

# : ENGINEERING: AUTONOMY AND ROBOTICS, MENG

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## In Workflow

1. U Program Review (dforgacs@illinois.edu; eastuby@illinois.edu; aledward@illinois.edu)
2. 1227 Head (kcp@illinois.edu; bsnewell@illinois.edu; danko@illinois.edu; jmakela@illinois.edu)
3. 1434 Head (namato@illinois.edu; vmahesh@illinois.edu; egunter@illinois.edu)
4. 1933 Head (b-hajek@illinois.edu; oelze@illinois.edu; erhan@illinois.edu)
5. KP Committee Chair (mch@illinois.edu; bsnewell@illinois.edu; danko@illinois.edu; kcp@illinois.edu)
6. KP Dean (candyd@illinois.edu)
7. University Librarian (jpwilkin@illinois.edu)
8. Grad\_College (agrindly@illinois.edu; jch@illinois.edu; lowry@illinois.edu)
9. Provost (kmartens@illinois.edu)
10. Senate EPC (bjlehman@illinois.edu; moorhouz@illinois.edu; kmartens@illinois.edu)
11. Senate (jtempel@illinois.edu)
12. U Senate Conf (none)
13. Board of Trustees (none)
14. IBHE (none)
15. DMI (eastuby@illinois.edu; aledward@illinois.edu; dforgacs@illinois.edu)

## Approval Path

1. Thu, 22 Oct 2020 21:17:48 GMT  
Deb Forgacs (dforgacs): Approved for U Program Review
2. Fri, 23 Oct 2020 19:16:40 GMT  
Keri Pipkins (kcp): Approved for 1227 Head
3. Fri, 23 Oct 2020 23:15:08 GMT  
Elsa Gunter (egunter): Approved for 1434 Head
4. Mon, 26 Oct 2020 13:40:27 GMT  
E Kudeki (erhan): Approved for 1933 Head
5. Mon, 16 Nov 2020 18:10:55 GMT  
Keri Pipkins (kcp): Approved for KP Committee Chair
6. Thu, 19 Nov 2020 22:04:08 GMT  
Candy Deaville (candyd): Approved for KP Dean
7. Thu, 19 Nov 2020 23:25:56 GMT  
John Wilkin (jpwilkin): Approved for University Librarian
8. Fri, 11 Dec 2020 20:48:51 GMT  
Allison McKinney (agrindly): Approved for Grad\_College
9. Sun, 13 Dec 2020 23:26:26 GMT  
Kathy Martensen (kmartens): Approved for Provost

## New Proposal

Date Submitted: Wed, 21 Oct 2020 22:23:54 GMT

## Viewing:: Engineering: Autonomy and Robotics, MENG

Changes proposed by: Keri Pipkins

## Proposal Type

### Proposal Type:

Concentration (ex. Dietetics)

Proposal Title:

**If this proposal is one piece of a multi-element change please include the other impacted programs here. *example: A BS revision with multiple concentration revisions***

Establish a Graduate Concentration in Autonomy and Robotics within the Master of Engineering in Engineering Degree

**EP Control Number**

EP.21.041

**Official Program Name**

Engineering: Autonomy and Robotics, MEng

**Effective Catalog Term**

Fall 2021

**Sponsor College**

Grainger College of Engineering

**Sponsor Department**

Engineering Administration

**Sponsor Name**

Geir Dullerud

**Sponsor Email**

dullerud@illinois.edu

**College Contact**

Harry Dankowicz

**College Contact Email**

danko@illinois.edu

## **Program Description and Justification**

**Provide *abrief* description and justification of the program, including highlights of the program objectives, and the careers, occupations, or further educational opportunities for which the program will prepare graduates, when appropriate.**

Brief description:

The proposed Concentration in Autonomy and Robotics is a fast-paced, one-year, professionally-oriented curriculum that aims to provide students with solid foundational and operational knowledge in the integration of principles of autonomy and robotics across a wide range of enterprises—including,

for instance, the aerospace, automotive, medical, construction, and entertainment industries. Students will learn to work with components of software systems, electronics, tools for algorithm design and machine learning, and physics-based dynamics, control and sensor systems. The 16 credit hours of core coursework includes interdisciplinary project experiences that present key topics in the context of practical applications. An additional 12 credit hours of elective coursework allows students to further customize their degree by choosing from a rich set of courses from several relevant disciplinary domains. The 4 credit hours of professional development coursework provide a capstone focus on skills relevant for industry careers.

Engineering analysis and design of current and future autonomous systems requires a broad range of skills and knowledge that do not entirely fit into any one of the traditional engineering departments or computer science. In contrast, all students in this program of study will learn about the complexities of the software systems needed to run autonomous systems; the mathematics, control, and information theory behind algorithm design; the physics needed to model robots and mobile vehicles; and the technologies for making and modifying physical prototypes. Students will have the opportunity to further specialize and concentrate their knowledge in one or more of these areas to which all will be introduced and exposed. This combination of breadth and depth will produce engineers able to contribute immediately to a specific area once employed, but will also put them in a unique position to pivot and learn other areas as required.

#### Justification:

A major technological revolution is underway in the areas of system automation and robotics, under the umbrella of autonomy. Applications include self-driving cars, delivery drones, remote and robotic surgical tools, micro-power grids, Internet-connected appliances, digital manufacturing equipment, and atmospheric control systems. This rapid transition requires engineers and computer scientists with cross-cutting training who can transform advances in digital hardware, communication networks, additive manufacturing, computational mechanics, and artificial intelligence into physical and information-system technologies. Although the US Bureau of Labor Statistics does not track robotics as a job category, the field draws employees from software engineering (21% projected growth from 2018-2028) and mechanical engineering (4% projected growth). At the start of 2020, Fior Markets projected that the global robotics market is expected to grow from USD 37.81 Billion in 2017 to USD 158.21 Billion by 2025 at a compound annual growth rate of 19.11%.

The proposed Concentration in Autonomy and Robotics aims to meet this critical need. It will position the University as a unique destination for prospective students interested in a professionally-oriented autonomy and robotics curriculum and will ensure our national leadership in education and research in every aspect of this rapidly growing field. It will also attract attention of employers from across the public, private, and non-government sectors who will be engaged as part of a deliberate effort to develop internship and career opportunities for program students and graduates. The proposed concentration is consistent with campus priorities that emphasize cooperation among multiple disciplines and that emphasize growth in the particular interdisciplinary area of autonomy and robotics, as evidenced by the creation of the Center for Autonomy in The Grainger College of Engineering. As an element of a revenue-generation strategy, the proposed concentration will provide resources for enhancing scholarship and educational opportunity.

Unique elements of the proposed curriculum relative to other disciplinary master's programs are opportunities for students to (i) work on complex autonomy testbeds that are not readily available in other master's programs; and (ii) to do so in multi-disciplinary project teams that integrate broad exposure to software, dynamics, control, electronics, and perception. These value-added features provide program graduates with a competitive advantage relative to those graduating from existing master's programs in robotics (e.g., at University of Michigan, University of Pennsylvania, and Carnegie Mellon University) when seeking employment in the rapidly expanding area of autonomy and robotics.

#### Is this program interdisciplinary?

Yes

#### Interdisciplinary Colleges and Departments (list other colleges/departments which are involved other than the sponsor chose above)

The proposed Concentration in Autonomy and Robotics is a formal collaboration between five academic units (Aerospace Engineering, Computer Science, Electrical & Computer Engineering, Industrial & Enterprise Systems Engineering, and Mechanical Science and Engineering) and the Center for Autonomy (founded using Investment-for-Growth funds), all in The Grainger College of Engineering. Governance and oversight will be implemented through an Admissions Committee and a Curriculum Oversight Committee with representation from each of the five departments on both committees. Committee members will be asked to serve overlapping three year commitments.

#### Curriculum Oversight Committee

The Curriculum Oversight Committee will consist of no fewer than four faculty members, including the chair, from the participating departments (Aero, CS, ECE, ISE, MechSE). Each member should be from a distinct department unless the size of committee exceeds five members, or there are other mitigating factors. The director of the Center for Autonomy will select the chair of the committee in consultation with the associate directors. The committee chair, director and associate directors will select the remaining committee members. Appointments to the committee will occur in alternating years, with a two-year term of service. Representation on the committee will be solicited from all participating departments each year. The Curriculum Oversight Committee will meet once a semester to review course offerings for the upcoming semester to ensure that core courses, as well as an appropriate selection of elective courses, are offered each semester for students to successfully complete this program in three semesters. The committee will review and update the program curriculum requirements on an annual basis to ensure students are receiving the advanced knowledge

and skills needed for industry positions in this field. Additionally, the committee will address any petitions or other course-related matters that arise during the running of the program on an ad hoc basis. Faculty that serve on this committee will be responsible for updating their home department on curriculum needs and future course plans for this concentration.

#### Admissions Committee

The Admissions Committee will consist of no fewer than four faculty members, including the chair, from the participating departments (Aero, CS, ECE, ISE, MechSE). Each member should be from a distinct department unless the size of committee exceeds five members, or there are other mitigating factors. The director of the Center for Autonomy will select the chair of the committee in consultation with the associate directors. The committee chair, director and associate directors will select the remaining committee members. Appointments to the committee will occur annually with a one-year term of service. Representation on the committee will be solicited from all participating departments each year. The Admissions Committee will be responsible for all admissions decisions for the program, and related adjudication. This committee will determine in advance the capacity for incoming students for each entering term with feedback from each of the participating departments. The committee will meet on a regular basis throughout the admission season for the Fall and Spring terms to review and admit applicants.

The program will leverage the shared services for MEng programs in The Grainger College of Engineering's Center for Professional and Executive Training and Education to provide administrative support for the program, including in support of student recruitment, career advising, and professional development. The Grainger College of Engineering Office of Graduate, Professional, and Online Programs will process all required paperwork for applicants and current students.

During the first three years the program cohorts will consist of 20-25 students. Therefore, advising will primarily be provided by the full-time Program Director. This will involve assisting students with choosing their courses, and dealing with other logistical academic matters that arise. The Director will also organize events to help acclimatize students to their new environment, and indeed continue leading such events throughout the program year; faculty involved with the program may also attend these events. For specific technical advice, students will be able to consult directly with faculty members who are involved with the program. The Director will also help direct students to appropriate University resources. For situations in which students require special support (for instance to deal with personal crises or challenges), the program will utilize the specially trained professional staff in the Office of the Associate Dean for Graduate, Professional and Online Programs.

#### College

Grainger College of Engineering

#### Department

Computer Science

#### Do you need to add an additional interdisciplinary relationship?

Yes

#### College

Grainger College of Engineering

#### Department

Electrical and Computer Engineering

#### Do you need to add an additional interdisciplinary relationship?

No

**Corresponding Program(s):**

**Corresponding Program(s)**

Engineering, MEng

**Academic Level**

Graduate

**Additional concentration notes (e.g., estimated enrollment, advising plans, etc.)**

During the first three years the program cohorts will consist of 20-25 students. Therefore, advising will primarily be provided by the full-time Program Director. This will involve assisting students with choosing their courses, and dealing with other logistical academic matters that arise. The Director will also organize events to help acclimatize students to their new environment, and indeed continue leading such events throughout the program year; faculty involved with the program may also attend these events. For specific technical advice, students will be able to consult directly with faculty members who are involved with the program. The Director will also help direct students to appropriate University resources. For situations in which students require special support (for instance to deal with personal crises or challenges), the program will utilize the specially trained professional staff in the Office of the Associate Dean for Graduate, Professional and Online Programs.

**Is This a Teacher Certification Program?**

No

**Will specialized accreditation be sought for this program?**

No

**Enrollment**

**Number of Students in Program (estimate)**

**Year One Estimate**

20

**5th Year Estimate (or when fully implemented)**

50

**What is the typical time to completion of this program?**

1 year

**What are the minimum Total Credit Hours required for this program?**

32

## Delivery Method

This program is available:

On Campus

## Budget

Will the program or revision require staffing (faculty, advisors, etc.) beyond what is currently available?

Yes

Please explain/describe:

A full-time Program Director will be hired to manage day-to-day operations and logistics for the MEng program. The Center for Autonomy will fund this position for the first two years. After that the program tuition revenue should be sufficient to cover this salary and other expenses associated with this position.

## Resource Implications

Facilities

Will the program require new or additional facilities or significant improvements to already existing facilities?

No

Technology

Will the program need additional technology beyond what is currently available for the unit?

No

Non-Technical Resources

Will the program require additional supplies, services or equipment (non-technical)?

No

## Resources

For each of these items, be sure to include in the response if the proposed new program or change will result in replacement of another program(s). If so, which program(s), what is the anticipated impact on faculty, students, and instructional resources? Please attach any letters of support/acknowledgement from faculty, students, and/or other impacted units as appropriate.

## Faculty Resources

**Please address the impact on faculty resources including any changes in numbers of faculty, class size, teaching loads, student-faculty ratios, etc. Describe how the unit will support student advising, including job placement and/or admission to advanced studies.**

The proposed core curriculum is built from courses currently taught (including as special topics classes) in the participating departments, along with electives chosen from courses offered by participating departments or other departments in The Grainger College of Engineering. There is no anticipated impact on faculty resources. The concentration is also strategically aligned with the expansion of The Grainger College of Engineering's footprint in research and education in autonomy and robotics as evidenced by the creation of the Center for Autonomy and by college-wide tenure-track hiring in this area.

## Library Resources

**Describe your proposal's impact on the University Library's resources, collections, and services. If necessary please consult with the appropriate disciplinary specialist within the University Library.**

There will be minimal to no impact on the University Library's resources, collections, and services.

## Instructional Resources

**Will there be any reduction in other course offerings, programs or concentrations by your department as a result of this new program/proposed change?**

No

**Does the program include other courses/subjects impacted by the creation/revision of this program?**

Yes

## Required courses

ECE 484 - Principles of Safe Autonomy  
ME 445 - Introduction to Robotics  
CS 588 - Autonomous Vehicle System Eng

**Explain how the inclusion or removal of the courses/subjects listed above impacts the offering departments.**

The three departments offering required courses are among the five academic units (Aerospace Engineering, Computer Science, Electrical & Computer Engineering, Industrial & Enterprise Systems Engineering, and Mechanical Science and Engineering) formally collaborating with the the Center for Autonomy in offering this concentration. Letters of support are attached. These departments will be compensated via agreed upon MOU's between the Center for Autonomy and each department.

**Attach letters of support from other departments.**

CS-Letter-of-Support-MEng-Autonomy-Robotics\_2020-05-31.pdf  
Nagi\_ISE Endorsement of MEng in Autonomy RN.pdf  
Jacobi-MechSE endorsement-10172019.pdf  
ISE\_MEng.pdf  
Hajek-ECE.pdf  
Freund-Aero.pdf

## Financial Resources

### How does the unit intend to financially support this proposal?

The unit is requesting self-supporting program status for this degree. Students enrolled in this degree will pay tuition. The Grainger College of Engineering will use some of the graduate tuition dollars returned to the college from the Office of the Vice Provost for Budget and Resource Planning to provide the participating departments with resources needed to support the proposed curriculum. Graduate tuition funds returned to the college from campus are considered state, recurring funds that may be used to fund faculty and lecturer salaries, support instruction, or at the discretion of the participating Department Heads in a manner consistent with campus policy on use of such funds. Additional financial support will be provided in the first three years by the Center for Autonomy in The Grainger College of Engineering.

### Will the unit need to seek campus or other external resources?

No

### Attach letters of support

MENG Autonomy and Robotics.pdf

### Is this program requesting self-supporting status?

Yes

## Program Regulation and Assessment

**Briefly describe the plan to assess and improve student learning, including the program's learning objectives; when, how, and where these learning objectives will be assessed; what metrics will be used to signify student's achievement of the stated learning objectives; and the process to ensure assessment results are used to improve student learning. (Describe how the program is aligned with or meets licensure, certification, and/or entitlement requirements, if applicable).**

The learning objectives of the proposed Concentration in Autonomy and Robotics include professionally-oriented competence in the application of software systems, electronics, tools for algorithm design and machine learning, and physics-based dynamics, control and sensor systems to the integration of autonomy in robotic systems. The learning objectives will be assessed in the core coursework and through the performance of students in the capstone project professional-development course. Such assessment will be analyzed annually by the Curriculum Oversight Committee to ensure students are receiving the advanced knowledge and skills needed for industry positions in this field. Additional metrics include placement of graduates in relevant careers measured in exit surveys.

### Is the career/profession for graduates of this program regulated by the State of Illinois?

No

## Program of Study

"Baccalaureate degree requires at least 120 semester credit hours or 180 quarter credit hours and at least 40 semester credit hours (60 quarter credit hours) in upper division courses" (source: <https://www.ibhe.org/assets/files/PrivateAdminRules2017.pdf>). For proposals for new bachelor's degrees, if this minimum is not explicitly met by specifically-required 300- and/or 400-level courses, please provide information on how the upper-division hours requirement will be satisfied.

All proposals must attach the new or revised version of the Academic Catalog program of study entry. Contact your college office if you have questions.

**For new programs, attach Program of Study**

AcademicCatalog\_MEng\_AutonomyandRoboticsv4.pdf

Catalog Page Text

**Catalog Page Text: Description of program for the catalog page. This is not official content, it is used to help build the catalog pages for the program. Can be edited in the catalog by the college or department.**

associate dean for graduate, professional and online programs : Harry Dankowicz

overview of admissions & requirements: <https://grainger.illinois.edu/academics/graduate>

overview of grad college admissions & requirements: <https://grad.illinois.edu/admissions/apply>

college website: <https://grainger.illinois.edu/>

address: 402 Engineering Hall, 1308 W Green St, Urbana, Illinois 61801

phone: (217) 244-2745

email: [enr-gpp@illinois.edu](mailto:enr-gpp@illinois.edu)

The Grainger College of Engineering offers a Master of Engineering (MEng) degree program for students whose primary intent is a professional career in industry or government. This degree differs from the Master of Science (MS) degree in that it is a professionally-oriented master's degree that is not a pathway to a doctoral program. The Major in Engineering for the M.Eng. degree requires the selection of an interdisciplinary concentration, which must be identified at the time of application. Available concentrations are:

Aerospace Systems Engineering

Autonomy and Robotics

Energy Systems

Plasma Engineering

Railway Engineering

**Admission**

Students with bachelor's or master's degrees in engineering or related sciences will be considered for admission if they have a grade point average of at least 3.00 (A = 4.00) for the last two years of undergraduate study. Admission is possible for the both the fall and spring semesters. Full details of admission requirements are on the Web page of the department offering the concentration.

All applicants whose native language is not English are required to submit TOEFL or International English Language Testing System (IELTS) scores as evidence of English proficiency. Minimum admission requirements are set by the Graduate College. Higher requirements may be imposed by specific concentrations.

**Financial Aid**

Students in concentrations under the MEng in Engineering major are not eligible for Board of Trustees (BOT) tuition-waiver generating assistantships at the University of Illinois.

**Statement for Programs of Study Catalog**

**Concentration Requirements**

Code	Title	Hours
<b>Core Coursework</b>		<b>12</b>
ME 445	Introduction to Robotics	
ECE 484	Principles of Safe Autonomy	
CS 588	Autonomous Vehicle System Engineering	

Select one of the following:

Control and Dynamics	
ECE 486	Control Systems
SE 422	Robot Dynamics and Control
Optimization	
AE 504	Optimal Aerospace Systems
ECE 490	Introduction to Optimization
Hardware Systems	
ME 451	Computer-Aided Mfg Systems
Artificial Intelligence and Perception	
CS 440	Artificial Intelligence
CS 543	Computer Vision
ECE 544	Topics in Signal Processing
Design and Applications	
CS 465	User Interface Design
<b>Professional Development Course</b>	
<b>4</b>	
ENG 573	Capstone Project
<b>Additional Coursework</b>	
Electives may be selected from the course list, with advisor approval. This list includes courses in Control and Dynamics, Optimization, Hardware Systems, Artificial Intelligence and Perception, Design and Applications.	
<b>12</b>	
Total Hours	
<b>32</b>	

## Other Requirements and Conditions (may overlap)

Requirement	Description
A minimum of 20 credit hours must be taken from the University of Illinois Urbana-Champaign campus.	
A minimum of 12 500-level credit hours.	
No courses used to fulfill any degree requirement may be taken using the "Credit/No Credit" option.	
Minimum GPA: 3.0	

## EP Documentation

### Attach Rollback/Approval Notices

Correspondence with sponsor EP 21041 – Engineering\_ Automony and Robotics Concentration.pdf  
CfA-MoU\_DEPTS\_final.pdf

## DMI Documentation

### Program Reviewer Comments

**Mahesh Viswanathan (vmahesh) (Tue, 25 Feb 2020 23:24:28 GMT):**Rollback: By request of Harry Dankowicz  
**Emily Stuby (eastuby) (Fri, 14 Aug 2020 20:05:32 GMT):**Rollback: Department Request

Key: 875

## MEng in Engineering: Concentration in Autonomy and Robotics

*for the degree of Master of Engineering in Engineering, Autonomy and Robotics Concentration*

### Overview

**associate dean for graduate, professional and online programs:** [Harry Dankowicz](#)

**overview of admissions & requirements:** <https://grainger.illinois.edu/academics/graduate>

**overview of grad college admissions & requirements:** <https://grad.illinois.edu/admissions/apply>

**college website:** <https://grainger.illinois.edu/>

**address:** 402 Engineering Hall, 1308 W Green St, Urbana, Illinois 61801

**phone:** (217) 244-2745

**email:** [engr-gpp@illinois.edu](mailto:engr-gpp@illinois.edu)

The Grainger College of Engineering offers a Master of Engineering (MEng) degree program for students whose primary intent is a professional career in industry or government. This degree differs from the Master of Science (MS) degree in that it is a professionally-oriented master's degree that is not a pathway to a doctoral program. The Major in Engineering for the M.Eng. degree requires the selection of an interdisciplinary concentration, which must be identified at the time of application. Available concentrations are:

- Aerospace Systems Engineering
- Autonomy and Robotics
- Energy Systems
- Plasma Engineering
- Railway Engineering

### Admission

Students with bachelor's or master's degrees in engineering or related sciences will be considered for admission if they have a grade point average of at least 3.00 (A = 4.00) for the last two years of undergraduate study. Admission is possible for the both the fall and spring semesters. Full details of admission requirements are on the Web page of the department offering the concentration.

All applicants whose native language is not English are required to submit [TOEFL](#) or [International English Language Testing System \(IELTS\)](#) scores as evidence of English proficiency. [Minimum admission requirements](#) are set by the Graduate College. Higher requirements may be imposed by specific concentrations.

### Financial Aid

Students in concentrations under the MEng in Engineering major are not eligible for Board of Trustees (BOT) tuition- waiver generating assistantships at the University of Illinois.

## Degree Requirements

### Concentration Requirements

<b>Core Coursework</b>	<b>16</b>
ME 445      Introduction to Robotics	4
ECE 484      Principles of Safe Autonomy	4
CS 588      Autonomous Vehicle System Engineering	4
Select one of the following:	4
<i>Control and Dynamics</i>	
ECE 486      Control Systems	
SE 422      Robot Dynamics and Control	
<i>Optimization</i>	
AE 504      Optimal Aerospace Systems	
ECE 490      Introduction to Optimization	
<i>Hardware Systems</i>	
ME 451      Computer-Aided Mfg Systems	
<i>Artificial Intelligence &amp; Perception</i>	
CS 440      Artificial Intelligence	
CS 543      Computer Vision	
ECE 544      Topics in Signal Processing	
<i>Design &amp; Applications</i>	
CS 465      User Interface Design	
<b>Professional Development Course</b>	<b>4</b>
ENG 573      Capstone Project	
<b>Additional Coursework</b>	<b>12</b>
Electives may be selected from the course list, with advisor approval. This list includes courses in Control and Dynamics, Optimization, Hardware Systems, Artificial Intelligence & Perception, and Design & Applications.	
<b>Total Hours</b>	<b>32</b>

### Other Requirements and Conditions (may overlap)

A minimum of 20 credit hours must be taken from the University of Illinois Urbana-Champaign campus.

A minimum of 12 500-level credit hours.

No courses used to fulfill any degree requirement may be taken using the "Credit/No Credit" option.

## Course List

Robotics & Automation MEng elective course list (12 credits = pick 3)

# indicates that the course was not offered in 2020

\* indicates that the course is also on the list of specialized core courses

### Control & Dynamics

<a href="#">AE 454</a>	Systems Dynamics & Control	3 or 4
<a href="#">AE 554</a>	Dynamical Systems Theory	4
<a href="#">AE 555</a>	Multivariable Control Design	4
<a href="#">AE 556</a>	Robust Control	4
<a href="#">ECE 515</a>	Control System Theory & Design	4
<a href="#">ECE 486</a>	Control Systems	4
<a href="#">ECE 489</a>	Robot Dynamics and Control	4
<a href="#">ECE 517</a>	Nonlinear & Adaptive Control	4
<a href="#">ECE 528</a>	Analysis of Nonlinear Systems	4
<a href="#">ECE 553</a>	Optimum Control Systems	4
<a href="#">ECE 555</a>	Control of Stochastic Systems	4
<a href="#">ECE 557</a>	Geometric Control Theory	4
<a href="#">ECE 568</a>	Model & Cntrl Electromech Syst	4
<a href="#">ECE 573</a>	Power System Control	4
<a href="#">ME 440</a>	Kinem & Dynamics of Mech Syst	3 or 4
<a href="#">ME 446</a>	Robot Dynamics and Control	4
<a href="#">ME 460</a>	Industrial Control Systems	4
<a href="#">ME 540</a>	Control System Theory & Design	4
<a href="#">ME 561</a>	Convex Methods in Control	4
<a href="#">ME 562</a>	Robust Adaptive Control	4
<a href="#">SE 424</a>	State Space Design for Control	3
<a href="#">SE 521</a>	Multivariable Control Design	4
<a href="#">SE 525</a>	Control of Complex Systems	4
<a href="#">TAM 412</a>	Intermediate Dynamics	4
<a href="#">TAM 516</a>	Dynamical Systems Theory	4

### Optimization

<a href="#">AE 504</a>	Optimal Aerospace Systems	4
<a href="#">CS 544</a>	Optimiz in Computer Vision	4
<a href="#">ECE 490</a>	Introduction to Optimization	3 or 4
<a href="#">ECE 580</a>	Optimiz by Vector Space Methds	4
<a href="#">IE 411</a>	Optimization of Large Systems	3 or 4
<a href="#">IE 519</a>	Combinatorial Optimization	4
<a href="#">IE 521</a>	Convex Optimization	4

### Hardware Systems

<a href="#">CS 431</a>	Embedded Systems	3 or 4
<a href="#">ECE 437</a>	Sensors and Instrumentation	3

<a href="#">ME 451</a>	Computer-Aided Mfg Systems	3 or 4
<a href="#">ME 452</a>	Num Control of Mfg Processes	3 or 4
<a href="#">ME 455</a>	Micromanufacturing Process & Automation	3 or 4
<a href="#">ME 461</a>	Computer Cntrl of Mech Systems	3 or 4
<a href="#">ME 541</a>	Control of Machine Systems	4
<a href="#">SE 420</a>	Digital Control Systems	4
<a href="#">SE 423</a>	Mechatronics	3

### Software Systems

<a href="#">CS 424</a>	Real-Time Systems	3 or 4
<a href="#">CS 425</a>	Distributed Systems	3 or 4
<a href="#">CS 427</a>	Software Engineering I	3 or 4
<a href="#">CS 428</a>	Software Engineering II	3 or 4
<a href="#">CS 438</a>	Communication Networks	3 or 4
<a href="#">CS 461</a>	Computer Security I	4
<a href="#">CS 476</a>	Program Verification	3 or 4
<a href="#">CS 477</a>	Formal Software Development Methods	3 or 4
<a href="#">CS 483</a>	Applied Parallel Programming	4
<a href="#">CS 484</a>	Parallel Programming	3 or 4

### Artificial Intelligence & Perception

<a href="#">AE 583</a>	Advanced Robotic Planning	4
<a href="#">CS 440</a>	Artificial Intelligence	3 or 4
<a href="#">CS 446</a>	Machine Learning	3 or 4
<a href="#">CS 447</a>	Natural Language Processing	3 or 4
<a href="#">CS 543</a>	Computer Vision	4
<a href="#">CS 546</a>	Machine Learning in NLP	4
<a href="#">ECE 534</a>	Random Processes	4
<a href="#">ECE 543</a>	Statistical Learning Theory	4
<a href="#">ECE 561</a>	Detection & Estimation Theory	4
<a href="#">ECE 566</a>	Computational Inference and Learning	4
<a href="#">IE 534</a>	Deep Learning	4
<a href="#">SE 524</a>	Data-Based Systems Modeling	4

### Design & Applications

<a href="#">AE 456</a>	Global Nav Satellite Systems	4
<a href="#">AE 484</a>	UAV Performance, Design, and Fabrication	3
<a href="#">CS 465</a>	User Interface Design	3 or 4
<a href="#">CS 565</a>	Human-Computer Interaction	4
<a href="#">SE 400</a>	Engineering Law	3 or 4

**Memorandum of Understanding: Financial Model M.Eng. in Autonomy & Robotics**  
**Participating Departments: Aero, CS, ECE, MechSE, ISE**

This document constitutes a memorandum of understanding (MOU), between the Center for Autonomy (CfA) and the 5 participating departments (listed above and hereafter referred to as the “Departments”), relating to the financial arrangements for the proposed M.Eng. in Autonomy and Robotics (hereafter referred to as the “Program”).

This agreement will be active for the first 3 years of the Program, starting the first semester the Program has admitted students. During this period the Program will be limited to a maximum of 20 students in each of years Y1 and Y2, and 25 students in Y3.

**The Basic Formula**

The CfA will receive some portion of the student tuition back from the CoE each year. Let T represent *this tuition quantity* and set

$$P = T - E,$$

where E represents the *Program related expenses* that the CfA pays to either the College or the Campus.

It is emphasized that E can *only* include expenses paid directly to these two sources, which could for instance include payments for space, utilities, cleaning, and may also include some clerical costs. Further to this, E will include both (i) expenses that are explicitly associated only with the Program; and (ii) expenses that may be co-mingled with other CfA expenses. In the case of (ii), for each such co-mingled expense the proportion that is reasonably attributable to the Program will be added to E; however, each of these expenses must be approved by *all* Departments.

This net amount P will be split each year between the CfA and the Departments, with 50% going to the CfA and the remaining 50% being split between the Departments, with each department receiving a customized amount dependent on its contribution to the teaching resources used by the Program. The specific amount AD received by department D will be computed as

$$AD = P/2 * WD,$$

where WD denotes department D’s weight given by

$$WD = (\text{total number of credits delivered by } \mathbf{department\ D} \text{ to Program students}) \mathbf{divided\ by} (\text{total number of credits taken by students in the Program}).$$

A course will be deemed to be delivered by department D if the instructor has their primary appointment in that department, irrespective of the course rubric. The CfA will maintain careful records of the specific instructors of all courses taken by students in the Program. These records, together with the quantities T, E, WD and AD, will be reported annually to all Departments for the 3 years covered by this MOU.

**Service in Excess for Faculty**

It is acknowledged that there may be unusual circumstances when it would be appropriate for the CfA to compensate faculty (e.g., service in excess, or ICR for research) for exceptional contributions to administering or delivering the Program. Such situations will be rare, will represent service in excess, and will be approved in advance by the Heads of all the Departments in an anonymous vote.

Any amendments to this MOU must be agreed to by all parties.

***Nancy M. Amato, Head, Computer Science***

***Jonathan Freund, Head, Aerospace Engineering***

***Bruce Hajek, Head, Electrical and Computer Engineering***

***Anthony M. Jacobi, Head, Mechanical Science and Engineering***

***Deborah Thurston, Interim Head, Industrial and Enterprise Systems Engineering***

***Geir E. Dullerud, Director, Center for Autonomy***



**GRADUATE COLLEGE**

110 Coble Hall, MC-322  
801 S. Wright St.  
Champaign, IL 61820

**PROGRAM TUITION WAIVER POLICY PROPOSAL**

Proposals to establish or revise tuition waiver policy for a graduate program will follow a shared governance approval process (Department, School, College, Graduate College).

**Definitions of Tuition Waiver Policy Designations:**

**Traditional Programs.** Programs either designated as generating full or base-rate tuition waivers. Base rate waivers waives only the Resident Graduate Base tuition amount. Non-Residents or students in a program with an additional tuition differential will be responsible for the remaining portion of tuition.

**Reimbursable Programs.** Programs identified as programs that would be reimbursed from an appointing unit outside their academic college.

**Cost-recovery and self-supporting programs.** Students in approved cost-recovery and self-supporting programs are not eligible to receive tuition and fee waivers except statutory waivers. Students in these programs are not eligible to hold a waiver generating graduate appointment (Assistantship or Fellowship). Full time employees may be admitted to these programs, but their employee waiver is not eligible for use towards a program with this designation.

Additional information related to these tuition waiver designations can be found here:  
<http://www.grad.illinois.edu/gradhandbook/2/chapter7/tuition-waivers#otherprovisions>.

**PROGRAM INFORMATION**

COLLEGE OR SCHOOL: Grainger College of Engineering

PROGRAM(s) (Include Program Codes if applicable):  
Autonomy and Robotics, MEng

**REQUESTED DESIGNATION (Select desired designation type):**

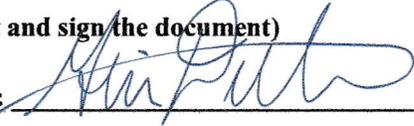
Self-Supporting

Comments:

**JUSTIFICATION: On a separate sheet, please address the following.**

1. Describe the reasons for this request and explain: (a) the pros and cons of the classification requested, and (b) how the requested classification will benefit and not adversely affect the academic quality of the program.
2. What type of financial assistance will be offered to students in the program?
3. Has this program had past practice of offering graduate assistantships? If so, please describe.
4. What provisions will be made to communicate the new classification to prospective and newly admitted students?

**APPROVALS: (May use Adobe Signature or print and sign the document)**

Department Executive Officer Signature and Date:  10/21/20

Disciplinary College Signature and Date: \_\_\_\_\_

Graduate College Signature and Date: \_\_\_\_\_



12-11-20



 12/11/20



**1. Describe the reasons for this request and explain: (a) the pros and cons of the classification requested, and (b) how the requested classification will benefit and not adversely affect the academic quality of the program.**

(a) The proposed concentration is not a research-oriented program. It is designed so that it can be completed in two or three semesters in order to address an academic training gap at a professional level. The requested classification enhances the educational experience of students and employability of graduates who, after attaining a BS degree in engineering or equivalent field, will benefit from the differentiated value provided by this advanced professional degree. The requested classification is not expected to adversely impact recruitment of students interested in a research oriented track with a traditional tuition model, nor significantly limit the potential pool of prospective students to the professionally-oriented track.

(b) The Grainger College of Engineering will use some of the graduate tuition dollars returned to the college from the Office of the Vice Provost for Budget and Resource Planning to provide the participating academic units with resources needed to support the proposed curriculum. Graduate tuition funds returned to the college from campus may be used to fund faculty and lecturer salaries, support instruction, or at the discretion of the participating Department Heads in a manner consistent with campus policy on use of such funds.

**2. What type of financial assistance will be offered to students in the program?**

The program may elect to offer scholarships to students in this program in an effort make the program more attractive and affordable for highly-qualified students and/or students from backgrounds underrepresented in STEM fields.

**3. Has this program had past practice of offering graduate assistantships? If so, please describe.**

This program will not offer graduate assistantships.

**4. What provisions will be made to communicate the new classification to prospective and newly admitted students?**

The self-supporting classification will be clearly explained on the program's website and in any and all communications to prospective students.



**COLLEGE OF ENGINEERING**

Department of Aerospace Engineering  
306 Talbot Laboratory, MC-236  
104 S. Wright St.  
Urbana, IL 61801

February 25, 2020

Dear Prof. Dullerud,

As head of the Department of Aerospace Engineering, based on discussion with departmental leadership I am writing to express the department's support for the proposed *M. Eng. In Engineering with a Concentration in Autonomy and Robotics*.

Aerospace Engineering is pleased to jointly sponsor this degree program, which will prepare professionally oriented students to enter the multi-disciplinary and rapidly expanding field of autonomy and robotics. I will encourage our faculty to serve on the Admissions Committee and on the Course Oversight Committee on a reasonable, as-needed basis. The graduate courses that our faculty teach in the area of autonomy and robotics will accept enrollment from qualified students in the proposed degree program.

Thank you for leading this important effort.

Sincerely,

A handwritten signature in black ink that reads "Jonathan B Freund". The signature is written in a cursive style with a large initial 'J' and a long horizontal stroke at the end.

Jonathan Freund  
Professor and Head, Aerospace Engineering

February 24, 2020

Dear Geir,

In October 2019, I shared your preliminary proposal with the ECE Advisory Committee and the Associate Department Heads, including the Associate Head for Graduate Affairs, Michael Oelze. Based on the brief discussion, I can report that ECE is pleased to endorse the proposed program, Engineering: Autonomy and Robotics, MEng. The organization, including a standing committee for admission and a standing committee for course oversight, is appropriate. You may want to consider the possibility of allowing each student to affiliate with an academic department. While details of the funding model are yet to be worked out, it will likely involve some portion of funds allocated to academic departments based on the instructional units provided by faculty members from those departments. ECE looks forward to cooperation and collaboration to make this an exciting, successful, model program.

Sincerely,



Bruce Hajek  
Head, Department of Electrical and Computer Engineering  
Center for Advanced Study Professor of Electrical and Computer Engineering  
Hoelt Endowed Chair in Engineering  
Professor, Coordinated Science Laboratory

March 31, 2020

Prof. Geir E. Dullerud  
W. Grafton and Lillian B. Wilkins Professor in Mechanical Engineering  
Director of Decision and Control Laboratory  
University of Illinois at Urbana-Champaign

Dear Geir:

The Department of Industrial & Enterprise Systems Engineering (ISE) at the University of Illinois at Urbana-Champaign's Grainger College of Engineering enthusiastically endorses the proposal for a new *M. Eng. In Engineering with a Concentration in Autonomy and Robotics*, organized through the Center for Autonomy under the able leadership of Prof. Tim Bretl and you. The ISE Courses and Curriculum Committee (CCC) discussed the proposal at its meeting on March 11, 2020. The CCC voted unanimously in favor of the proposal.

The university enjoys #1 rank in *Automation and Control* according to the 2019 Shanghai Rankings of World Universities. This program puts together 5 strong departments to offer this unique professionally oriented program at a very timely manner as autonomy is becoming pervasive to our lives. The curriculum is strong and there is a strong demand for such a specialization.

The ISE courses listed from IE and SE rubrics are strong courses for this degree program and have space to accommodate the MEng students at this time. I understand admissions will be done by a joint committee with representatives from each of the 5 CoE departments: ECE, MechSE, Aero, CS, and ISE.

Please don't hesitate to contact me if I can be of further assistance in this matter.

Sincerely,



Deborah L. Thurston, P.E., Ph.D., ASME Fellow  
Gutsgell Professor and Interim Head, Industrial and Enterprise Systems Engineering  
Co-Director, The Hoeft Technology and Management Program  
Director, Decision Systems Laboratory

October 17, 2019

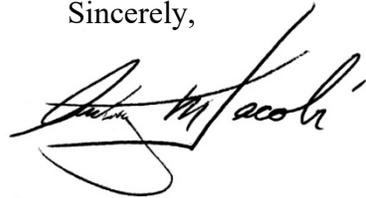
Dear Professor Dullerud,

As head of the Department of Mechanical Science and Engineering, I offer our department's full support for the proposed *M.Eng. in Engineering with a Concentration in Autonomy and Robotics*.

The MechSE Department is pleased to jointly sponsor this degree program with the departments of Aerospace Engineering, Computer Science, Electrical and Computer Engineering, and Industrial & Enterprise Systems Engineering. The program will prepare students seeking a professional engineering degree to enter the multidisciplinary field of autonomy and robotics. I commit to providing faculty to serve on the Admissions Committee and the Course Oversight Committee on a reasonable, as-needed basis. The graduate courses that our faculty teach in the area of autonomy and robotics will accept enrollment from qualified students in the proposed degree program.

I am proud that the Department of Mechanical Science and Engineering will play a key role in educating students in this rapidly developing field. Thank you for your endeavors.

Sincerely,



Anthony M. Jacobi  
Richard W. Kritzer Distinguished Professor  
Department Head, Mechanical Science & Engineering

October 14, 2019

Prof. Geir E. Dullerud  
W. Grafton and Lillian B. Wilkins Professor in Mechanical Engineering  
Director of Decision and Control Laboratory  
University of Illinois at Urbana-Champaign

Dear Geir:

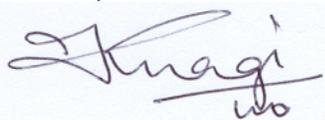
The Department of Industrial & Enterprise Systems Engineering (ISE) at the University of Illinois at Urbana-Champaign's Grainger College of Engineering enthusiastically endorses the proposal for a new *M. Eng. in Engineering with a Concentration in Autonomy and Robotics*, organized through the Center for Autonomy under the able leadership of Prof. Tim Bretl and you.

The university enjoys #1 rank in *Automation and Control* according to the 2019 Shanghai Rankings of World Universities. This program puts together 5 strong departments to offer this unique professionally oriented program at a very timely manner as autonomy is becoming pervasive to our lives. The curriculum is strong and there is a strong demand for such a specialization.

The ISE courses listed from IE and SE rubrics are strong courses for this degree program and have space to accommodate the MEng students at this time. I understand admissions will be done by a joint committee with representatives from each of the 5 CoE departments: ECE, MechSE, Aero, CS, and ISE.

Please don't hesitate to contact me if I can be of further assistance in this matter.

Sincerely,



Rakesh Nagi, PhD  
Donald Biggar Willett Professor of Engineering and Department Head  
[nagi@illinois.edu](mailto:nagi@illinois.edu)



**DEPARTMENT OF COMPUTER SCIENCE**

Thomas M. Siebel Center for Computer Science  
201 N. Goodwin Ave.  
Urbana, IL 61801-2302 USA

**NANCY M. AMATO**

Abel Bliss Professor and Head  
2248 Siebel Center  
namato@illinois.edu

May 31, 2020

Professor Geir Dullerud  
W. Grafton and Lillian B. Wilkins Professor in Mechanical Engineering  
Director of the Center for Autonomy

The Department of Computer Science enthusiastically endorses the proposed *M.Eng. in Engineering with a Concentration in Autonomy and Robotics*.

In order to evaluate this new degree program, the proposal was reviewed by the AI Area (responsible for coordinating and overseeing AI teaching and research activities in the Department), the Departmental Graduate Study Committee, the Director of Graduate Studies, Professor Brian Bailey, the Associate Head for Academics, Professor Mahesh Viswanathan, and myself, the Department Head. Additionally, I discussed the matter with the Director of the Center for Autonomy, Professor Geir Dullerud.

The Computer Science Department is excited to jointly sponsor this degree program with the departments of Aerospace Engineering, Electrical and Computer Engineering, Industrial & Enterprise Systems Engineering, and Mechanical Science & Engineering. The Computer Science Leadership is supportive of our faculty participating in the administration of this program, e.g., by serving on the Admissions Committee and the Course Oversight Committee on a reasonable, as-needed basis. The graduate courses that our faculty teach in the area of autonomy and robotics will accept enrollment from qualified students in the proposed degree program.

This is a timely program that will prepare professionally oriented students to enter the multi-disciplinary and rapidly expanding field of autonomy and robotics. The program will take advantage of Illinois' long standing strength in autonomy and control and will provide more visibility to our strong and growing activity in robotics.

Sincerely,

**Nancy M. Amato**  
Abel Bliss Professor and Head  
Department of Computer Science

**From:** [Pahre, Jennifer N](#)  
**To:** [Dullerud, Geir E](#)  
**Cc:** [Martensen, Kathy](#); [Lehman, Barbara J](#)  
**Subject:** Re: Senate Educational Policy Proposal Number 21.041 -- Engineering: Automony and Robotics Concentration  
**Date:** Thursday, January 21, 2021 3:44:01 PM  
**Attachments:** [Outlook-v1q3ggav.png](#)

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Dear Geir,

Thank you for your very timely and helpful response. You thoroughly have answered all pending questions. If anything else arises, I will reach out.

All best,

Jennie

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**I ILLINOIS**

College of Law

Jennifer N. Pahre

Director of Undergraduate Studies

Assistant Teaching Professor

University of Illinois College of Law

504 East Pennsylvania Avenue

Champaign, Illinois 61820

Pronouns: She/her/hers

Under the Illinois Freedom of Information Act (FOIA), any written communication to or from University employees regarding University business is a public record and may be subject to public disclosure.

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**From:** Dullerud, Geir E <dullerud@illinois.edu>

**Sent:** Thursday, January 21, 2021 3:29 PM

**To:** Pahre, Jennifer N <jpahre@illinois.edu>

**Cc:** Martensen, Kathy <kmartens@illinois.edu>; Lehman, Barbara J <bjlehman@illinois.edu>

**Subject:** Re: Senate Educational Policy Proposal Number 21.041 -- Engineering: Automony and Robotics Concentration

Dear Jennie,

Thank you for your email—great to hear that your subcommittee is now considering our M.Eng. proposal. Concerning the questions raised:

The first question concerns the number of members in the oversight committees.

It seems that the two oversight committees (Admissions and Curriculum) are to have just four members each. Given the interdisciplinary nature of the program among five academic units in Grainger, why not have at least one member from each unit on the committees? *(I understand the impetus to follow other protocols -- perhaps the choice of four members is consistent with other similar committees in Grainger?)*

Each of these committees will have a minimum of 4 members each but may have more; we specifically chose this number to provide additional flexibility for staffing the committees, as it might not be possible to always have members from all 5 departments on each committee. Members from all 5 participating departments will be solicited each year for each committee, and certainly we expect that between the 2 committees we will have representation from all 5 departments. We would prefer to keep this flexibility as proposed if possible, provided your subcommittee is supportive. Let me confirm that the proposal has been approved by all 5 departments and also subsequently by the Grainger Executive Committee with full support, and so it can reasonably be inferred that the plan for these committees is in compliance with accepted norms within the College.

The second question concerns the sharing of revenue and costs across the departments. Is there any formalized way that costs and revenues are going to be allocated? *(Again, I wonder if sharing would be managed by other, existing management practices?)*

Yes, there is a formalized agreement to which all 5 departments have agreed, as has Grainger; I am attaching it here.

If I can provide additional input or clarification please do not hesitate to reach out.

Again, I very much appreciate the work of the Subcommittee and am glad to hear that the proposal may be considered at the upcoming meeting on the 25th.

Best regards,  
Geir

//  
// Geir E. Dullerud  
// W. Grafton and Lillian B. Wilkins Professor in Mechanical Engineering  
// Director of Decision and Control Laboratory  
// Affiliate Professor of Electrical and Computer Engineering  
// Affiliate Professor of Computer Science  
// Research Professor of Coordinated Science Laboratory  
// University of Illinois at Urbana-Champaign  
//  
// mail: Department of Mechanical Science and Engineering

// University of Illinois, MC-244  
// 1206 West Green Street, Urbana, IL 61801  
//  
// vox: 217-265-5078  
// fax: 217-244-6534  
// skype: dullerudg  
// e-mail: [dullerud@illinois.edu](mailto:dullerud@illinois.edu)  
// www: <http://www.mechse.illinois.edu/directory/faculty/dullerud>  
//

I look forward to hearing from you.

With thanks for your assistance,

Jennie

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Jennifer N. Pahre

Director of Undergraduate Studies

Assistant Teaching Professor

University of Illinois College of Law

504 East Pennsylvania Avenue

Champaign, Illinois 61820

Pronouns: She/her/hers

Under the Illinois Freedom of Information Act (FOIA), any written communication to or from University employees regarding University business is a public record and may be subject to public disclosure.