

New Graduate Degree Program Development Plan Master of Science and Doctor of Philosophy in Mechatronics Engineering

The PDP should address, in a summary narrative of no more than five pages (exclusive of appendices, which should be kept as brief as possible), the following concerns:

1. Designation of the new degree program, rationale for that designation, definition of the focus of the program and a brief description of its disciplinary purpose and significance.

The designations of the new programs are Master of Science and Doctor of Philosophy in Mechatronics Engineering. These designations are appropriate to complement the existing Bachelor of Science degree in Mechatronics Engineering at Kent State University and increase the profile of the program. These designations provide industry, government, and academic recognition and are easily identifiable by students and their potential employers. Such degrees will attract the highest-quality students and research faculty.

Currently there is not a graduate engineering degree at Kent State University. There is a Master of Technology (MTEC) degree. The MTEC is considered a professional degree. There is a revision underway to make this a Master of Engineering Technology (MET) which will also be a professional degree.

The focus of the MS/PhD degrees is to provide students a theoretical and research-oriented curriculum that provides significant depth in mechatronics-specific disciplines. Establishment of these degrees allows the university to compete with other institutions offering engineering graduate degrees.

The purpose, significance, and importance of mechatronics engineering in today's society is immeasurable. Autonomous systems, robotics, and manufacturing touch or affect almost every other discipline on Earth. Humankind's continued progress as well as protection of the planet requires engineers with specialized knowledge in mechanical, electrical, control, and computer systems.

2. Description of the proposed curriculum including identification of any specializations intended to appear on the student transcript (see Section IV).

M. S. The proposed curriculum requires 31 credit hour with the 1.0 credit Aeronautics and Engineering (AE) seminar requirement. Students can select a thesis or non-thesis option. The thesis option is recommended for students who anticipate future doctoral study. The non-thesis option is recommended for those who do not anticipate pursuing a doctoral program.

M.S. Degree – Mechatronics Engineering

Topic	Thesis	Non-Thesis
Graduate Seminar	1.0	1.0
Advanced Mathematics ¹	6.0	6.0
Graduate Engineering Core (to be established)	9.0	9.0
Thesis / Research Credits ²	9.0	3.0
Graduate Elective Courses	6.0	12.0
Total	31.0	31.0

¹students select two from a pre-approved list of mathematics courses.

²thesis option consists of 6.0 thesis credits and 3.0 graduate research credits for a total of 9.0 credit hours. Non-thesis option consists of 3.0 graduate research credits.

Ph.D. The proposed curriculum requires 90 credit hours beyond the baccalaureate degree and 60 credit hours beyond the master's degree. The curricular requirements for both post-baccalaureate and post-masters options are provided in the following table:

Doctor of Philosophy – Mechatronics Engineering

Topic	Post-baccalaureate	Post-masters
Graduate Seminar (Repeating 1.0 credit hour course)	3.0	3.0
Advanced Mathematics*	9.0	3.0
Research – Dissertation (30.0 max) & Research Credits	48.0	39.0
Graduate Elective Courses	30.0	15.0
Total	90.0	60.0
*students select from a pre-approved list of mathematics courses.		

In addition to the course requirements, the Ph.D. requires the successful completion of four exams: 1) qualifying exam, 2) candidacy exam, to from a PhD committee and address the questions of committee members including the PhD advisor, 3) proposal defense exam, and 4) final examination, also known as a dissertation defense.

Information for both programs. No specializations will appear on the student transcript for either degree. The college will work with the Department of Mathematical Sciences to select appropriate graduate courses for these degrees.

CAE already has relevant graduate courses pertaining to the foundational areas of mechatronics (mechanical, electrical, control and computer) but will work with appropriate Kent State University units as appropriate to leverage existing courses. For example, we will collaborate closely with the Department of Computer Science to ensure there is no overlap in computer science and robotics. There will be some additional development of graduate courses over time, including courses in the following areas: dynamics/vibrations/controls; manufacturing/industrial automation and robotics; mechanics and structures; electronics; and engineering design.

Course names and descriptions will follow in the full proposal. The college expects a majority of the coursework in both degrees to be combined 60000/70000 courses. The M.S. degree might have some 50000-level coursework.

3. Description of a required culminating, or integrated learning, experience.

Examples of suitable culminating experiences include, but are not limited to: preparation of a thesis, dissertation or other creative written work; capstone or exit projects, which may be applied in nature and not necessarily involve research; comprehensive examinations; supervised field experiences, or any other integrated learning experience.

M.S. The master-of-science degree requires a research component, both in the thesis and non-thesis option. For the thesis option, the culminating experience consists of 9.0 credit hours of thesis research in consultation with a thesis advisor and committee. The committee approves the thesis topic and then accepts the final thesis after a successful thesis defense.

For the non-thesis option, the culminating experience consists of 3.0 research credit hours in consultation with a faculty advisor. At the discretion of the advisor, design and creativity projects

may satisfy this requirement. At a minimum, the non-thesis activity requires a report, and a presentation and/or demonstration. A course will be established for non-thesis research.

Ph.D. The culminating experience for the Ph.D. is specialized research, leading to a definitive contribution to the candidate's research focus-area. This contribution should be of sufficient importance to warrant publication in a recognized journal. The candidate must successfully propose and defend their research dissertation in a public setting.

4. Administrative arrangements for the proposed program: department and school or college involved.

Both degrees will reside in the College of Aeronautics & Engineering. The faculty graduate coordinator provides oversight in conjunction with the faculty engineering coordinator. The Dean has committed administrative assistant support for the college's graduate programs. Graduate engineering faculty will serve as student advisors.

5. Evidence of need for the new degree program, including the opportunities for employment of graduates. This section should also address other similar programs in the state addressing this need and potential duplication of programs in the state and region.

At the college level, this program is required to achieve university strategic priorities. The university prioritizes research and tenure-track faculty to increase its scholarly productivity. Tenure-track faculty have a research requirement. Research requires graduate students and hence graduate programs. The college requires graduate engineering programs to attract quality faculty who can secure funding that will attract quality students to the program. Through the three previous tenure track faculty searches, every single interview candidate highlighted the paradox of a research requirement despite having no research-based graduate program.

The United States Department of Labor, Bureau of Labor Statistics (BLS) predicts an 11.5% increase in postsecondary teacher employment from 2018 to 2028 ¹. Also, Deloitte and The Manufacturing Institute found that the number of new manufacturing jobs is predicted to grow to 1.96 million workers by 2028. Within this same time frame, 2.6 million baby boomers are expected to retire, leaving 2.4 million jobs unfilled ².

Mechatronics engineering focuses on designing, modeling, manufacturing, and maintaining products that have both mechanical and electronic components. Graduates of mechatronics engineering programs are spearheading the development of safer, streamlined workplace in many industries, such as automotive, transportation, and instrumentation. Goodyear has reclassified their engineering positions as mechatronics engineers as opposed to mechanical because they understand the skill set that is needed to exist in today's manufacturing environment. Companies like Rockwell Automation, Swagelok, Tesla and many other car manufactures also employ large numbers of mechatronics engineers. With the retirement of so many baby boomers, many of whom hold senior engineering positions, there is a critical need for individuals who can lead and conduct mechatronics engineering in industry, government, and academia.

Currently, there are no public institutions within the state of Ohio offering graduate degrees in mechatronics engineering and only a very few nationwide. If accepted, Kent State University

¹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Postsecondary Teachers, on the Internet at <https://www.bls.gov/ooh/education-training-and-library/postsecondary-teachers.htm> (visited October 01, 2019).

² <https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-skills-gap-study.html>

would be the only public institution in Ohio to offer a graduate degree in mechatronics engineering.

6. Prospective enrollment.

The Master of Science and Doctor of Philosophy in Mechatronics Engineering are expected to draw students from several areas within and outside of Kent State University. In only its second year of existence, the Bachelor of Science in Mechatronics Engineering has an enrollment of 14 students. The Bachelor of Science in Mechatronics Engineering Technology has an enrollment of 38 students. As these students graduate, the expectation is that some of them will continue into the graduate program. Some students from the current Master of Technology program may also transfer to the graduate program in mechatronics engineering. The program should also attract students from outside of Kent State University who possess Bachelor of Science degrees in mechanical and electrical engineering as well as a few from computer engineering and other disciplines. A conservative estimate would be 10 students in the first year and 40 students by year four. Once a full complement of faculty is assembled with adequate research capabilities, that number could double to approximately 20 students per year.

7. Special efforts to enroll and retain underrepresented groups in the given discipline.

The college already takes great efforts to recruit, enroll, and retain under-represented groups in the discipline. This began through the recruitment of six new faculty members into the college in 2019-2020. The college has already established student organizations supporting under-represented groups and annually celebrates its international students. The college will emphasize diversity through its seminar series, by inviting diverse members of academia and industry to discuss diverse topics relevant to the college.

8. Availability and adequacy of the faculty and facilities available for the new degree program.

There are currently 13 faculty members (including the Dean) with doctoral degrees in engineering, physics, or applied sciences who can support this program in some capacity. Current CAE faculty members are sufficient to launch this program at present and additional faculty who will have the credentials to support the proposed degree will be added in the future as the program grows.

The college has recently opened a new facility called, FedEx Aeronautics Academic Center, which is located at the Kent State University Airport. The new 17,800 square foot facility will provide amenities and collaborative spaces for students, classrooms, briefing rooms, simulator rooms and faculty and staff offices. The facility will also provide space for current and additional courses and allow for the establishment of several mechatronics projects including aerospace robotics and autonomous systems.

9. Need for additional facilities and staff and the plans to meet this need.

There is a planned wing annex already part of Kent State's Master Plan for the Aeronautics & Engineering Building, which will provide an additional 17,000 square feet of faculty, classroom, and research space. The university is in the process of fundraising with projected groundbreaking in the next two years. With the addition of this space, current university research allocation initiatives, and additional collaborative space available through the university's design and innovation initiative, the facility issues should be adequately addressed.

10. Projected additional costs associated with the program and evidence of institutional commitment and capacity to meet these costs.

Projected additional costs include those associated with additional faculty, recruiting, and moving some content online.

The following are examples of institutional commitment.

- The college has recently hired two new associate deans and six new tenure-track faculty.
- The college provides a start-up package to its tenure-track faculty and provides professional development funding for all faculty and staff.
- In Fall 2018, the college embarked on a re-structuring initiative to ensure that it operates in a manner consistent with other engineering colleges at other institutions.
- The college has launched two new undergraduate engineering programs since 2016, with the first graduating class of aerospace engineers this Spring 2020.
- The university conducted a thorough review of the college in 2016, which resulted in the current name and structure of the college.
- The college conducted a national dean search in 2017/18 to provide the visionary leadership necessary for achieving institutional goals. The Dean was hired in Fall 2018.
- College infrastructure projects are among the top five infrastructure goals of the university, with additional construction planned on the Airport Academic Complex with the addition of a maintenance facility, and with development and fundraising of the college building extension continuing toward groundbreaking next year.