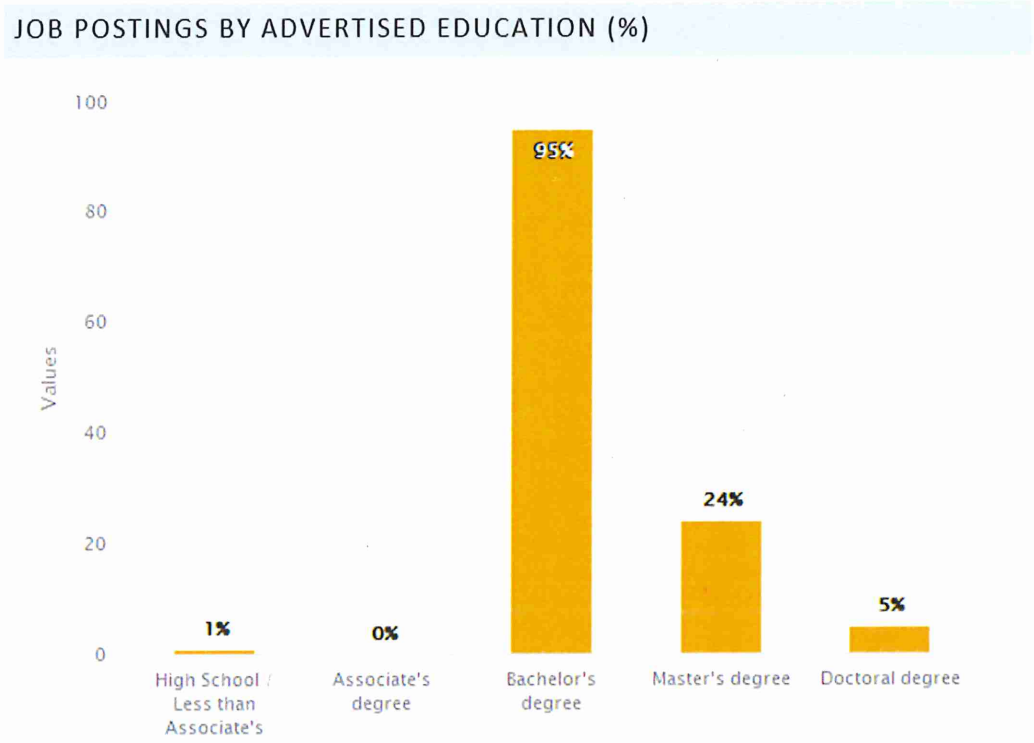
I. RATIONALE

1.1 Program Need

The field of mechatronics and robotics engineering is experiencing exponential growth and is poised to reshape various industries. There is an urgent need for skilled professionals who can bridge the gap between mechanical engineering, electrical engineering, computer engineering, and computer science. In order to meet the demands of the ever-evolving technological landscape, our institution must establish a comprehensive undergraduate program in Mechatronics and Robotics Engineering. There are many compelling reasons why this is the opportune time to launch such a program, namely, the vast range of career opportunities it presents to our prospective students, the industry demand for skilled professionals in these fields, and the demonstrated success of existing programs at other esteemed universities.

The Electrical and Computer Engineering (ECE) Department, in collaboration with other departments within SECS, has been offering an MS in Mechatronics Systems Engineering for about 15 years now and has 52 students enrolled according to the latest, September 6, 2023, report available for Fall 23. The MS Program is currently being reviewed for modification by the OU Graduate Council for renaming to "MS in Mechatronics and Robotics Engineering" and the addition of track and stackable certificates as a result of the program review and "modernization" efforts that we started coming out of the pandemic. This proposal for an undergraduate degree is the next step in ensuring that OU offers a program at the undergraduate level in this same developing field. The "Burning Glass" report recently run by eLIS for the program code "Mechatronics, Robotics, and Automation Engineering (14.4201)" in

Michigan cannot make any stronger case for the need to offer a degree program at the undergraduate level.



The job postings requiring an MS level degree in "Mechatronics, Robotics, and Automation Engineering (14.4201)" is 24%. The nationwide report results are similar: 95% of job ads target bachelor's degree holders, while 29% target master's degree holders. We already offer an MS program. And as discussed below, many local and national universities already offering degrees in this area at the undergraduate level. OU needs to offer one as well and we are well positioned to do so; building on our demonstrated success with our existing MS degree as well as the significant expertise we have in funded research and development in the areas of robotics and mechatronics.

Right Time for the Program

The world around us is transforming at an unprecedented pace, driven by advancements in automation, mobility, artificial intelligence, and robotics. Industries ranging from manufacturing and healthcare to transportation and entertainment are eagerly embracing these technologies to enhance efficiency, productivity, and innovation. The demand for professionals with a comprehensive understanding of mechatronics and robotics engineering has never been higher.

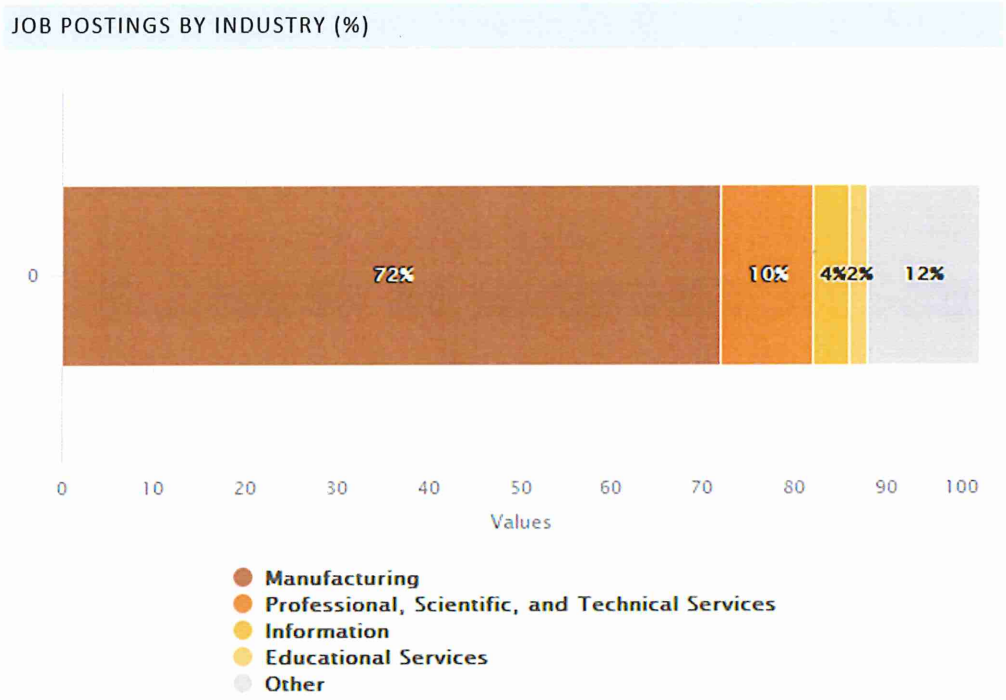
By launching a dedicated program in Mechatronics and Robotics Engineering, we will equip our undergraduate students with a unique skill set that is highly sought-after in the job market. Graduates of this program will possess the expertise to design, develop, and operate complex

robotic systems, intelligent machines, and automated processes. They will be at the forefront of shaping the future, unlocking endless opportunities across various industries.

Competing universities locally and nationally, as discussed below, already offer similar degrees successfully. We have more than it takes in terms of expertise, facilities, and track record to offer this program, so the time to offer it is now.

Career Opportunities

The job prospects for graduates in this field are incredibly promising. Students who complete the program will have a wide range of career options, including robotics engineers, automation specialists, mechatronics engineers, control systems engineers, research scientists, and technology consultants. According to Burning Glass, the following shows the general breakup by industry for graduates of the proposed program in Michigan.



As robotics engineers, our graduates will have the knowledge and skills to excel in contributing to the design and implementation of advanced robotic systems across industries. As automation specialists, with a strong foundation in mechatronics, students will be well-positioned to become responsible for optimizing manufacturing processes and improving efficiency. The program will also equip students with the expertise to design and implement control systems for mechatronics and robotics applications, opening opportunities in fields such as aerospace, mobility, and renewable energy. Moreover, with the advent of the Internet of Things (IoT) and the growing integration of robotics into everyday life, new job roles and entrepreneurial ventures are continually emerging, presenting our graduates with even more exciting possibilities.

Industry Demand

It is crucial to acknowledge the pressing need in the industry for a future workforce that is well-versed in mechatronics and robotics engineering. Companies are actively seeking professionals who possess a multidisciplinary skillset, combining electrical and mechanical engineering principles with knowledge of electronics, computer programming, and automation.

The manufacturing industry is undergoing a rapid transformation towards automation and intelligent systems. Companies are increasingly investing in robotic solutions to enhance production efficiency, reduce costs, and improve product quality. The demand for mechatronics and robotics engineers who can design and implement automation solutions is skyrocketing. For example, major automobile manufacturers such as General Motors, Ford, and Tesla have integrated robotics extensively into their manufacturing processes. These companies rely on mechatronics and robotics engineers to develop and optimize assembly line automation.

The healthcare sector is experiencing a significant need for mechatronics and robotics engineers to develop innovative solutions that enhance patient care and streamline medical procedures. Robotic-assisted surgeries, rehabilitation robotics, and assistive devices for the elderly and differently-abled individuals are just a few examples of applications where mechatronics and robotics engineering play a crucial role. Robotic surgical platforms like Da Vinci Surgical System, have revolutionized minimally invasive surgeries. The success of such systems underscores the demand for skilled engineers who can contribute to the development and advancement of healthcare robotics.

Industries such as oil and gas, energy, and aerospace require mechatronics and robotics engineers to design and implement complex control systems. These systems monitor and regulate critical processes, ensuring safety, efficiency, and precision. Siemens, a global leader in automation and control, employs mechatronics and robotics engineers to develop advanced control systems for power plants, industrial automation solutions, and sustainable energy projects. The demand for professionals with expertise in this field is consistently high.

Following are links to select articles from reputable sources that describe the existing prospects in the field of robotics and mechatronics:

- "**The Future of Manufacturing with Mechatronics and Robotics**," Robotics Careers, 12/22/2022, https://www.roboticscareer.org/news-and-events/news/27427
- "**Mechatronics and Robotics are careers of future**,' Education Times, 09/16/2021, https://www.educationtimes.com/article/careers-it-and-engineering/86254285/mechatronics-and-robotics-are-careers-of-future

- "**Embrace the Future with Mechatronics Technology**," Tech Insider Buzz, 06/02/2023, https://techinsiderbuzz.com/blog/embrace-the-future-with-mechatronics-technology/
- "**Robotics Engineer Salary: High Job Satisfaction & Growing Opportunities**," UDACITY, 07/30/2020, https://www.udacity.com/blog/2020/07/robotics-engineer-salary-high-job-satisfaction-growing-opportunities.html
- "**The Excitement Of The World With Mechatronics And Robotics Technology**," Medium, 07/07/2021, https://medium.com/databulls/the-excitement-of-the-world-with-mechatronics-and-robotics-technology-3e33dd89ef78
- "**Why Robotics And Artificial Intelligence Are The Future Of Mankind**," Forbes, 05/31/2022, https://www.forbes.com/sites/forbestechcouncil/2022/05/31/why-robotics-and-artificial-intelligence-are-the-future-of-mankind/?sh=5d42ab331689

Furthermore, attached to this proposal, in Appendix C, are 9 letters from local industry experts supporting this proposal and describing its significance. By establishing this program, we will not only cater to the demands of industry but also contribute to the economic growth and technological advancement of the Southeast Michigan region and beyond.

Success of Existing Programs

Several leading universities across the globe have recognized the significance of mechatronics and robotics engineering and have already implemented successful programs in this field. Institutions such as the University of Michigan-Ann Arbor, Carnegie Mellon University, and Georgia Institute of Technology have paved the way, producing graduates who have made significant contributions to their respective industries.

Carnegie Mellon University's Robotics Institute offers an esteemed undergraduate program in Robotics Engineering. This program has gained international recognition for producing graduates who have made significant contributions to the robotics industry and autonomous systems development. Graduates have gone on to work at renowned companies like Boston Dynamics, Amazon Robotics, and NASA's Jet Propulsion Laboratory, and have been instrumental in advancing the field through their innovative research and practical applications.

The University of Waterloo in Canada has a highly regarded undergraduate program in Mechatronics Engineering. This program equips students with a multidisciplinary skillset, combining mechanical, electrical, and computer engineering principles. Graduates have found success in diverse industries, such as robotics, automotive manufacturing, and industrial automation. They have been at the forefront of developing cutting-edge technologies, driving innovation, and addressing the complex challenges faced by industries today.

Delft University of Technology in the Netherlands offers a comprehensive undergraduate program in Mechatronics and Robotics. This program emphasizes hands-on experience, collaborative projects, and industry partnerships. Graduates have demonstrated exceptional expertise in designing and developing advanced robotic systems. Many have pursued

successful careers in research, industry, and academia, contributing to the field's growth and advancements.

The University of Michigan (Ann Arbor Campus) has also just established a BS in Robotics degree, which admitted its first students in the Fall of 2022. They furthermore created an independent Robotics Department and are currently developing a minor in robotics.

By joining the ranks of such institutions, we will align ourselves with the leaders in engineering education and ensure that our students receive a world-class education.

The introduction of a Mechatronics and Robotics Engineering program at our institution is not only timely but also crucial for preparing our students for the demands of the digital age. This program will empower our graduates to excel in emerging fields, secure rewarding careers, and drive innovation across industries. We need to seize this opportunity to be at the forefront of technological education, equipping the next generation of engineers to thrive in a world powered by robotics and automation.

1.2 How Program Will Promote the Role and Mission of the University and College/School

The overall mission of the School of Engineering and Computer Science is threefold:

- To provide high-quality undergraduate and graduate programs of instruction in engineering and computer science to prepare graduates for careers in the coming decades,
- To advance knowledge through basic and applied research in relevant branches of engineering and computer science, and
- To provide service to both the engineering profession and public of the State of Michigan.

Due to the proximity of Oakland University to a large number of automotive-related manufacturing companies in southeastern Michigan, the research interests of the faculty include a strong component of applied research. This research emphasizes product design, development, and manufacturing in support of both large and small companies. In addition, the faculty is engaged in research projects in a wide variety of scholarly areas of engineering and computer science.

Mechanical systems and robotics have evolved and continue to evolve into systems that require expertise and capabilities in electrical, computer, and mechanical engineering. In order to maintain a modern, progressive program at Oakland University, it is incumbent upon us to offer this multidisciplinary degree to train students and attract and retain faculty with expertise in mechatronics and robotics. Decades from now, systems will continue to be more sustainable and provide more automation using mechatronics and robotics.

1.3 Program Goals

The goal of this program is to add a new 4-year undergraduate curriculum at OU to address the growing robotics and mechatronics market, and its social and economic impacts that have resulted in significant interest from undergraduate students in the area of mechatronics and robotics. All students in the program will take a set of core courses from science and engineering. Students will then take a core set of professional subjects in mechatronics and robotics to prepare them for specializing in particular topical areas. Students will finish out their courses through a choice of one of the following major-dependent concentrations: Automotive Mechatronic Systems, Autonomous Vehicles, Electric Drives and Powertrains, Human-Robot Interaction, Industrial Robotics and Automation, and Intelligent Robotics and Controls. These specialty areas will give students a solid foundational background in engineering with specific depth areas useful to industry and as precursors to graduate studies.

The proposed program also has the goals of increasing enrollment in science and engineering at Oakland University; advance OU's reputation by providing a program that focuses on state-of-the-art technologies; and stimulate research collaborations and funding within Oakland and between the University and industry.

1.4 Comparison to Similar Programs (State/National)

Several academic institutions across the nation offer either a combined degree program in Mechatronics and Robotics or separate degree programs in Mechatronics or Robotics. Among Michigan institutions, a representative list includes University of Michigan (Dearborn), University of Detroit Mercy, Michigan Technological University, University of Michigan (Ann Arbor), Lawrence Technological University and Lake Superior State University. Among the national institutions, a representative list includes Kennesaw State University, Southern Illinois University, Indiana Tech, Oklahoma State University, Northeastern University, Kent State University and Virginia Tech. Although a few of the above programs were launched recently, the others were started in the last decade. A summary of the above programs and the links to their websites is provided below.

Mechatronics/Robotics programs at Michigan Universities

In Michigan, there are six robotics/mechatronics engineering degree programs, namely:

1. The University of Michigan (Dearborn) Robotics Engineering Program (https://umdearborn.edu/cecs/departments/electrical-and-computer-engineering/undergraduate-programs/bse-robotics-engineering)

The ECE department at University of Michigan (Dearborn) offers an ABET accredited BSE degree in Robotics Engineering. The annual enrollment in this program has been around 40 for last few years. In addition to the above degree program, they also offer a graduate MSE degree program in Robotics Engineering and a graduate certificate program in Industrial Mechatronics. This multi-technological program underwent a

successful ABET visit for accreditation as an electrical engineering degree in 2016-17 when its first batch of students graduated.

2. The University of Detroit Mercy Mechatronics and Robotics Engineering Program
(https://www.udmercy.edu/academics/catalog/undergraduate2020-2021/colleges/eng-sci/robotics-mechatronics-engineering.php)

The University of Detroit Mercy's Bachelor of Robotics and Mechatronic Systems Engineering program with a concentration in Electrical Engineering is an ABET accredited electrical engineering degree program. It focusses on the fundamentals necessary for the design of systems and products in which electronic and computer control of mechanisms, as well as environment sensing and interpretation, are combined to achieve intelligent products and environments and life-like performance. This multi-technological program underwent a successful ABET visit for accreditation as an electrical engineering degree in 2016-17 when its first students graduated.

3. The Michigan Tech Programs in Robotics Engineering and Mechatronics
(https://www.mtu.edu/ece/undergraduate/robotics/,
https://www.mtu.edu/admissions/academics/programs/majors/mechatronics/)

Michigan Tech University (MTU) offers two separate bachelor degree programs in Mechatronics and Robotics Engineering. The BS in Mechatronics at Michigan Tech is an interdisciplinary effort between the College of Computing's Department of Applied Computing and the College of Engineering's Department of Manufacturing and Mechanical Engineering Technology (MMET). BS in Mechatronics coursework and labs incorporate elements of engineering, engineering technology, and computing. In addition to above, the ECE department at MTU offers a BS degree in Robotics Engineering.

4. University of Michigan (Ann Arbor) Robotics Engineering Program
(https://robotics.umich.edu/2022/new-u-m-undergraduate-robotics-program/)

The BS Robotics degree program at University of Michigan (Ann Arbor) was launched in Fall, 2022. It focuses on the study of embodied intelligences that must sense, reason, act, and work with people to improve quality of life and productivity equitably across society. They also offer a MS degree program in Robotics.

5. Lawrence Technological University Robotics Engineering Program
(https://www.ltu.edu/engineering/mrie/undergrad-robotics)

The department of Mechanical, Robotics, and Industrial Engineering at Lawrence Technological University offers an ABET accredited BS degree in Robotics Engineering. It was launched in 2011 with the goal of educating robotics engineers who are capable of solving multidisciplinary technical problems related to robotics. They also offer a MS degree in Mechatronics and Robotics Engineering.

6. Lake Superior State University Programs in Robotics Engineering and Mechatronics
(https://www.lssu.edu/college-innovation-solutions/school-engineering-technology/engineering-degree-programs/mechatronics/, https://www.lssu.edu/college-innovation-solutions/school-engineering-technology/engineering-degree-programs/robotics/)

Lake Superior State University offers two separate bachelor degree programs in Mechatronics and Robotics Engineering. Both programs are new, launched in Fall, 2022.

Mechatronics/Robotics programs at other US Institutions

Across USA there are many engineering schools offering bachelor's programs either in the form of a combined degree program in Mechatronics and Robotics or separate degree programs in Mechatronics and/or Robotics. A representative list includes Kennesaw State University, Southern Illinois University, Indiana Tech, Oklahoma State University, Northeastern University, Kent State University and Virginia Tech. The links to the websites of the programs offered by the above institutions are provided below.

Indiana Tech - BS in Mechatronics and Robotics Engineering
https://academics.indianatech.edu/programs/mechatronics-and-robotics-engineering-bs/

Oklahoma State University - BS in Mechatronics and Robotics
https://go.okstate.edu/undergraduate-academics/majors/mechatronics-and-robotics.html
(Launched in Fall, 2022)

Northeastern University - BS in Mechatronics
https://cps.northeastern.edu/program/bachelor-of-science-in-mechatronics-boston/

Kent State University - BS in Mechatronics Engineering
https://catalog.kent.edu/colleges/ar/mechatronics-engineering-bs/

Virginia Tech - BSE in Robotics and Mechatronics
https://me.vt.edu/for-students/undergraduate/robotics-major.html

For the sake of brevity, only the degree program offered by Kennesaw State University is highlighted below.

Kennesaw State University Program in Mechatronics Engineering
(https://engineering.kennesaw.edu/robotics-mechatronics/degrees/bs-mechatronics.php)

The department of Robotics and Mechatronics Engineering at Kennesaw State University, in Georgia, offers an ABET-accredited bachelor's degree program in Mechatronics Engineering. This undergraduate program combines practices from mechanical, electrical, computer engineering, and computer science to provide students

with a multidisciplinary engineering education in the fast growing area of mechatronics engineering. The program is very popular there with enrollments of a few hundred students every year. In addition to the BS program, the department also offers an online MS degree program in Intelligent Robotic Systems, a Mechatronics Minor and a Robotics Programming Certificate for students wishing to incorporate robotic engineering and automation into their education.

II. ACADEMIC UNIT

2.1 How Program Supports Goals of the Unit

The Department of Electrical and Computer Engineering has dedicated faculty hires to mechatronics and robotics over the past ten years as the demand for courses and research in these areas has increased. While we have hired talented faculty, created new courses, and advanced our curriculums in these rapidly emerging areas, we have not created a degree program specifically for students in this area – until now. This degree program is the logical next step for the department to represent to prospective students, faculty, and employers the high-quality mechatronics and robotics curriculum that we have invested in over the past ten years. Electrical and Computer Engineering at Oakland consists primarily of electrical engineering, computer engineering, control systems, mechatronics systems, and robotics. With the support of the Mechanical, Computer Science, and the Industrial and Systems Engineering departments in SECS, this degree will showcase our capabilities in these areas and explicitly offers a modern curriculum for prospective and existing students to build careers in electromechanical systems and robotics.

2.2 Staffing Needs

To support the Mechatronics and Robotics Engineering program at both the undergraduate and graduate level, the ECE Department is requesting additional staff in the form of:

- A single tenure track faculty line in Year 2
- Two PhD Graduate Assistant Packages
- One MS TA Graduate Assistant Package

The ECE Department, as well as the SECS as a whole, has been working hard to update course and program offerings at both the undergraduate and graduate levels to better advertise the education opportunities available within the department and school. The Mechatronics and Robotics Engineering undergraduate program is a major part of this endeavor, and while only one new course was created and one course newly cross-listed specifically for this program, the program benefits from courses created and/or cross listed in support of other initiatives within the department or school. Since many of these new courses play a major role in the new program, we will need a single tenure track faculty line in support of this program.

The program lists 8 unique ECE rubric courses and 4 unique ME rubric courses under "Required Professional Subject." Under "Professional Electives" which are also the required

courses for the separate major-dependent concentrations, there are 11 unique ECE courses and 1 ISE course. The Required Professional Subject courses must be scheduled every semester, and the required courses for the concentrations must be scheduled at least once a year to ensure students have adequate courses to select from each semester. With current staffing, including about 6 to 8 part-time lecturers from the surrounding industry that we hire each semester, the ECE department is able to offer:

- All but two of the Required Professional Subject courses every semester. The two Required Professional Subject courses that we can't support with the current faculty are:
    - **ECE 3540 – Introduction to ROS** is a new course specifically designed for this program. With current faculty it can be offered every other year. As a Required Professional Subject courses, it will need to be offered every semester.
    - **ECE 4731 – Fundamentals of Embedded Systems Design** was a newly cross listed course as of Fall 2023. It was developed to support the Embedded Software Engineering and Computing track in the proposed BS in Software Engineering program from the Computer Science and Engineering Department. The course is currently offered once a year, but it will now also serve the Mechatronics and Robotics Engineering program as a Required Professional Subjects course and will need to be offered every semester.
- The ECE Department, with current faculty, is able to support all but four of the required courses for the major-dependent concentrations at least once a year. In support of the Mechatronics and Robotics Engineering concentration, the ECE department will need to begin offering the following courses every year rather than every other year.
    - **ECE 4520 – Automotive Mechatronics I** – currently offered every other year. It is also offered as an accelerated course during the summer semester if the faculty member desires to teach in the summer. With the creation of the Automotive Mechatronic Systems Concentration, we will begin offering the course at least once a year.
    - **ECE 4740 – Embedded Artificial Intelligence (AI)** is a new course as of Fall 2023. The instructor is currently supporting the course every other year. We will want to offer this course every year, as it is now a required course within the "Autonomous Vehicles" and "Intelligent Robotics and Controls" concentrations.
    - **ECE 4630 – Electric and Hybrid Drive Systems** is currently offered every other year. If the course instructor desires to teach during the summer, the course has also been offered as an accelerated summer course. This course serves as a required courses in the Electric Drives and Powertrains Concentration, so we will begin offering the course at least once a year to support the concentration.
    - **ECE 4640 - Battery Management Systems** will be a new course starting Fall 2024. The course is designed to support two major-dependent concentrations, Automotive Electrification in the BSE in Electrical Engineering program (new 2024), and the Electric Drives and Powertrains Concentration in the Mechatronics and Robotics Engineering BSE program. With our current faculty and part-time instructors, the ECE Department is only able to support offering

this course every other year. As a required course for a major-dependent concentration, we will begin offering the course once a year.

A tenure track faculty line will help us to meet these scheduling goals as well as bring additional talent and research to the program. Scheduling needs will be adjusted based on popularity of courses and part-time faculty from industry will help fill any additional gaps.

In addition to scheduling the courses for the program, the Mechatronics and Robotics Engineering program includes three courses which will now have linked laboratory sections in support of the lecture portion of the course. To support these laboratory offerings and to support research within the Mechatronics and Robotics Engineering area, the ECE department is also requesting two PhD Graduate Assistant Packages and one MS Graduate Assistant Package.

The PhD students and the Master's student will help in the department as Research Assistants and Teaching Assistants. In their Teaching Assistant role, they will support the laboratory sections for the following courses within the program:

- ECE 3540 – Introduction to ROS
- ECE 4600 – AC Motors Analysis and Design
- ECE 4640 – Battery Management Systems

Each of these courses will be new in Fall 2024 and each will have a linked laboratory section that will need Graduate Assistant support.

2.3 Faculty Qualifications

The current faculty members of the Electrical and Computer Engineering (ECE) and Mechanical Engineering (ME) Departments have the required expertise to teach all courses for the new program. The ECE Department currently has 21 and the ME Department has 23 full-time faculty members, each of them is holding a Ph.D. degree. Please visit the departments' homepages at
https://oakland.edu/secs/departments/ece/
https://oakland.edu/secs/departments/me/
for teaching and research interests of the faculty and links to their homepages.

2.4 Impact on Current Programs

A slight decline in enrollment in the EE, CE and ME program is probable at the beginning of this program because many students have expressed interests in the new major. For all the programs we have reviewed, Mechatronics and Robotics Engineering programs are often smaller than other ECE and ME programs. Therefore, we expect that the impact on the ECE and ME programs to be minimal. In the long run, however, we expect the new major to help grow all the programs in both departments by the increased synergy created by the new program and the number of new electives available to the students. Furthermore, we expect to attract students that previously chose other local universities over OU because we do/did not offer a program in robotics or mechatronics at the undergraduate level. To change this, we have

developed an exciting eight-semester 129-credit course plan for the Mechatronics and Robotics Engineering program and expect a significant number of students to enroll into the program as is the case at other universities offering such a program.

III. PROGRAM PLAN

3.1 Admissions Requirements

The admissions requirements for the BSE in Mechatronics and Robotics Engineering program are the same as those for admission into the School of Engineering and Computer Science (SECS). Specifically, a 3.0 high school grade-point average is required. Students who do not meet this requirement will be designated as an EGR/CS Candidate major, and will be required to follow the internal transfer policy to change to the BSE in Mechatronics and Robotics Engineering program. It is recommended, but not required for admission, that students entering from high school will have completed four years of high school mathematics with chemistry, physics, and computer programming.

3.2 Degree Requirements

The degree requirements for the BSE in Mechatronics and Robotics Engineering program include:

1. Complete at least 129 total credits and a minimum of 32 credits must be in courses at the 3000 level or above.
2. Students must complete at least 45 credits at Oakland University. The credits taken at Oakland must include at least 24 credits from the required courses within the program which can include courses from either the Engineering Core, Required Professional Subjects, or both.
3. Fulfill the university General Education Requirements.
4. Obtain major standing in the BSE in Mechatronics and Robotics Engineering major
5. Satisfy the following program requirements (for specific courses, please see the curriculum overview). Students must complete:
    - A course in Professional Ethics
    - A course in Economics
    - A minimum of 30 credits of Mathematics and Sciences
    - Engineering Core courses
    - Required Professional Subjects
    - Professional electives courses or an Optional Concentration
6. Earn a cumulative grade point average of at least 2.0 in courses taken at Oakland University
7. All students must apply to graduate by submitting an Application for Degree.

Major Standing

To gain major standing in Mechatronics and Robotics Engineering, students must:

A) have an average GPA of 2.0 in the following mathematics and science courses: MTH 1554, MTH 1555, APM 2555, CHM 1440, PHY 1510 and PHY 1520;

B) have an average GPA of 2.0 in engineering core courses;

C) have no more than two grades below C in the required courses listed in A and B above;
D) have not attempted any course listed in A and B above more than three times; and
E) have not repeated more than three different courses listed in A and B. Courses in which a W (withdrawal) grade is recorded will not be counted.

Performance requirements

Satisfactory completion of the program requires a GPA of at least 2.0 within each course group: mathematics and sciences, engineering core, and professional courses (including required professional subjects and concentration/elective) and a grade of C or better in the senior design capstone course (ECE 4999). Within professional courses, at most two grades below C are permitted, at most two different courses may be repeated, and a total of three attempts per course are permitted.

3.3 Intended program length

The program is designed to be completed over 8-semester or 4-years if the student chooses not to take summer courses.

3.4 Overview of Curriculum

General Education

The General Education Requirements are comprised of three parts: Foundations, Explorations, and Integration. In addition, U.S. Diversity requirements must also be met. For details, refer to the General Education section of the catalog. In order to satisfy both general education and other program requirements, in some of the general education areas students should select from the courses listed below:

Foundations:

- Writing Foundations - WRT 1060
- Formal Reasoning (Satisfied by MTH 1554 for engineering majors; see Mathematics and sciences)

Explorations: One course from each of the seven Explorations areas:

- Arts
- Language and Culture
- Global Perspective
- Literature
- Natural Science and Technology (satisfied by EGR 2400 or EGR 2500; see engineering core)
- Social Science (satisfied by ECN 1500, ECN 2010, or ECN 2020; see Additional Major Requirements)
- Western Civilization (satisfied by PHL 1310; see Additional Major Requirements)

Integration:

- Knowledge Applications (satisfied by MTH 1555; see Mathematics and sciences)
- Capstone (satisfied by ECE 4999; see Required Professional Subjects)

U.S. Diversity:

- May be met by an approved course in the Explorations area

Writing Intensive:

- Writing Intensive in the Major (satisfied by ECE 4999; see Required Professional Subjects)
- Writing Intensive in General Education (may be met by an approved course in the Explorations area)

Additional Major Requirements:

All students must meet the following requirements. Courses from these selections can meet general education exploration areas above,

- Professional Ethics: PHL 1310
- Economics: Choose one from ECN 1500, ECN 2010, or ECN 2020

In order to graduate on-schedule without taking additional courses, it is highly recommended that students meet with an SECS Undergraduate Academic Adviser concerning the selection of all of their general education courses.

Mathematics and Sciences

Students must complete at least 30 credits in the required math/science area. Students with fewer than 30 credit hours of math/science, for example due to transfers from another institution, must take additional courses to satisfy this requirement. Additional courses in math/science must be from the approved Math/Science Elective Options listed below.

- MTH 1554 - Calculus I (4)
- MTH 1555 - Calculus II (4)
- APM 2555 - Introduction to Differential Equations with Matrix Algebra (4)
- MTH 2554 - Multivariable Calculus (4)
- CHM 1440 - General Chemistry I (4)
- PHY 1510 – Introductory Physics I (4)
- PHY 1520 – Introductory Physics II (4)
- Approved Math/Science Elective from list below (4)

Approved Math/Science Elective Options:

Students majoring in Mechatronics and Robotics Engineering are advised to take **MTH 2775** to broaden their knowledge of Linear Algebra. However, students who have an explicit interest in broadening their knowledge in another area of math or science should select an elective from the following approved course list:

- APM 2663 - Discrete Mathematics (4)
- APM 3332 - Applied Matrix Theory (4)
- APM 3557 - Elements Partial Differential Equations (4)
- APM 4333 - Numerical Methods (4)
- APM 4334 - Applied Numerical Methods: Matrix Methods (4)

- APM 4555 - Intermediate Ordinary Differential Equations (4)
- APM 4663 - Graph Theory and Combinatorial Mathematics (4)
- APM 4777 - Computer Algebra (4)
- BIO 1200 - Biology I (4)
- BIO 1300 - Biology II (4)
- BIO 2100 - Human Anatomy (4)
- BIO 2600 - Human Physiology (4)
- BIO 3400 - Genetics (4)
- BIO 3220 - Neurobiology (4)
- BIO 4412 - Functional Genomics and Bioinformatics (4)
- CHM 1450 - General Chemistry II (4)
- MTH 2775 - Linear Algebra (4)
- MTH 3552 - Complex Variables (4)
- PHY 3250 - Biological Physics (4)
- PHY 3260 - Medical Physics (4)
- PHY 3310 - Optics (4)
- PHY 3610 - Mechanics I (4)
- PHY 3660 - Vibrations and Waves (4)
- PHY 3710 - Foundations of Modern Physics (4)
- PHY 4310 - Lasers and Applications (4)
- STA 2226 - Applied Probability and Statistics (4)
- or others by approval by petition to the SECS Committee on Academic Standing.

Engineering Core

- EGR 1200 - Engineering Graphics and CAD (1)
- EGR 1400 - Computer Problem Solving in Engineering and Computer Science (4)
- EGR 2400 - Introduction to Electrical and Computer Engineering (4)
- EGR 2500 - Introduction to Thermal Engineering (4)
- EGR 2600 - Introduction to Industrial and Systems Engineering (4)
- EGR 2800 - Design and Analysis of Electromechanical Systems (4)

Required Professional Subjects

Required:

- ECE 2005 - Electric Circuits (4)
- ECE 3204 - Signals and Systems (4)
- ECE 3540 – Introduction to ROS (4) (new course)
- ECE 4999 Senior Design (4) or ME 4999 Senior Design (4)

Choose any two courses from the list below:

Some of these courses are prerequisites of the Professional Elective courses.

- ECE 3100 - Electronic Circuits and Devices I (4)

- ECE 3105 – Electronic Circuits and Devices II (4)
- ECE 3600 – Electric Machines (4)
- ECE 4731 – Fundamentals of Embedded Systems Design (4)
- ME 3200 Engineering Mechanics (4)
- ME 3250 - Mechanics of Materials (4)
- ME 3300 - Computer Aided Design (3)

Professional Elective:

Students must complete 6 professional elective courses. To complete this requirement, students can either select a concentration or select courses from any of the depth areas listed below. Students interested in selecting a concentration can find the requirements printed following the list of depth areas.

Automotive Mechatronic Systems:

- ECE 4134 Fundamentals of MEMS (4)
- ECE 4400 Automatic Control Systems (4)
- ECE 4415 Microcomputer-based Control Systems (4)
- ECE 4520 Automotive Mechatronics I (4)

Autonomous Vehicles:

- ECE 4510 Machine Vision (4)
- ECE 4532 Autonomous Vehicle Systems I (4) (newly cross-listed)
- ECE 4740 Embedded Artificial Intelligence (AI) (4)

Electric Drives and Powertrains:

- ECE 4610 – Introduction to Power Electronics (4)
- ECE 4630 – Electric and Hybrid Drive Systems (4)
- ECE 4640 – Battery Management Systems (4)

Human-Robot Interaction:

- ECE 4551 - Human Robot Interaction (4)

Industrial Robotics and Automation:

- ISE 4423 Industrial Automation Systems (4)
- ECE 4500 Robotics and Control (4)
- ECE 4510 Machine Vision (4)

Intelligent Robotics and Controls:

- ECE 4400 - Automatic Control Systems (4)
- ECE 4500 Robotics and Control (4)
- ECE 4740 Embedded Artificial Intelligence (AI) (4)

Concentrations:

The Electrical and Computer Engineering Department offers optional concentrations in Automotive Mechatronic Systems, Autonomous Vehicles, Electric Drives and Powertrains, Human-Robot Interaction, Industrial Robotics and Automation, and Intelligent Robotics and Controls to students interested in broadening their knowledge in a specific area of mechatronics and robotics engineering and wishing an area of concentration in their degree. The following concentrations are available to, but not required of, any student enrolled in the Bachelor of Science degree in Mechatronics and Robotics Engineering. The sequences of courses listed below for each concentration are taken to satisfy the professional electives requirement. Note that completing the Bachelor of Science degree in Mechatronics and Robotics Engineering with a concentration may require more than 129 credits. Students may earn only one concentration and the concentration must be completed as part of their degree. The concentration will be noted on the students' transcript.

1. Automotive Mechatronic Systems

Required Courses:

- ECE 4400 - Automatic Control Systems (4)
- ECE 4415 Microcomputer-based Control Systems (4)
- ECE 4520 Automotive Mechatronics I (4)

Electives (Choose 3 Courses):

- ECE 4134 Fundamentals of MEMS (4)
- ECE 4510 Machine Vision (4)
- ECE 4532 Autonomous Vehicle Systems I (4)
- ECE 4731 Fundamentals of Embedded System Design (4)
- ME 4220 Vehicle Dynamics (4)
- ME 4200 Vibration and Control (4)
- ME 4205 Controls and Diagnostics of Automotive Systems (4)
- ME 4540 Internal Combustion Engines I (4)

2. Autonomous Vehicles

Required Courses:

- ECE 4510 Machine Vision (4)
- ECE 4532 Autonomous Vehicle Systems I (4)
- ECE 4740 Embedded Artificial Intelligence (AI) (4)

Electives (Choose 3 Courses):

- ECE 4400 - Automatic Control Systems (4)
- ECE 4415 Microcomputer-based Control Systems (4)
- ECE 4520 Automotive Mechatronics I (4)
- ECE 4731 Fundamentals of Embedded System Design (4)
- ME 4220 Vehicle Dynamics (4)
- ME 4205 Controls and Diagnostics of Automotive Systems (4)

3. Electric Drives and Powertrains

Required Courses:

- ECE 4610 Introduction to Power Electronics (4)
- ECE 4630 Electric and Hybrid Drive Systems (4)
- ECE 4640 Battery Management Systems (4)

Electives (Choose 3 Courses):

- ECE 4400 Automatic Control Systems (4)
- ECE 4520 Automotive Mechatronics I (4)
- ECE 4600 AC Motors Analysis and Design (4)
- ME 4525 Fundamental of Fuel Cell Science (4)
- ME 4535 Introduction to Electric Drive Vehicle Engineering (4)
- ME 4545 Fundamentals of Battery Systems for Hybrid and Electric Vehicles (4)

4. Human-Robot Interaction

Required Course:

- ECE 4551 - Human Robot Interaction (4)

Electives (Choose 5 Courses):

- ECE 4500 Robotics and Control (4)
- ECE 4510 Machine Vision (4)
- ECE 4532 Autonomous Vehicle Systems I (4)
- ECE 4740 Embedded Artificial Intelligence (AI) (4)
- CSI 3500 - Human-Computer Interaction (4)
- CSI 4130 - Artificial Intelligence (4)
- CSI 4810 - Information Retrieval and Knowledge Discovery (4)
- ISE 3341 - Ergonomics and Work Design (4)
- BE 3150 – Bioinstrumentation (4)
- BE 4100 - Biomedical Signal Processing (4)

5. Industrial Robotics and Automation

Required Courses:

- ISE 4423 - Industrial Automation Systems (4)
- ECE 4500 Robotics and Control (4)
- ECE 4510 Machine Vision (4)

Electives (12 credits):

- ISE 4431 - Engineering Operations Research - Stochastic Models (4)
- ISE 4461 - PLM Applications - Product Data Management (2)
- ISE 4462 - PLM Applications- Robotic Systems (2)
- ISE 4463 - PLM Applications - Ergonomics (2)
- ISE 4464 - Design for Manufacturing and Assembly Analysis (4)
- ISE 4466 - PLM Applications - Change Management (2)
- ISE 4467 - PLM Applications - Throughput Simulation (2)
- ECE 4551 - Human Robot Interaction (4)
- ISE 4483 Production Sys and Workflow Analysis (4)

- ME 4360 Mechanical Computer-Aided Manufacturing (4)

6. Intelligent Robotics and Controls

Required Courses:

- ECE 4400 - Automatic Control Systems (4)
- ECE 4500 Robotics and Control (4)
- ECE 4740 Embedded Artificial Intelligence (AI) (4)

Electives (Choose 3 Courses):

- ECE 4510 Machine Vision (4)
- ECE 4410 - Digital Control Systems (4)
- ECE 4415 - Microcomputer-based Control Systems (4)
- CSI 4810 - Information Retrieval and Knowledge Discovery (4)
- ME 4200 - Vibrations and Controls (4)
- ECE 4551 - Human Robot Interaction (4)
- CSI 4130 - Artificial Intelligence (4)

Description of new courses or newly cross-listed courses

ECE 3540 – Introduction to ROS (4)
This course provides an introduction to the robotics operating system (ROS) for robotics engineers in training to obtain first-hand experience in the development of robotic applications. Students will obtain first-hand experience on implementing software that enables a robot to sense, plan, and act. Namely, students will learn to develop software for a robot to:

- Obtain sensory information from a sensor, process the data, perceive the environment, and update its model of the state of the world around itself
- Create a plan for the robot to perform given its short-term and long-term understanding of the state of the world around itself
- Actuate a robot's motor given an input plan.

The course will culminate in the development of software that integrates the sense, plan, act paradigm to enable a robot to autonomously achieve a goal.
Prerequisite: Major Standing

ECE 4532 - Autonomous Vehicle Systems I (4)
The purpose of this course is to provide an overview of common techniques and challenges encountered in mobile robotics. Broadly, such topics include sensor data processing, sensor fusion, environment perception and mapping, and path planning and control.

Toward this end, the student will also be exposed to the Robot Operating System (ROS) software development environment. ROS is supported by a rapidly-growing community of open-source developers, and is starting to be adopted widely in many research, industrial, and automotive applications. ROS will be used to illustrate the theoretical components of the course,

as well as providing the student with a meaningful hands-on experience that will help the student learn the concepts more effectively.

Programming homework will be distributed and submitted using the Git version control tool. Besides making the submission and grading of homework more efficient, the student will also gain experience using version control tools that are widely used in both industrial and open-source software development.
Prerequisite: ECE 3540

3.5 Support of Other Departments and Academic Units

Mechatronics and Robotics Engineering is a discipline that spans multiple engineering and computer science areas. As such, the program was developed in close consultation with all departments and SECS and was voted on and approved by the relevant SECS committees and the SECS Assembly. Furthermore, the program was designed with the specific goal of allowing other departments the ability to develop additional Concentrations within the program in the future, making it what may be called an "umbrella" program. It is rare, within the SECS, for an undergraduate program to allow for 24 credits (6 courses) of Professional Electives. With six courses available, each Concentration is a meaningful exploration of an area. Currently, most concentrations are primarily ECE related, with the exception of the Industrial Robotics and Automation Concentrations which is comprised primarily of Industrial and System Engineering courses. All other departments contributed to the program by suggesting additional courses from their program that would support the Mechatronics and Robotics Engineering curriculum. In the future, there may be a Concentration within Mechatronics and Robotics Engineering that is more heavily focused on Mechanical Engineering, Computer Science, and/or Bioengineering. For now, the program has been created with the support and input from all other departments within the SECS.

3.6 Source of Students

The evolution of electro-mechanical systems from those traditionally run on fossil fuels coupled with robotic automation with artificial intelligence and augmented reality has increased demand for engineering professionals with expertise in robotics and electrical and mechanical systems. Some of the proposed new Mechatronics and Robotics program enrollment comes from existing engineering students interested in these areas. Since the automotive and adjacent manufacturing industries are one of the top communities that Oakland serves locally and globally, this program will certainly attract new students to Oakland University because of its expanded multidisciplinary nature and its long-term relevance to industry, society, and graduate school.

Oakland University will be an attractive option for students who wish to major in mechatronics and robotics because it will be a smaller, individualized program incorporating unique undergraduate experiences not offered by larger institutions at the undergraduate level. Furthermore, Oakland's location among the heart of automation alley, major automotive

companies, robotics companies, and manufacturing centers are attractive to students interested in learning about mechatronics and robotics.

Overall, there is an undeniable growing interest in not only Mechanical Engineering or Electrical Engineering but the multidisciplinary field of Mechatronics and Robotics Engineering from students. Offering this major will attract students who would not have come to Oakland otherwise; failing to cater to this growing interest will lead students to transfer to institutions that do.

3.7 Recruiting

One of the key missions of the introduction of this program is the opportunity to attract new students to Oakland. We will therefore devote resources to recruitment, advising, and mentoring to ensure that they are properly advised and retained in the program. We see the need for proper advertising of the program and outreach efforts to make it visible.

Recruitment efforts for this program can be coordinated with other initiatives on campus. The School of Engineering and Computer Science offers REU programs that target undergraduate and graduate students from OU and neighboring institutions and mentors them in research for the purpose of attracting them to the field of mechatronics and robotics. We will use a combination of flyers and advertising over the web to recruit students to Oakland and into this program. In addition, we already have significant research efforts and student organization activities that will inevitably play a visible role in attracting attention to our program. These include the ongoing industry and federally funded research in the areas of social robotics, electrified powertrain, autonomous vehicle technology, industrial robotics, battery management and control, augmented and virtual reality, as well as opportunities for student engagement through the Electric Racing Club, the Makers Club, the Oakland Robotics Club, and the smart vehicle Club.

3.8 Expected Enrollment

Over the past five years, a number of students in the School of Engineering and Computer Science have shown keen interests in mechatronics and robotics courses. As shown in the following table, the enrollments in these courses have been very robust for a number of years and are amongst the most popular electives in the department.

Enrollments in Mechatronics and Robotics Courses at OU

The ECE department offers four main courses in the areas of mechatronics and robotics:

- ECE 4500/5500 - Robotic Systems and Control (4)
- ECE 4510 - Machine Vision (4)
- ECE 4520/5520 - Automotive Mechatronics I (4)
- ECE 4551/5551 (4900/5900) - Human Robot Interaction (4)

Three of these courses, ECE 4500/5500, ECE 4510 and ECE 4520/5520, have been offered regularly for a number of years, but ECE 4551/5551 is a relatively new course. The recent enrollments in the above courses are shown in the following table.

Recent Enrollments in ECE Robotics/Mechatronics Courses				
Semester	**ECE 4500/5500**	**ECE 4510**	**ECE 4520/5520**	**ECE 4551/5551 (ECE 4900/5900)**
Winter 2023	37/7	-	-	5/4
Fall 2022	-	21	6/31	-
Winter 2022	51/8	-	-	-
Fall 2021	-	30	30/18	2/8
Winter 2021	61/15	-	-	-
Fall 2020	-	37	-	5/6
Winter 2020	40/8	-	-	-
Fall 2019	-	27	24/52	3/6
Winter 2019	33/10	-	-	-
Fall 2018	-	26	31/42	-

As evident from the above table, the enrollments in the three key robotics/mechatronics courses, ECE 4500/5500, ECE 4510 and ECE 4520/5520, have been moderately high for a number of years, which is a testament to their popularity and worth in the job market.

Some of the enrollment in the proposed new Mechatronics and Robotics Engineering degree program would thus come from existing engineering, mathematics, and natural science students who possess an interest in mechatronics and robotics. The program is also expected to attract new students to Oakland University because of its interdisciplinary nature and its relevance to industry, society, and graduate school.

Oakland University will be an attractive option for students who wish to major in Mechatronics and Robotics because it will be a smaller, individualized program incorporating unique undergraduate experiences not offered by larger institutions at the undergraduate level. The program will improve retention because many students initially seek Oakland as an institution where they can study locally, then transfer to another institution which has the specific program in which they develop an interest. Presently, students interested in earning a degree in Robotics and/or Mechatronics must select a university other than Oakland or major in a traditional engineering discipline at Oakland. This makes them less competitive for a job requiring robotics/mechatronics skills after their baccalaureate degree, and places them at a disadvantage for graduate studies in these fields.

Overall, there is an undeniable growing interest among OU students in Mechatronics and Robotics because of their ever-increasing importance in automotive industries, health care, manufacturing, industrial drives and numerous other related fields. Offering this major we will attract students who would not have come to Oakland otherwise; failing to cater to this growing interest will lead students to transfer out to institutions that do.

As a testament to the above, the enrollments in similar programs offered by University of Michigan-Dearborn (UMD) and Kennesaw State University (KSU), Atlanta, are provided below.

These can be regarded as reflections of the regional and national enrollment trends in similar programs elsewhere.

Enrollments in the Programs Offered by a Michigan and a National Institution

University of Michigan-Dearborn Enrollment/graduation data for BSE degree program in Robotics Engineering		
Academic Year	Fall Enrollment	Degrees Awarded
2022-2023	38	
2021-2022	36	9
2020-2021	33	5
2019-2020	43	12
2018-2019	45	4

The UMD program's website claims that "Recent UM-Dearborn graduates with a BSE in electrical engineering with a focus on robotic systems have found professional employment in such companies as AT&T, DTE Energy, Ford, General Dynamics, General Electric, Harman Becker, Lockheed Martin, Masco, Motorola, NASA, N.S.A., Ricardo Industries, US Steel, Visteon, and Xilinx."

Michigan Technological University (Michigan Tech) has two separate BS programs, A BS in Mechatronics and a BS in Robotics Engineering. The Fall 22 enrollment is 34 students in the first program and 70 students in the latter (historical data is not available to us). The combined enrollment in mechatronics and robotics engineering at Michigan tech is hence 104 undergraduate students.

Kennesaw State University, Atlanta Enrollment/graduation data for BS degree program in Mechatronics Engineering		
Academic Year	Fall Enrollment	Degrees Awarded
2021-2022	354	63
2020-2021	329	82
2019-2020	429	48
2018-2019	414	42
2017-2018	407	44

The KSU program's website claims that "With nearly a 100% employment rate for robotics and mechatronics engineering graduates and an average entry-level salary of $64,000 (recruiter.com), Kennesaw State University SPCEET's robotics and mechatronics graduates enter a steadily growing job environment with unique hands-on experience."

The enrollment data at Michigan Tech and KSU is especially encouraging, because it illustrates the growth potential for a BS degree in robotics/mechatronics engineering. The electrification

drive underway in the automotive and ancillary industries in Southeastern Michigan is expected to act as a catalyst for this growth in the years ahead.

Based on reviewing the current numbers at other universities, considering our capabilities and reputation in the field, and considering the expected growth and popularity of robotics and mechatronics (which will positively affect our enrollment and that of competing schools as well), we expect the program to start with 15 students in the first year and grow to a steady 60 students in year 4. We can see the program to ultimately become as popular as our other engineering programs with over 100 students enrolled.

3.9 Retention Plan

The retention efforts for this program will utilize the current retention resources currently in place for the SECS. The SECS advisors identify struggling students and help to advise the students on techniques and resources to help them improve. The student will be advised to do one or more of the following:

- reduce their credits per semester,
- take advantage of professor office hours
- take advantage of tutoring available for the math, science, and engineering core classes

If the above is not successful, students are encouraged to meet with faculty to discuss a potential change of major within the SECS.

We find that most of our retention difficulties occur in the math requirements for the first few years of the engineering programs. The SECS is currently running a pilot program in the development of two courses to help struggling students. The first pilot course to be offered in Winter 2024 is being run by the Mechanical Engineering department. The course is designed to bridge the gap between the math courses and the mechanical engineering courses. The goal is to improve the students' knowledge retention as they move into the professional subject courses. This effort, if successful, will aid students who are struggling in their major specific courses.

The second course is designed for students who are not calculus ready when they enter the engineering program. This course is modeled after similar efforts implemented at Wright State and multiple other universities. For the pilot, we are targeting students majoring in programs within the Electrical and Computer Engineering department. The course is designed to teach students how math is used in the engineering disciplines while providing additional support and encouragement to these students. All engineering programs that have implemented a course of this type have shown an increase in retention. Dr. Nathan Klingbeil from Wright State will be presenting a talk about this course to the Oakland University community on November 6th. A short video of Dr. Klingbeil discussing the approach can be found here (https://youtu.be/CWCWq155hyc).

3.10 Academic Advising

Students interested in the program will be supported and advised by the: SECS advising office, faculty, Academic Programs Coordinator, and Department Chair within the Electrical and Computer Engineering Department. Students will be required to meet with an SECS advisor at least once a year for schedule planning, major standing application, and evaluation of the performance requirements of the program. The requirements for obtaining Major Standing within the program and the Performance Requirements will be the same as the other engineering programs within the SECS, so the SECS advising office staff are already experts in helping students navigate those aspects of this program. The SECS advising office has reviewed and provided feedback concerning the curriculum, major standing requirements, and performance requirements for this program.

Faculty within the department are experts on the subject material and are best suited for helping students choose either a concentration or non-concentration route through the program based on discussions with the students. The SECS advising office encourages students in all engineering programs to seek faculty advise about choosing Professional Elective courses based on career goals and/or student interest. If a student decides to specialize, faculty will advise the students on which concentration to choose.

Students who have special circumstances requiring a different path through the curriculum, prerequisite waivers, and/or petitions will be advised by the SECS advising office, the Program Coordinator, and/or the Department Chair. In most situations, the Program Coordinator and/or Department Chair will be able to resolve most problems with support from the advising office. In the cases where petitions are required, the Undergraduate Committee on Academic Standing (CAS) will review the student's records, petition request, and advising office input, to make final determinations on approving or denying the petition. The CAS committee is composed of a representative from every department and an at-large member who is selected, by election, from all tenured or untenured faculty within the SECS.

IV. NEEDS AND COSTS OF THE PROGRAM

4.1 New Resources Needed for the Program

A tenure track faculty member is required for the program to:

- Develop and teach courses in the program
- Ensure the department has enough faculty within the Mechatronics and Robotics Engineering program to offer the courses in this program on a regular basis
- Bring additional research and expertise to the program

As described in Section 2.2, the department will need to offer a new course ECE 3540 – Introduction to ROS, and increase how often five other courses are offered. A tenure track faculty member dedicated to the Mechatronics and Robotics Engineering program will be an investment in the continued success and growth of the program.

Two PhD Graduate Assistants packages and one MS Graduate Assistant package are required to support the new teaching labs that will be offered as part of this program, and to support the research efforts of faculty research in the Mechatronics and Robotics Engineering area.

Also described in Section 2.2, new teaching lab exercises will be provided to give students additional hands-on experience with topics related to mechatronics and robotics. Two PhD and one MS Graduate assistants are needed to help develop and run the labs for the new ECE 3540 – Introduction to ROS course, and both the ECE 4600 – AC Motors Analysis and Design and ECE 4640 – Battery Management Systems courses which serve multiple programs within the department.

4.2 Source of New Resources

Tuition from students enrolling in the Mechatronics and Robotics Engineering program will fully support the cost of the new resources as shown in the Proforma Budget provided in Appendix D.

4.3 Budget and Revenue from Program

The Proforma Budget is provided in Appendix D. Tuition revenue projections for the first three years of the program. Note that tuition numbers are conservative as they are taken from lower-level tuition only and assume that there is no tuition increase in the latter years. Expenses include that of 1 assistant professor line and 3 GAs described above. No other expenses are necessary because this new program is primarily based on the infrastructure, expertise, courses, laboratories, and other resources already available supporting the current ECE and other SECS programs.

4.4 Library Holdings

No changes to the library support is necessary. The coursework and scholarly resources are already available and in use by existing SECS programs (i.e., BSE Electrical Engineering, BSE Computer Engineering, BSE Mechanical Engineering, BSE Industrial and Systems Engineering, and MS in Mechatronics and Robotics Engineering)

4.5 Classroom, Laboratory, Space Needs

No additional laboratory or equipment are required for this program. Current resources within the ECE Department will be sufficient to run the program.

4.6. Equipment Needs

No additional laboratory or equipment are required for this program. Current resources within the ECE Department will be sufficient to run the program.

V. IMPLEMENTATION PLAN AND TIMELINE

The program will begin in the Fall 2024 semester. We expect some students in the BSE in Electrical Engineering, BSE in Computer Engineering, and BSE in Mechanical Engineering programs will likely desire to switch to the BSE in Mechatronics and Robotics Engineering. Due to the common Engineering Core, students as late as their Junior year, will be able to switch to the new program without any effect to their planned graduation date. As such, we are prepared to offer the new ECE 3540 – Introduction to ROS course in either Fall 2024 or Winter 2025 (potentially both semesters if the new faculty member is hired by Winter 2025). We foresee no issues with supporting current students switching to and new students joining the program in Fall 2024.

VI. PROGRAM DELIVERY METHOD

The undergraduate program in Mechatronics and Robotics Engineering is planned to be fully in-person.

If your proposed new program has a delivery method of either fully online (50% or more of the courses have content that is 75% or more online) or blended (50% or more of the courses have content that is 10%-74% online), please contact the e-LIS department before continuing through this process –elis@oakland.edu.

I have met with e-LIS prior to completing this proposal:
_____Yes
___X_____Not applicable

VII. ASSESSMENT OF STUDENT LEARNING

Type of assessment plan:
External Mapping
The External Mapping form has been completed and sent to OIRA for review.

VIII. EXPECTED CAREER OPTIONS FOR GRADUATES

Owing to the multidisciplinary nature of the mechatronics and robotics engineering (MRE) program, students graduating with an MRE degree are expected to have a wide variety of career options available to them. Examples of such career opportunities include:

- Automotive/industrial manufacturing
- Automation engineering
- Prosthetic engineering
- Artificial intelligence engineering
- Medical robotics engineering
- Assistive robotics engineering
- Mechatronic systems engineering
- Control systems engineering

- Electric drive systems engineering
- Embedded systems engineering

The above career options are briefly discussed below.

Automotive/industrial manufacturing

There is a huge demand for engineers having in-depth knowledge of industrial robotics and automation for jobs related to automotive/industrial manufacturing. This stems from the ever-growing use of robots in manufacturing, assembly lines, and industrial processes. Mechatronics and robotics engineers fulfill their need by designing robots and ancillary tools that can boost both productivity and quality of the finished products. Although employers have traditionally relied on specially trained mechanical engineers to fulfill these needs, nowadays they increasingly prefer mechatronics and robotics engineers for such jobs.

Automation engineering

Automation is the current buzzword and goal across a majority of manufacturing industries worldwide, and engineers having in-depth knowledge of industrial robotics and automation are increasingly being sought to implement such automation challenges. The work of such an engineer may involve not just designing and testing of automated tools and systems suitable for specific tasks, but also applying their high-level programming skills to make them work efficiently.

Prosthetic engineering

The prosthetics engineers are responsible for researching, designing, and developing prosthetic devices, such as artificial limbs, artificial hearts, artificial kidney machines, etc. The mechatronics and robotics engineers are ideally suited for designing prosthetic devices, but because of the multidisciplinary nature of such jobs, they have to work with biomedical engineers, doctors, and other scientists to come up with new designs, improving existing devices, and designing appropriate software systems to operate them. They may also interact with prosthetic wearers to gather feedback about prototype designs and improve them, as necessary.

Artificial intelligence engineering

Artificial intelligence (AI) is another buzzword often heard these days, because it is expected to have a revolutionary impact in just about every branch of engineering, science, business, and humanities in the years ahead. Since mechatronics and robotics engineers are expected to acquire some AI programming and application skills as a part of their curriculum, they are expected to be well prepared for a wide variety of jobs related to applications of AI. Examples of such jobs include design and development of intelligent robotics systems, smart vision systems, autonomous vehicles, medical diagnosis, healthcare, security, forensics, finance, and social sciences.

Medical robotics engineering

There is a growing demand for mechatronics and robotics engineers for the design, development and programming of surgical robots used for a wide variety of minimal invasive surgeries (MIS).

MIS has already made a transformative impact in many fields of surgery and it is expected to see a rapid growth in the years ahead.

Assistive robotics engineering

An assistive robot is a device that can sense, process sensory information, and perform actions that benefit people with disabilities and seniors. With the ageing population worldwide, there is a growing demand for mechatronics and robotics engineers for the design and development of such assistive robotic systems.

Mechatronic systems engineering

The mechatronics and robotics engineers are regarded as highly skilled professionals, who can bring together their multidisciplinary knowledge and skills to solve complex engineering design challenges involving integration of modern machineries, robots and ancillary tools/devices. Such skills are high in demand because fewer devices and systems these days are either purely mechanical or purely electrical in nature.

Control systems engineering

Just about every mechanical, electrical, electromechanical, and biomedical devices/systems require feedback control for their proper functioning, and control being an integral component of a mechatronics and robotics engineer's skillsets, such engineers are ideally suited for tacking a wide variety control engineering challenges.

Electric drive systems engineering

Transportation electrification is another current buzzword, the ultimate goal of which involves transitioning passenger cars, trucks, buses and trains, and airplanes from fossil-fueled vehicles to ones powered by electricity. This is already creating a huge demand for engineers skilled in the design and development of electric drive systems, and this demand is expected to witness a phenomenal growth in the years ahead. In addition to above, just about every industry across the globe needs electric drive systems to run their machineries and tools, which is also witnessing a growing demand for such engineers. Thus, the future job market looks especially bright for the mechatronics and robotics engineers trained in the design and development of electric drive systems

Embedded systems engineering

Embedded system engineering involves controlling devices, machines, and systems using microcomputers, field programmable gate arrays (FPGAs) and/or other electronic hardware devices. It requires a combination of both hardware and software system design and integration skills that are often acquired by mechatronics and robotics engineers as a part of their curriculum. Such skills are high in demand because of the advent of computer controls everywhere.

APPENDICES

Appendix A – Faculty Profiles

Following are the profiles of the faculty in the Electrical and Computer Engineering Department. For Profiles of faculty in other SECS department, please visit: https://oakland.edu/secs/directory/

DEPARTMENT OF

ELECTRICAL AND COMPUTER ENGINEERING

DEPARTMENT CHAIR

Osamah A. Rawashdeh, Ph.D., P.E.
University of Kentucky
Professor and Chair
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At the undergraduate level, the ECE Department offers two ABET-accredited degrees, a Bachelor of Science in Engineering (B.S.E.) with a major in Electrical Engineering and a B.S.E. with a major in Computer Engineering. The Department offers five advanced graduate degrees: Master of Science (M.S.) in Electrical and Computer Engineering, M.S. in Embedded Systems, M.S. in Mechatronic Systems Engineering, a Ph.D. in Electrical and Computer Engineering, and a Ph.D. in Systems Engineering. Faculty's areas of research include:

- Artificial/Embedded Intelligence – machine learning, deep learning, and embedded techniques for high-speed intelligent processing
- Bio-Inspired and Biomedical Devices – biosensors, bio-inspired systems/sensor design, and automated IR cancer detection
- Controls and Systems Engineering – adaptive control, nonlinear control, and intelligent control of human-machine interactive systems
- Electronics at the Micro- and Nano-Scale
- Electromagnetics – antenna design, vehicle-level measurements/analysis, and intra-vehicle wireless sensor networks
- Embedded Systems – autonomous driving and advanced driver assistance systems, embedded controls, and reconfigurable computing
- High performance Computing – multicore computing, embedded system design and general purpose computing with GPUs
- Micro-Electro-Mechanical Systems (MEMs) – sensors, CMOS-MEMs technology, MEMS/NEMS modeling; Modeling and Simulation
- Power Systems Engineering – smart-grids, microgrids, and renewable energy
- Robotics – autonomous mobile robots, socially assistive robots, and human-robot interactions
- Sensors
- Signal and Image Processing – adaptive signal processing, biomedical imaging, and computer vision
- Unmanned Vehicles

ADMINISTRATIVE ASSISTANT
Bonnie Koch | EC 446 | (248) 370-2177 | Fax: (248) 370-4633 | bkoch@oakland.edu

Teaching
EGR 2400 - Introduction to Electrical and Computer Engineering; EGR 2800 - Design and Analysis of Electromechanical Systems; ECE 4999 - Senior Design; ECE 3720 - Microprocessors; ECE 4721/5721 - Embedded Systems Design; ECE 5731 - Embedded Computing in Mechatronics; ECE 6760 - Fault Tolerant Systems

Research
Drones/unmanned systems; embedded computing in automotive and healthcare; engineering education

Selected Publications
A. Hijaz, W. –Y. G. Louie, M. Bellafaire, O. Rawashdeh, I. Mansour, "Driver Visual Focus of Attention Estimation in Autonomous Vehicles," in SAE World Congress, 2020.

Hamzeh Alzu'bi, Iyad Mansour, and Osamah Rawashdeh, "Loon Copter: Implementation of a hybrid unmanned aquatic–aerial quadcopter with active buoyancy control," Journal of Field Robotics, https://doi.org/10.1002/rob.21777, 23 February 2018.

Waseem Sadeh, Osamah Rawashdeh, Dona Burkard, Kelvin Dobbins, Tony Lockwood, and Atilla Bulmus, "Development of a Fork-Join Dynamic Scheduling Middle-Layer for Automotive Powertrain Control Software," SAE Int. J. Passeng. Cars – Electron. Electr. Syst. 10(2):2017, doi:10.4271/2017-01-1620.

Rami Abousleiman, Osamah Rawashdeh, and Rami Boimer, "Electric Vehicles Energy Efficient Routing using Ant Colony Optimization," SAE International Journal of Alternative Powertrains, vol. V126-8EJ, December 2016.

Abdullah Al-Refai and Osamah Rawashdeh, "An Experimental Survey of Li-Ion Battery Charging Methods," SAE International Journal of Alternative Powertrains, vol. 125-8, May 1, 2016.

Belal H. Sababha, Hamzeh M. Al Zu'bi, and Osamah A. Rawashdeh, "A rotor-tilt-free tricopter UAV: design, modeling, and stability control," Int. Journal of Mechatronics and Automation, vol. 5, no.2/3, pp. 107 - 113, 2015.

Selected Patents
Belal Hussein Sababha, Hamzeh Mahmoud Alzu'bi, Osamah Ahmad Rawashdeh, " A Fixed Motor-Pitch Tri-Rotor VTOL UAV," US Patent Publication Number: US20180057163 A1, Mar.1, 2018 & US 2019/0185160 A1, June 20, 2019.

M. Sharawi, B. Sababha, H. Alzubi, and O. Rawashdeh, "A Single-Antenna Direction Finding System for Multi-rotor Platforms," US Patent No. 8,907,846/ US20140218239, Dec. 9, 2014.

M. Sharawi and O. Rawashdeh, "Food Calorie Counting System," US Patent No. 8,330,057, Dec. 11, 2012.

R. Vallance, B. Walcott, J. Lumpp, A. Balasubramanian, and O. Rawashdeh, "Linear actuator using shape memory wire with controller," U.S. Patent No. 7,555,900, July 7, 2009.

Vallance, R.R., S. Chikkamaranahalli, O.A. Rawashdeh, J.E. Lumpp, B. Walcott, and E. Wolsing, "System and Device for Characterizing Shape Memory Alloy Wires," U.S. Patent No. 6,916,115, July 12, 2005.

Hoda Abdel-Aty-Zohdy, Ph.D.
University of Waterloo (Canada)

Professor
Electrical and Computer Engineering
Director of the Microelectronics & Bio-Inspired Systems Design Lab

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Teaching
Electronic Materials and Devices; Electronic Circuit Design; Integrated Circuits and Devices

Research
Director of the Microelectronics & Bio-Inspired Systems Design Lab; Biotechnology with Intelligent Signal Processing on Integrated Chips for Medical; Wireless Accurate Classification Applications on Sub-micro-electronics

Selected Publications
"Chemical Absorbate Detection on Graphene by Applying Electronic Structure Calculations to Energy Minimized Molecular Models," *Symposium on Graphene Nanomaterials and Neural Interfaces*, 2011.

"Cognitive Information Processing Using H/W Spiking Neural Networks," *45th Conference of the Institute for Statistical Studies and Research (ISSR)*, 2010.

"Sampling Spiking Neural Network Electronic Nose on a Tiny Chi," *Proceedings of the IEEE MWSCAS*, 2010.

"Hyper-Fuzzy Modeling and Control for Bio-Inspired Radar Processing," *Proceedings from the IEEE National Aerospace & Electronics Conference, NAECON*, 2010.

"Spiking Neural Network E-NOSE Classifier Chip," *Proceedings of the IEEE National Aerospace & Electronics Conference, NAECON*, 2010.

"A Renewable Energy Primer: Myths, Reality, Business and Social Perception," *Europe's Premier Wind Energy Conference*, 2010.

Shadi Alawneh, Ph.D.
Memorial University of Newfoundland (Canada)

Assistant Professor
Electrical and Computer Engineering

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(248) 370-2242

Teaching
GPU Accelerated Computing; Microprocessor-Based System Design; Digital Logic Design Microprocessors; Senior Design

Research
General-Purpose Computing on Graphics Processing Units (GPGPU); High Performance Computing; Embedded System Design with GPUs; Autonomous Driving; Software Optimization; Numerical Simulation and Modeling; Machine Learning; Internet of Things (IoT); Software Design Analysis

Selected Publications
"Neural Network Implementation for Lane Tracking in Self-Driving Cars," Shadi Alawneh and Ayomide Yusuf, London Journal of Research in Computer Science and Technology, vol. 22, pp. 1-14, 2022.

"GPU-Based Sparse Power Flow Studies with Modified Newton's Method," Lei Zeng, Shadi Alawneh and Seyed Ali Arefifar, The IEEE Access, vol. 9, pp. 153226-153239, 2021.

"Optimization of Gabor Filters by Employing NVIDIA GPUs in Python," Conner McInnes and Shadi Alawneh, The Journal of Image and Graphics, Vol. 9, No. 4, pp. 146-151, December 2021.

"Intelligent Wearable Heart Rate Sensor Implementation for In-Vehicle Infotainment and Assistance", Giribabu Sinnapolu and Shadi Alawneh, The Internet of Things: Engineering Cyber Physical Human Systems, August 2020.

"Predicting Pedestrian Intention to Cross The Road," Karam Abughalieh and Shadi Alawneh, The IEEE Access Journal, Volume 8, Pages 72558-72569, April 2020.

"A Survey of Parallel Implementations for Model Predictive Control," Karam Abughalieh and Shadi Alawneh, The IEEE Access Journal, Volume 7, Pages 34348-34360, March 2019.

"A Survey of GPU Implementations for Hyperspectral Image Classification in Remote Sensing," Ayomide Yusuf and Shadi Alawneh, The Canadian Journal of Remote Sensing, Volume 44, 2018, Issue 5, Pages 532-550, February 2019.

"GPU Implementation for Automatic Lane Tracking in Self-Driving Cars," Ayomide Yusuf and Shadi Alawneh, SAE Technical Paper in the WCX SAE World Congress Experience (WCX 2019), April 2019, Detroit, Michigan, USA.

"Real Time 2D Pose Estimation for Pedestrian Path Estimation using GPU Computing," Karam Abughalieh and Shadi Alawneh, SAE Technical Paper in the WCX SAE World Congress Experience (WCX 2019), April 2019, Detroit, Michigan, USA.

"Acceleration of Image Stitching Using Embedded Graphics Processing Unit," Karam Abughalieh, Omar Bataineh and Shadi Alawneh, Proc. The 2018 IEEE International Conference on Electro/Information Technology (EIT 2018), May 2018, Rochester, Michigan, USA.

Daniel N. Aloi, Ph.D.
Ohio University

Professor, Electrical and Computer Engineering
Director of Research; Director, Applied EMAG and Wireless Lab

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(248) 370-4633

Teaching
Antennas; Communications; Global Navigation Satellite Systems (GNSS)

Research
Applied Electromagnetics, Antenna Measurements (Vehicle-level and component-level), Antenna Modeling, Antenna (SISO, MIMO and Smart) Design, Automotive Radar, EMC/EMI, Cellular 5G, C-V2X, GNSS

Selected Publications
Rezvan Alavi, Ahmed Harb, Daniel Aloi, "Comparison of NF and FF Automotive Antenna Measurement in DSRC and C-V2X Applications," 2022 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, 10-15 July 2022, Denver, CO, USA.

Mohamed O. Khalifa, Ahmad M. Yacoub, Daniel N. Aloi, "A Multiwideband Compact Antenna Design for Vehicular Sub-6 GHz 5G Wireless Systems," IEEE Transactions on Antennas and Propagation, vol. 69, no. 12, pp. 8136-8142, Dec. 2021, doi: 10.1109/TAP.2021.3083770.

Ran Liu and Daniel N. Aloi, "Dual Band GNSS Antenna Phase Center Characterization for Automotive Applications," International Journal of Antennas (IJANT), Vol. 7, No. 2/3/4, October 2021, https://doi.org/10.48550/arXiv.2111.04569.

Mohamed O. Khalifa, Ahmad M. Yacoub, Daniel N. Aloi, "Compact 2x2 and 4x4 MIMO Antenna Systems for 5G Automotive Applications," Applied Computational Electromagnetics Society Journal (ACES), vol. 36, no. 06, pp. 762–778, Nov. 2021.

Ahmad M. Yacoub, Mohamed O. Khalifa, and Daniel N. Aloi, "Wide Bandwidth Low Profile PIFA Antenna for Vehicular Sub-6 GHz 5G and V2X Wireless Systems," Progress in Electromagnetics Research C (PIERC), Vol. 109, page 257-273, 2021, doi:10.2528/PIERC21010609.

Daniel N. Aloi and Ehab Abdul-Rahman., "Modeling of a Far-Field Automotive Antenna Range Using Computational Electromagnetic Tools", 14th European Conference on Antennas and Propagation (EuCAP 2020), Copenhagen, Denmark held 15-20, March 2020.

Marg Lyell and Daniel N. Aloi, "A Study of SAR on Child Passengers and Driver Due to Cellphone Connectivity within Vehicle," Applied Computational Electromagnetic Society Journal (ACES), Vol. 34, No. 2, pp. 385-387, 2019.

Daniel Llamocca and Daniel N. Aloi, "Self-reconfigurable implementation for a Switched Beam Smart Antenna," Microprocessor and Microsystems, Vol. 60, pp. 1-14, July 2018

S. Ali Arefifar, Ph.D.
University of Alberta (Canada)

Assistant Professor
Electrical and Computer Engineering

arefifar@oakland.edu
(248) 370-2222

Teaching
Electrical Energy Systems; Electrical Machines; Power Electronics

Research
Power Systems Engineering; Including Smart-Grids; Microgrids; Renewable Energy; Energy Storage; Computational and Experimental Methods; Power System Protection; Electric Power Transmission and Distribution

Selected Publications
Arefifar, S.A., Mohamed, Y.A.R.I., Ordonez, M., "Voltage and Current Controllability in Multi-Microgrid Smart Distribution Systems," *IEEE Transactions on Smart Grid*, 2016.

Arefifar, S.A., Ordonez, M., Mohamed, Y.A.R.I. "Energy Management in Multi-Microgrid Systems — Development and Assessment," *IEEE Transactions on Power Systems*, 2016.

Arefifar, S.A., Ordonez, M., Mohamed, Y.A.R.I. "V-I Controllability-Based Optimal Allocation of Renewable Resources in Smart Grids," *IEEE Transactions on Smart Grid*, vol.62, no.2, pp.711,723, 2015.

Arefifar, S.A., Mohamed, Y.A.R.I., EL-Fouly, T.H.M. "Optimized Multiple Microgrid-Based Clustering of Active Distribution Systems Considering Communication and Control Requirements," *IEEE Transactions on Industrial Electronics*, vol.7, no.3, pp.1378-1388, 2016.

Manohar Das, Ph.D.
Colorado State University

Professor
Electrical and Computer Engineering

das@oakland.edu
(248) 370-2237

Teaching
Digital Signal Processing; Communication Systems; Power Electronics; Signals and Systems; System Optimization

Research
Fast Safe Charging and Management of Li-ion Batteries; Adaptive Control and Signal Processing; Modeling, System Modeling and Identification; Digital Signal and Image Processing; Data Compression; Pattern Recognition; Optimization.

Selected Publications
S. Jarid and M. Das, An Electro-Thermal Model based fast optimal charging strategy for Li-ion batteries, AIMS Energy, 2021, Volume 9, Issue 5: 915-933. doi: 10.3934/energy.2021043.

L. Khasawneh and M. Das, Lateral Trajectory Tracking Control using Backstepping Method for Autonomous Vehicles, Proceedings of 2021 IEEE International Midwest Symposium on Circuits and Systems, held on August 9-11, 2021, at Michigan State University.

Z. Kas and M. Das, Adaptive Control of Resistance Spot Welding Based on a Dynamic Resistance Model, Journal of Mathematical and Computational Applications, 2019, 24(4), 86; https://doi.org/10.3390/mca24040086.

R. N. K. Loh and M. K. Das, Nonlinear Unknown‐Input Observer‐Based Systems for Secure Communication, *Advances in Underwater Acoustics*, Dr. Andrzej Zak (Ed.), pub. InTech, 2017, pp. 45-73. DOI: 10.5772/intechopen.69239.

A. Mostafa and M. Das, A Study of Recursive Techniques for Robust Identification of Time-Varying Electrical Equivalent Circuit Models of Li-Ion Batteries, *International Journal of Handheld Computing Research*, Vol 8, Issue 3,pp. 55-74, 2017.

S. I. Chaudhry and M. Das, Design of optimum reference temperature profiles for energy saving control of indoor temperature in a building, *AIMS Energy*, Vol. 4, Issue 6, November 2016, pp. 906-920.

Z. Kas and M. Das, An Electrothermal Model Based Adaptive Control of Resistance Spot Welding, *Intelligent Control and Automation*, 2015, pp. 134-146.

E. Gu and M. Das, "Backstepping Control Design for Vehicle Active Restraint Systems," *ASME Transactions on Dyn. Sys. Measurements and Control*, 2013.

G. Kedar-Dongarkar and M. Das, "Driver Classification for Optimization of Energy Usage in a Vehicle," *Proceedings of 2012 Conference on Systems Engineering Research*, St. Louis, Missouri, March, 2012.

Y. Chen and M. Das, Devendra Bajpai, "Vehicle Tracking and Distance Estimation Based on Multiple Image Features," *Proceedings of 2007 Canadian Conference on Computer and Robot Vision*. DOI: 10.1109/CRV.2007.68.

Y. Chen and M. Das, "An Automated Technique for Image Noise Identification Using a Simple Pattern Classification Approach," *Proceedings of 2007 IEEE Midwest Conference*. DOI: 10.1109/MWSCAS.2007.4488699.

Brian K. Dean, Ph.D.
University of Wyoming

Associate Professor and Academic Programs Coordinator
Electrical and Computer Engineering; Bioengineering

bkdean@oakland.edu
(248) 370-2822

Teaching
Instrumentation and Measurement; Bioinstrumentation and Signal Processing; Circuits

Research
Sensors; Signal Conditioning and Signal Processing; Biomimicry; Electric Motors; Embedded Systems

Selected Publications
Agrawal, S; Dean B.K., "Edge Detection Algorithm for Musca-Domestica Inspired Vision System," *IEEE Sensors Journal*, vol 19, issue 22, pp. 10591-10599, Nov. 2019.

Agrawal, S and Dean B.K., "Digitization of Biomimetic Vision Sensor based on the Common Housefly (Musca Domestica), *Proc. of Bioinspiration, Biomimetic, and Bioreplication IX*, vol. 109650R, March 2019.

Agrawal, S and Dean B.K., "Multiple Cartridges Improve Edge Detection Algorithm for Fly Inspired Vision System," *Proc. of IEEE Sensors 2018*, Oct. 2018.

Adabonyan, A.N; Llamocca, D.; and Dean, B.K., "Fly-Inspired Edge Detection: Architecture and Reconfigurable Embedded Implementation," *61st IEEE International Midwest Symposium on Circuits and Systems*, August 2018.

Dean, B.K; Rawashdeh, O.A., "An Interdisciplinary Undergraduate Research Program in Electrical and Computer Engineering – Lessons Learned through 6 Years of Program Operations," *American Society for Engineering Education Annual Conference & Exposition (ASEE Annual)*, April 2017.

Agrawal, S.; Dean, B.K.; Carpenter, K. (HS teacher); Grimm, W. (HS teacher); Motzny, M. (HS teacher), "Removal of Signal Artifacts from Biomimetic Vision Sensor Based on the Common Housefly," *Medical Measurements and Applications (MeMeA)*, April 2017.

Llamocca, D.; Dean, B.K., "A Scalable Pipelined Architecture for Biomimetic Vision Sensors," International Conference on Field-programmable Logic and Applications (FPL), 2015, pp. 1-6, 2015.

Ka Chai Cheok, Ph.D.
Oakland University

Professor; John Dodge Chair
Electrical and Computer Engineering

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(248) 370-2232

Teaching
Automotive Mechatronics; Microcomputer-based Control Systems; Electric Hybrid Drive; Adaptive Control; Intelligent Control, Robotics Systems & Autonomous Vehicles, Annual Intelligent Ground Vehicle Competition

Research
Theory and application of control, estimation, computer vision, computational intelligence including fuzzy logic, neural networks, machine learning, deep learning and global optimization. Practical realization and experience in autonomous mobile robots, local positioning, omnidirectional vehicles, mine-detection robots, self-driving technologies and automated IR cancer detection.

"My academic research strives in grasping deep insights of the subjects and extend their potentials into useful tools. I work with professionals and entrepreneurs to bring these ideas to meaningful real world applications."

Selected Publications
"Co-Active Neuro-Fuzzy Inference System Modeling with Clustering Methods," *Int'l Journal of Computers and Their Applications*, Vol 26, No 3, Sept 2019, pp 120-128

"Smooth Trajectory Planning for Autonomous Leader-Follower Robots," *International Conference on Computers and Their Applications* (CATA 2019), Honolulu, HA, USA, 18-20 March 2019.

"Lane Keeping System and Lane Centering System", ***US Patent Pub No: US 2016/0059856 A1***, Mar 3, 2016.

"Eye-Hand Tracking Simulator for Training AI Learning Systems." *2018 Int'l Conf on Computers and Their Applications*, Las Vegas, 2018.

"Development of a Two Step Self-Triggered Adapting Control System," *2017 IEEE 5th Inter'l Symp on Robotics & Intelligent Systems*, Montreal, CA, 2017.

Multimode Surround View for ADAS Vehicles." *2016 IEEE 4th International Symposium on Robotics and Intelligent Systems*, Tokyo, Japan, 2016.

"LMA Tuned Gradient Descent-based Model Reference Adaptive Control Scheme." *2016 Comp Appl in Industry & Engr (CAINE)*, Denver, CO, 2016.

"Simultaneous Multi-veh Control & Obstacle Avoidance with Supervised Optimal Planning," *2014 IEEE Int. Conf. Tech Pract Robot Appl*, Philadelphia, 2014.

"Omni-Directional Autonom Guided Veh w Wireless Navigation," *2013 Grnd Veh Syst Engr & Tech Symp – Autonom Robotics*, Troy, MI, 2013

Jun Chen, Ph.D.
Iowa State University

Assistant Professor
Electrical and Computer Engineering

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(248) 370- 4797

Teaching
Automatic Control Systems; Model Predictive Control

Research
Model Predictive Control (MPC); Real-time Optimization and Estimation; Reinforcement Learning; Event-trigger Control; Autonomous Vehicles; Electric Vehicles; Propulsion Systems; Renewable Energy Integration.

"My research is in the area of model predictive control (MPC) with applications in automotive systems and energy systems. The real-time optimization capability offered by MPC is a key to achieve higher energy efficiency and better comfort in our transportation and energy sectors."

Selected Publications
J. Chen and R. Kumar, "Stochastic Failure Prognosis of Discrete Event Systems," IEEE Transactions on Automatic Control, October 2022.

R. Badawi and J. Chen, "Enhancing Enumeration-Based Model Predictive Control for DC-DC Boost Converter with Event-Triggered Control," European Control Conference, London, UK, July 12-15, 2022.

J. Chen, X. Meng and Z. Li, "Reinforcement Learning-based Event-Triggered Model Predictive Control for Autonomous Vehicle Path Following," 2022 American Control Conference, Atlanta, GA, June 8-10, 2022.

J. Chen, A. Behal and C. Li, "Active Cell Balancing by Model Predictive Control for Real Time Range Extension," IEEE Conference on Decision and Control, Austin, TX, December 13–15, 2021.

J. Chen and Z. Yi, "Comparison of Event-Triggered Model Predictive Control for Autonomous Vehicle Path Tracking," 2021 IEEE Conference on Control Technology and Applications, San Diego, CA, August 8–11, 2021.

X. Yin, J. Chen, Z. Li and S. Li, "Robust Fault Diagnosis of Stochastic Discrete Event Systems," IEEE Transactions on Automatic Control, 64 (2019): 4237–4244.

J. Chen and H. Garcia, "Economic Optimization of Operations for Hybrid Energy Systems under Variable Markets," Applied Energy, 177 (2016): 11-24.

Patents
J. Chen, R. Long and Y. Hu, "Method for Increasing Control Performance of Model Predictive Control Cost Functions," U.S. Patent No. US11192561 B2, December 7, 2021.

J. Chen, D. Edwards, Y. Hu, M. Sun, Adam Heinzen and Michael Smith, "Method and System for Determining Thermal State," U.S. Patent No. 10995688 B2, May 4, 2021.

Subraminiam Ganesan, Ph.D.
Indian Institute of Science (Bangalore)

Professor, Electrical and Computer Engineering
Associate Director Center for Robotics, Unmanned and Intelligent Systems

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Teaching
Real Time Systems; FPGA-based Embedded Systems; Microprocessor-based Embedded Systems; DSP in Embedded Systems; Validation and Verification of Embedded Systems; Parallel Computer Architecture and Multi-Core Embedded System Programming; Developing Embedded Systems for Real Time Tracking and Internet of Things

Research
Divisible Load Scheduling in Multi-Core and Multi-Processor Systems; Condition-based Maintenance; Real Time DSP/Multiprocessor Systems for Specific Applications; Model Based Systems Design; Multicore Controller for Low Cost and High Performance; Real-Time Tracking, Connected Vehicles and Internet of Things security.

Selected Publications
Lakshmi Namblar, Vinod Kumar Gopal, Ashwin D, Subramaniam Ganesan "Optimization of Solar Energy Utilization, System Reliability and Utility Savings using a New Framework" International Journal of Recent Technology and Engineering (IJRTE) (http://www.ijrte.org/) ISSN: 2277-3878, Volume-8 Issue-6, March 2020

Manimurugan Shanmuganathan ; Saad Almutairi ; Majed Mohammed Aborokbah ; Subramaniam Ganesan ; Varatharajan R, "Review of advanced computational approaches on multiple sclerosis segmentation and classification", IET Signal Processing, https://digital-library.theiet.org/ search?value1 =&option1=all&value2 =manimurugan+ shanmuganathan&option2=author, 2020

Priyank Srivastava, Dinesh Khanduja, Subramaniam Ganesan "Fuzzy methodology application for risk analysis of mechanical system in process industry" Int J Syst Assur Eng Manag https://doi.org/10.1007/ s13198-019-00857-y; Springer, 20 September 2019, 16 pages.

U Shukla, A Mishra, G Jasmine, V Vaidehi, Subramaniam Ganesan, "A deep neural network for roadside analysis and lane detection" Proceedings of Computer Science, Elsevier, Science Direct, 165 (2019) pp 252-258. www.science direct.com – open access article.

Kahlon, M., and Ganesan, S. "Real Time Driver Drowsiness Detection." IEEE EIT Conference, 2018.

Doan, T.P., and Ganesan, S. "CAN Crypto Chipo to Secure Data Transmitted Through CAN Bus

Using AES 128 and SHA-1 Algorithms with\ Asymmetric Key." SAE World Congress,

Paper number: 2017-01-1612, 2017.

Patents
Steve Oberc, Hare Patnaik and Subra Ganesan, Application No.: 62/169,194, Filed: June 1, 2015; For: Systems and Methods for Obtaining Sports-Related Data.

Edward Y. Gu, Ph.D.
Purdue University

Professor
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Teaching
Robotic Systems and Control; Analysis of Nonlinear Control Systems; Electromechanical Energy conversion; Automatic Control Systems; Signals and Systems.

Research
Kinematics, Task-Planning, Dynamics Modeling and Control of Robotic Systems; Nonlinear Systems Modeling, Analysis, Adaptive Control and Computer Simulations, Human Biomechanical and Biodynamic Modeling and Digital Simulations/Animations; Learning and Intelligent Control of Human-Machine Interactive Systems.

"The major research interests are in the areas of robotic kinematics, dynamics and control, nonlinear control systems, and digital human modeling and applications. Robotics research and technology development have enhanced industrial applications for decades, and are now at the cutting-edge of making another big leap to create a robot that imitates the entire human capability and intelligence. The impact will be tremendous on society and economics in the near future."

Selected Publications
Book: "Advanced Dynamics Modeling, Duality and Control of Robotic Systems", CRC Press, Taylor and Francis Group, ISBN 978-0-367-65371-2, 2021.

Book: "A Journey from Robot to Digital Human", Springer, Berlin Heidelberg, ISBN 978-3-642-39046-3, 2013.

"Fall Protection Framework of Lower Extremities Exoskeleton Walking Systems on Differential Motion Planning", *International Journal of Social Robotics*, 1-12, July 20, 2020, Springer.

"Backstepping Control Design for Vehicle Active Restraint Systems," *ASME Transactions: Journal of Dynamic Systems, Measurement and Control*, Vol. 135, No. 1, paper number 011012, pp. 1-9, 2013.

"Modeling of Human-Vehicle Dynamic Interactions and Control of Vehicle Active Systems," *International Journal on Vehicle Autonomous Systems*, Vol. 10, No. 4, pp. 297-314, 2012.

"Trust-Based Coalition Formation in Multi-Agent Systems," *Journal of Defense Modeling and Simulation: Applications, Methodology, Technology*, SAGE Publications, 2013.

Darrin M. Hanna, Ph.D.
Oakland University

Professor, Electrical and Computer Engineering; Bioengineering
Outstanding Teaching Award

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Teaching
Embedded Systems; Computer Problem Solving; Digital Logic and Micro-processors; Information Networks

Research
Using mixed-mode microprocessorless systems such as FPGAs, ASICs, and MEMS with Artificial Intelligence for embedded systems

Selected Publications
Jason Gorski and Darrin Hanna, "The FPOA, a Medium-grained Reconfigurable Architecture for High-level Synthesis," ACM Trans. Reconfigurable Technol. Syst. 12, 4, Article 18, November 2019.

Bryant Jones and Darrin Hanna, "Automatic cache partitioning method for high-level synthesis," Microprocessors and Microsystems - Embedded Hardware Design, 67, 71-81, 2019.

Darrin Hanna, Michael Lohrer, David Stern, Alexander Postlmayr, Adam Kollin, Shuo Wang, and Gang-yu Liu, "An online Algorithm for Detecting Anomalies using Fuzzy Clustering," Proceedings of the International Conference on Artificial Intelligence, in Las Vegas, NV, July 30 – August 2, 2018.

Michael F. Lohrer, Darrin M. Hanna, Yang Liu, Kang-Hsin Wang, Fu-Tong Liu, Ted A. Laurence, Gang-Yu Liu, "Applying Pattern Recognition to High-Resolution Images to Determine Cellular Signaling Status", IEEE Transactions on Nanobioscience, September 2017, 16(6):438-446.

Ranjeeta Thapa, Jason Gorski, Anthony Bogedin, Michael Maywood, Christopher Clement, Seyedmehdi Hossaini Nasr, Darrin Hanna, Xuefei Huang, Bradley J Roth, Gerard Madlambayan, George D Wilson, "Hyaluronan-mediated ferric oxide nanoparticles causes apoptosis of CD44 expressing head and neck squamous cell carcinoma cells," Intl. Journal of Cancer Therapy and Oncology vol 4(2), April-June 2016.

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Teaching
Electronic Devices and Circuits-II; High Frequency Electronics

Research
Microwave, and Millimeter-wave circuits, Wireless Communications, Nanomaterials based RF circuits, flexible electronics, RF bio/chemical sensors, Additive Manufacturing (3D Printing).

Selected Publications
Ghazali, L., Karuppuswami, S., Kaur, A., Chahal, P., "Embedded Activities Using Additive Manufacturing for High Density RF Circuits and System. In *Transactions on Components, Packaging and Manufacturing Technology*, IEEE, 2019

Kaur, A., and Chahal, P., "RF Characterization of NiO and TiO2 Based Metal-Insulator-Metal (MIM) Diodes on Flexible Substrates. *IEEE Access*, 6, 2018, pp.55653-55660.

Ghazali, L., Karuppuswami, S., Kaur, A., Chahal, P., "3-D Printed Air Substrates for the Design and Fabrication of RF Components," *IEEE Transactions on Components, Packaging and Manufacturing Technology*, 2017

Kaur, A., Chahal, P., and Hogan, T., "Selective Fabrication of SiC/Si Diodes by Excimer Laser under Ambient Conditions," *Electron Device Letters, IEEE*, vol.37, pp. 142-145, 2016.

Kaur, A., Yang, X., and Chahal, P., "CNT and Graphene based Diodes for Microwave and Millimeterwave Circuits on Flexible Substrates", In *Transactions on Components, Packaging and Manufacturing Technology, IEEE*, 2016, pp.1766-1775

Kaur, A., Chahal, P., and Hogan, T., "Selective Fabrication of SiC/Si Diodes by Excimer Laser under Ambient Conditions," *Electron Device Letters, IEEE*, vol.37, pp. 142-145, 2016.

Kaur, A., Yang, X., and Chahal, P., "CNT and Graphene based Diodes for Microwave and Millimeterwave Circuits on Flexible Substrates", In *Transactions on Components, Packaging and Manufacturing Technology, IEEE*, 2016, pp.1766-1775

Jia Li, Ph.D.
University of Michigan

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Teaching
Signals and Systems; Advanced Digital Signal Processing; Biomedical Signal Processing; Signal Detection and Estimation Theory; Random Signals and Processes; Digital Image Processing; Communication Systems; Principles of Digital Communications; Radar Systems

Research
Statistical learning and signal processing with applications in radar, sensor fusion, communications, and biomedicine.

Selected Publications
L. Yuan, H. Qu, J. Li, "Velostat Sensor Array for Object Recognition," IEEE Sensors Journal, vol. 22, no. 2, pp. 1692-1704, Jan. 2022. DOI: 10.1109/JSEN.2021.3132793

J. Li, R. Ewing, E. Blasch, "Dynamic Data Driven Multistatic Radio Frequency Imaging," IEEE Trans. on Aerospace and Electronic Systems, vol. 57, no. 6, pp. 4363-4374, Dec. 2021. DOI: 10.1109/TAES.2021.3098160, 2021.

Vakil, J. Liu, P. Zulch, E. Blasch, R. Ewing, J. Li, "A Survey of Multimodal Sensor Fusion for Passive RF and EO Information Integration," IEEE Aerospace and Electronic Systems Magazine, vol. 36, no. 7, pp. 44-61, Jul. 2021.

J. Andrews, J. Li, "Human Detection and Biometric Authentication with Ambient Sensors," In book: Signal Processing in Medicine and Biology: Emerging Trends in Research and Application, Springer, 2021.

L. Yuan, J. Li, "Smart Cushion Based on Pressure Sensor Array for Human Sitting Posture Recognition," Proc. of 2021 IEEE Sensors Conference, 2021. DOI: 10.1109/SENSORS47087.2021.9639463

Daniel Llamocca, Ph.D.
University of New Mexico

Assistant Professor
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(248) 370-4042

Teaching
Reconfigurable Computing; Computer Architecture; Digital Logic; Microprocessors; Embedded Systems; Hardware Implementation of Digital Signal and Image Processing applications

Research
Run-time Reconfigurable Architectures; Embedded Systems; High Performance architectures for computer arithmetic, signal and image processing, and video communications.

"Research in run-time automatic adaptation of hardware resources to time-varying constraints with the purpose of delivering the optimal hardware solution at any given time."

Selected Publications
Llamocca, D., "Self-Reconfigurable Architectures for HEVC Forward and Inverse Transform," *Journal of Parallel and Distributed Computing*, vol. 109, pp. 178-192, 2017.

Carranza, C., Llamocca, D., Pattichis, M., "Fast 2D Convolutions and Cross-Correlations using Scalable Architectures," *IEEE Transactions on Image Processing*, vol. 26, no. 5, pp. 2230-2245, 2017.

Carranza, C., Llamocca, D., Pattichis, M., "Fast and Scalable Computation of the Forward and Inverse Discrete Periodic Radon Transform," *IEEE Transactions on Image Processing*, vol. 25, no. 1, pp 119-133, 2016.

Llamocca, D., Pattichis, M., "Dynamic Energy, Performance, and Accuracy Optimization and Management using automatically generated constraints for separable 2-D FIR filtering for digital video processing," *ACM Transactions on Reconfigurable Technology and Systems (TRETS)*, vol. 7, no. 4, Article 31, 2015.

Steven Louis, Ph.D.
Oakland University

Special Instructor
Electrical and Computer Engineering

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(248) 370-3873

Teaching
Introductory Circuits; Transistor Electronics; Communications; Signal Processing; High Frequency Electronics; Digital Signal Processing; Antennas; Electromagnetics.

Research
Focus: Bringing the potential of recent scientific findings in magnetism and spintronics to technological fruition.
Recent Projects: Spectrum analysis: Nanoscale ultrafast spectrum analyzer with a ns time resolution based on a spin torque nano oscillator. Self-powered computing: Magnetic tunnel junction capable of harvesting stray rf energy to power a black phosphorus transistor Neuromorphic, AI hardware: Developing energy efficient, THz frequency computer hardware based on non-von Neumann architectures.

Selected Publications
Fang, B., Carpentieri, M., Louis, S., Tiberkevich, V., Slavin, A., Krivorotov, I. N., ... & Zeng, Z. (2019). Experimental demonstration of spintronic broadband microwave detectors and their capability for powering nanodevices. Physical Review Applied, 11(1), 014022.

Louis, S., Sulymenko, O., Tiberkevich, V., Li, J., Aloi, D., Prokopenko, O., ... & Slavin, A. (2018). Ultra-fast wide band spectrum analyzer based on a rapidly tuned spin-torque nano-oscillator. Applied Physics Letters, 113(11), 112401.

Litvinenko, A., Iurchuk, V., Sethi, P., Louis, S., Tyberkevych, V., Li, J., ... & Ebels, U. (2020). Ultrafast sweep-tuned spectrum analyzer with temporal resolution based on a spin-torque nano-oscillator. Nano letters, 20(8), 6104-6111.

Artemchuk, P. Y., Sulymenko, O. R., Louis, S., Li, J., Khymyn, R. S., Bankowski, E., ... & Prokopenko, O. V. (2020). Terahertz frequency spectrum analysis with a nanoscale antiferromagnetic tunnel junction. Journal of Applied Physics, 127(6), 063905

Wing-Yue Geoffrey Louie, Ph.D.
University of Toronto

Assistant Professor
Electrical and Computer Engineering

louie@oakland.edu
(248) 370-2860

Teaching
Human-Robot Interaction; Autonomous Vehicle Systems; Design and Analysis of Electromechanical Systems

Research
Healthcare, Service, and Manufacturing Robotics; Sensing and Controls; Human-Robot /Autonomy Interactions; Machine Learning and Artificial Intelligence; Virtual/Augmented/Mixed Reality; User-Centered Design

"The core theme of my research is on the development of robot technology that can be easily utilized by non-experts for real-world application scenarios such as manufacturing, medical, service, space, social and personal robotics."

Selected Publications
R. Kulkovskiy, M. Sochanski, A. Hijaz, M. Eaton, J. Korneder, and W.-Y. G. Louie, "Can Therapists Design Robot-Mediated Interventions and Teleoperate Robots Using VR to Deliver Interventions for ASD?," IEEE International Conference on Robotics and Automation, 2021.

A. Hijaz, J. Korneder, and W.-Y. G. Louie, "In-the-Wild Learning from Demonstration for Therapies for Autism Spectrum Disorder," IEEE International Conference on Robot & Human Interactive Communication, 2021.

M. Sochanski, K. Snyder, J. Korneder, and W.-Y. G. Louie, "Therapists' Perspectives After Implementing a Robot into Autism Therapy," IEEE International Conference on Robot & Human Interactive Communication, 2021.

J. Korneder, W.-Y. G. Louie, C. M. Pawluk, I. Abbas, M. Brys, and F. Rooney, "Robot-Mediated Interventions for Teaching Children with ASD a New Intraverbal Skill," Assistive Technology, 2021, Available: https://doi.org/10.1080/10400435.2021.1930284.

W.-Y.G. Louie, Jessica Korneder, Ibrahim Abbas, and Cristyn Pawluk, "A Study on an Applied Behavior Analysis Based Robot-Mediated Listening Comprehension Intervention for ASD," Paladyn Journal of Behavioral Robotics, vol. 21, no. 1, pp. 31-46, 2021, Available: https://doi.org/10.1515/pjbr-2021-0005

W.-Y. G. Louie and G. Nejat, "A Social Robot Learning to Facilitate an Assistive Group-Based Activity from Non-expert Caregivers," International Journal of Social Robotics, 2020, Available: https://doi.org/10.1007/s12369-020-00621-4

A. Hijaz, W.-Y.G. Louie, and I. Mansour, "Towards a Driver Monitoring System for Estimating Driver Situational Awareness," in IEEE International Conference on Robot & Human Interactive Communication, 2019, pp. 1-6, Available: http://doi.org/10.1109/RO-MAN46459.2019.8956378.

T. Zhang, W.-Y. G. Louie, G. Nejat, and B. Benhabib, "Robot Imitation Learning of Social Gestures with Self-Collision Avoidance Using a 3D Sensor," Sensors, vol. 18, no. 7, pp. 1-17, 2018, Available: https://doi.org/10.3390/s18072355.

W.-Y. G. Louie, D. McColl, and G. Nejat, "Acceptance and attitudes toward a human-like socially assistive robot by older adults," Assistive Technology, vol. 26, no. 3, pp. 140–150, 2014, Available: https://doi.org/10.1080/10400435.2013.869703.

W.-Y. G. Louie and G. Nejat, "A victim identification methodology for rescue robots operating in cluttered USAR environments," Advanced Robotics, vol. 27, no. 5, pp. 373–384, 2013.

Khalid Mirza, Ph.D.
The Ohio State University

Founding Director, Augmented Reality Center (ARC)
Director, OU-FCA Robotics Lab
Electrical and Computer Engineering

mirza@oakland.edu
(248) 370-4629

Teaching
Industrial Robotics Elective; Robotic Systems and Control; Machine Vision; Augmented Reality; Machine Learning; Electric Circuits; Introduction to Electrical and Computer Engineering.

Research
Industrial Robots (Machine Vision, Sensor Integration, Teaching Interfaces); Industrial Mobile Robots (Autonomous Navigation, Scalable Indoor/Outdoor Platforms, Safety standards); Cloud Robotics and Automation (Machine Learning, Augmented Reality, IoT, Industry 4.0).

"Intelligent robots, immersive technologies, and flexible automation is the future of advanced manufacturing. My research and work are focused on developing ideas and engage in multidisciplinary fields to enable this future."

Selected Publications
"Intuitive 3D-Vision Based Wand for Robot Tool Path Teaching," Proceedings of the 2014 International Conference on Advanced and Agile Manufacturing Systems.

"General formulation for force distribution in power grasp," IEEE International Conference on Robotics and Automation.

"Dynamic simulation of enveloping power grasps," IEEE International Conference on Robotics and Automation.

"Force control of planar power grasp in the DIGITS System," Fourth International Symposium on Robotics and Manufacturing.

"Power grasp force distribution control using artificial neural network," Journal of Robotic Systems.

Hongwei Qu, Ph.D.
University of Florida

Professor
Electrical and Computer Engineering

qu2@oakland.edu
(248) 370-2205

Teaching
ECE 3100: Electronic Circuits and Devices; ECE 3105: Advanced Electronics Design; ECE 5134: Fundamentals of MEMS; ECE 5130: Integrated Devices and Circuits

Research
Micro-Electro-Mechanical Systems (MEMS), Solid-State Sensors, CMOS-MEMS Technology, Applications of MEMS in Biomedicine and Security, Nanotechnology and Devices, MEMS/NEMS Modeling, Electronic Materials Characterization

Selected Publications
Xiong, Y.; Li, Y.; Bidthanapally, R.; Sklenar, J.; Hammami, M.; Hall, S.; et al., "Detecting phase-resolved magnetization dynamics by magneto-optic effects at 1550-nm wavelength." IEEE Transactions on Magnetics, 1-1, (2020).

Xiong, Y.; Li, Y.; Hammami, M., Bidthanapally, R., Sklenar, J.; Zhang, X.; Qu, H., Srinivasan, G.; et al., "Probing magnon-magnon coupling in exchange coupled Y3Fe5O12/Permalloy bilayers with magneto?optical effects", Scientific Report, 10 (2020), 12548.

Xu, M.; Li, M.; Khanal, P.; Habiboglu, A.; Insana, B.; Xiong, Y.; et al., "Voltage-Controlled Antiferromagnetism in Magnetic Tunnel Junctions", Physical Review Letters, 124, 187701 (2020).

Zhang, J. T.; Zhu, W.; Chen, D.; Qu, H.; Zhou, P.; Popov, M.; Jiang, L.; Cao, L.; Srinivasan, G., "Magnetoelectric effects and power conversion efficiencies in gyrators with compositionally-graded ferrites and piezoelectrics." Journal of Magnetism and Magnetic Materials, 473: 131-135. (2019).

P. Qu; G. Sreenivasulu; R. Bidthanapally; V. Petrov; G. Srinivasan and H. Qu, "Fabrication and characterization of a MEMS nano-Tesla ferromagnetic-piezoelectric magnetic sensor array", Applied Physics Letters, 108, 242412 (2016).

Patents
US 8445234, "Method of wafer-level fabrication of MEMS devices", 2013.
US 8324519, "MEMS Switch with Latch Mechanism", 2012.

Alycen Wiacek, Ph.D.
Johns Hopkins University

Assistant Professor
Electrical and Computer Engineering; Bioengineering

awiacek@oakland.edu
248) 370-2694

Teaching
Signals and Systems; Medical Imaging Systems

Research
Medical Imaging; Signal Processing; Beamforming; Machine Learning/Artificial Intelligence; Radiology; Ultrasound Imaging; Photoacoustic Imaging

"My interdisciplinary research pairs non-invasive medical imaging technologies, such as ultrasound and photoacoustic imaging, with novel signal processing and machine learning algorithms to improve the detection and diagnosis of disease, particularly in low-resource settings."

Selected Publications
Wiacek, K. C. Wang, H. Wu, and M. A. L. Bell, "Photoacoustic-guided laparoscopic and open hysterectomy procedures demonstrated with human cadavers," IEEE Transactions on Medical Imaging, vol. 40, no. 12, pp. 3279–3292, 2021.

D. Hyun, A. Wiacek, et al., "Deep Learning for Ultrasound Image Formation: CUBDL Evaluation Framework & Open Datasets," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 68, no. 12, pp. 3466–3483, 2021.

Wiacek and M. A. L. Bell, "Photoacoustic-guided surgery from head to toe," Biomedical Optics Express, vol. 12, no. 4, pp. 2079–2117, 2021.

Wiacek, E. Gonzalez, and M. A. L. Bell, "CohereNet: A deep learning architecture for ultrasound spatial correlation estimation and coherence-based beamforming," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 67, no. 12, pp. 2574–2583, 2020.

Wiacek, E. Oluyemi, K. Myers, L. Mullen, and M. A. L. Bell, "Coherence-based beamforming increases the diagnostic certainty of distinguishing fluid from solid masses in breast ultrasound exams," Ultrasound in Medicine & Biology, vol. 46, no. 6, pp. 1380–1394, 2020.

Wiacek, O. M. H. Rindal, E. Falomo, K. Myers, K. Fabrega-Foster, S. Harvey, and M. A. L. Bell, "Robust short-lag spatial coherence imaging of breast ultrasound data: Initial clinical results," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 66, no. 3, pp. 527–540, 2019.

Mohamed A. Zohdy, Ph.D.
University of Waterloo (Canada)

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Teaching
Signal and Linear Systems Analysis; Optimal Control Theory; Automatic Control Systems; Optimal Estimation; Digital control

Research
Advanced Control and Estimation; Intelligent Pattern Information Processing; Neural, Fuzzy, Evolutionary Systems; Chaos Control; Smart Simulation; Hybrid Systems. Research contracts with government, industry; Recent seed funds on Fuel Cell modeling and control for transportation; Hold considerable promise for improving vehicle energy supply, as well as FCA Powertrain controls, Lear Power Electronics, Kia motors, NSF, USAID.

Selected Publications
"Application of Hyper-Fuzzy Modeling and Control for Bioinspired Systems," *IOCAE*, 2011.

"Unscented Kalman Filters for Continuous Phase FSK Equalizations," *ICN*, 2011.

"Modeling Nonlinear Systems using Multiple Piecewise Linear Equations," *Nonlinear Analysis and Modeling and Control*, 2010.

"An accurate Model of Polyglutamine," *Proteins Structure Function and Bioinformatics*, 2010.

"Robust Motion Control of Biped Walking Robot," *WSEA Trans Systems and Control*, 2010.

Appendix B – Sample Plan of Study

Sample mechatronics and robotics engineering program schedule

Students entering the School of Engineering and Computer Science with the required background may follow a schedule such as the one indicated below. However, students will need additional time to complete the program if they do not have the required background upon entrance to the program.

Freshman year

Fall semester – 17 credits

- CHM 1440 – Chemical Principles (4)
- EGR 1200 - Engineering Graphics and CAD (1)
- EGR 1400 - Computer Problem Solving in Engineering and Computer Science (4)
- MTH 1554 - Calculus I (4)
- **WRT or General Education (4)**

Winter semester – 16 credits

- EGR 2400 - Introduction to Electrical and Computer Engineering (4)
- MTH 1555 - Calculus II (4)
- PHY 1610 - Fundamentals of Physics I (4)
- **General Education (4)**

Sophomore year

Fall semester – 16 credits

- APM 2555 - Introduction to Differential Equations with Matrix Algebra (4)
- ECE 2005 - Electric Circuits (4)
- PHY 1620 - Fundamentals of Physics II (4)
- **General Education (4)**

Winter semester – 16 credits

- EGR 2500 - Introduction to Thermal Engineering (4)
- EGR 2600 - Introduction to Industrial and Systems Engineering (4)
- EGR 2800 - Design and Analysis of Electromechanical Systems (4)
- **General Education (4)**

Junior year

Fall semester – 16 credits

- ECE 3540 – Intro to ROS (4)
- Required Professional Subject Choice 1 of 2 (4)
- ECE 3204 - Signals and Systems (4)
- MTH 2554 - Multivariable Calculus (4)

Winter semester – 16 credits

- Required Professional Subject Choice 2 of 2 (4)
- Professional Elective (Depth or Concentration 1 of 6) * (4)
- Professional Elective (Depth or Concentration 2 of 6) * (4)
- General Education (4)

Senior year

Fall semester – 16 credits

- Professional Elective (Depth or Concentration 3 of 6) * (4)
- Professional Elective (Depth or Concentration 4 of 6) * (4)
- Mathematics and Sciences elective (4)
- General Education (4)

Winter semester – 16 credits

- Professional Elective (Depth or Concentration 5 of 6) * (4)
- Professional Elective (Depth or Concentration 6 of 6) * (4)
- ECE or ME 4999 - Senior Design (4)
- General education (4)

* For professional electives, students electing to take a Concentration should review both the required and elective courses to properly plan the order to take courses to satisfy pre-requisites among all six courses.

Appendix C – Industry Letters of Support

Raymond Slowik, MEE
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21 July 2023

Dr. Khalid Mirza
Special Instructor
Founding Director, Augmented Reality Center
Director, OU-Stellantis Controls and Robotics Laboratory
Director, Industrial Robotics Laboratory
Electrical and Computer Engineering Department
Oakland University

Subject: Letter of Support for Proposed Robotics and Mechatronics Bachelor of Engineering Course

Dear Dr. Mirza,

I am writing this letter to express my enthusiastic support for the proposed Robotics and Mechatronics Bachelor of Engineering course at Oakland University. As a Research and Development professional with a strong background in engineering and a passion for advancing technology, I believe that this curriculum is well-designed to prepare the next generation of engineers to tackle the challenges of the modern world and contribute significantly to the field of robotics and mechatronics.

The curriculum's emphasis on Mathematics and Sciences is commendable, as it lays a solid foundation for students to understand the theoretical underpinnings of robotics and mechatronics. The requirement for students to complete at least 30 credits in the required math/science area ensures that they possess the necessary quantitative skills to excel in this field. Moreover, the provision for additional math/science courses allows for flexibility, accommodating students from various academic backgrounds and ensuring their success in the program.

The list of approved Math/Science Elective Options offers a diverse range of courses that allow students to delve deeper into areas that align with their interests and career goals. Courses such as Applied Matrix Theory, Numerical Methods, and Biological Physics provide students with valuable insights into cutting-edge fields, fostering a well-rounded education. The inclusion of Computer Algebra and Artificial Intelligence showcases the curriculum's commitment to staying at the forefront of emerging technologies and trends in the engineering industry.

The Engineering Core is thoughtfully designed to expose students to essential engineering principles and practices. From Engineering Graphics and CAD to Design and Analysis of

Electromechanical Systems, these courses equip students with hands-on skills necessary to design, analyze, and develop innovative robotic and mechatronic systems.

I am particularly impressed with the inclusion of Required Professional Subjects such as Electric Circuits, Signals and Systems, and Intro to ROS (with robot projects). These subjects are crucial in providing students with the foundational knowledge and practical experience needed to work on advanced robotics and mechatronics projects. The capstone project in Senior Design is an excellent opportunity for students to apply their learning to real-world challenges, fostering teamwork and creativity.

The range of Professional Elective options offers students the chance to specialize in various fields, catering to their specific interests and career aspirations. The specialization areas, such as Automotive Mechatronic Systems, Autonomous Vehicles, Electric Drives, Human-Robot Interaction, Industrial Robotics and Automation, and Intelligent Robotics and Controls, exemplify the curriculum's versatility and relevance to the current demands of the industry.

I believe that this proposed Robotics and Mechatronics Bachelor of Engineering course will play a pivotal role in producing skilled engineers equipped to lead the robotics revolution in various sectors, from manufacturing and healthcare to transportation and beyond. By fostering a deep understanding of core engineering principles and providing opportunities for specialization, this curriculum will undoubtedly create graduates who are sought after by employers and at the forefront of technological innovation.

In conclusion, I wholeheartedly support the establishment of the Robotics and Mechatronics Bachelor of Engineering course at your college. The thoughtfully crafted curriculum, diverse elective options, and emphasis on practical experience make it a program that will undoubtedly shape future engineering leaders. I am confident that this course will attract bright minds and contribute significantly to the advancement of robotics and mechatronics in our society.

Thank you for considering my endorsement of this innovative educational endeavor. If you require any further information or assistance, please feel free to contact me at Raymond.Slowik@valiantmachine.com or 248-961-7704.

Best Regards / Cordialement/ Mit freundlichen Grüßen / 最好的祝福, Cu stimă,

Raymond Slowik MSEE
Senior R&D Engineer
VALIANT TMS

Magna Electronics
26360 American Drive
Southfield, Michigan 48034
magna.com

July 18, 2023

Khalid Mirza, Ph.D.
Special Instructor
Electrical and Computer Engineering Department
Oakland University

Dear Dr. Mirza:

Thank you for bringing my attention to your proposed Bachelor of Science in Robotics and Mechatronics Engineering. I fully endorse the inclusion of this major within the School of Engineering and Computer Science.

In automotive we are experiencing a major transition in the realm of autonomy and driver assistance. It was about 80 years ago that drivers could push a cruise control button and have the car maintain a speed, regardless of whether that car was on a roadway or headed into a field. It was a breakthrough by Ralph Teetor in the 1940's and didn't see much in the way of change until the past decade.

We are now expecting more from that cruise control button. When set, vehicles are responding to surrounding traffic, painted lane markings, traffic control devices and more. To advance the state of the art and continue to deliver more convenience and safety we need well trained engineers coming up through the ranks and this curriculum looks to provide that.

In 2022 over 42,000 people died in vehicle related accidents in the USA. According to the World Health Organization there is a vehicular fatality somewhere in the world every 10 seconds. We can do something about this and through advanced sensing, drive policy software, and vehicle actuators we will make a difference. Your courses provide for excellent insights into these areas and will introduce new engineers to the exciting careers available in automotive that can have a meaningful impact on bringing people home to their loved ones safely.

As a four time graduate of OU, I know the importance of launching into a career with a firm foundation. I'm proud of my alma mater and the caliber of students you are bringing to the workforce.

Sincerely,

Christopher L. Van Dan Elzen
Vice President, Radar Product Area

21 July 2023

Professor Khalid Mirza
Oakland University
mirza@oakland.edu

Dr. Mirza,

I am writing in regards to the proposed curriculum for a new Bachelor of Science in Robotics and Mechatronics Engineering in the School of Engineering and Computer Science. The news of this proposal is a welcome and exciting development for Oakland University, ABB, the local community, and the robotics industry.

We expect that the global growth of the robotics market to expand exponentially in the next 10 years as the world looks for safer and more sustainable ways to work. Oakland University has the ability to be a leader in this market with a rigorous platform for students to learn and gain experience. The robotics integration industry is starving for capable engineers who understand mechanical, controls, and process engineering in the robotics field to drive new technologies and help customers thrive. Multi-talented engineering is vital to this market because a system with robotics must coordinate not only with the robot, but with the safety system, the logistics, the human interface, and the up and coming automated mobile robots (AMRs) that are becoming a dominant component of the factory of the future.

Engineers in Mechatronics will be serious contenders and participants in the job market.

As a graduate of Oakland University (BS - HRD, 1996), I understand and value the Oakland University education. ABB's Robotics group for the United States is headquartered in Auburn Hills, MI; with other locations in Atlanta, Houston, and San Jose, CA. Oakland's representation in our business at all levels in Auburn Hills, and the reputation of its graduates, is solid. ABB is excited to recruit more students from the local area to build their careers and enhance our corporate culture.

We are eager to follow the development of this new program. Know that ABB will be interested in its progress so that ABB can incorporate these graduates into our global business with opportunities in 100+ countries. Please let me know if we can further our discussion.

Respectfully,

Joseph O. Wydeven
Vice President, Customer Service - US
ABB Robotics

ABB Inc.
Robotics Business Unit
Robotics and Discrete Automation Division
United States of America

1250 Brown Road
Auburn Hills, MI 48326 USA
Phone: +1 248 391 9000
www.abb.com/robotics

1/1

AMT
Integrating industrial automation since 1989

219 Kay Industrial Dr. (248) 409-2000 phone
Orion, MI 48359 (248) 409-2027 fax www.appliedmfg.com

Dr. Khalid Mirza
Electrical and Computer Engineering Department
Oakland University

Dear Dr. Mirza,

Applied Manufacturing Technologies (AMT), is a system integrator and engineering services provider established in 1989. In the last two years, our revenue has more than doubled. The lack of workers to fill jobs and the urgency to bring manufacturing back to the United States has driven the demand for robotic automation to a level that outpaces the ability to satisfy the need.

Last August we purchased a building adjacent to our headquarters to double the size of the shop floors where we build automated systems. There is more land available when we need it. Not so readily available are the engineers with the skills to design and build robotic automated systems.

The program you are proposing, the BSE in Robotics and Mechatronics Engineering, would provide students with the fundamentals necessary for careers in automation. AMT will be among the companies competing for their talent.

Sincerely,

Michael Jacobs

Michael Jacobs
CEO, Founder Applied Manufacturing Technologies

AMT
Integrating industrial automation since 1989

219 Kay Industrial Dr. (248) 409-2000 phone
Orion, MI 48359 (248) 409-2027 fax www.appliedmfg.com

Dr. Khalid Mirza
Electrical and Computer Engineering Department
Oakland University

Dear Dr. Mirza,

As a fan and graduate of the School of Engineering and Computer Science, I am very excited about the proposed BSE in Robotics and Mechatronics Engineering. My education at Oakland provided me with a solid command of engineering fundamentals and a special focus on machine vision that served me well for many years.

As Chief Knowledge Officer at Applied Manufacturing Technologies (AMT), my responsibilities as an executive include strategic planning along with the day-to-day operational challenges. One of our greatest difficulties is a lack of incoming engineering talent. The work we do is complex and challenging. We often refer to our Automation Engineers as the "Swiss Army Knives" of engineers. They need mechanical, electrical, programming, and very strong problem-solving skills. The curriculum proposed in this new program is right in line with what we are looking for in an incoming engineer.

Industry publications and professional organizations we belong to consistently provide statistics on the explosive demand for automated systems. We need engineers that can help us to meet the challenge.

Kind Regards,

Diane Haig

Diane Haig
Chief Knowledge Officer, Applied Manufacturing Technologies

Nabtesco

Nabtesco Motion Control Inc.
23967 Freeway Park Dr.
Farmington Hills MI 48335

July 19, 2023

Khalid Mirza, Ph.D.
Special Instructor
Electrical and Computer Engineering Department
Oakland University

Dear Dr. Mirza:

As we have seen over the past few years more automation and robotics are entering everyday life all the time. From Industrial technology (Automation/Robotics) to consumer technology (Vacuum cleaners, lawnmowers and even helping the elderly and disabled.) One of the biggest challenges is creating, understanding, using, and maintaining all the upcoming new technology.

From my many years of industrial background, a Mechatronic program is long overdue. I have found that having separated disciplines (Electrical, Pneumatic, Hydraulic, etc.) is great, but lacking a real sense of all things connected and the ability to communicate how those connections work.

In the past, Mechatronic specialists have been made! "Forged under fire" in industrial environments. Not always, resulting in the best Mechatronics. The time is overdue to properly educate and train professionals in the field of Mechatronics. Creating individuals and groups ready to enter the workforce with this aptitude of crossed disciplines is a must.

I believe in my time working with Oakland University as, an industrial partner that OU has the best staff, access to understanding real-time industry needs, and resources to suit a very good Mechatronics program which will be beneficial to the expansion of courses that appeal to the lasts generations of Engineers and technician and also to hugely benefit any students with this education. I feel the students will graduate with one of the most diverse toolboxes allowing these students to go anywhere and do anything in our ever-increasing technological world.

Before many of these programs were degreed or accredited, I completed certificate programs in Electronics, Pneumatics, Hydraulics, and CAD. In addition to teaching myself a wide range of computer skills and proprietary industrial controls. This allowed me a good overview of Automation/Robotics and an understanding of the workflow needed to accomplish what I needed to do in manufacturing industries. To me, a mechatronics program is something I really would have appreciated if it was available when I was starting in the industry.

Sincerely,

Jim Gruszczynski
Business Development Manager
Nabtesco Motion Control Inc.

HIROTEC AMERICA

3000 High Meadow Circle • Auburn Hills, MI 48326-2837
(248) 836-5100 Fax (248) 836-5101

July 18, 2023

To Oakland University:

HIROTEC, which has just celebrated our ninetieth company anniversary, is pleased to submit this letter to the School of Engineering and Computer Science, endorsing their new degree program in Robotics and Mechatronics Engineering.

As an automotive manufacturing company specializing in vehicle closures and flexible manufacturing systems, it is vital to understand the robotics industry and the critical role it plays in various other industries. A Bachelor of Science in Robotics and Mechatronics Engineering brings substantial opportunity for future students, and it perfectly aligns with emerging demands within industry.

With this new program, students will utilize hands-on learning to prepare them for an industry that is continuously evolving. Knowledgeable candidates from Oakland University will enter the workforce ready to help grow the industry, leveraging their passion for robotics and automation.

HIROTEC America feels that a new Bachelor of Science in this area will not only help the industry but impact the community as well. With an increasing reliance on automation, our community will benefit from the innovation and economic growth these skilled professionals will bring. We trust Oakland University to produce the needed classes and experience our future generations need to be successful.

Endorsed by:

Jim Toeniskoetter
President | CTO

Endorsed by:

Brian G. McGinnity
CFO

KUKA

KUKA Robotics Corporation 51870 Shelby Parkway, Shelby Township, MI 48315

Dr. Khalid Mirza
Program Development Faculty Committee
School of Engineering and Computer Science
Oakland University
Rochester, MI 48309
USA

Date: July 31, 2023

Subject: Letter of Endorsement for Bachelor of Science in Robotics and Mechatronics Engineering Program

Dear Dr. Mirza,

I am honored to have received your request to provide a letter of endorsement for the proposed Bachelor of Science in Robotics and Mechatronics Engineering program at Oakland University. I commend the Program Development Faculty Committee for their approach in developing a program that effectively caters to the ever-evolving demands and trends in the field of robotics and mechatronics engineering.

Robotics and automation, in general, has undergone unprecedented growth over the past few decades, transforming industries and revolutionizing the way we live and work. As an industry executive with KUKA Robotics, I have over 25 years of experience in robotics and automation and been in all facets of automation during my career. I have witnessed first-hand the increasing significance of robotics and mechatronics in enhancing efficiency, improving safety, and driving progress across various sectors. The rapid advancements in automation, artificial intelligence, and autonomous systems have opened up new possibilities, and it is evident that these technologies will continue to play a pivotal role in shaping the future.

The proposed Bachelor of Science in Robotics and Mechatronics Engineering program will equip aspiring students with the essential knowledge, practical skills, and interdisciplinary mindset required to excel in this dynamic field. By emphasizing hands-on learning and offering a comprehensive understanding of cutting-edge technologies, the program will produce graduates who are not only technically competent but also innovative and adaptable.

I believe that the alignment of this program with the emerging demands and trends in the industry is very important. As the industry evolves, there will be a growing need for skilled professionals who possess expertise in robotics, automation, and artificial intelligence. By providing students with the opportunity to explore these areas, Oakland University is positioning itself as a hub for cultivating talent that will drive the future of robotics and mechatronics engineering.

The benefits of this program extend beyond the industry itself. Robotics and mechatronics engineering have far-reaching implications, touching various aspects of our society, including healthcare,

KUKA

transportation, environmental sustainability, and more. Graduates of this program will contribute to solving real-world challenges and improving the quality of life for people globally.

Oakland University has consistently demonstrated its commitment to providing a high-quality educational experience. The establishment of this program is a testament to the institution's dedication to academic excellence and fostering an environment that encourages innovation and collaboration. I am confident that the university possesses the necessary resources and expertise to deliver an outstanding educational experience in this field.

I am happy to extend my endorsement of the Bachelor of Science in Robotics and Mechatronics Engineering program at Oakland University. I believe this program will make a significant contribution to the robotics and mechatronics engineering field and produce graduates who will be at the forefront of innovation and change. Please consider this letter as my support for this educational initiative.

Sincerely,

Ed Volcic

Vice President Industry Management

KUKA Robotics Corporation

KUKA Robotics Corporation 51870 Shelby Parkway, Shelby Township, MI 48315 / USA T +1 866 873-5852 F +1 866 329-5852

Applied Manufacturing Technologies, 219 Kay Industrial Drive, Orion, MI 48359, 248-409-2000

July 21, 2023

Subject: Endorsement for the BS in Robotics and Mechatronics Engineering at Oakland University

To: Khalid Mirza, Ph. D
Founding Director, Augmented Reality Center
Director, Industrial Robotics Laboratory
Electrical and Computer Engineering Department
Oakland University

Dear Khalid

Applied Manufacturing Technologies (AMT) enthusiastically endorses the proposal for a Bachelor of Science degree in Robotics and Mechatronics Engineering at Oakland University.

The demand for robotic solutions has steadily escalated over the last decade and will continue to do so. Advancements in robotic technology and artificial intelligence, along with the adoption of robotics by industries outside of the conventional manufacturing and warehousing have propelled the demand for robotic solutions across the globe..

An Oakland University program focused on mechatronics, robotics, and automation technologies, such a PLC programming and vision, would be highly desirable by companies in Michigan and across the United States. Current demand for engineers skilled in automation outstrips demand. As the demand for robotics solutions escalates, so will the demand for engineers skilled in automation.

AMT has benefited tremendously from the engineering graduates recruited from Oakland University. They have proven to be excellent engineering assets for our automation team and have become leaders and mentors to our entry level automation engineers. We are confident the mechatronics and robotics engineering program would prove an advantageous degree for students and technology companies across the state of Michigan. The Oakland University Engineering staff and career counselling center does and excellent job preparing students for the future demands of the professional engineering world. AMT values our partnership with Oakland University and looks forward to continued success of our relationship.

Thang you,

Craig Salvalaggio
AMT President
csalvalaggio@appliedmfg.com

Appendix D – Proforma Budget

SBRC Proforma Template

BSE Mechatronics and Robotics Engineering

FY2024

Most Likely Scenario

		Year 1	Year 2	Year 3	Year 4	Year 5
Est. New Students to Program		15	15	15	15	15
1st Year Cohort Revenue		$ 255,634	$ 255,634	$ 255,634	$ 255,634	$ 255,634
2nd Year Cohort Revenue		$ -	$ 251,460	$ 251,460	$ 251,460	$ 251,460
3rd Year Cohort Revenue		$ -	$ -	$ 255,390	$ 255,390	$ 255,390
4th Year Cohort Revenue		$ -	$ -	$ -	$ 253,425	$ 253,425
Gross Tuition Revenue		$ 255,634	$ 507,094	$ 762,484	$ 1,015,909	$ 1,015,909
Less: Avg Financial Aid (30%)		$ (76,690)	$ (152,128)	$ (228,745)	$ (304,773)	$ (304,773)
Net Tuition Revenue		**$ 178,944**	**$ 354,966**	**$ 533,739**	**$ 711,136**	**$ 711,136**
Expenses						
Salaries						
Faculty Salaries	6101	$ -	$ 95,000	$ 95,000	$ 95,000	$ 95,000
Visiting Faculty	6101					
Administrative Professionals	6201					

Clerical Technical	6211								
Administrative IC	6221								
Faculty Inload/Replacement Costs	6301								
Faculty Overload	6301								
Part-Time Faculty	6301								
Graduate Assistant	6311	$ 38,135	$ 38,135	$ 38,135	$ 38,135	$ 38,135
Casual/Temp	6401					
Out of Classification	6401					
Student Labor	6501					
Total Salary Expense		**$ 38,135**	**$ 133,135**	**$ 133,135**	**$ 133,135**	**$ 133,135**
Fringe Benefits	6701	$ -	$ 41,040	$ 41,040	$ 41,040	$ 41,040
Total Compensation		**$ 38,135**	**$ 174,175**	**$ 174,175**	**$ 174,175**	**$ 174,175**
Operating Expenses						
Supplies and Services	7101					
Graduate Tuition	7101	$ 41,916	$ 41,916	$ 41,916	$ 41,916	$ 41,916
E-Learning Support	7102					
Travel	7201					
Equipment	7501					
Maintenance	7110					
Recruitment and advertising	7101	$ 25,000	$ 25,000	$ 10,000	$ 10,000	$ 10,000
Library	7401	$ -	$ -	$ -	$ -	$ -
Total Operating Expenses		$ 66,916	$ 66,916	$ 51,916	$ 51,916	$ 51,916

Total Expenses	**$ 105,051**	**$ 241,091**	**$ 226,091**	**$ 226,091**	**$ 226,091**
Net Income (Loss)	**$ 73,893**	**$ 113,875**	**$ 307,648**	**$ 485,045**	**$ 485,045**

[1]The tuition calculations do not account for any attrition of students.

ECE Dept. Notes

Recruitment and Advertisement Budget provided by Cheryl Russell, OU Senior Marketing Account Manager

Requested faculty line starts in Year 2.

"Est. New Students to the Program" are repisented as FYE (Full Year Equivalent)

Grad Assistant cost total provided by SECS Business Manager, Keith Harvey: Graduate Assistant (6311) $38,135 and Graduate Tuition (7101) $41,916.

Appendix E – University Communications and Marketing plan

We will work with University Communications and Marketing to advertise the program. A detailed plan was not provided with this proposal as it was not part of the proposal template provided for new undergraduate programs. The department had completed the proposal prior to the new proposal template being posted to Curriculog on Sept. 18th and announced to the SECS at the end of September. The ECE Department will work with UCM to develop a plan while the proposal proceeds through governance. An initial Recruitment and Advertisement Budget estimate was provided by Cheryl Russell, OU Senior Marketing Account Manager and included in the proforma; $25k for the first 2 years, then $10k for the remaining 3 years.

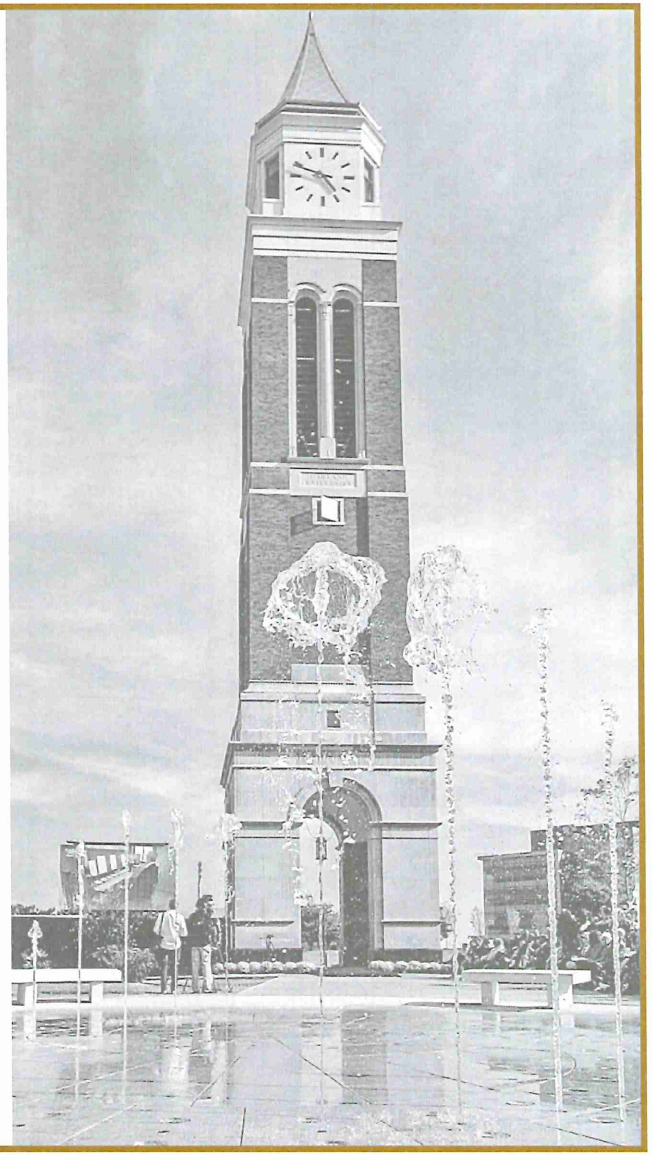
Mechatronics and Robotics Engineering, B.S.E.

Board of Trustees

Mechatronics and Robotics Engineering, B.S.E.

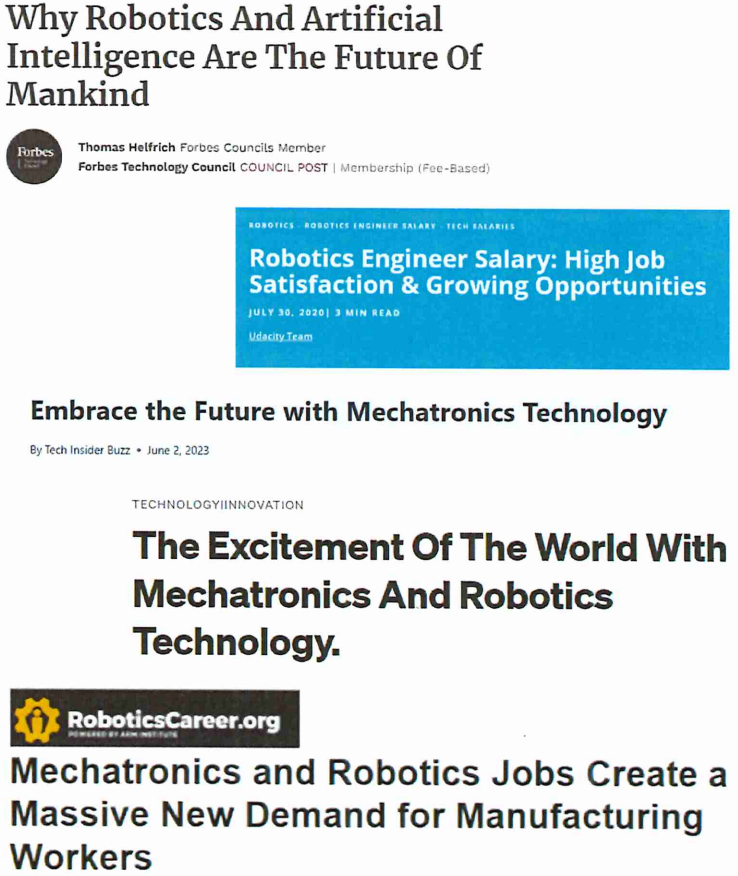
Department of Electrical and Computer Engineering,
School of Engineering and Computer Science
Presented by: Osamah Rawashdeh, Prof. and Chair

OAKLAND UNIVERSITY



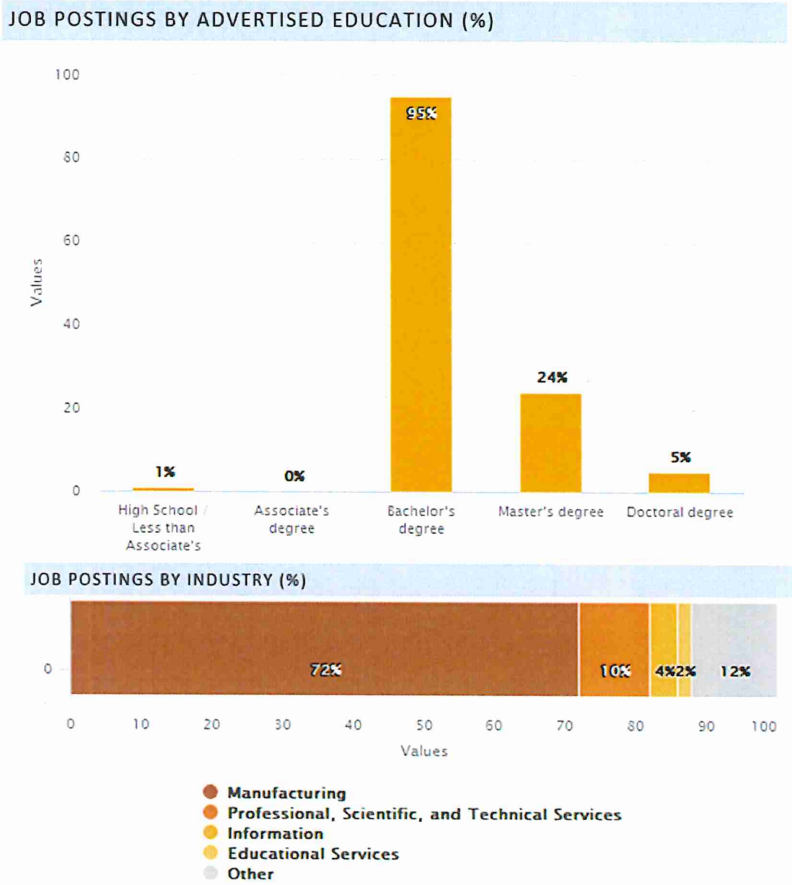
Summary of Need / Market Analysis

- The field of mechatronics and robotics is experiencing exponential growth and will continue to reshape various industries
- Programs already at Michigan Tech, LTU, UMD, UM, UM-Dearborn, and others
- Mechatronics and robotics topics are already part of existing programs and research activity in SECS
- We have been offering an **MS in Mechatronics** successfully for ~16 years



Summary of Need / Market Analysis

- The “Burning Glass” job report for Mechatronics, Robotics, and Automation Engineering in Michigan highlights the need for **undergraduate** degree holders
- The program will provide exciting career options in electrification, autonomous systems, mobility, automation, robotics areas, automotive mechatronics, controls, and many others



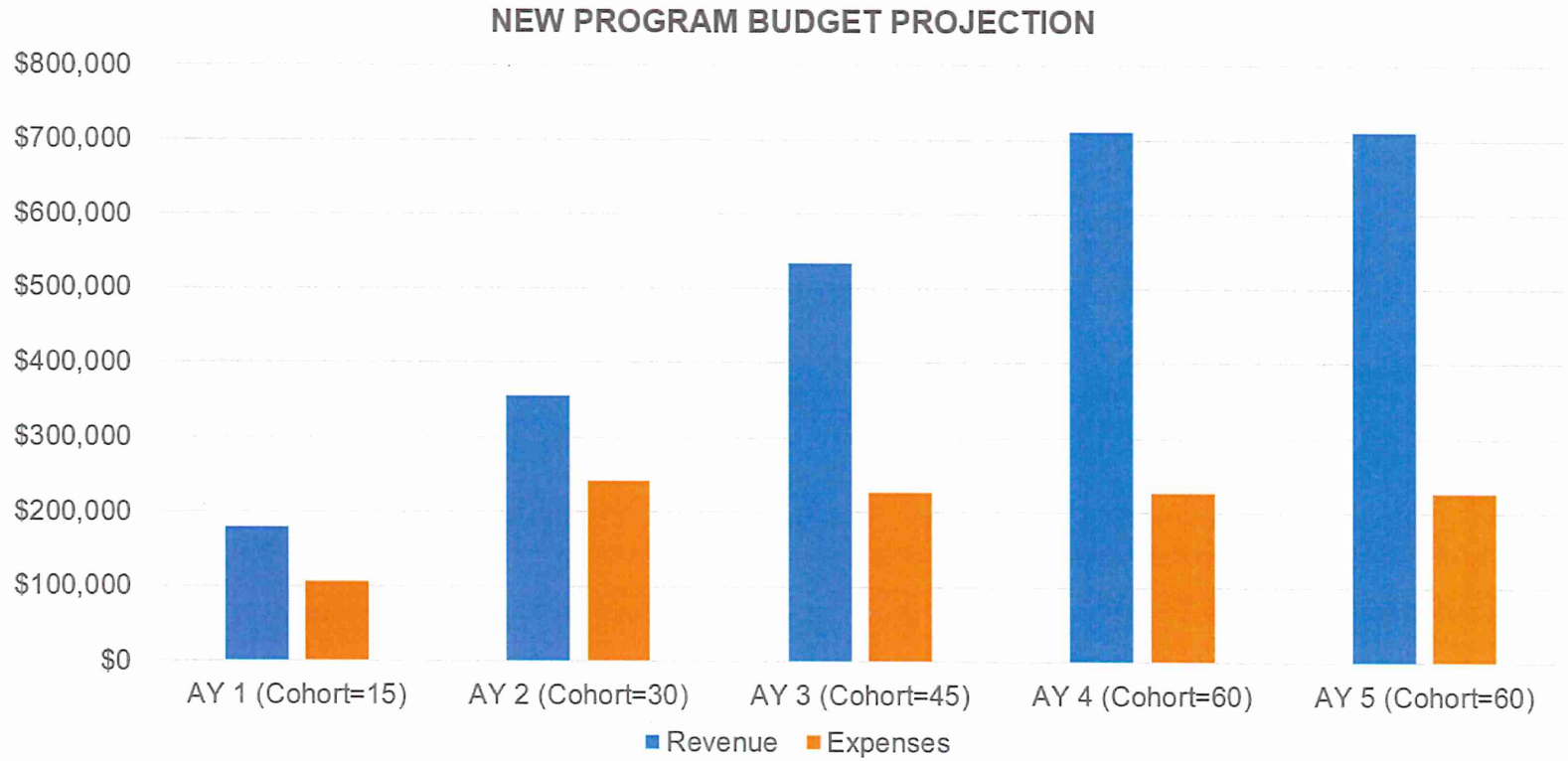
Rationale and Goal

- The industry, perspective students, and technology trends need engineers with expertise in **mechatronics** and in **robotic systems**
- The proposed program has been in the works for 2+ years as a **collaboration** among all SECS departments
- Instead of creating individualized degrees, we development an **"Umbrella" degree** that contains several subdisciplines (and has room to grow)
- Majority of courses, laboratory resources, and faculty **expertise is already available** (only need 2 new courses,1 faculty line, and 3 graduate assistants)

Description of Program

- The degree is modeled after our existing BSE degrees with **ABET accreditation** in sight
- Degree requirements - **129 total credits**
  - **General Education:** **28 credits**
  - **Math and Science:** **32 credits**
  - **Engineering Core:** **21 credits**
  - **Required Professional Subjects:** **24 credits**
  - **Professional Electives (depth):** **24 credits**
- Optional Major-Dependent Concentration (replaces "Professional Electives")
  - Automotive Mechatronic Systems
  - Autonomous Vehicles
  - Electric Drives and Powertrains
  - Human-Robot Interaction
  - Industrial Robotics and Automation
  - Intelligent Robotics and Controls

Proforma


NEW PROGRAM BUDGET PROJECTION
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0
AY 1 (Cohort=15)
AY 2 (Cohort=30)
AY 3 (Cohort=45)
AY 4 (Cohort=60)
AY 5 (Cohort=60)
Revenue
Expenses

ROI

- Attract and provide **opportunities** to a more **diverse student** population
- **Support SE MI** with graduates that have in-demand knowledge and expertise
- Enhance research opportunities and industry collaborations by further developing **faculty expertise** and **our reputation** in the field of robotics and mechatronics
- **DEI, retention, and graduation rates** will continue to be a major focus for existing SECS engineering programs and will be for this new program