WORCESTER POLYTECHNIC INSTITUTE
December 6, 2018

To: The WPI Faculty

From: Tanja Dominko
Secretary of the Faculty

The fourth Faculty meeting of the 2018-2019 academic year will be held on **Thursday, December 6, 2018 at 3:15 pm in Olin Hall 107**.

1. Call to Order — T. Dominko
   - Approval of the Agenda
   - Approval of the Consent Agenda and the Minutes from 11-8-18
2. Secretary's Report — T. Dominko
3. President's Report — L. Leshin
4. Provost's Report — W. Soboyejo
5. Committee Business
   - Committee on Academic Operations (CAO)
     December 2018 Undergraduate Student Graduation List — A. Mattson
   - Committee on Graduate Studies and Research (CGSR)
     December 2018 Graduate Student Graduation List — S. Scarlata
   - Committee on Graduate Studies and Research (CGSR)
     New Graduate Program in Neuroscience — S. Scarlata
6. Special Reports
   - Update of the Task Force on the Status of NTT faculty — K. Boudreau
   - Update on the Faculty Conduct Policy — M. Richman
7. New Business
8. A Special Announcement
9. Adjournment

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WORCESTER POLYTECHNIC INSTITUTE
Faculty Meeting Minutes
November 8, 2018

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4. Reading of Memorial Resolution: Professor Francis Lutz (CEE)
5. Committee Business: CAP
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7. Special Report: Advancing toward Equity for STEM faculty
8. Adjournment

Detail:

1. Call to Order

The third Faculty meeting of the 2018-2019 academic year was called to order in Olin Hall 107 by **Prof. Dominko (BBT).** She reminded everyone that the meeting is being recorded for the purpose of accuracy in taking minutes. The agenda (with the omission of the President's Report due to travel), and consent agenda (including the minutes from the November 8, 2018 Faculty meeting) were approved as distributed.

2. Announcements

Prof. Dominko reported on her presentation to the Board of Trustees meeting on November 2nd, 2018. Prof. Dominko highlighted Faculty accomplishments during the previous Academic year, recognized over 90 faculty, students, administration and staff committee members. She stressed the importance of shared roles and responsibilities in governance of the institution, the need for collaborative deliberations and decision making on campus-wide issues involving faculty and academic affairs (See **Addendum #1** attached to these minutes).

3. Provost's Report

Provost Soboyejo commended Prof. Dominko for her opening remarks and for her presentation to the Board on the significance of Faculty contributions, the work they do at WPI and in Faculty Governance. He also expressed his gratitude to Faculty Governance for the support he has received. The Provost also spoke for President Leshin in her absence (She was receiving an honorary doctorate in Worcester, England; was the commencement speaker; and was interacting with WPI students there).

The Provost reminded all that WPI was established nearly 150 years ago by creators who would use theory and practice to educate and prepare generations of students to transform this city, and areas around us. He spoke of the graduates of WPI, who went on to thrive in area industries, in what was (at the peak of its operation) the center of the industrial revolution. He spoke about WPI being one of the first three institutions in the United States, along with RPI and MIT, and the historic buildings here on campus, and what makes WPI special, and the impact on the

community. He spoke about Project-based learning, and how that enriches the learning experience at WPI, and how WPI has become a university of teaching and research.

The Provost spoke about the challenges of the coming years, and how using collective experiences we can solve problems (including lack of space) and financial matters as a WPI team.

He spoke about the November 2018 Board meeting, which shows that we can enable cross-cutting of education and research, enable a global school, and excite Trustees, academics, students and staff with a vision aligned with possibilities that take WPI to the next level, if implemented as a team. The Provost stated that he was impressed with Prof. Dominko's presentation to the Board of Trustees, where she emphasized how we, as a community, could work together to achieve many of these goals.

The Provost stated that at last week's Board of Trustees meeting, the board voted on a new set of Bylaws, which describe positions and hierarchy in the organization, and define roles and responsibilities of all stakeholders. He stated that the Bylaws had not been modified for some time, and that those primarily defined the President, Trustees and Provost, and that WPI has become a more complex operation. He stated that the new Bylaws state that WPI now has a School of Engineering, a School of Arts and Sciences and the current Foisie School of Business, and a Global School, defined by the Board of Trustees. What is needed now, is to build the academic content, the academic programs and structure, as a Faculty, as the next stage. The Provost spoke about the Faculty working with the Administration to build the structures to achieve academic excellence. Besides defining the roles and responsibilities of all stakeholders and establishing the four schools, the Board of Trustees also embedded the idea of shared governance and academic freedom into the Bylaws. He stressed that this is a continuous process, whereby Faculty and staff will be consulted for input. The next step will be, as stated by the President, that the Effective Collaboration Working Group (ECWG), which includes the members of the Board of Trustees, the President, the Provost, TTT Faculty, NTT Faculty, Administration, and Faculty Governance members, who will work to build on the culture of WPI. Discussion also included combining Faculty Governance tenure and promotion decisions with Administrative decisions, and having equal numbers of members for both sides, for equality in those decisions.

The Provost concluded by expressing his wishes for the Faculty and Administration to work together with these new Bylaws and make WPI the best University.

4. Reading of Memorial Resolution

Prof. El-Korchi (CEE) read a memorial resolution for Prof. Francis Lutz, who passed away on April 19, 2015. (See **Addendum #2** attached to these minutes.) The resolution passed and a moment of silence was observed in Prof. Lutz' honor.

5. Committee Business

Prof. Olinger (ME), for the Committee on Academic Operations (CAO), moved to change the grade replacement policy for repeated undergraduate courses. **Prof. Bar-On (ME)** asked for clarification on both grades used to calculate/done manually to discount it. **Ms. Miles**

(Registrar) stated that there is a distinction between the numerical equivalent calculation and what is allowed to count toward the requirements. WPI has never allowed a course that was passed twice, to count more than once toward the degree, however since they both exist, they are counted in the numerical equivalent (which is not printed on the transcript). **Dean Taylor (FBS)** asked if the policy asking to change an NR grade from the original instructor was going to change in any way. Prof. Olinger stated that there was no change to that portion. **Prof. Mathews (BBT)** asked if there was a limit to the number of times a student can take a course. Prof. Olinger stated there was not a limit. **Prof. Richman (ME)** asked why a course would be included on the transcript, if it doesn't count on the GPA. Ms. Miles stated that only a grade of NR (according to the Undergraduate Catalog) is allowed not to show up on the transcript. Prof. Bar-On (ME) stated that this is an improvement over the current practice, and also thought a student should be able to appeal having more than one grade for the same course on the transcript. **Dean Rissmiller (IGSD)** stated that it is important to see, when evaluating a student for the global program participation, all the courses taken on their transcript, for reasons like academic probation, to see consistent ability and any grades of NR. Prof. Richman (ME) stressed that it is better to remove the lower grade on the transcript, since the NR will not be listed, however the lower grade would penalize that student's record. **Prof. Heineman (CS)** did not agree that it is penalizing the student, that it simply states that the student took the class more than once, and that he/she received multiple grades, and that it is an accurate reflection of the grades received for courses taken. **Prof. Fehribach (MA)** stated that he routinely changes a lower grade to a grade of NR, of a course taken more than once. **Prof. Boudreau (HUA)** asked if it undermines the Faculty's authority when a student takes multiple courses with different Faculty members and the lower grade is removed.
The motion **passed**.

6. Committee Reports
CAP/CGSR
Prof. Heineman (CS), for the Committee on Academic Policy (CAP) and the Committee on Graduate Studies and Research (CGSR), spoke about the three-year pilot program to evaluate the success of the new online course reporting system. He asked that any questions or concerns be sent to him, as the Chair for 2018-2019. He explained that there is representation from the CAP, CGSR, Undergraduate Students, Graduate Student and respective Deans. He stated that the committee has already met once, and that the charge of the committee is to ensure a smooth transition in the process, to gather data and report back to CAP/CGSR with findings in C term on the first two terms and provide a summary at the end of D term. The hope is that this will be a two-year endeavor.

7. Special Report
Prof. Skorinko (SSPS) announced a recent NSF grant received and gave a presentation on Advance Adaptation: Advancing toward Equity for STEM faculty: Addressing gender equity in promotion – producing systemic change. (See **Addendum #3** attached to these minutes.) Prof. Skorinko introduced the team for this grant (besides herself) Prof. Demetry (ME), Prof. Farney (BBT), Prof. Lingo (FBS) and Prof. Roberts (CHE). She stated that the idea for the grant came about from data received from the COACH survey, which was information that identified dissatisfaction of the promotions policies at WPI. She stated that tenured faculty members are not satisfied with the mentoring of associate faculty and that non-tenure track faculty members

are not satisfied with the clarity of promotion criteria. She spoke about the promotion success rate, and that women are not at the same succeeding rate as men; that women are staying in the associate rank longer than their male colleagues. Prof. Dominko stated that the team is in the process of compiling groups and looking for volunteers for workshops. Small stipends will be offered to those volunteers.

10. Adjournment
Meeting was adjourned at 4:20pm by **Prof. Dominko**.

Respectfully submitted,

Tanja Dominko
Secretary of the Faculty

Addenda on file with these minutes:
1. Addendum #1 Secretary of the Faculty's Presentation to the Board of Trustees – November 8, 2018
2. Addendum #2 Memorial Resolution, Prof. Francis Lutz – November 8, 2018
3. Addendum #3 Advance Adaptation: Advancing toward Equity for STEM faculty: Addressing gender equity in promotion – producing systemic change – November 8, 2018

Appendix: Consent Agenda Motions

Date: December 6, 2018

To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to change distribution requirements for the Architectural Engineering Major, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.0.: The Committee on Academic Operation recommends and I move, that the distribution requirements for the Architectural Engineering Major be modified as described below:

Program Distribution Requirements for the Architectural Engineering Major
The program is designed according to the ABET criteria for Architectural Engineering accreditation. The four basic architectural engineering curriculum areas are building structures, building mechanical systems, building electrical systems and construction/construction management. The normal period of residency at WPI is 16 terms. In addition to WPI requirements applicable to all students (see WPI Degree requirements), students wishing to receive a Bachelor degree in "Architectural Engineering" must satisfy the following distribution requirements:

REQUIREMENTS MINIMUM UNITS (**Current**)

1. Mathematics and Basic Science (Note 1)	4
2. Architectural Engineering Complements (Note 2)	1
3. Engineering Science and Design (Notes 3, 4, 5)	5 1/3

REQUIREMENTS MINIMUM UNITS (**New with markup**)
(New content is underlined and deletions are shown with a ~~strikethrough~~)

1. Mathematics, Basic Science, and Supplemental Science (Note 1)	4
2. ~~Architectural Engineering Complements (Note 2)~~	~~1~~
2 ~~3~~. Architectural Engineering Science and Design (Notes 2, 3, 4, ~~5~~)	7 ~~5 1/3~~

REQUIREMENTS MINIMUM UNITS (**New without markup**)

1. Mathematics, Basic Science, and Supplemental Science (Note 1)	4
2. Architectural Engineering Science and Design (Notes 2, 3, 4)	7

Provided below are the new notes (with and without markup)
NOTES (new notes with markup)
New content is underlined and deletions are shown with a ~~strikethrough~~

1. Mathematics must include differential and integral calculus, differential equations, statistics ~~probability~~, and matrices and linear algebra. Science must include 2/3 unit in calculus-based physics (either the PH 1110 or PH 1111 series), 1/3 unit in chemistry, 1/3 unit in thermodynamics (can be fulfilled by PH 2101 or other approved equivalent course such as ES 3001*), and 1/3 unit in fluid mechanics (can be fulfilled by ES 3004).
2. ~~Must include topics in architectural design (AREN 2002 and AREN 3002), and architectural history (AR 2114), or approved equivalents.~~

3. ~~Must include 5 1/3 units in the four areas of Architectural Engineering, distributed as follows or with approved equivalents~~.
2. Must include 7 units of Architectural Engineering Science and Design in the different areas of Architectural Engineering, distributed as follows or with approved equivalents.

a) 2/3 units ~~in the general architectural engineering area~~ of architectural engineering complements, including introduction to architectural engineering (AREN 2023) and ~~building physics (AREN 3024)~~ and topics related to the history and theory of architecture (AR 2114)..
b) 2/3 units in construction/construction management including project evaluation (CE 3025) or Engineering Economics (OIE 2850), and either legal aspects of professional practice (CE 3022) or project management (CE 3020).
c) 5/3 ~~2/3~~ units in building mechanical systems including Building Physics (AREN 3024), Principles of HVAC design for buildings (AREN 3003), Advanced HVAC system design (AREN 3006), and two integrated architectural design studios: Architectural Design IV - Building energy simulation (AREN ~~3025~~ 3020), and Architectural Design V - Building Envelop Design (AREN 3026 3022). ~~and either building envelope design (AREN 3026) or building fire safety system design (FP 3080).~~
d) 2/3 units in building electrical systems with topics in building electrical systems (AREN 2025) and Architectural Design II - Light and Lighting Systems (AREN ~~3005~~ 2004)
e) ~~3/3 2/3 units in advanced courses in building mechanical systems selected from topics in advanced HVAC system design (AREN 3006), topics related to radiation heat transfer (ES 3005 or approved equivalent), fundamentals of fire safety analysis (FP 3070) and building energy simulation (AREN 3025). Or 2/3 units in advanced courses in building structures selected from topics in steel design (CE 3006), concrete design (CE 3008), pre-stressed concrete design (CE 4017), and structural engineering (CE 3010)~~
f) 5/3 units in building structural systems including Analytical Mechanics 1 and 2 (CE 2000 and CE 2001), Introduction to Analysis and Design (CE 2002), and two design level structural engineering courses (such as CE 3006, CE 3008, CE 3010, or CE 3044)
g) 2/3 Units in general architectural design including Architectural Design I (AREN 2002), and Architectural Design III (AREN 3002).

3. Must include 1/3 unit in Experimentation (fulfilled by AREN 3003, AREN 3025, ME 3901, CE 3026 or approved equivalent).
4. Must include the Capstone Design activity through the MQP ~~in one of the architectural engineering areas~~ that achieves design proficiency in either the structural or mechanical area.
5. Great Problem Seminar (GPS) courses can only be used to fulfill the HUA, SSPS, or the Free Elective requirements.

*If ES 3001 is used to satisfy the thermodynamics requirement then it counts as a free elective and a Math or Basic Science (CH, BB, PH, GE) course must be taken to complete the 4 Unit requirement.

NOTES (new notes without markup):

1. Mathematics must include differential and integral calculus, differential equations, statistics, and matrices and linear algebra. Science must include 2/3 unit in calculus-based physics (either the PH 1110 or PH 1111 series), 1/3 unit in chemistry, 1/3 unit in thermodynamics (can be fulfilled by PH 2101 or other approved equivalent course such as ES 3001*), and 1/3 unit in fluid mechanics (can be fulfilled by ES 3004).

2. Must include 7 units of Architectural Engineering Science and Design in the different areas of architectural engineering, distributed as follows or with approved equivalents:

a) 2/3 units of architectural engineering complements, including introduction to architectural engineering (AREN 2023) and topics related to the history and theory of architecture (AR 2114).

b) 2/3 units in construction/construction management including project evaluation (CE 3025) or Engineering Economics (OIE 2850), and either legal aspects of professional practice (CE 3022) or project management (CE 3020).

c) 5/3 units in building mechanical systems including Building Physics (AREN 3024), Principles of HVAC design for buildings (AREN 3003), Advanced HVAC system design (AREN 3006), and two integrated architectural design studios: Architectural Design IV - Building energy simulation (AREN 3020), and Architectural Design V - Building Envelop Design (AREN 3022).

d) 2/3 units in building electrical systems with topics in building electrical systems (AREN 2025) and Architectural Design II - Light and Lighting Systems (AREN 2004)

e) 5/3 units in building structural systems including Analytical Mechanics 1 and 2 (CE 2000 and CE 2001), Introduction to Analysis and Design (CE 2002), and two design level structural engineering courses (such as CE 3006, CE 3008, CE 3010, or CE 3044)

f) 2/3 Units in general architectural design including Architectural Design I (AREN 2002), and Architectural Design III (AREN 3002).

3. Must include 1/3 unit in Experimentation (fulfilled by AREN 3003, AREN 3025, ME 3901, CE 3026 or approved equivalent).
4. Must include the Capstone Design activity through the MQP that achieves design proficiency in either the structural or mechanical area.
5. Great Problem Seminar (GPS) courses can only be used to fulfill the HUA, SSPS, or the Free Elective requirements.

*If ES 3001 is used to satisfy the thermodynamics requirement then it counts as a free elective and a Math or Basic Science (CH, BB, PH, GE) course must be taken to complete the 4 Unit requirement.

Rationale

The AREN program has been developed according to the ABET criteria for architectural engineering programs, as provided below (from ABET):

Curriculum (from ABET)

"The program must demonstrate that graduates can apply mathematics through differential equations, calculus-based physics, and chemistry. The four basic architectural engineering curriculum areas are building structures, building mechanical systems, building electrical systems, and construction/construction management. Graduates are expected to reach the synthesis (design) level in one of these areas, the application level in a second area, and the comprehension level in the remaining two areas. The engineering topics required by the general criteria shall support the engineering fundamentals of each of these four areas at the specified level. Graduates are expected to discuss the basic concepts of architecture in a context of architectural design and history."

The specific ABET stipulations regarding the required level of design that a student should attain are listed below (from ABET):

"The design level must be in a context that:

a. Considers the systems or processes from other architectural engineering curricular areas,
b. Works within the overall architectural design,
c. Includes communication and collaboration with other design or construction team members
d. Includes computer-based technology and considers applicable codes and standards, and
e. Considers fundamental attributes of building performance and sustainability."

The general ABET curriculum requirement emphasizes the importance of reaching the design level in one of the four topical areas, but also stresses the importance of attaining design development skills that integrate multiple criteria holistically using advanced tools and team collaborations. Currently our program is designed such that students take design level courses in either the building structures or building mechanical systems areas. If a student is following the mechanical track, he or she does not take design level courses in the other areas, vice versa. The integration of design is currently intended to culminate in the MQP with students focusing on either building structures or building mechanical systems.

Experience over the first 5 years of the program has shown that students are not always well prepared to reach the required level of design that truly integrates different areas of their discipline as well as architectural design, as intended by ABET. Interactions between AREN students and the AREN industry advisory board during annual MQP reviews has further confirmed the need to ground engineering design skills within a project based architectural design context.
This motion entails changes to our curriculum and distribution requirements that are designed to improve the design, design development, and design integration abilities of our graduates, as intended by ABET and desired by our program. The main changes to our distribution requirements are outlined below:

1. Current distribution requirements include two architectural design studio-type courses

(AREN 2002 and 3002). The new distribution requirements will include five architectural design studio- type courses. This will be accomplished by restructuring the delivery format of three existing courses AREN 3005, 3025, 3026. (Please see accompanying motions for revisions and/or replacement of these courses). The proposed change will emphasize "integrative" architectural design skills earlier in the program, thus better preparing students for a comprehensive design experience during their MQP. The change will also bring the architectural design studio-type courses (and the time commitments for these) in line with what is the norm at other accredited programs. The proposed change will establish a much stronger architectural design culture within our program, which is also motivating the expansion to our architectural design studio-based curriculum.

2. Current distribution requirements require students to opt into one of the concentration tracks (i.e. structural or mechanical) during their junior year when they select 3000-level design courses in one of the tracks. The new distribution requirements will eliminate this early distinction and will assure that all students take design level courses in both the structural and mechanical tracks. Students then opt into one of the tracks during their MQP, which is the only remaining differentiator between the two tracks. The proposed change will deliver a more comprehensive architectural engineering graduate that can truly integrate the different disciplines. In this fashion, the program will also become more distinctive from the civil and mechanical engineering majors.
3. To create the required space in the WPI curriculum we will integrate some of our topical areas (lighting systems, building energy simulation, building envelope design) into the architectural design studio format. In this new format, the course delivery method will change from a (primarily) lecture based format to a mixed studio and lecture based format. The new courses will meet during studio times on MWR from 2pm to 5:50 pm. These courses will include about 9 hours of student-faculty studio interaction per week (desk critiques), 3 hours of lectures per week, and about 6 hours of work outside the classroom per week. In line with WPI guidelines, these mixed format courses will require at least 15-17 hours of work per week, including work outside the classroom. (WPI catalogue, page 118)
4. In addition to the above changes, we are also making changes to the mathematics and science requirement for our program. The term "Supplemental Science" has been added to the mathematics and basic science subcategory. This will allow student more flexibility to select appropriate preparatory ES courses (i.e. thermodynamics, fluid mechanics). The mathematics probability course requirement is replaced with a course in statistics, which will better prepare students to enter emerging fields such as data science and/or graduate education. The proposed change requires that students also take coursework in fluid mechanics, which will enhance preparedness for energy related courses, such as HVAC systems design, building physics, and building energy modeling. Fluid mechanics and thermodynamics are foundation courses for the mechanical track of our program. The program remains in compliance with the current ABET Math. and Basic Science requirement for engineering programs (>32 semester hours or equivalent)

The proposed changes require a revision of our distribution requirement to assure that students can complete their degree over the course of 16 terms, while retaining sufficient flexibility in their selection of IQP's or pursuit of an off campus co-op experience. The current distribution

requirements amount to 10- 1/3 units. The new distribution requirements amount to 11 units. The free electives for our program have been adjusted from 3/3 to 1/3 units to accommodate the increase in distribution requirements. The changes allow us to stay within the normal 15 unit required for a bachelor's degree at WPI. Please note that similar to the existing requirements, 1/3 unit of the distribution requirements counts towards the Humanities and Arts requirement (AR 2144, Modern Arch. in the American Era, 1750-2001 and Beyond).

Architectural Engineering is a multidisciplinary field of study that requires coursework in multiple areas of engineering science and design (structures, mechanical systems, electrical systems and lighting, and construction / project management). Architectural engineering graduates are furthermore expected to understand the basic concepts of architecture in a context of architectural design and history. These requirements demand an architectural design education that includes architectural studio-type coursework as well as coursework in architectural history. The proposed distribution requirements are on a par with other multidisciplinary programs such as environmental engineering, chemical engineering, and environmental and sustainability studies.

Impact on student schedules or other departments:
The re-developed curriculum will include more courses that utilize a mixed studio and lecture based delivery format. These mixed format courses will meet MWR from 2pm to 5:50 pm. Studio and other course schedules will be aligned to avoid major scheduling conflicts and accommodate IQPs in different terms (See appendix A for sample course schedule templates that consider different IQP-term scenarios and a co-op experience).

We have verified that the proposed studio schedules will not cause scheduling conflicts for students (see appendix B for matrix of course schedules). Most required CE courses are offered during the morning, thus avoiding conflicts with the studio based AREN courses. All AREN lecture type classes are scheduled in the morning or during T-F afternoons (the lab session of AREN 3024 will be rescheduled to fall outside of the proposed studio timeslot). The proposed studio schedules, including studio contact times, are very similar to studios organized at peer educational programs in architecture and architectural engineering across the US and globally. The extended studio time allows sufficient time for one-on-one desk review sessions.

Course equivalencies for students immediately affected by the changes are provided in appendix C. For changes, deletions, and additions of/to specific courses, please see accompanying motions 1.1 to 1.8 For new course numbers and course equivalencies, see appendix C. The new course numbers are in order by which the courses are to be taken. Sample course schedules are provided in Appendix A.

We anticipate no major impact on other departments or programs.

Changes to AREN minor
Please see AREN motion 1.9

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

The changes in distribution requirements and courses will trigger changes to the Architectural Engineering program chart of course recommendations (page 36 of WPI catalogue). Provided below are the existing and new Architectural Engineering program charts:

Current Program Chart

ARCHITECTURAL ENGINEERING PROGRAM CHART

This chart summarize course recommendations.

4 UNITS OF MATHEMATICS AND BASIC SCIENCE

Mathematics		**7/3 Units**
MA 1021	Calculus I	
MA 1022	Calculus II	
MA 1023	Calculus III	
MA 1024	Calculus IV	
MA 2051	Ordinary Differential Equations	
MA 2071	Matrices and Linear Algebra	
MA 2621	Probability for Applications	
Physics		**2/3 Units**
PH 1110 or PH 1111	Mechanics	
PH 1120 or PH 1121	Electricity and Magnetism	
Chemistry		**1/3 Units**
CH 1010 or CH 1020	Chemical Properties, Bonding, and Forces or Chemical Reactions	
Thermodynamics		**1/3 Units**
PH 2101	Principles of Thermodynamics (Note 1)	
Electives (Note 2)		**1/3 Units**

1 UNIT OF ARCHITECTURAL ENGINEERING COMPLEMENTS

AR 2114	Modern Architecture in the American Era, 1750-2001 and Beyond
AREN 2002	Architectural Design I
AREN 3002	Architectural Design II

5 1/3 UNITS OF ENGINEERING SCIENCE AND DESIGN (Notes 3, 4)

General Architectural Engineering		**2/3 Units**
AREN 2023	Introduction to Architectural Engineering Systems	
AREN 3024	Building Physics	
Construction/Construction Management (select two)		**2/3 Units**
CE 3020	Project Management	
CE 3022	Legal Aspects of Professional Practice	
CE 3025 (required)	Project Evaluation	
Building Mechanical Systems (select two)		**2/3 Units**
AREN 3003 (required)	Principles of HVAC Design for Buildings	
AREN 3026	Building Envelope Design	
FP 3080	Introduction to Building Fire Safety System Design	
Building Structural Engineering (select three)		**3/3 Units**
CE 2000	Analytical Mechanics I (or ES 2501)	
CE 2001	Analytical Mechanics II (or ES 2502)	
CE 2002	Introduction to Analysis and Design	
CE 3041	Soil Mechanics	
Building Electrical Systems		**2/3 Units**
AREN 2025	Building Electrical Systems	
AREN 3005	Lighting Systems	

Students can achieve design proficiency in either the structural or mechanical area.

Design Focus on the Structural Area (select two)		**2/3 Units**
CE 3006	Design of Steel Structures	
CE 3008	Design of Reinforced Concrete Structures	
CE 3010	Structural Engineering	
CE 4017	Prestressed Concrete Design	
OR		
Design Focus on the Mechanical Area (select two)		**2/3 Units**
AREN 3006	Advanced HVAC System Design	
AREN 3025	Building Energy Simulation	
ES 3005	Radiation Heat Transfer Applications	
FP 3070	Fundamentals of Fire Safety Analysis	
Major Qualifying Project (Note 5)		**3/3 Units**

Note 1: Can be fulfilled by PH 2101 or other approved equivalent course such as ES 3001. If ES 3001 is used to satisfy the thermodynamics requirement then it counts as a free elective and a Math and Basic Science course must be taken to complete the 4 Unit requirement.
Note 2: MA 2611 Applied Statistics I is suggested.
Note 3: Must include 1/3 unit in Experimentation (fulfilled by AREN 3003, AREN 3025, ME 3901, CE 3026 or approved equivalent).
Note 4: The courses in the above Engineering Science and Design chart can be replaced by other approved equivalents.
Note 5: Must include the Capstone Design activity.

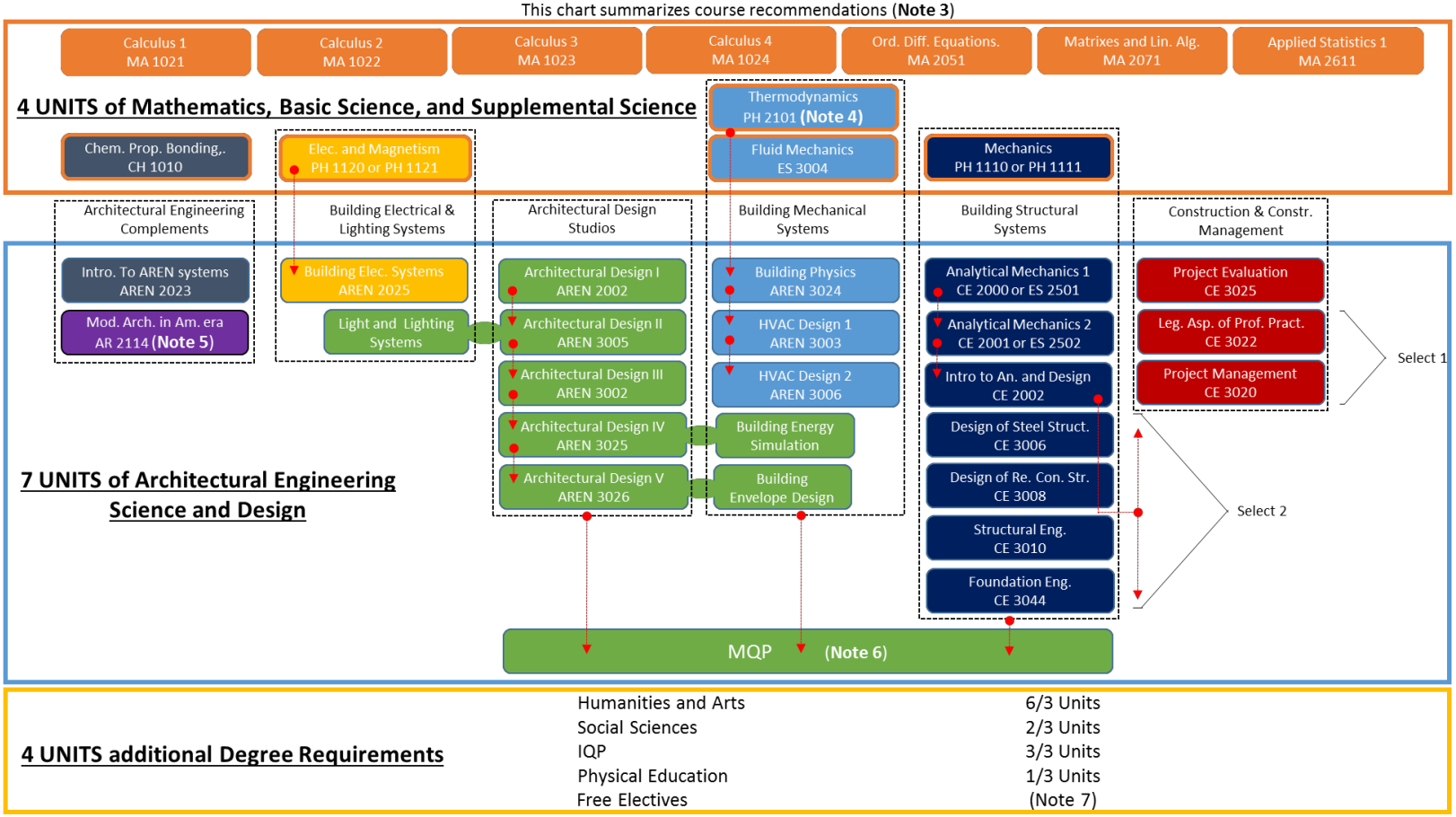
5 UNITS ADDITIONAL DEGREE REQUIREMENTS

Humanities and Arts	6/3 Units
Social Sciences ‡	2/3 Units
IQP	3/3 Units
Physical Education	1/3 Units
Free Electives	3/3 Units

‡ Many SS courses compliment topics in architectural engineering. Courses in environmental policy, regulations as well as environmental and development economics are recommended.

ARCHITECTURAL ENGINEERING PROGRAM CHART (Note 1,2)

This chart summarizes course recommendations (**Note 3**)



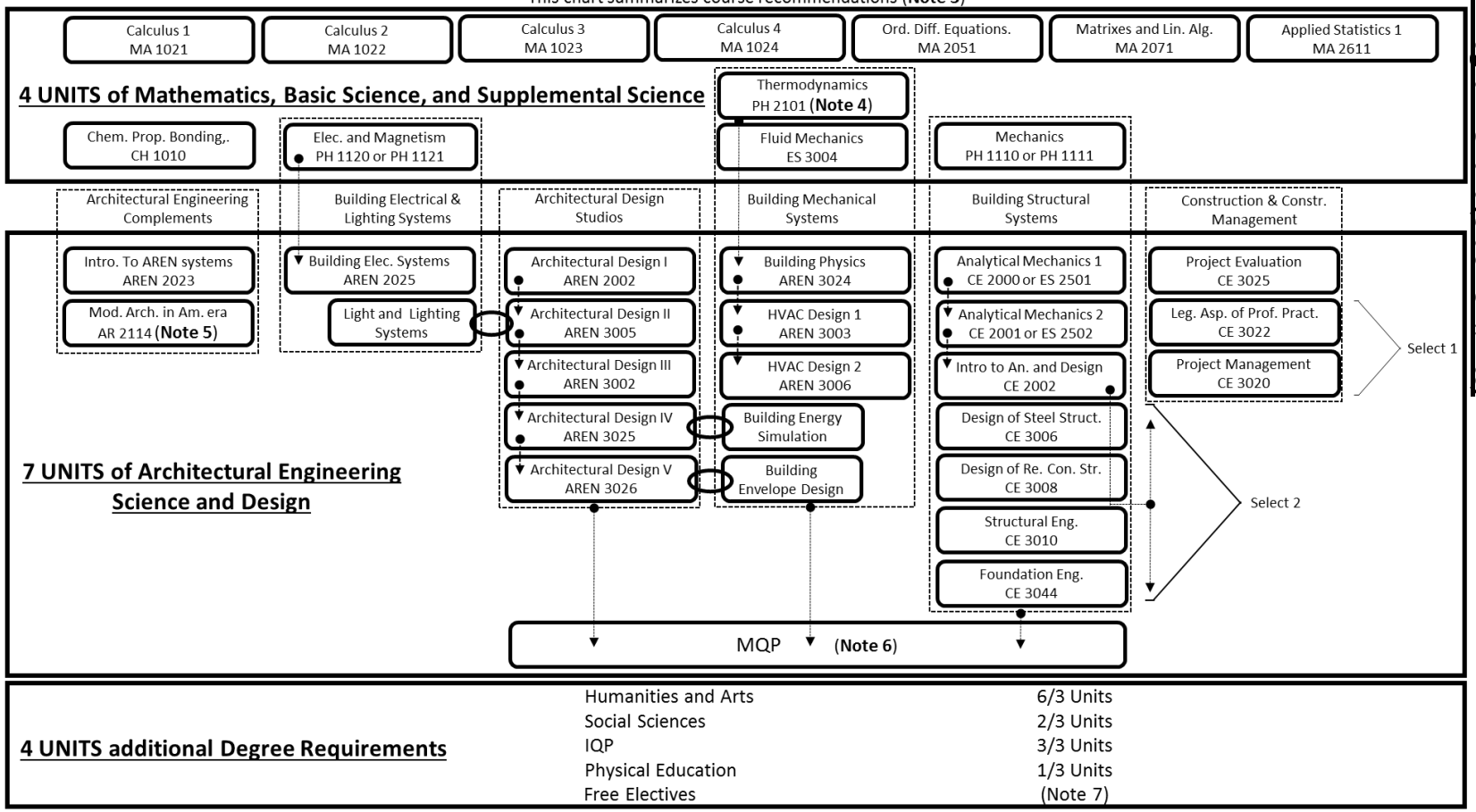
New Program Chart (color)

Note 1: The courses in this Architectural Engineering Program chart can be replaced by approved equivalents.
Note 2: Must include 1/3 unit in Experimentation (fulfilled by AREN 3003, AREN 3025, or approved equivalent).
Note 3: Arrows indicate recommended order of topics.
Note 4: Can be fulfilled by PH 2101 or other approved equivalent course such as ES 3001. If ES 3001 is used to satisfy the thermodynamics requirement then it counts as a free elective and a Math and Basic Science course must be taken to complete the 4 Unit requirement
Note 5: This course can also help fulfill the Humanities and Arts requirement.
Note 6: Must include the Capstone Design activity that achieves design proficiency in either the structural or mechanical area.
Note 7: The minimum academic credit required for the Bachelor degree is 15 units. Credit accumulated beyond the published distribution requirements shall be accomplished by the addition of "free elective" work.

New Program Chart (black & white)

ARCHITECTURAL ENGINEERING PROGRAM CHART (Note 1,2)

This chart summarizes course recommendations (**Note 3**)



Note 1: The courses in this Architectural Engineering Program chart can be replaced by approved equivalents.
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Note 4: Can be fulfilled by PH 2101 or other approved equivalent course such as ES 3001. If ES 3001 is used to satisfy the thermodynamics requirement then it counts as a free elective and a Math and Basic Science course must be taken to complete the 4 Unit requirement
Note 5: This course can also help fulfill the Humanities and Arts requirement.
Note 6: Must include the Capstone Design activity that achieves design proficiency in either the structural or mechanical area.
Note 7: The minimum academic credit required for the Bachelor degree is 15 units. Credit accumulated beyond the published distribution requirements shall be accomplished by the addition of "free elective" work.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to change the course description and delivery format for **ARCHITECTURAL DESIGN I (AREN 2002)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.1.: The Committee on Academic Operation recommends and I move, that **ARCHITECTURAL DESIGN I (AREN 2002)** be revised as described below.

Current Course Title /Catalog Description
AREN 2002. ARCHITECTURAL DESIGN I. (Category I)
This course aims to develop an understanding of the architectural design process as an activity based upon observation, critical inquiry, and communication. Through a series of design exercises, this course aims to teach the basic architectural design skills needed for the creation of spaces that respond to human needs in terms of materiality, use, and scale. Graphic means for communicating and exchanging design content will be taught alongside the design exercises and as an integral part of the design process. The course covers the following topics: Nature of design, siting and context, human scale, architectural drawings (plans, elevations and cross sections), isometric projections and detail drawings This is a studio course that uses modeling software, hand drawings, and physical model making.
Recommended background: AREN 2023 Suggested background: CE 3030

New Course Title / Catalog Description
AREN 2002. ARCHITECTURAL DESIGN I. (Category I)
This course offers an introduction to the architectural design process by exploring the relations between materials, structures, spaces, and architectural composition. Studio: The studio design component explores the syntax of architecture, siting, context, and human scale. Students will engage these topics through architectural design studies for a project of limited scope and programmatic complexity. Hand drawing and sketching, modeling and visualization software, orthographic drawings, and physical models are used to explore, develop, and communicate architectural design concepts. Lectures / lab: The lecture/lab component of the course focuses on two-dimensional drawing techniques (including hand drawings and sketching), drawing conventions, and architectural representation techniques. Students are introduced to the fundamental uses of modeling software in engineering and architectural design practice. Advanced topics may include three dimensional modeling rendering, animation, and parametric design.

This course uses studio, lecture, and lab based teaching methods
Recommended background: none

Rationale:
This course is a revision of AREN 2002. ARCHITECTURAL DESIGN I.
The proposed course is part of our initiative to strengthen the program's integrated architectural design curriculum. AREN 2002 currently focuses on the architectural design process through

development of projects. The revised course also introduces students to drawing techniques and conventions, and the use of modeling software in engineering and architectural practice. The course retains and expands the design components of AREN 2002, but will also emphasize providing a technical foundation through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.
The course delivery method will change from a (primarily) studio based format to a mixed studio and lecture based format. The current course meets MWR from 2pm to 3:50pm during A-term. The new course will meet during studio times on MWR from 2pm to 5:50pm. The course will include about 9 hours of student-faculty studio interaction per week (desk critiques), 3 hours of lectures per week, and about 6 hours of work outside the classroom per week. In line with WPI guidelines, the course requires at least 15-17 hours of work per week, including work outside the classroom. (WPI catalogue, page 118)

Impact on student schedules or other departments:
The course will utilize a mixed studio and lecture based delivery format. The course will meet MWR from 2pm to 5:50 pm. Studio and other course schedules will be aligned to avoid scheduling conflicts. Most CE courses are offered during the morning, thus avoiding conflicts with the studio based courses. All AREN lecture type courses are scheduled during T-F afternoons, thus also avoiding scheduling conflicts.
We anticipate no major impact on other departments or programs. AREN 2002 was offered during A-term and is a category I course. This revised course will also be offered in A-term and is also a category I course.

Impact on resources: This course is delivered by faculty with backgrounds in architectural design and materials and methods of construction. The course will be hosted in the architectural design studio (KH 207). This course is currently taught by Soroush Farzinmoghadam, who will continue to teach the revised course (studio and lecture component). This course is also envisioned to receive significant input from design professionals from industry (architects) that participate in the weekly desk-review sessions and end-of-term reviews (standard practice in architectural design education). While such interactions are not strictly essential to the course delivery, the student experience will be greatly enhanced through such input. We are therefore planning to request additional resources for an adjunct studio instructor to support the desk review sessions within the studio format.
Recommended background: none

Changes to Distribution requirements
FROM NOTES

See separate AREN MOTION 1.0. for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove **lighting systems (AREN 3005)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.2.: The Committee on Academic Operation recommends and I move, that **Lighting Systems (AREN 3005)** as described below, be removed from the undergraduate catalog.

Current Course Title / Catalog Description
AREN 3005 Lighting systems (Category I).
This course focuses on the design of illumination systems in buildings. It provides a general introduction to the visual environment, including subjective and objective scales of measurement, visual perception, photometry, brightness, luminance, illumination, natural and artificial lighting. Other topics include photometric units, light sources, daylight luminaries, lighting quality, light loss factors, average luminance calculations (lumen method), point-by-point calculations, performance impacts, and ethics. Field measurements and computer simulations are used to explore some major aspects of architectural illumination systems. Design problems are solved by considering economic evaluation, energy saving criteria and applicable standards and building codes. Recommended background: electrical systems (AREN 2025 or equivalent).

Rationale:
This course will be replaced by the following new course:
Architectural Design II - Light and lighting systems (AREN 2004)

The proposed revised course is part of our initiative to strengthen the AREN program's architectural design curriculum. AREN 3005 currently focuses on the technical components of lighting system design for buildings. The revised course will broaden understanding of light in architecture through a series of architectural design exercises. The new course retains the technical components of AREN 3005, but will also emphasize developing architectural design skills through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.

Impact on student schedules or other departments:
Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 2004	ARCHITECTURAL DESIGN II - Light and Lighting Systems	AREN 3005	LIGHTING SYSTEMS

We anticipate no major impact on other departments or programs.

Changes to Distribution requirements
FROM NOTES
See separate AREN MOTION 1.0 for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add **ARCHITECTURAL DESIGN II - light and lighting systems (AREN 2004)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.3.: The Committee on Academic Operation recommends and I move, that **ARCHITECTURAL DESIGN II - light and lighting systems (AREN 2004)** as described below, be added to the undergraduate catalogue.

New Course Title / Catalog Description

AREN 2004 ARCHITECTURAL DESIGN II - Light and Lighting Systems. (Category I)
This course aims to develop an understanding of the role of light and lighting in the perception of architecture and human well-being. Studio: The studio component of the course will explore the interactions between light, materials, spaces, and people. Students will engage these topics through architectural design studies for a project with well- specified lighting and architectural needs. Modeling, visualization and simulation software, orthographic drawings, and physical models are used to explore and analyze architectural design concepts. Lectures: The lecture components of the course focuses on the design of illumination systems in buildings. A general introduction to the visual environment is provided, including subjective and objective scales of measurement, visual perception, photometry, brightness, luminance, illumination, natural and artificial lighting. Other topics include photometric units, light sources, daylight luminaries, lighting quality, light loss factors, average luminance calculations (lumen method), point-by-point calculations, performance impacts, and ethics. Field measurements and computer simulations are used to explore some major aspects of architectural illumination systems. Design problems are solved by considering economic evaluation, energy saving criteria and applicable standards and building codes. Students will be introduced to the use of computer tools for the design, analysis, and visualization of natural and artificial lighting in buildings.

This course uses studio and lecture based teaching methods
Recommended background: Introductory architectural design (AREN 2002 or equivalent).
Students may not receive credit for both AREN 2004 and AREN 3005

Rationale:
This course replaces AREN 3005. LIGHTING SYSTEMS

The proposed revised course is part of our initiative to strengthen the AREN program's architectural design curriculum. AREN 3005 currently focuses on the technical components of lighting system design for buildings. The revised course will broaden understanding of light in architecture through a series of architectural design exercises. The course retains the technical components of AREN 3005, but will also emphasize developing architectural design skills through actual project based design activities.

Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.

The course delivery method will change from a (primarily) lecture based format to a mixed studio and lecture based format. The current course meets MT-RF from 10am to 10:50am during A-term. The new course will meet during studio times on MWR from 2pm to 5:50 pm. The course will include about 9 hours of student-faculty studio interaction per week (desk critiques), 3 hours of lectures per week, and about 6 hours of work outside the classroom per week. In line with WPI guidelines, the course requires at least 15-17hours of work per week, including work outside the classroom. (WPI catalogue, page 118)

Impact on student schedules or other departments:
The re-developed course will utilize a mixed studio and lecture based delivery format. The course will meet MWR from 2pm to 5:50 pm. Studio and other course schedules will be aligned to avoid scheduling conflicts and accommodate IQPs. Most CE courses are offered during the morning, thus avoiding conflicts with the studio based courses. All AREN lecture type classes are scheduled during T-F afternoons, thus avoiding scheduling conflicts.

We anticipate no major impact on other departments or programs. AREN 3005 was offered during A-term and is a category I course. This new course will be offered in B-term and is also a category I course.

Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 2004	ARCHITECTURAL DESIGN II - Light and Lighting Systems	AREN 3005	LIGHTING SYSTEMS

Impact on resources: This course is delivered by faculty with backgrounds in architectural design and lighting system design. The course will be hosted in the architectural design studio (KH 207). This course is currently taught by Clyde Robinson, who will continue to teach the revised course (studio and lecture component). This course replaces AREN 3005 (we are not proposing an additional class). This course is also envisioned to receive significant input from design professionals from industry (architects) that participate in the weekly desk-review sessions and end-of-term reviews (standard practice in architectural design education). While such interactions are not strictly essential to the course delivery, the student experience will be greatly enhanced through such input. We are therefore planning to request additional resources for an adjunct studio instructor to support the desk review sessions within the studio format.

Recommended background: Introductory architectural design (AREN 2002 or equivalent).

Changes to Distribution requirements
FROM NOTES
See separate AREN MOTION 1.0 for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to change the course title, course description, and delivery format for **ARCHITECTURAL DESIGN II (AREN 3002)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.4.: The Committee on Academic Operation recommends and I move, that **ARCHITECTURAL DESIGN II (AREN 3002)** be revised as described below

Current Course Title /Catalog Description
AREN 3002. ARCHITECTURAL DESIGN II. (Category I)
This course is a continuation of AREN 2002, and is designed to further the student's knowledge in the process of architectural design through the studies of ideas, principles and methods of design. The concepts are explored with the completion of a project, including a residential or a commercial project, which at its completion, will be reviewed by invited guest critics. The course emphasizes the development of form, space, spatial relationships, materials, and architectural presentation techniques through the use of computer graphics. It introduces principles of passive approaches to reduce energy consumption. It also covers building codes in the design process. Recommended background: AREN 3001.

New Course Title / Catalog Description
AREN 3002. ARCHITECTURAL DESIGN III. (Category I)
This course aims to further a student's knowledge of the architectural design process through study of ideas, principles and methods of design and construction. Studio: Architectural concepts are developed with the completion of a project of expanded scope and complexity. The course emphasizes the development of form, space, spatial relationships, materials, context, program, and architectural presentation techniques. Hand drawing and sketching, modeling and visualization software, orthographic drawings, detail drawings, and physical models are used to explore, develop, and communicate architectural design concepts. Lectures: The lecture/lab component of the course focuses on three-dimensional modeling and architectural representation techniques. Students are introduced to advanced modeling software in engineering and architectural design practice. Topics include three dimensional modeling, rendering, animation, and parametric design.

This course uses studio, lecture, and lab based teaching methods
Recommended background: Intermediate architectural design (AREN 2002 and AREN 2004 or equivalent)

Rationale:
This course is a revision of AREN 3002. ARCHITECTURAL DESIGN II.

The proposed course revision is part of our initiative to strengthen the program's integrated architectural design curriculum. AREN 3002 currently focuses on the architectural design process through development of projects. The revised course also introduces students to the use of advanced modeling software in engineering and architectural practice. The course retains and expands the design components of AREN 3002, but will also emphasize providing a technical foundation through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.

The course delivery method will change from a (primarily) studio based format to a mixed studio and lecture based format. The current course meets MWR from 2pm to 3:50pm during A-term. The new course will meet during studio times on MWR from 2pm to 5:50pm. The course will include about 9 hours of student-faculty studio interaction per week (desk critiques), 3 hours of lectures per week, and about 6 hours of work outside the classroom per week. In line with WPI guidelines, the course requires at least 15-17 hours of work per week, including work outside the classroom. (WPI catalogue, page 118)

Impact on student schedules or other departments:
The course will utilize a mixed studio and lecture based delivery format. The course will meet MWR from 2pm to 5:50 pm. Studio and other course schedules will be aligned to avoid scheduling conflicts. Most CE courses are offered during the morning, thus avoiding conflicts with the studio based courses. All AREN lecture type courses are scheduled during T-F afternoons, thus also avoiding scheduling conflicts.

We anticipate no major impact on other departments or programs. AREN 3002 was offered during D-term and is a category I course. This revised course will also be offered in D-term and is also a category I course.

Impact on resources: This course is delivered by faculty with backgrounds in architectural design and materials and methods of construction. The course will be hosted in the architectural design studio (KH 207). This course is currently taught by Soroush Farzinmoghadam, who will continue to teach the revised course (studio and lecture component). This course is also envisioned to receive significant input from design professionals from industry (architects) that participate in the weekly desk-review sessions and end-of-term reviews (standard practice in architectural design education). While such interactions are not strictly essential to the course delivery, the student experience will be greatly enhanced through such input. We are therefore planning to request additional resources for an adjunct studio instructor to support the desk review sessions within the studio format.
Recommended background: Intermediate architectural design (AREN 2002 and AREN 2004 or equivalent)

Changes to Distribution requirements
FROM NOTES

See separate AREN MOTION 1.0. for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove **building energy simulation (AREN 3025)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.5.: The Committee on Academic Operation recommends and I move, that **Building energy simulation (AREN 3025)** be removed from the undergraduate catalog.

Current course title /Catalog Description

AREN 3025. BUILDING ENERGY SIMULATION (Category I)

The course addresses the basic principles of building energy simulation, with a focus on the practical applications of building energy simulation tools to building design. Topics being covered include various model input parameters such as building geometry, orientation, climate, comfort, zoning, material properties, operation schedules, and HVAC systems. Building energy simulation software packages are illustrated and applied to the analysis of various case studies of buildings. Simulation output results are critically analyzed and compared to the results obtained from other building energy calculation methods.
Recommended background: building physics (AREN 3024 or equivalent).

Rationale:

This course will be replaced by the following new course: Architectural Design IV - Building Energy Simulation (AREN 3020)

The proposed new course is part of our initiative to strengthen the program's architectural design curriculum. AREN 3025 currently focuses on the technical components of building energy simulation. The revised course aims to expand understanding of sustainable design principles and energy use in buildings through architectural design exercises. The new course retains the technical components of AREN 3025, but will also emphasize developing architectural design skills through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.

Impact on student schedules or other departments:

Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 3020	ARCHITECTURAL DESIGN IV - Building Energy Simulation	AREN 3025	BUILDING ENERGY SIMULATION

We anticipate no major impact on other departments or programs.

Changes to Distribution requirements
FROM NOTES
See separate AREN MOTION 1.0 for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add **AREN 3020 ARCHITECTURAL DESIGN IV - Building Energy Simulation,** as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.6.: The Committee on Academic Operation recommends and I move, that **ARCHITECTURAL DESIGN IV - Building Energy Simulation (AREN 3020)** as described below, be added to the undergraduate catalogue.

New Course Title / Catalog Description

AREN 3020 ARCHITECTURAL DESIGN IV - Building Energy Simulation. (Category I)
This course aims to develop an understanding of sustainability in architecture and introduces the fundamentals and applications of energy simulation tools. Studio: The studio component of the course will explore the relationships between people, buildings, and the environment. Students will explore the impact of building site and context, orientation, building massing and envelop configuration, occupancy and other factors. Students will engage these topics through architectural design studies and simulations for a project of increased scope and programmatic complexity. Modeling and visualization software, simulation tools, orthographic drawings, and physical models are used to explore and develop architectural design concepts. Lectures: The lecture components of the course focuses on the principles of building energy simulation, with a focus on the practical applications of building energy simulation tools to building design. Topics being covered include various model input parameters such as building geometry, orientation, climate, comfort, zoning, material properties, operation schedules, and HVAC systems. Building energy simulation software is illustrated and applied to the analysis of case studies and/or design projects. Simulation output results are critically analyzed and compared to the results obtained from other building energy calculation methods.

This course uses studio and lecture based teaching methods
Recommended background: Building Physics and HVAC system design (AREN 3024 and AREN 3003) and Architectural Design (AREN 2002, AREN 2004, and AREN 3002 or equivalent).
Students may not receive credit for both AREN 3020 and AREN 3025

Rationale:
This course replaces AREN 3025. BUILDING ENERGY SIMULATION.
The proposed course is part of our initiative to strengthen the program's architectural design curriculum. AREN 3025 currently focuses on the technical components of building energy simulation. The revised course aims to expand understanding of sustainable design principles and energy use in buildings through architectural design exercises.

AREN 3020 retains the technical components of AREN 3025, but will also emphasize developing architectural design skills through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.
The course delivery method will change from a (primarily) lecture based format to a mixed studio and lecture based format. The current course meets MWR from 1pm to 2:50pm during A-term. The new course will meet during studio times on MWR from 2pm to 5:50pm. The course will include about 9 hours of student-faculty studio interaction per week (desk critiques), 3 hours of lectures per week, and about 6 hours of work outside the classroom per week. In line with WPI guidelines, the course requires at least 15-17 hours of work per week, including work outside the classroom. (WPI catalogue, page 118)

Impact on student schedules or other departments:
The course will utilize a mixed studio and lecture based delivery format. The course will meet MWR from 2pm to 5:50 pm. Studio and other course schedules will be aligned to avoid scheduling conflicts. Most CE courses are offered during the morning, thus avoiding conflicts with the studio based courses. All AREN lecture type courses are scheduled during T-F afternoons, thus also avoiding scheduling conflicts.
We anticipate no major impact on other departments or programs. AREN 3025 was offered during D-term and is a category I course. This revised course will be offered in A- term and is also a category I course.

Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 3020	ARCHITECTURAL DESIGN IV - Building Energy Simulation	AREN 3025	BUILDING ENERGY SIMULATION

Impact on resources: This course is delivered by faculty with backgrounds in architectural design and building energy simulation. The course will be hosted in the architectural design studio (KH 207). This course is currently taught by Shichao Liu, who will continue to teach the revised course (studio and lecture component). This course replaces AREN 3025 (we are not proposing an additional class). This course is envisioned to also receive significant input from design professionals from industry (architects) that participate in the weekly desk-review sessions and end-of-term reviews (standard practice in architectural design education). While such interactions are not strictly essential to the course delivery, the student experience will be greatly enhanced through such input. We are therefore planning to request additional resources for an adjunct studio instructor to support the desk review sessions within the studio format.

Recommended background: Building Physics and HVAC system design (AREN 3024 and AREN 3003) and Architectural Design (AREN 2002, ARENC2004, and AREN 3002 or equivalent).

Changes to Distribution requirements FROM
NOTES

See separate motion 1.0. for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove **Building envelope design (AREN 3026)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.7.: The Committee on Academic Operation recommends and I move, that **Building envelop design (AREN 3026)** as described below, be removed from the undergraduate catalog.

Current Course Title /Catalog Description

AREN 3026. BUILDING ENVELOPE DESIGN (Category I)
The course presents the basic principles of building envelope design, focusing primarily on its functional performance requirements and practical constructability aspects. Various building envelope systems are discussed and analyzed through case studies. Lecture topics include façade and roofing systems made of masonry, stone, concrete, timber, glass, and various metals. In addition, more complex building envelope strategies such as double skin facades, passive solar design, and building automation approaches, are discussed. The course includes design exercises and a case study project. Recommended background: architectural engineering systems and architectural drafting (AREN 2023, AREN 3001 or equivalent)

Rationale:
This course will be replaced by the following new course: Architectural Design V – Building Envelope Design (AREN 3022)
The proposed new course is part of our initiative to strengthen the program's architectural design curriculum. AREN 3026 currently focuses on the technical components ofbuilding envelope design. The revised course aims to expand understanding of the design development process through architectural design exercises. The course retains the technical components of AREN 3026, but will also emphasize developing architectural design skills through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.

Impact on student schedules or other departments:

Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 3022	ARCHITECTURAL DESIGN V - Building Envelope Design	AREN 3026	BUILDING ENVELOPE DESIGN

We anticipate no major impact on other departments or programs.

Changes to Distribution requirements
FROM NOTES

See separate AREN MOTION 1.0 for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add **ARCHITECTURAL DESIGN V - building envelop design (AREN 3022)**, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.8.: The Committee on Academic Operation recommends and I move, that **ARCHITECTURAL DESIGN V - building envelop design (AREN 3022)** as described below, be added to the undergraduate catalogue.

New Course Title / Catalog Description

AREN 3022. ARCHITECTURAL DESIGN V - Building Envelope Design. (Category I) This course aims to develop an understanding of the architectural design development process with special focus on the design and detailing of building envelopes. Studio: Through an iterative process, students will advance the architectural and technical development of an architectural project of increased complexity. Modeling and simulation software, orthographic drawings, detail drawings, and physical models are used to advance the development of architectural design concepts. Lectures: The lecture component of the course covers the basic principles of building envelope design, focusing primarily on functional performance requirements and practical constructability aspects. Various building envelope systems are reviewed, including façade and roofing systems made of masonry, stone, concrete, timber, glass, and various metals. More elaborate building envelope strategies will also be reviewed; such as double skin facades and passive solar design approaches. Students will be introduced to computer tools and other methods for the analysis of heat and moisture transfer within building envelopes and components thereof.

This course uses studio and lecture based teaching methods
Recommended background: Building Physics and HVAC system design (AREN 3024 and AREN 3003) and Architectural Design (AREN 2002, AREN 2004, and AREN 3002 or equivalent).
Students may not receive credit for both AREN 3022 and AREN 3026

Rationale:

This course replaces AREN 3026. BUILDING ENVELOPE DESIGN.
The proposed course is part of our initiative to strengthen the program's architectural design curriculum. AREN 3026 currently focuses on the technical components of building envelope design. The revised course aims to expand understanding of the design development process through architectural design exercises. The course retains the technical components of AREN 3026, but will also emphasize developing architectural design skills through actual project based design activities. Technical knowledge is introduced alongside the design work as an integral part of the design process. The change in focus will broaden student architectural and technical design skills, which will increase their ability to pursue a wider range of career and graduate school options.
The course delivery method will change from a (primarily) lecture based format to a mixed studio and lecture based format. The current course meets TR from 9am to 11:50am during C-term. The new course will meet during studio times on MWR from 2pm to 5:50pm. The course will include about 9 hours of student-faculty studio interaction per week (desk critiques), 3 hours of lectures per week, and about 6 hours of work outside the classroom per week. In line with WPI guidelines, the course requires at least

15-17 hours of work per week, including work outside the classroom. (WPI catalogue, page 118)

Impact on student schedules or other departments:
The course will utilize a mixed studio and lecture based delivery format. The course will meet MWR from 2pm to 5:50 pm. Studio and other course schedules will be aligned to avoid scheduling conflicts. Most CE courses are offered during the morning, thus avoiding conflicts with the studio based courses. All AREN lecture type courses are scheduled during T-F afternoons, thus also avoiding scheduling conflicts.
We anticipate no major impact on other departments or programs. AREN 3026 was offered during C-term and is a category I course. This revised course will also be offered in C-term and is also a category I course.
Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 3022	ARCHITECTURAL DESIGN V - Building Envelope Design	AREN 3026	BUILDING ENVELOPE DESIGN

Impact on resources: This course is delivered by faculty with backgrounds in architectural design and building envelope design and design development. The course will be hosted in the architectural design studio (KH 207). This course is currently taught by Steven Van Dessel, who will continue to teach the revised course (studio and lecture component). This course replaces AREN 3026 (we are not proposing an additional class).This course is envisioned to also receive significant input from design professionals from industry (architects) that participate in the weekly desk-review sessions and end-of- term reviews (standard practice in architectural design education). While such interactions are not strictly essential to the course delivery, the student experience will be greatly enhanced through such input. We are therefore planning to request additional resources for an adjunct studio instructor to support the desk review sessions within the studio format.

Recommended background: Building Physics and HVAC system design (AREN 3024 and AREN 3003) and Architectural Design (AREN 2002, AREN 2004, and AREN 3002 or equivalent).

Changes to Distribution requirements FROM
NOTES
See separate AREN MOTION 1.0. for changes to AREN distribution requirements

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to change requirements for the Architectural Engineering Minor, as approved by the Architectural Engineering Curriculum Committee (October 15, 2018) and the Civil and Environmental Engineering Department Faculty (October 24, 2018).

Motion 1.9.: The Committee on Academic Operation recommends and I move, that the requirements for the Architectural Engineering Minor be modified as described below:

Current requirements for Minor in Architectural Engineering

MINOR IN ARCHITECTURAL ENGINEERING (AREN)
For students who are not AREN majors and are interested in broadening their exposure to and understanding of architectural engineering, the Architectural Engineering Program offers a Minor in Architectural Engineering. Successful candidates for the Minor in AREN must complete two units of work from courses with the pre fix "AREN" as outlined in the table below.

2 Units in Architectural Engineering
Must include:
AREN 2002 Architectural Design I
AREN 2023 Introduction to Architectural Engineering Systems AREN 3003 Principles of HVAC Design for Buildings

Elective courses (select three)
AREN 2025 Building Electrical Systems AREN 3005 Lighting Systems
AREN 3006 Advanced HVAC System Design AREN 3024 Building Physics
AREN 3025 Building Energy Simulation AREN 3026 Building Envelope Design

New requirements for Minor in Architectural Engineering (with markup) (New content is underlined and deletions are shown with a ~~strikethrough~~)

2 Units in Architectural Engineering
Must include:
AREN 2002 Architectural Design I
AREN 2023 Introduction to Architectural Engineering Systems AREN 3003 Principles of HVAC Design for Buildings

Elective courses (select three)
AREN 2025 Building Electrical Systems
~~AREN 3005 Lighting Systems~~
AREN 2004 Architectural Design II – Light and lighting systems AREN 3002 Architectural Design III
AREN 3006 Advanced HVAC System Design AREN 3024 Building Physics
~~AREN 3025 Building Energy Simulation~~
AREN 3020 Architectural Design IV - Building Energy Simulation ~~AREN 3026 Building Envelope Design~~

AREN 3022 Architectural Design V - Building Envelope Design

New requirements for Minor in Architectural Engineering (without markup)

2 Units in Architectural Engineering
Must include:
AREN 2002 Architectural Design I
AREN 2023 Introduction to Architectural Engineering Systems AREN 3003 Principles of HVAC Design for Buildings

Elective courses (select three)
AREN 2025 Building Electrical Systems
AREN 2004 Architectural Design II – Light and lighting systems AREN 3002 Architectural Design III
AREN 3006 Advanced HVAC System Design AREN 3024 Building Physics
AREN 3020 Architectural Design IV - Building Energy Simulation AREN 3022 Architectural Design V - Building Envelope Design

Rationale:
The course listings for the minor in Architectural Engineering are updated to reflect changes made to individual course offerings (additions and deletions, see AREN MOTIONS 1.1 to 1.8)

Impact on student schedules or other departments:
Course equivalency for students immediately affected by the change is provided below

Equivalencies			
Course #	Course Title (New)	Course Title (Old)	
AREN 2002	ARCHITECTURAL DESIGN I	AREN 2002	ARCHITECTURAL DESIGN I
AREN 2004	ARCHITECTURAL DESIGN II - Light and Lighting Systems	AREN 3005	LIGHTING SYSTEMS
AREN 3002	ARCHITECTURAL DESIGN III	AREN 3002	ARCHITECTURAL DESIGN II
AREN 3020	ARCHITECTURAL DESIGN IV - Building Energy Simulation	AREN 3025	BUILDING ENERGY SIMULATION
AREN 3022	ARCHITECTURAL DESIGN V - Building Envelope Design	AREN 3026	BUILDING ENVELOPE DESIGN

We anticipate no major impact on other departments or programs.
Changes to Distribution requirements
n.a.

Implementation Date:
Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove cross-listing of an AE/ME course and remove it from the AE section of the undergraduate catalog course descriptions approved by the AE Program on 9/18/2018.

Motion 1: The Committee on Academic Operations recommends and I move that the following course, currently cross-listed with the prefix "AE/ME" in the Undergraduate Catalog, have the cross-listing removed and instead be designated with either the prefix "AE" under the "Aerospace Engineering, " and "ME" under the "Mechanical Engineering, " heading in Section 3 of the Undergraduate Catalog .

AEROSPACE ENGINEERING
AE~~/ME~~ 4718 ADVANCED MATERIALS WITH AEROSPACE APPLICATIONS

MECHANICAL ENGINEERING
~~AE~~/ME 4718 ADVANCED MATERIALS WITH AEROSPACE APPLICATIONS

Motion 2: The Committee on Academic Operations recommends and I move that the following course be removed from under the "Aerospace Engineering" heading in Section 3 (Course Descriptions) of the Undergraduate Catalog as noted below. This effectively drops the AE version of the course.

AEROSPACE ENGINEERING
~~AE 4718 ADVANCED MATERIALS WITH AEROSPACE APPLICATIONS~~

Rationale:
In AY2016, the AE program introduced a new course, AE 4717 Fundamentals of Composite Materials that aligns its coverage with the current AE distribution requirements. Since the 2016-17 academic year, AE4717 has been used by AE Majors in order to satisfy the distribution requirement in "Aerospace Materials." The course AE/ME4718 Advanced Materials with Aerospace Applications has become an elective and keeping it under the Aerospace Engineering course descriptions creates confusion as to its functionality. The motion drop AE4718 but retains the ME4718 course in the catalog under the Mechanical Engineering section. This action clearly identifies ME4718 as an elective for AE majors.

Implementation Date: Implementation date for this action is the 2019-2020 Academic year.

Resource Needs:
No additional resources are needed.
Impact on Distribution Requirements:
Removing the "AE" cross-listing from the AE/ME 4718 course and dropping AE 4718 has no impact on the AE distribution requirements. AE 4717 Fundamentals of Composite Materials is the course used since 2016-17 to satisfy the advanced Materials distribution requirements for AE majors.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to drop AE 4710: GAS TURBINES FOR PROPULSION AND POWER GENERATION and add AE 4711: FUNDAMENTALS OF AIR-BREATHING PROPULSION to the undergraduate catalog, approved by Aerospace Engineering Program Committee on October 30, 2018.

Motion 1: The Committee on Academic Operation recommends, and I move, that **AE 4710: GAS TURBINES FOR PROPULSION AND POWER GENERATION** be removed from the undergraduate catalog.

Rationale:

The course includes topics related to closed-cycle gas turbine engines for power generation, and does not leave time for in-depth coverage of specific topics related to aircraft propulsion. The course will be replaced by AE4711: FUNDAMENTALS OF AIR-BREATHING PROPULSION.

Course description:

AE 4710: GAS TURBINES FOR PROPULSION AND POWER GENERATION
Cat. I
This course provides a study of open-cycle and closed-cycle gas turbines. Topics covered include: thermodynamic cycles and fluid dynamics of airbreathing gas turbines (turbojets, turbofans, turboprops), ramjets, and scramjets; thermodynamic cycles and fluid dynamics of closed-cycle gas turbines. Performance of specific engine components such as inlets, combustors, nozzles, as well as axial compressors and turbines will be addressed.
Recommended background: compressible fluid dynamics (AE/ME 3410 or equivalent).

Impact on Distribution Requirements and Other Courses:

There is no impact on distribution requirements for the aerospace engineering program or other programs.

What term is this course typically offered and is it Cat. I or Cat. II?

AE 4710: GAS TURBINES FOR PROPULSION AND POWER GENERATION is a Cat. 1 course offered usually in A-term.

If there is a course to replace this, which one?
AE 4711: FUNDAMENTALS OF AIR-BREATHING PROPULSION.

Resource Requirements: No additional resources are needed for this motion.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.

<u>Motion 2</u>: The Committee on Academic Operation recommends, and I move, that **AE 4711. FUNDAMENTALS OF AIR-BREATHING PROPULSION** be added to the undergraduate catalog.

Course/Catalog Description:
AE 4711. FUNDAMENTALS OF AIR-BREATHING PROPULSION. Cat. I
This course introduces the principles of operation of air-breathing engines, including gas-turbines (turbojets, turbofans, and turboprops), ramjets, and scramjets. Topics covered include: engine thrust and efficiency analysis; working principles and performance analysis of diffusers, compressors, combustors, and nozzles; parametric cycle analysis; effect of irreversibilities on performance. The topics covered are also relevant to the operation of gas-turbines used for power generation.
Recommended background: thermodynamics (ES 3001, CH 3510, PH 2101 or equivalent), compressible fluid dynamics (AE/ME 3410 or equivalent).
Students may not receive credit for both AE 4710 and AE 4711.

Rationale:
The new course ~~M~~AE4711 FUNDAMENTALS OF AIR-BREATHING PROPULSION better meets ABET requirements in the air-breathing propulsion area and replaces AE 4710: GAS TURBINES FOR PROPULSION AND POWER GENERATION. In the new course we removed topics related to closed-cycle gas turbines used for power generation, which left more time for in-depth coverage of specific topics related to aircraft propulsion.

Implementation Date:
Implementation date for this action is the 2019-2020 academic year.

Resource Needs:
No additional resources are needed for this motion. The Aerospace Engineering Program has instructors available for this course; Prof. Jagannath Jayachandran (primary), Prof. David J. Olinger (secondary).

Impact on Distribution Requirements and Other Courses:
There is no impact on distribution requirements for the aerospace engineering program or other programs.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to change the description for CS 3133 approved by Computer Science Department on October 30, 2018.

Motion: The Committee on Academic Operation recommends and I move, that the description for CS 3133 be changed as described below.

Existing title, description and course offering schedule:
CS 3133. FOUNDATIONS OF COMPUTER SCIENCE.
Cat. I
This course introduces the theoretical foundations of computer science. These form the basis for a more complete understanding of the proficiency in computer science.
Topics include computational models, formal languages, and an introduction to compatibility and complexity theory, including NP-completeness.
Students will be expected to complete a variety of exercises and proofs.
Undergraduate credit may not be earned both for this course and for CS 503.
Recommended Background: CS 2022 and CS 2223.
Students who have credit for CS 4121 may not receive credit for CS 3133.

Proposed title, description, and course offering:
CS 3133. FOUNDATIONS OF COMPUTER SCIENCE.
Cat. I
This course introduces the theoretical foundations of computer science. These form the basis for a more complete understanding of the proficiency in computer science.
Topics include computational models, formal languages, and an introduction to compatibility and complexity theory, including NP-completeness.
Students will be expected to complete a variety of exercises and proofs.
Undergraduate credit may not be earned for both this course and for CS 5003.
Recommended Background: discrete mathematics (CS 2022 or equivalent), and algorithms (CS 2223 or equivalent).
Students who have credit for CS 4121 may not receive credit for CS 3133.

Explanation of Motion: The proposed change does not impact the content of any course. It only affects the set of courses for which a student may receive undergraduate credit in conjunction with CS 3133.

Rationale: A few years ago, the computer science department created a new course, CS 5003, as a Master's-level Foundation class, which allowed CS 503 to be taught at a level more appropriate for PhD students. That change means that an undergraduate can now benefit from taking CS 503 subsequent to CS 3133, and hence should be able to receive undergraduate credit for both. However, a student should not be able to receive undergraduate credit for both CS 5003 and CS 3133.

Impacts on students: The proposed change could add more flexibility to computer science BS/MS students who have taken both CS 3133 and CS 503, as they would be able to receive undergraduate credit for both. On the other hand, future BS/MS students would no longer be able to receive

undergraduate credit for both CS 3133 and CS 5003. The number of students in the latter category is likely very small.

Resource Needs:
No changes.

Implementation Date: 2019-20 Academic year.

Note: Cat. II to Cat. I must go to full faculty for a vote. Cat. I to Cat. II only needs to go to CAO.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to change the description for CS 4120 approved by Computer Science Department on October 30, 2018.

Motion: The Committee on Academic Operation recommends and I move, that the description for CS 4120 be changed as described below.

Existing title, description and course offering schedule:
CS 4120. ANALYSIS OF ALGORITHMS.
Cat. II
This course develops the skill of analyzing the behavior of algorithms.
Topics include the analysis — with respect to average and worst case behavior — and correctness of algorithms for internal sorting, pattern matching on strings, graph algorithms, and methods such as recursion elimination, dynamic programming, and program profiling.
Students will be expected to write and analyze programs.
Undergraduate credit may not be earned both for this course and for CS 504.
Recommended background: CS 2223 and some knowledge of probability.
This course will be offered in 2018-19, and in alternating years thereafter.

Proposed title, description, and course offering:
CS 4120. ANALYSIS OF ALGORITHMS.
Cat. II
This course develops the skill of analyzing the behavior of algorithms.
Topics include the analysis — with respect to average and worst case behavior — and correctness of algorithms for internal sorting, pattern matching on strings, graph algorithms, and methods such as recursion elimination, dynamic programming, and program profiling.
Students will be expected to write and analyze programs.
Undergraduate credit may not be earned for both this course and for CS 5084.
Recommended background: algorithms (CS 2223 or equivalent), and some knowledge of probability.

This course will be offered in 2018-19, and in alternating years thereafter.

Explanation of Motion: The proposed change does not impact the content of any course. It only affects the set of courses for which a student may receive undergraduate credit in conjunction with CS 4120.

Rationale: A few years ago, the computer science department created a new course, CS 5084, as a Master's-level Algorithms class, which allowed CS 504 to be taught at a level more appropriate for PhD students. That change means that an undergraduate can now benefit from taking CS 504 subsequent to CS 4120, and hence should be able to receive undergraduate credit for both. However, a student should not be able to receive undergraduate credit for both CS 5084 and CS 4120.

Impacts on students: The proposed change could add more flexibility to computer science BS/MS students who have taken both CS 4120 and CS 504, as they would be able to receive undergraduate credit for both. On the other hand, future BS/MS students would no longer be able to receive

undergraduate credit for both CS 4120 and CS 5084. The number of students in the latter category is likely very small.

Resource Needs:
No changes.

Implementation Date: 2019-20 Academic year.

Note: Cat. II to Cat. I must go to full faculty for a vote. Cat. I to Cat. II only needs to go to CAO.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add "MACHINE LEARNING" (CS 4342, cross-listed as DS 4342) approved by Computer Science Department and Data Science Program on October 30, 2018.

Motion: The Committee on Academic Operation recommends and I move, that "MACHINE LEARNING" (CS 4342) as described below, be added.

Course/Catalog Description:
CS 4342 MACHINE LEARNING
Cat.I.
In this course, students will explore both theoretical and practical aspects of machine learning, including algorithms for regression, classification, dimensionality reduction, clustering, and density estimation. Specific topics may include neural networks and deep learning, Bayesian networks and probabilistic graphical models, principal component analysis, k-means clustering, decision trees and random forests, support vector machines, and kernel methods. Recommended background: Multivariate Calculus (MA 1024 or MA 1034), Linear Algebra (such as MA 2071), Probability (MA 2621 or MA 2631), and Algorithms (CS 2223). Students may not earn credit for both CS 453X and CS 4342. Undergraduate credit may not be earned both for this course and for CS 539.

Anticipated Instructors: Prof. Jacob Whitehill, Prof. Carolina Ruiz, Prof. Joseph Beck, or Prof. Xiangnan Kong.

Rationale: Interest in machine learning among students at WPI, within the software industry, and in society at large, has grown rapidly during the past 5-8 years. Machine learning has largely been responsible for the tremendous advances in artificial intelligence over the same time period, especially in the domains of image and video retrieval, speech recognition, face recognition, robotic control, and many others. It is important that our undergraduate CS majors understand how machine learning systems are built and how machine learning algorithms are designed and can be improved. Especially in a world in which increasingly almost everything is being recorded, understanding how machine learning works from the inside out (not just as a "black box") is important to help ensure that citizens' privacy is maintained. The purposes of the proposed course are (1) Help students to understand the mathematical and computational foundations of machine learning algorithms. With a clear understanding of how they work, these algorithms cease to be "black boxes" and instead become useful computational tools that can be sensibly manipulated, redesigned, and combined for specific application domains. (2) Give students some practical experience in applying machine learning problems to interesting, non-trivial problem domains.

Machine learning (ML) is a subset of the larger domain of artificial intelligence (AI). WPI currently offers an undergraduate CS course (4341) on Artificial Intelligence, and some of the topics (which depend on the particular instructor who is teaching) that are taught in this course are about machine learning. However, the emphasis within the AI course is more about understanding how to use off-the-shelf ML algorithms than on understanding their inner workings from the ground-up. The proposed ML course (4342) is explicitly designed to teach students to derive — from basic mathematic principles of calculus, linear algebra, probability theory, and statistics — the algorithms themselves. In the

experimental version of 453X, this approach resonated well with students (i.e., several students stated this in their written feedback in the student course evaluations).

Demand for the proposed course is expected to be strong. In the experimental version of the course in 2018 (D-term), over 50 students either registered for or were placed on the waitlist for the course. (As of the add/drop deadline for that term, 43 students were registered.)

This first run of the course was received well by students. On student course evaluations, the course received a 4.83 for "overall rating of the quality of this course" (question #1), 4.90 for "overall rating of the instructor's teaching" (question #2), and 4.69 of "amount I learned from the course" (question #9).

Implementation Date: Implementation date for this action is the 2019-2020 Academic year.

Resource Needs:
Please summarize basic resources needed to deliver this course, including the following:

- One additional large classroom (up to 75 students).
- Library resources (including staff support as well as print and electronic resources): none.
- Information Technology (special software or support from the Academic Technology center): none.

Impact on Distribution Requirements and Other Courses: The proposed CS 4342 course can be one of the 4000-level courses required by CS majors to graduate. It will not fulfill any other specific area requirement for the BS degree. For BS/MS students, CS 4342 (and CS 453X) will count as a core course in the AI bin. Also, due to significant overlap in content, CS 4342 and CS 539 will be added as a new row in the table in the 2018-19 graduate catalog on page 80. Finally, CS 4342 will be cross-listed as DS 4342.

Also include original experimental course proposal if applicable.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add ISE 2820 Intensive Reading for Non-native Speakers of English approved by Department of Humanities and Arts on 11/9/2018

Motion: The Committee on Academic Operation recommends and I move, that ISE 2820 Intensive Reading for Non-native Speakers of English, as described below, be added.

Course/Catalog Description:
ISE 2820 Intensive Reading for Non-native Speakers.
Cat II.

The goal of this course is to provide non-native English language students the skills to work with the highest levels of academic and professional reading. Students will develop active and critical reading skills by annotating self-selected academic journal articles, research reports, current news reports and autobiographical literature. Students will create annotated bibliographies, summaries, literature reviews, and critical reaction papers. Students will learn to analyze, synthesize and cite multiple sources when doing academic work. Students will also increase their vocabulary of high-level academic and professional terms.
Recommended background: Composition for Non-native Speakers of English (as covered in ISE 1801) or equivalent skills.
Note: Students who have taken ISE 282X may not receive credit for this course.
This course will be offered in 2019-20, and in alternate years thereafter.

Anticipated Instructor: Prof. Althea Danielski

Rationale: As part of the English for International Students course sequence, this proposed course would serve the needs of high-intermediate/advanced English language learners by developing their skills in reading comprehension. While we have several writing-intensive classes, we do not currently have a reading-intensive course; this proposed course would fill that gap and allow our students to progress and excel at this vital academic skill. The main ideas in academic texts and professional journals are often veiled in complicated language structures and advanced vocabulary; our students will practice identifying, decoding and engaging with the ideas in these texts. Students will learn specific strategies to annotate and summarize complex texts, analyze and critique arguments, and locate research and readings of importance to their academic and professional disciplines. Students will also work on improving their comprehension of vocabulary specific to their disciplines, and the corresponding rules of usage. Students will practice reading deeply as well as widely, by engaging with a work of autobiographical literature. We will use this reading to explore questions in contemporary American culture and link it to issues of social justice in contemporary US society.
The proposed course number has not been used previously.

This course was taught as an experimental course in Academic Years 2017 and 2018 during A-terms. A summary of student feedback and outcomes from questions 1, 2, 9 and 26 of course evaluations is presented below for both sections A-2017 (4 responses) and A-2018 (12 responses):

	A-17	A-18
Q.1	4.3	4.5
Q.2	4.5	4.8
Q.9	4	4.7
Q.26 1-5 hrs 6-10hrs 11-15hrs 16-20hrs	 3 1 	 1 6 3 2

Student feedback:

"By doing the project I not only broadened my knowledge about biosensors, but also discovered a new thing about myself that I have never thought of. Before doing this project, I didn't think that I were capable of reading scientific articles, as I considered it long and boring and time-consuming. But after doing the project, I found out that with the annotation skills that I learned in the class, I could get the most important information from the paper without having to read the whole thing, which not only saved me a lot of time but also generated my curiosity about the research that the author mentioned. Finally, by doing this project, I knew the importance of teamwork. Such experience in working in a team will definitely help me in my future schoolwork as well as my career afterward, as I will have to work with different people for the future projects as well as in my future career."

"This literature review project proved to be extremely beneficial in developing our research skills. We learned how to extract the important message from a multi-page article and then summarize the main points in our words. In addition to that, we wrote an abstract which was something absolutely new for all of us. Overall, through these series of assignments we were able to further develop our writing, reading and research skill set that will help us in various future projects."

"Writing a Literature Review for the first time taught me a lot in how to organize and structuralize a review paper and find connection between different work to support our group message. I also learn how to read a research paper and got what I need for the topic instead of trying to understand everything… I really like this project and this course. It helped me a lot in working in team and writing a paper. I would definitely recommend it people to take this course. It is fun!"

"Reading Malcolm X was very worthwhile. Before this class, I didn't even really know who he was but now, I know his life story. Malcolm X is a big part of African American history and without this class, I would not know about him."

"I think it was amazing that we read the autobiography of Malcolm X, reading this book allowed me to learn more about Malcolm and the kid of person he was. This book helped me understand him better and appreciate more the things he believed in. If it wasn't for this book a lot of my misconceptions of Malcolm X would have remained."

"The most enjoyable part of the project for me is the ePortfolio making process. I enjoyed designing the ePortfolio webpage by setting up the theme color and matching up the color tone of background images with the theme. Also, we took a team picture and uploaded it to ePortfolio; it not only goes well with the whole look of design, but also shows great team bonding. At the end, I feel confident about the appearance of our ePortfolio."

"I have learned the skills of conducting annotation, bibliography and formatting literature reviews. These skills have already helped me on the ID2050 class I am taking this term. I believe they will be even more useful when I am writing my IQP paper next term as well as my MQP paper at D term. Annotation skills will keep benefit me from reading other papers, and the formatting skills will save me

a lot of time on conducting papers of my own in the future."

Feedback from course evaluations:
"I learnt how to write a literature review and bibliography which is really helpful. But the best thing is the reading part. All the reading are great and I love when we discuss our thought after reading. I like the team work and all the interaction we have in class."

"I love the way professor Danielski teaches. She tries to make the material interesting to learn about."

"This is really helpful in how to read and analize research paper. I especially would love to encourage freshmen because I think all the skills in class will help them a lot in a future reading experience."

"I learned skills that are necessary for future research work."

Instructor feedback and reflection:
I taught this course twice as an experimental course, in A term of 2017 with 4 enrolled students and B term of 2018 with 13 enrolled students (the course is capped at 15). In both terms, students showed interest and enthusiasm for the course content. We met the learning objectives and I noticed that my students gained confidence and skill reading technical and complex articles from research and academic journals.
I was impressed with the depth of critical thinking and openness to new ideas that my students showed in our study of The Autobiography of Malcolm X. My hope was that by learning more about Malcolm X's experience, they would be gain greater awareness of some of the history of racial injustice in the US, and thereby be better equipped to navigate the complicated terrain of race in contemporary US society. My students' showed a remarkable willingness to hold and weigh opposing viewpoints, discuss controversial statements and ideas, and offer their honest and measured opinions.
If this course becomes permanent, I will continue to use the same book and supplementary materials to support student learning. I will continue to have students create a group ePortfolio to record and reflect on their Reading Portfolio project. The ePortfolio is particularly useful for promoting students' reflections on their group's process and their personal contributions to it. One change I will make is to increase the amount of reading we do from The Autobiography of Malcolm X. I worried that students would find the amount of reading to be too much, but they were able to handle it, and showed enthusiasm to read more.
We anticipate student interest in this course will increase and the projected enrollment is 15 in each section.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.

Resource Needs: The proposed course will be taught by Prof. Althea Danielski, who has taught this course twice as an experimental course. The use of a (small) multimedia classroom is required. No special software or additional library resources will be needed.
Impact on Distribution Requirements and Other Courses: The new course will have no impact on current distribution requirements. This course will be a permanent course offering.

Appendix A: Original Experimental Course Proposal

To: Chair, Committee on Academic Operations
From: Professor Kris Boudreau, Department Head, Humanities and Arts
Re: Motion to add experimental course ISE 282X Intensive Reading for Non-Native Speakers of English approved by Department of Humanities and Arts on Sept. 16, 2016.
Date: 09/23/2016

The Department of Humanities and Arts requests the approval of the following experimental course *ISE 282X, Intensive Reading for Non-Native Speakers of English* in Academic Years 2017 and 2018 during A-term.

Note: Experimental courses are approved for two offerings.

Contact: Profs. Althea Danielski or Esther Boucher-Yip
Preferred term: A
Expected enrollment: 15
Course type: Lecture/Lab
Intended audience: If the course becomes permanent: potentially all high-intermediate and advanced level non-native English-speaking students.

Anticipated Instructor: Prof. Althea Danielski

Course/Catalog Description: ISE 282X Intensive Reading for Non-native Speakers. Cat I. The goal of this course is to provide non-native English language students the skills to work with the highest levels of academic and professional reading. Students will develop active and critical reading skills by annotating self-selected textbook readings, academic journal articles, research reports, current news reports and essays. Students will create summaries, critiques, and reactions, and learn to analyze, synthesize and cite multiple sources when doing academic work. Students will also increase their vocabulary of high-level academic and professional terms. Recommended background: Composition for Non-native Speakers of English (ISE 1801) or equivalent skills.

Rationale: As part of the English for International Students course sequence, this proposed course would serve the needs of high-intermediate/advanced English language learners by developing their skills in reading comprehension. While we have several writing-intensive classes, we do not currently have a reading-intensive course; this proposed course would fill that gap and allow our students to progress and excel at this vital academic skill. The main ideas in academic texts and professional journals are often veiled in complicated language structures and advanced vocabulary; our students will practice identifying, decoding and engaging with the ideas in these texts. Students will learn specific strategies to annotate and summarize complex texts, analyze and critique arguments and essays, and locate research and readings of importance to their academic and professional disciplines. Students will also work on improving their comprehension of vocabulary specific to their disciplines, and the corresponding rules of usage.
Resource Needs: No new resources are required. Prof Althea Danielski currently teaches the introductory academic reading course (ISE 1800) and will be assigned to teach this high-intermediate/advanced-level reading course.

Assessment: (1) questions 1, 2, 9, and 26 of student course evaluations; (2) students' feedback apart

from course evaluations; (3) instructor's feedback and reflections; and (4) course population number.

Impact on Distribution Requirements: This course will have no impact on current distribution requirements. International students can choose to use this course to fulfill depth in the HUA sequence (with WR courses) or breadth.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add HI1350 for AY 2019-2020 consistent with the approval by a vote of the HUA faculty on October 26, 2018

Motion: The Committee on Academic Operations recommends and I move that HI 1350, as described below, be added to the catalog.

Course/Catalog Description:

HI 1350. INTRODUCTION TO ENVIRONMENTAL HISTORY
Cat. I
An introduction to the questions, methods, and source materials that shape historical studies of the environment. This course will explore the influence of nature (i.e., climate, topography, plants, animals, and microorganisms) on human history and the reciprocal influence of people on nature.

Anticipated Instructors: William San Martin, Joseph Cullon, Constance Clark, David Spanagel, and Peter Hansen

Expected Enrollment: 25 per section

Intended Audiences: HUA Majors/Minors; HUA Requirement (Breadth/Depth); Minors in Sustainability Engineering and Global Public Health; Major/Minors in Environmental and Sustainability Studies and International and Global Studies; Free Elective.

Rationale: This course completes a sequence of courses in environmental history, as HI 2400 and HI 3317 provide an intermediate survey and advanced seminar work, respectively. This course will introduce students to historical practice in evaluating primary evidence and historical interpretation of past human-environment interactions; formulating historical arguments about change and continuity over time; and communicating those arguments with evidence in clear oral and written communications. Students completing this introduction not only will be well prepared to more deeply engage historical materials in intermediate and advanced environmental history courses but also to apply environmental history approaches to other courses in the broader history curriculum. The general description of the course will allow instructors to select from a broad range of geographic emphases (nation/state, regional, global) or thematic foci (urban environments, wilderness, environmental health, etc.). This allows sections to correspond with the trends in established scholarship that promote regional (i.e., North American, Latin American or other geographic appellations) and transregional (i.e., Global) approaches as well as grant faculty the flexibility to develop sections aligned with their research and Global Project Center advising. Although sections might vary in geographic or thematic focus, students can receive credit only once for HI 1350, thus pushing them to engage environmental history in more depth and sophistication with HI 2400 and/or HI 3317.

Implementation Date: AY 2019-2020

Resources Needs: With the proposed addition of HI 1350, HUA simultaneously asks CAO to remove

HI 1341 (Introduction to Global History) from the catalog. This represents no net change in resources required as one *Cat. I* introductory course (HI 1341) is being replaced with a new *Cat. I* introductory course (HI 1350).
Classroom: No new addition of resources, reallocation of existing resources
Library: No new addition of resources. reallocation of existing resources
Information Technology: No new addition resources, reallocation of existing resources

Impact on Distribution Requirements and Other Courses: There is no anticipated impact.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add HI 2310 to the catalog for AY 2019-2020 as approved by the HUA Department on October 26, 2018

Motion: The Committee on Academic Operations recommends and I move, that a topics course HI 2310, as described below, be added to the catalog.

Course/Catalog Description:

HI 2310. TOPICS IN URBAN HISTORY
Cat. I
This course surveys the interplay of social, economic, demographic, political and cultural forces in shaping the growth, decline and occasional rebirth of urban spaces. Emphasis is placed upon building chronological narratives while attending to the themes, approaches, and sources historians use to reconstruct the tangled infrastructures, stratified economies, segregated spaces and political/administrative structures of cities. Geographies will vary across sections and topics may include Industrializing Cities, Race and Urban Space, Post-Industrial Cities, Urban Technological Infrastructures, or Social Justice in the City. Students can receive credit only once for HI 2310.

Anticipated Instructors: Constance Clark, Joseph Cullon, and Jim Hanlan.

Expected Enrollment: 50 per section

Intended Audiences: HUA Majors/Minors; HUA Requirement (Breadth/Depth); Free Elective; Minors in Sustainability Engineering and Global Public Health; Major/Minors in Environmental and Sustainability Studies and International and Global Studies.

Rationale: The History Section of the HUA Department has long offered HI 1311: Introduction to American Urban History as well as 3000-level topics seminars, but there has not been an intermediate survey course for students to further develop their interests in urban history and prepare them for research-focused inquiry seminars in urban history. Historically sections of HI 1311 and 3000-level topics seminars are either fully or over enrolled and recent student interest in the Urban Humanities suggests a broad audience for intermediate and advanced work in urban history. Adoption of a topics approach will allow chronologies, geographies and themes to vary with trends in recent scholarship on the industrial city, post-war urban renewal, and postindustrial urbanism. Further, at a time when alternative teaching or administrative assignments frequently draw history faculty from their established courses, this revision would allow stand-in instructors greater autonomy in establishing the chronological and thematic emphasis of their sections to correspond with their other teaching initiatives and research enterprises.

Implementation Date: AY 2019-2020

Resources Needs: The addition of HI 2310 represents a reallocation of existing resources in two ways. First, HUA has offered two sections a year of HI 2400: Topics in Environmental History (previously HI

2401 and HI 2403), but with approval of this proposal HUA will offer one section of HI 2400 and one section of HI 2310, for no net addition to courses offered. Second, HUA has been engaged in an extended revision of the HI curriculum, with CAO approving the removal of 8 2000-level courses (HI 2331, HI 2331, HI 2352, HI 2353, HI 2354, HI 2401, HI 2402, and HI 2403) in 2017-2018 and the addition of just 3 2000-level courses (HI 2335, HI 2350, HI 2400) in their place.

Classroom: No new addition of resources, reallocation of existing resources
Library: No new addition of resources, reallocation of existing resources
Information Technology: No new addition of resources, reallocation of existing resources

Impact on Distribution Requirements and Other Courses: There is no anticipated impact.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove
FIN 3250 *Finance, Technology & Risk Analysis* (Cat I)
FIN 2260 *Investment and Security Analysis* (Cat I)
FIN 2250 *Financial System of the United States* (Cat II)
from the undergraduate catalog and to add
FIN 3300 *Finance, Risk Analytics & Technology*

Motion 1: The Committee on Academic Operations (CAO) recommends and I move that the courses FIN 3250 *Finance, Technology & Risk Analysis*, FIN 2260 *Investment and Security Analysis*, and FIN 2250 *Financial System of the United States* be removed and that a new course, FIN 3300 *Finance, Risk Analytics & Technology* be added to the undergraduate catalog

Rationale:
Enrollment in these three courses has been low (averaging 10 to 21 between AY16-17 and AY 19-20) and there is some overlap in content between the courses. Removing these courses will not have a significant impact on students as the new proposed course *Finance, Risk Analytics & Technology* - FIN 3300 incorporates key concepts from all three of these courses while providing improved focus on current financial topics such as risk analytics. It has also been tailored to the interest in technology of WPI students. Based on past enrollment in FIN 3250, FIN 2260 and FIN 2250 we anticipate an enrollment of about 40 students in the new course.

Courses to be removed:

FIN 3250 - Finance, Technology & Risk Analysis
This course will focus on the intersection of finance and technology. Students will learn about risk analysis in the context of the financial services sector including liquidity risk, regulation risk, operations risk, country risk, credit risk, enterprise risk, and market risk. In addition, students will learn about asset valuations including credit derivatives, structures, and financial products. Students will design models of risk assessment. Financial reporting using such technologies as visual dashboards and mobile devices will be included in order to provide real time information such as actual costs vs. budgets, and estimated targets vs. actual production and sales targets. The course will feature guest speakers from Wall Street firms as well as recent journal articles and case studies. Recommended background: An understanding of introductory economics and statistics principles.

FIN 2260 - Investment and Security Analysis
This course is designed to provide an introduction to the language and methodology of security analysis. It is intended to serve two different groups of students: those interested in the subject from the viewpoint of intelligent management of their own portfolios, and those students who have a possible career interest in some facet of the securities industry. Principal topics include: institutional structure and language of the securities market; investment research; alternative investment opportunities; financial statement analysis; fundamental evaluation of common stocks, preferred stocks and bonds; technical analysis; and business cycle analysis. Recommended background: BUS 2060 and ECON 1120.

FIN 2250 - Financial System of the United States
An analysis of how the financial system of the United States has developed and contributes to the achievement of broad national economic goals as high national income, satisfactory economic growth, stable prices, and equilibrium in balance of payments with other countries. Emphasis is placed on the theory of the supply and demand for short-term money and long-term capital, and the resultant effect on interest rates. Primary concentration on the sources and uses of funds of the major non-bank financial institutions, such as insurance companies, pension funds, mutual funds, finance companies, savings and loan banks and mutual savings banks. A discussion of the reforms of financial institutions, and of money and capital markets to more efficiently allocate the scarce resources of the country. This course is intended to serve the business major and other students interested in understanding the role of financial intermediaries in the United States economy. Suggested background: some knowledge of accounting and economics will be helpful in taking this course. This course will be offered in 2018-19, and in alternating years thereafter.

Course to be Added:

Course/Catalog Description:
FIN 3300 - Finance, Risk Analytics & Technology

This course provides an in-depth overview of finance, methods in risk analytics, and the importance of financial technology in today's global and interconnected marketplace. In this course, students learn the most up-to-date methods and tools that are used globally within the financial services industry. Topics covered include portfolio formation based on personal and risk preferences, the formation and backtesting of trading strategies, fundamental and technical analysis, the mutual fund and hedge fund industries, and cryptocurrencies. These topics are explored using big data and risk analytics methods such as time series modeling, prediction models, volatility risk forecasting, and the identification and distinction between market-wide and industry-specific risks. Throughout the course, students will learn how to use Bloomberg to analyze data across market sectors to make financial decisions. This course is especially suited to those seeking careers where data analytics and information technologies play critical roles in finance or the management of risks. Topics covered in this course appear regularly in examinations required for professional certifications, such as the Chartered Financial Analyst (CFA) certification. The risk analytics portion of this course also covers topics that appear regularly in the financial mathematics examination by the Society of Actuaries (SOA).

Recommended Background: Introductory business and finance topics such as those found in BUS2060.

Anticipated Instructor: The instructor (D. Koutmous) who has been teaching FIN 3250 which will be dropped will be teaching FIN 3300.

Changes to the undergraduate catalog:

The courses FIN 3250, FIN 2260 and FIN 2250 should be replaced by **FIN 3300 Finance, Risk Analytics & Technology whenever** referenced in the catalog.

In the Financial Technology concentration (p. 46), the existing description should be modified as follows:

Financial Technology Concentration – 2 units

~~Select two~~ Required: ~~FIN 2250, FIN 2260, FIN 3250~~ FIN 3300

Select ~~three~~ four: CS 2119 -or- CS 2102 -or- CS 2103, MIS 3720, MIS 3740, MIS 4720, MIS 4741

One 2000-level or higher course from: ~~BUS 310X~~ BUS 2060, CS (excluding CS 2022, CS 3043), ECON, FIN, MIS, OIE, and actuarial math courses (MA 2211, MA 2212, MA 2621)

BU majors with Financial Technology concentration cannot receive credit for both FIN 3250 and FIN 3300.

The MQP must be in Financial Technology with a Financial Technology advisor. (Profs. H. Higgins, D. Koutmos, F. Miller, K. Sweeney)

Resource Needs:
No additional resources will be needed

Implementation Date:
Implementation date for this action is the 2019-20 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove WR 2213: Introduction to Journalism from the undergraduate catalog, approved by Department of Humanities and Arts on October 26, 2018.

Motion: The Committee on Academic Operation recommends and I move, that WR 2213 be removed from the undergraduate catalog.

Rationale:
This 20-student course has filled only twice since its introduction in 2009. In the meantime, WPI's writing curriculum has expanded significantly, including courses like WR 1011, Writing About Science and Technology, which covers scientific journalism. The impact on students will be minimal. The elimination of WR 2213 means that WPI students completing the HUA requirement, a minor in writing or a major in Professional Writing or IMGD with a concentration in writing will have to choose a different course.

Provide course description:

The course is for students who may wish to make careers in journalism or communications and for those who wish to understand the history, function, production and contemporary challenges of print journalism. Students will analyze articles from newspapers, magazines and Web sites. They will learn and practice the skills of the journalist: finding the story, researching, interviewing, writing on deadline, copy-editing and proof-reading. Classes will also cover matters such as objectivity, fairness, ethics and libel, as well as wider issues of mass communication such as agenda setting, citizen journalism and the implications of converging media. To give students a more keen sense of audience, work will be read and discussed in class. Students will be urged to write for the college newspaper. Publication beyond the campus will be strongly encouraged.

Note changes to catalog:
WR 2213 must be deleted from page 168 in the current catalog. A reference to the course under IMGD BA: Concentrations: IMGD Writing Concentration (p. 82 in the current catalog) must be deleted.

Impact on Distribution Requirements and Other Courses: Minimal. Only IMGD will be affected, as noted above.

What term is this course typically offered and is it Cat. I or Cat. II?
B term, Cat. I

If there is a course to replace this, which one?
No.

Note if there are any changes to resource requirements.
We will be hiring one less adjunct to teach this course.

Implementation Date: Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to remove WR 3310: Digital Rhetoric from the undergraduate catalog, approved by Department of Humanities and Arts on October 26, 2018.

Motion: The Committee on Academic Operation recommends and I move, that WR 3310 be removed from the undergraduate catalog.

Rationale:
This is an advanced level project-based course. The 20-student Cat II course has been under-enrolled since it was last taught in 2015. Students interested in learning rhetoric and communication in the digital environment have the option of taking WR 2310 Rhetoric of Visual Design and/or WR 3400 Writing Narratives for IMGD. Thus, the impact on students will be minimal. The elimination of WR 3310 means that WPI students completing the HUA requirement, a minor in writing or a major in Professional Writing or IMGD with a concentration in writing will have to choose a different course.

Provide course description:
This course will explore the changing nature of rhetoric and communication in a digital environment by articulating a theory of rhetoric that accounts for digital communication. In a seminar format, students will read and respond to a number of readings that consider the roles of databases, algorithms, social networks, and the like on contemporary communication practices. Students will put into practice their theories on digital rhetoric through a series of class projects: website design, podcasting, interactive storytelling, database design, virtual representations, and the like. Throughout the course, students will recursively understand their practices through theoretical works and gain new insight into theory through the practice of writing in digital spaces.

Note changes to catalog:
WR 3310 must be deleted from page 169 in the current catalog. A reference to the course under IMGD BA: Concentrations: IMGD Writing Concentration (p. 82 in the current catalog) must be deleted.

Impact on Distribution Requirements and Other Courses: Minimal. Only IMGD will be affected, as noted above.

What term is this course typically offered and is it Cat. I or Cat. II?
B term, Cat. II

If there is a course to replace this, which one?
No.

Note if there are any changes to resource requirements.
We will be hiring one less adjunct to teach this course.

Implementation Date: Implementation date for this action is the 2019-2020 Academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to drop HI 1341 from the catalog beginning in AY 2019-2020 consistent with the approval by a vote of the HUA faculty on October 26, 2018

Motion: The Committee on Academic Operations recommends and I move that HI 1341 be removed from the catalog.

Rationale: Given the recent development of the International and Global Studies (INTL) curriculum in HUA, HI 1341 (Introduction of Global History) now offers similar content to INTL 1100 (Introduction to International and Global Studies). Therefore, this revision would eliminate a redundancy in the curriculum.

Impact on Distribution Requirements and Other Courses: There is no anticipated impact. HUA is simultaneously proposing the addition of another thematic introductory course (HI 1350) to ensure that there is not a net loss of seats in HI introductory courses. Further, HUA will continue to offer multiple sections of INTL 1100 (historically two sections per year) to satisfy interest in international and global approaches to the Humanities. Further, HI 1341 was not a prerequisite for upper divisions HUA courses or minors.

Implementation Date: AY 2019-2020

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to add MA4635 Data Analytics and Statistical Learning approved by the Mathematical Sciences Department on 11/13/2018.

Motion: The Committee on Academic Operation recommends, and I move, that MA4635 Data Analytics and Statistical Learning as described below, be added.

Course/Catalog Description: MA4635 Data Analytics and Statistical Learning.
Cat. I.
The focus of this class will be on statistical learning – the intersection of applied statistics and modeling techniques used to analyze and to make predictions and inferences from complex real-world data. Topics covered include: regression; classification/clustering; sampling methods (bootstrap and cross validation); and decision tree learning. Students may not receive credit for both MA463X and MA4635.

Recommended background: Linear Algebra (MA2071 or equivalent), Applied Statistics and Regression (MA2612 or equivalent), Probability (MA2631 or equivalent). The ability to write computer programs in a scientific language is assumed.

Anticipated Instructor: Prof. Randy Paffenroth, Prof. Jian Zou, and other instructors of MA could teach the course as well.

Rationale:
The American Statistical Association (ASA) publication Curriculum Guidelines for Undergraduate Programs in Statistical Science says that "there is growing demand for a variety of strong undergraduate programs in statistics to help prepare the next generation of students to make sense of the information around them." The proposed course complements the current offering of statistics courses in the Department of Mathematical Sciences to remain in step with best practices and to align with the curriculum recommendations of the ASA. In particular, we need a course that provides the experience and knowledge to study and analyze data in practical problems of real world interest. Students need to gain the basic tools for making predictions and inferences when the data of interest has features emblematic of those found in industrial applications. The course plays also a fundamental role as advanced mathematical course for the programs in Data Science (major and minor).

Course Learning Objectives and Outcomes:
Students will be able to:
• Gain insights into different data analysis methods in statistical learning
• Implement various statistical learning algorithms in software such as R and Python and get experience analyzing data
• Interpret results and make predictions from statistical analyses of complex data
• Communicate results effectively
• Engage in discussions on the ethical use of data and statistics.

Metrics for Student Evaluations

The grading for the course is comprised of assigned homework problems, a midterm exam, a final exam, and a final project.

Evaluation of the Experimental Course

Standard course evaluations indicate the effectiveness of the course. Table 1 summarizes the student responses. Table 2 summarizes student responses to question 26B of the course evaluation, indicating the amount of work students spent outside class.

Table 1: Average Student Evaluations

Year	# Students Enrolled	# Responses	Q1	Q2	Q9
D-2017	16	13	4.77	4.92	4.54
D-2018	14	10	4.90	4.90	4.90

Answers are on a 1-5 Scale. Q1: My overall rating of the quality of this course is. Q2: My overall rating of the instructor's teaching is. Q9: The amount I learned from the course was.

Table 2: Average Number of Hours Spent Outside of Class

Year	1-5	6-10	11-15	16-20	>20
D-2017	1/13	7/13	5/13	0/13	0/13
D-2018	4/10	4/10	2/10	0/10	0/10

In addition, students were asked to provide specific feedback as to the perceived value of the class to their professional preparation, how the class could be improved, etc. Comments from the first and second year are provided below:

> *Professor Paffenroth's MA463X was one of the most influential courses I've taken at WPI. His enthusiasm to teach every lecture and his ability to explain even the most difficult concepts inspired me to pursue a career in machine learning.*
>
> *Stimulating and applicable subject matter, enthusiastic knowledgeable professor.*
>
> *I really liked the final project and the amount of creativity we were able to use.*
>
> *I really enjoyed this course. I didn't have any experience at all with Data Science initially, but this class really showed me what it is like and why it is interesting. I appreciate the computational side to it.*
>
> *This course has been my favorite at WPI so far. Until taking this class I was unsure which direction I wanted to go in CS field.*
>
> *I liked the data-driven nature of the course. Learning about how to analyze data to intelligently decide what methods to apply.*

Reflections on course: Looking back on the course, and based upon discussions with the students, there are several areas for extension and improvement that come to mind. First, the most successful part of the course has been the final project. Having the students actively interact with real datasets has been an excellent learning experience for many students. Accordingly, emphasizing the final project even more (e.g., by starting is even earlier in the term), promises to pay educational dividends. Second, the students who have taken the course are, in large part, quite well prepared for the material covered in the class. This suggests that the selection of material that comprises the courses can be accelerated and extend to make it even more challenging and rewarding for the students who take the class.

Implementation Date: Implementation date for this action is the 2018-2019 Academic year with the next offering of the course in D-term 2019.

Resource Needs:

The basic resources needed to deliver this course include the following:

- Information on the instructor – Profs. Paffenroth and Zou are available to teach this course when it is offered. The Department of Mathematical Sciences is conducting a search for a tenure-track faculty whose focus will be in statistics. This person would begin teaching at WPI in AY 2019/2010 and will also be available to teach the proposed new statistics course, as well as other faculty of the Mathematical Sciences Department.
- Classroom – A room with seating of 30 students will be requested. The classroom will need to be technology enabled allowing for demos on the computer and for course capturing. The classroom will be needed for 4 hours a week.
- Laboratory – The course will have a conference which will take place in a computer lab to allow interactive learning. The computer labs in Kaven Hall 202 and Stratton Hall 003 will be available for use.
- Library resources – N/A
- Information Technology – N/A

Impact on Distribution Requirements and Other Courses:

- MA 4635 should be listed as "course of interest" in the Probability and Statistics area (catalog p. 95 and tables p. 94 and 95)
- MA 4635 should be listed as "Upper-level Course" in the Statistics Minor (catalog p. 96) and will be thus a potential capstone course for this minor
- MA 4635 should be a Mathematical Sciences course for the Minor in Data Science (p. 85 of the catalog), replacing the experimental version MA 463X
- MA 4635 should be a Mathematical Sciences course for the new Major in Data Science (as listed in the proposal for the major)

Also include original experimental course proposal if applicable.

To: Chair, Committee on Academic Operations
From: Department of Mathematical Sciences
Re: Motion to add *Data Analytics and Statistical Learning MA 463X* approved by the Department of Mathematical Sciences on 02/16/2016

Date: 02/18/2016

The Department of Mathematical Sciences requests the approval of the following experimental course (*MA 463X, Data Analytics and Statistical Learning)* in Academic Years: 2016/17 and 2017/18.
Note: Experimental courses are approved for two offerings.

Contact: Prof. Suzanne Weekes, Prof. Jian Zou
Preferred term: A, B, C, or D
Expected enrollment: 15
Course type: Category I. Junior / Senior level course.
Intended audience: If the course becomes permanent, this course will be of interest to all Mathematical Sciences undergraduate students in their Junior or Senior year. Additionally, any student with sufficient mathematics and statistics background who is interested in the analysis of complex data would also benefit from this course.

Anticipated Instructors: Prof. Randy Paffenroth, Prof. Joseph Petruccelli, and Prof. Jian Zou

Course/Catalog Description:
MA 463X, Data Analytics and Statistical Learning (Cat. I)
Cat. I. The focus of this class will be on statistical learning – the intersection of applied statistics and modeling techniques used to analyze and to make predictions and inferences from complex real-world data. Topics covered include: regression; classification/clustering; sampling methods (bootstrap and cross validation); and decision tree learning.
Recommended background: Linear Algebra (MA2071 or equivalent), Applied Statistics II (MA2612 or equivalent), Probability (MA2631 or equivalent). The ability to write computer programs in a scientific language is assumed.

Rationale: The American Statistical Association (ASA) publication *Curriculum Guidelines for Undergraduate Programs in Statistical Science* says that "there is growing demand for a variety of strong undergraduate programs in statistics to help prepare the next generation of students to make sense of the information around them." The proposed course complements the current offering of statistics courses in the Department of Mathematical Sciences to remain in step with best practices and to align with the curriculum recommendations of the ASA. In particular, we need a course that provides the experience and knowledge to study and analyze data in practical problems of real world interest. Students
need to gain the basic tools for making predictions and inferences when the data of interest has features emblematic of those found in industrial applications.

Course Learning Objectives and Outcomes:
Students will be able to:

- Gain insights into different data analysis methods in statistical learning
- Implement various statistical learning algorithms in software such as R and Python and get experience analyzing data
- Interpret results and make predictions from statistical analyses of complex data
- Communicate results effectively
- Engage in discussions on the ethical use of data and statistics.

Resource Needs:
Please summarize basic resources needed to deliver this course, including the following:

- Information on the instructor – Profs. Paffenroth, Petruccelli, and Zou are available to teach this course when it is offered. The Department of Mathematical Sciences is conducting a search for a non-tenure-track faculty whose focus will be in statistics. This person would begin teaching at WPI in AY 2016/17 and will also be available to teach the proposed new statistics course. • Classroom – A room with seating of 30 students will be requested. The classroom will need to be technology enabled allowing for demos on the computer and for course capturing. The classroom will be needed for 4 hours a week.
- Laboratory – The course will have a conference which will take place in a computer lab to allow interactive learning. The computer labs in Kaven Hall 202 and Stratton Hall 003 will be available for use.
- Library resources – N/A
- Information Technology – N/A

Assessment: Students will be assessed through exams, homework, and a project that focuses on working on real data. Student feedback will be determined via course evaluations as well as a set of questions to evaluate the project portion of the class and the use of high performance computing. The outcomes of questions 1, 2, 9, and 26 of student course evaluations will be utilized to help design the second running of the course. The number of students who enrolled in the courses will also be considered.

This course is not a required course. This course will not have any impact on the distribution requirements of any mathematical sciences majors, or any other major.

Committee Business:

- Committee on Academic Operations (CAO)
    - December 2018 Undergraduate Student Graduation List
- Committee on Graduate Studies and Research (CGSR)
    - December 2018 Graduate Student Graduation List
- Committee on Graduate Studies and Research (CGSR)
    - New Graduate Program in Neuroscience

Date: December 6, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mattson, Chair)
Re: Motion to approve the December 2018 undergraduate student graduation list

Motion: The Office of the Registrar reports that the following candidates have either completed all the requirements for the degree designated in the department or program indicated, or are expected to complete their degree requirements before December 30, 2018. They therefore are or will be eligible to receive that degree, and on behalf of the Committee on Academic Operations, I move that – pending final verification by the Registrar that all those on the list have in fact completed their degree requirements - they be approved for December 30, 2018 graduation.

Bachelor of Science

Aerospace Engineering:
Nicholas Andrew Bograd
Minor: Electrical and Computer Engineering
Marios Kontopyrgos
Finn Eamon O'Brien
Double Major
Rose A. Whittle

Biochemistry:
Rebekah Grace Johnson
Kathryn Andrea Merritt
Double Major

Biomedical Engineering:
Thomas G. Blais
Michelle Jeanette Bleau
Sydney C. Garcia
Lucas C. Zuccolo
Double Major

Chemical Engineering:
Alexandra Gabrielle Connor
Alden T. Graham
Kathryn Andrea Merritt
Double Major
Loc Nguyen
Hien Thi Thu Truong
Minor: Mechanical Engineering
Ali Valamanesh
Ian Waugh

Chemistry:
Colby Jennings Johnson
Concentration in Medicinal Chemistry

Civil Engineering:
Sarah Brown
Double Major
Kaleigh M. Iler
Minor: Music
Sabrina Andrea Napoli
Geoffrey Joel Narlee
Alana Meryl Sher

Computer Science:
David Deisadze
Double Major
Jacob Thomas Fakult
Leo Sonny Grande
Dasheng Gu
Rachel Jean Hahn
Jinan Hu
Double Major
Sam Huang
Cameron Russell Maitland
Paul-Henry M. Schoenhagen
Minor: Philosophy and Religion
Brady Snowden
David Byron Swenarton
Minor: Music
Alexander A. Taglieri
Double Major
Gianluca Tarquinio

Computer Science cont.:
Drew D. Tisdelle
Double Major
Frederick Murphy Wight
Colin John Willoughby

Electrical and Computer Engineering:
Calum Richard Briggs
Double Major
Linnea Johnson Brown
Kornkanok Bunwong
Arturo Fontinele de Albuquerque Cardoni
Wei Chen
Jared A. Goldman
Minor: Computer Science
Muhaimin Islam
Austin J. Kosin
Thomas Peter Mackintosh
Brian Stephen Mahan, Jr.
Jourdan Rae McKenna
Jake Merdich
Michael R. Morisseau
Joseph J. Salice
Kyle Robert Scaplen
Minor: Computer Science
Thomas Michael Scaplen
Minor: Computer Science
Justin Palmer Seeley
Sean Howard St.Pierre
Galahad Michael Boorse Wernsing
Brian James Westgate

Industrial Engineering:
Thyagarajan Ramachandran
Minor: International and Global Studies
Cassandra Lynne Salafia

Interactive Media and Game Development:
Chandler O. Reynolds
Drew D. Tisdelle
Double Major

Management Engineering:
Andrew Anthony Aberdale II
Double Major
Concentration in Operations Management
Brian Amado
Concentration in Operations Management
Akaash Claypool
Concentration in Operations Management
David Deisadze
Double Major
Jason Lamb
Concentration in Operations Management

Management Information Systems:
Andrew Anthony Aberdale II
Double Major

Mathematical Sciences:
Daniel Joseph Perreault
Dominic P. Redding
Minor: Computer Science

Mechanical Engineering:
David Cardoza
Eric Paul James
Andrew M. Kelly
Brad S. Leach, Jr.
Mark E. Lightbody
Concentration in Mechanical Design
Melissa Helen McCormick
Larissa Naidoo
Mitch N. Read
Concentration in Mechanical Design
John Robert Sengstaken, Jr.
Minor: Music
Mariah Kathleen Sullivan
Concentration in Biomechanical
Anthony D. Vigliotta
Lucas C. Zuccolo
Double Major

Physics:
Finn Eamon O'Brien
Double Major

Professional Writing:
Sarah Brown
Double Major

Robotics Engineering:
Jonathan Ross Berry
Minor: Drama/Theatre
Calum Richard Briggs
Double Major
Meghan Elizabeth Broughton
Minor: Mechanical Engineering
Jinan Hu
Double Major
Andre Imperiali
Dylan Michael Roncati
John T. Stegeman
Minor: Computer Science
Alexander A. Taglieri
Double Major

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, Co-Chair)
Re: Motion to approve the December 2018 graduate student graduation list

Motion: The Office of the Registrar reports that the following candidates have either completed all the requirements for the degree designated in the department or program indicated, or are expected to complete their degree requirements before December 30, 2018. They therefore are or will be eligible to receive that degree, and on behalf of the Committee on Graduate Studies and Research, I move that – pending final verification by the Registrar that all those on the list have in fact completed their degree requirements - they be approved for December 30, 2018 graduation.

Doctor of Philosophy

Aerospace Engineering:
Benjamin Sherman Cooper
Zetian Zhang

Bioinformatics and Computational Biology:
Andi Dhroso

Biology and Biotechnology:
Christopher D. Chute

Biomedical Engineering:
Kyra Rand Burnett
Ying Fang
Joshua Robert Gershlak

Chemical Engineering:
Lida Farsi

Chemistry:
Anqi Wang
Jingjing Yan

Computer Science:
Xinyue Liu
Abhishek Mukherji

Electrical and Computer Engineering:
Bader A.M.A.H. Alkandari
Jianping Gong
Mehmet Sinan Inci
Sulin Li
Sabah Razavi

Fire Protection Engineering:
Majed Almejmaj

Learning Sciences and Technology:
Kim Marie Kelly

Manufacturing Engineering:
Victor Kenneth Champagne, Jr.
Richard William Henley

Materials Science and Engineering:
Xiaoqing Cai
Jin Liu
Mark Lawrence Strauss
Caitlin Elizabeth Walde

Mechanical Engineering:
Michal Talmor
Chaoyang Ti

Robotics Engineering:
Siamak Ghorbani Faal
Selim Ozel
Erik Howard Skorina

Statistics:
Lu Chen
Hong Yan

Master of Business Administration

Daniel Joseph Abrams
Michael Paul Clark
Ian Lateef Goens
Julie Elizabeth Grise
Bryan Lloyd Hughes
Cynthia Walker Lamb
Tommi Rochelle LaRoche
Brendan Mathews
Nicholas W. Oren
Corie A. Pol
Jordan M. Spaman
Matthew Ryan Tomasko
Heather L. Vedovelli
Han Yang

Master of Engineering

Electrical and Computer Engineering:
Hongjian Gao
Derek John Howe
Ruojun Li

Power Systems Engineering:
Jose Armando Dominguez
Daniel A. Fortin
David Roy Hargis
Cory Reid Johnson
David McAlpine Judge
Zachary John Merana
Joseph Akinolu Temowo
Daniel I. Velasquez

Master of Mathematics for Educators

Theresa Mary Berna
Neil D. Polucha
Caroline Rossi

Master of Science

Aerospace Engineering:
Travis Lee Austin
Matias Francisco Campos Abad
Umang Gangwar
Marcus James Knodler
Binxin Liu
Joshua Carl O'Connor

Applied Statistics:
Charles Bruno Alberts IV

Bioinformatics and Computational Biology:
Siqin Li

Biology and Biotechnology:
Alexander Earl Putnam

Biomedical Engineering:
Emily Anne Caron

Bioscience Administration:
Robert M. Femino, Jr.

Chemical Engineering:
Patricia Guerra

Chemistry:
Kenneth Michael Zielinski

Civil Engineering:
Joshua Todd Anderson
Carolina Elisa Leguizamon Baez

Computer Science:
Xuanyu Chen
Nichole Etienne
Anqi Lu
Zhenyu Mao
Hang Qi
Yupeng Su
Jie Tang
Jacek Andrew Tulacz
Jonathan Wang

Kyle W. McClintick
Samuel Wesley Partington
Steven Shih
Xiaokai Xu
James C. Yee

Environmental Engineering:
Steven Lawrence Carey
Michele Lee Mensing
Adam Henry Weiss

Fire Protection Engineering:
Daniel Paul Arthur
Paul M. Buchanan
Tanner Burke
Aaron Scott Butler
Elizabeth Marie Coffey
Thomas John Hlavenka
Joseph D. Igoe
Erik Brian Jackvony
Brendan Michael Johnson
Raeshawn Dominic Kennedy
Yoon Kyong Lee
Sorin Traian Lupascu
Kevin Neil Lynch
Alex Conant Manternach
Nadia Mofidi
Alex J. Riley
Dylan Roche
Kathyrn Rauss Sherrick
Jenna Angela Troio
Brendon M. Ward

Information Technology:
Tina Marie Aguiar
Khalid Mohammed Alzahrani
Kavita Basavaraj Baradur
James H. Hughes
Neenad Suresh Jadhav
Madhushree Sourabh Kulkarni
Yanming Li
Abhinav Singh
Xishuang Zhang

Computer Science cont.:
Tianyu Wu
Zijun Xu
Boya Zhou

Construction Project Management:
Brett Michael Storro

Data Science:
Rosemarie J. Day
Mohamad El-Rifai
Melanie Ann Jutras
Rui Li
Huanhan Liu
Stephanie Akunna Okpoebo
Yi Pan
Harsh Nilesh Pathak
Alexander Keiya Shoop
Biao Yin
Yun Yue
Huayi Zhang
Shujun Zhou

Electrical and Computer Engineering:
Daniel James Adamowicz
Jordyn Leigh Ansari
Jonathan Edward Ardrey
Roy E. Behymer
Kishore K. Biswas
Davon C. Brown
Keith Allen Chernek
Michael Andrew Conrad
Elvis Arturo Crespo
Robert Charles Crimmins
Nathaniel A. Emmons
Gurvinder S. Gosal
Thomas Richard Guerra
Khalid Habbab
Md Mirajul Haque
Mark Kenneth Howard
Marcel Leger Hoza
Yifeng Hu
Derek Thomas Krzysiak
Lei Li
Max Hongming Li
Darran Lim

Interactive Media and Game Development:
Prateek Pradip Chatterjee
Parag Mahala
Matthew John Micciolo
Aaron Segal

Learning Sciences and Technology:
Eric G. Van Inwegen

Management:
Tianheng Chang
Christopher John Connor, Jr.
Katherine A. Elmes
Chi Duc Hoang
Ying Wang

Manufacturing Engineering:
Kyle Peter Fitzgerald

Marketing and Innovation:
Han Liu
Minkun Liu
Ruoxuan Tian
Yisu Wang

Marketing and Technological Innovation:
Kevin R. Borer

Materials Process Engineering:
Reade Clemens

Materials Science and Engineering:
Jiajun Chen
Theofilos Gatsos
Rachel Judith Huntley
Joshua Abraham Morales
Qingyu Pan
Jeffrey R. Porzio
Alino Te
Diqing Yue

Mechanical Engineering:
Nicholas Geordi Borsari
Brandon Johann Bozeat
John William Christensen Bylund
Tyler William Carbone
Michael Anthony Conceicao
Reynaldo David Duran
Nicholas Scott Fessenden
Travis Michael Fields
Brendan K. Flynn
Jessica Marie Grabinsky
Michael John Griffin
William Louis Holtzman
Conor J. Knox
Nicholas Alexander Lima
Nicholas Angelo Maio
Ryan A. Majka
Mark Philip Millay
Sean Miles Mokler
Kirkland Mui
Nathaniel John O'Connor
Gregory James Porter
Madeline Divan Seigle
Melody Man Man Shum
Matthew Timothy Sweeney
Nicolas Vayas Tobar
Brian R. Ventura
Julia Halannah White
Nolan Timothy Winderl
Aaron Zarenski
Rui Zhang

Operations Analytics and Management:
Narges Ahani
Yifan Cao
Tzu-Ying Chang
Mengjie Chen
Shikhar Gupta
Jie Jian
Guanjie Ma

Physics for Educators:
Thomas Patrick Noviello

Robotics Engineering:
Ankur Agrawal
Guled Grede Elmi
Namrita Madhusoodanan
Krishna Suresh Matta
Karankumar A. Patel
Gregory Michael Port
Zhenyu Wan
Yan Wang
Ruibo Yan
Kyle Christopher Young

Supply Chain Management:
Zhuosheng Pan

Systems Engineering:
Marissa Lynn Ard
Alhaji Sanusi Bah
David Edward Baker, Jr.
Raymond Francis Bounds
Mitchell Cayman Cady
Jonathan D. Cahill
Richard Cerniglia II
Ting-Shuo Che
Joseph Branca Clapis
Andrew George Curtis
Taoufik Daadi
Karen E. Dufour
David Eli Ferber
Kenneth Alexander German
Peter Kelly Goss
Jonathan Robert Grover
James R. Haupt
Dillon Michael Hawley
Megan Joanna Hollander
Philip Huang
Janna Kamenetsky
Bibi S. Khan Buell
Linda Marie Knisley
Andrea Anne Kunz
Brendan T. Malone
Christopher Edward Marden
Michael T. McCarthy
Nicholas Stephen Merrill
Steven J. Modzelewski
Adam Andrew Morehouse
David Craig Morin
David Roger Morin
Brian J. Palumbo
Frank Picca
Gregory Thomas Quinn
James Douglas Richard
Jasmine Joy Sangalang
David James Skiba
Steven Marton Taskovics
Duane Edward Taylor
Mitchell W. Tilbury
Michael Timothy Torchio
James Philip Tripi
John Gerard Wetmur
Julie Hennessey Wilcox
Daniel Joseph Zakzewski
Kimberly Marie Zielinski

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, Chair)
Re: Motion to approve a new Master's of Science Degree Program in Neuroscience and the addition of the associated courses

Motion: The Committee on Graduate Studies and Research recommends and I move that the following new graduate program in Neuroscience be added to the WPI Graduate Catalog.

The field of neuroscience brings together a wide range of interdisciplinary fields to investigate and understand the human brain and nervous system, how they function, and how they perceive and interact with the world. This is one of the most significant and urgent scientific challenges of our time. This field is growing nationally and globally, and the U.S. government is making substantial investments in neuroscience, such as through the NIH BRAIN Initiative. Given WPI's core strengths in the Life Sciences and Computational and Data Sciences, our lack of a Neuroscience program is concerning. Establishing a Neuroscience program that builds on these core strengths will provide fertile ground for interdisciplinary research collaborations across campus and for degree granting programs. A Neuroscience program is likely to be well-received by our current and prospective students. Students with interdisciplinary interests have been among our best students in the past, and we may lose them in the future to schools with defined programs in Neuroscience.

The Neuroscience Task Force was formed after an open, campus-wide meeting on a potential neuroscience initiative in October 2017 that drew 18 faculty from five departments on campus. Members of this interdisciplinary task force have been working together to design and develop this new program throughout the Fall of 2017 and the Spring, Summer and Fall of 2018. This task force proposes to introduce a Neuroscience M.S. degree program first, as described later in this motion, which may be followed by a proposal for a Ph.D. program in future years.

RATIONALE FOR THE NEUROSCIENCE PROGRAM

Understanding the human brain is one of the most significant and urgent scientific challenges of our time. The brain, with its billions of neurons, is perhaps the most complex biological system and holds the key to who we are and how we perceive and interact with the world. The complexity of this system has also created limitations in identifying treatments for disorders of the brain. A growing number of individuals are affected by neurological and psychiatric illnesses that are poorly understood. According to the National Institute of Mental Health, an estimated 44 million adults suffer from mental illness and the National Institute for Neurological Disorders and Stroke estimates there are 50 million people in the United Sates with a neurological disorder. Only a comprehensive understanding of brain function—both physiological and pathological—will enable progress in addressing these disorders, which touch all generations from young children to the elderly.
The field of neuroscience is at a point where new and major breakthroughs can and will happen. The field is growing nationally and the U.S. government is making significant investments in neuroscience research and initiatives, such as through the NIH BRAIN Initiative. The Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative is aimed at revolutionizing understanding of the human brain by focusing on the development of next-generation tools for exploring how dynamic patterns of neural activity in the brain control thoughts, feelings and movements. The scope of this

investment in neuroscience is demonstrated through the NIH's collaboration with numerous other government agencies including the Defense Advanced Research Projects Agency (DARPA), National Science Foundation (NSF), the U.S. Food and Drug Administration (FDA) and Intelligence Advanced Research Projects Activity (IARPA). Development of a neuroscience program at WPI is well-timed with this significant investment in research funding.

The proposed graduate program in neuroscience seeks to train students in the complexity of the nervous system to position them to work on the many unanswered questions about the brain and how it functions. This proposed graduate program in neuroscience distinguish itself from other programs by its transdisciplinary nature and WPI's strength in the computational area, and puts students at the cutting edge of discovery and innovation.

***Comparison to Existing Programs at WPI*:** No Neuroscience degree program exists at WPI. The NEU program was developed with input from the following departments and program, which would have some role in this transdisciplinary degree program: Bioinformatics and Computational Biology Program, Biology and Biotechnology Department, Biomedical Engineering Department, Computer Science Department, Chemistry and Biochemistry Department, Data Science Program, Mathematical Sciences Department, and Social Science and Policy Studies Department.
***Impact on other Existing Programs at WPI*:** This program builds upon existing curriculum from the departments and programs listed above. The four main participating departments – Biology and Biotechnology, Chemistry and Biochemistry, Computer Science and Social and Policy Studies – have endorsed this M.S. degree in Neuroscience proposal.
Competing Programs: There are 155 degree-granting Neuroscience programs across the US. These programs offer BS/BA (155), MS/MA (80), joint BS/MS (45), PhD (112), graduate certificate (9), a concentration or "option" within another subject in any of these, and any combination of these degrees in neuroscience. There are 16 degree-granting Neuroscience programs or other similar programs with different names at colleges across the state of Massachusetts. Programs offered within the state are BS/BA (13), MS/MA (80), joint BS/MS (4), PhD (5), and graduate certificate (9). Most programs focus on Cellular, Molecular and Systems Neuroscience. However, a Neuroscience M.S. program with focus on Computational Neuroscience is currently lacking.

These current programs in New England leave plenty of room for WPI to distinguish itself from the local competition, given WPI's core strengths in the areas of Computational and Data Sciences, as well as in the Life Science areas involved in this degree. Establishment of a program that builds on our core strengths is likely to be well received by our current and prospective students. Students with interdisciplinary interests have been some of our best students in the past, and we are likely to lose them in the future to schools with defined programs in Neuroscience.

The Neuroscience Industry: Neuroscience as a discipline has grown rapidly in the past two decades and spawned a new generation of scientists interested in learning more about the wonders and mysteries of the brain. Recent focus has been on developing new technologies to visualize and image human brain activity in several neurodegenerative disorders. In the Boston area, an increased private-sector interest in neuroscience has resulted in many of the bigger biotech firms investing in neuroscience research. Many companies in the life sciences area already hire WPI students on a regular basis; we expect this new degree program will only enhance their excitement about WPI and its innovative education program.

Since 2014, the life sciences industry in Massachusetts has grown at approximately double the rate of the state and U.S. economy. According to the 2018 Industry Snapshot from the Massachusetts Biotechnology Council, 83% of life sciences companies reported plans to expand their headcount in the next 12 months, consistent with the last two years, and 11,976 new jobs are forecast to be created between May 2017 and May 2023.

PROPOSED M.S. DEGREE PROGRAM IN NEUROSCIENCE

1. Proposed Description for Graduate Catalog:

The Neuroscience program offers graduate studies toward the M.S. degree. This program is designed to provide students with a strong foundation in molecular, psychological, computational, quantitative and interdisciplinary approaches to neuroscience. Neuroscience is a critical and challenging area of human endeavor. Our faculty and students thrive from the synergy of our diverse approaches to understanding the brain and nervous system. The faculty involved in the program have a strong record of extramural funding and provide an excellent research-oriented environment. As a 'Program' in Neuroscience, faculty from departments across campus train our students and collaborate on research and projects. The program comprises four broadly defined areas:

*Cellular and Molecular Neuroscience***:** Training in neurophysiological methods such as electrophysiology, optogenetics, molecular biology, genetics, biochemistry and biophysics, appropriate to topics in neurobiology.

Systems Neuroscience: Training in structure-function relationship of neural networks, neural substrates of learning and memory, psychopharmacology of nervous system disorders including Alzheimer's disease.

Computational Neuroscience: Training in the use of experimental and theoretical methods for the analysis of brain function.

Psychological Science: Training in how the brain and nervous system interact with development, mental health, cognition, social processes, and behavior.

2. Goals of the M.S. Degree Program

The goals of this proposed M.S. degree in Neuroscience are:

1) Prepare future professional students and industry leaders in the field of neuroscience so that they are ready to help solve the world's most challenging problems affecting the brain.
2) Create a comprehensive educational interdisciplinary program in neuroscience at WPI that distinguishes our program from others typically offered at the master's level due to the focus on both basic and translational neuroscience coupled with a strong computational base and links to industry partners.
3) Development of research areas linking neuroscience to areas like data science and biomedical engineering, in order to train students in a multidisciplinary approach.

3. Admissions Requirements

Students applying to the M.S. Degree program in Neuroscience are expected to have a bachelor's degree in biology, biochemistry, computer science, mathematics, psychology, neuroscience, or a related field, and to have taken introductory courses in a neuroscience-related field such as biology, biochemistry, computer science, mathematics and/or psychology. For example, a student with a bachelor's degree in biology is expected to have also completed courses in calculus and statistics prior to submitting an application. A strong applicant who is missing background coursework as needed for course requirements may be admitted, with the expectation that he or she will take and pass one or more undergraduate courses in this area of deficiency either during the summer prior to admission or within the first semester after admission. These remedial courses will not count towards meeting the M.S. degree requirements. The determination of what course or courses will satisfy this provision will be made by the Neuroscience Faculty Steering Committee, which consists of faculty members from the participating departments at WPI. Students who are not WPI undergraduates or graduates will be required to submit GRE/TOEFL scores.

4. Requirements for the M.S. Degree

Students pursuing the M.S. degree in Neuroscience must complete a minimum of 31 credits of relevant work at the graduate level. The M.S. degree requirements have been designed to provide a comprehensive yet flexible program to students who are pursuing an M.S. degree exclusively, and students who plan to pursue a PhD degree later.

Matriculated students will be assigned an academic advisor from the neuroscience program. In consultation with the academic advisor, the student will prepare a Plan of Study outlining the selections that will satisfy the M.S. degree requirements. This Plan of Study must then be approved by the Program's Review Committee, which consists of faculty members from each of the participating departments.

CORE NEUROSCIENCE COURSEWORK REQUIREMENTS (MINIMUM OF 19 CREDITS)
A student in the M.S. program must take courses to satisfy each of the following requirements:

REQUIREMENTS	MINIMUM CREDITS
1. At least three Neuroscience courses (Note 1)	9
2. At least one Biology courses (Note 2)	3
3. At least one Computer Science course (Note 2)	3
4. One Bioethics course (Note 3)	1
5. One Scientific Writing or Experimental Design course (Note 4)	3

NOTES:

1. Chosen from the list of graduate NEU courses.
   (See Section 4 below for a description of these new Neuroscience courses)

2. Chosen from the corresponding lists of Program Elective Courses below.

3. For example, BB 551 Research Integrity in the Sciences or ID 500 Responsible Conduct of Research

4. For example, BB 553 Experimental Design and Statistics in the Life Sciences, MA 546 Design and Analysis of Experiments. Courses such as ID 527 Fundamentals of Scientific Teaching and Pedagogy are currently offered for no credit and will be considered for meeting this requirement at which time they are offered to students for credit.

In addition to the 19 credits in the Core Neuroscience Coursework Requirement, M.S. students must complete either the Thesis Option or the Non-thesis Option described below. Students supported with a Teaching Assistantship, Research Assistantship or Fellowship for more than one academic year are required to do the Thesis Option.

M.S. THESIS OPTION

Students in the M.S. thesis option must complete a 9-credit thesis. Students interested in research, and in particular those who are considering pursuing a Ph.D. degree in Neuroscience or a related area, are strongly encouraged to select the M.S. thesis option. The thesis must be advised or co-advised by a faculty member affiliated with the Neuroscience Program. If the advisor is not a tenure-track faculty at WPI, then a Neuroscience affiliated tenure-track faculty must serve as the thesis co-advisor. A thesis proposal must be submitted to and approved by the student's advisor(s) and the Neuroscience Faculty Steering Committee before the student can register for more than three thesis credits. Upon approval of the thesis proposal, the Steering Committee will appoint a thesis reader, who should be a faculty member affiliated with the Neuroscience program from a department different to that (those) of the thesis advisor(s). The thesis reader will serve as an examiner for the student's thesis. The student then must satisfactorily complete a written thesis that is approved by the thesis advisor(s) and the thesis reader, and present the thesis results to the Neuroscience faculty in a public presentation.

NON-THESIS OPTION

Student in the M.S. non-thesis option must complete the remainder of the 31 credits required for the M.S. degree using one or both of the following choices:

- **A 3-6 credit research or practice-oriented internship.** All non-thesis students are strongly encouraged to pursue this choice. The internship is to be carried out in cooperation with a sponsoring organization or affiliated research lab, and must be approved and overseen by a faculty member affiliated with the Neuroscience Program. The faculty member is responsible for supervising the internship and ensuring that the internship has sufficient rigor and content for graduate-level neuroscience work. Internships will often focus on applied projects in an industry setting, although internships could also be completed in a research lab. Students will produce a written report at the conclusion of the internship. The format for the report—which is significantly shorter and less formal than a thesis—will be determined by the student's advisor. Students will also be encouraged to present their work to the Neuroscience faculty in a public presentation.

- **Additional Program Elective Courses.** Elective courses must include one Neuroscience course (in addition to the three Neuroscience courses in the Core Neuroscience Requirements) and any additional graduate courses on the list of Program Elective Courses below.

PROGRAM ELECTIVE COURSES

Student in the Neuroscience M.S. program may take program electives, as needed, to satisfy the remainder of the 31-credit degree requirement, and to tailor their Neuroscience degree program to areas of personal interest. An elective can be any graduate course listed below, although students are expected to select electives to produce a consistent program of study. Other graduate courses, graduate research credits, or ISGs not on this list may be used with prior approval of the Faculty Steering Committee, and if consistent with the student's Plan of Study.

List of Elective Courses:

Relevant Neuroscience courses:
NEU 501 Neuroscience
NEU 502 Neural Plasticity
NEU 503 Computational Neuroscience
NEU 504 Advanced Psychophysiology
NEU 505 Brain-Computer Interaction

Relevant Bioinformatics and Computational Biology courses:
BCB 501/BBT 581 Bioinformatics
BCB 502/CS 582 Bio visualization
BCB 503/CS 583 Biological and Biomedical Database Mining
BCB 504/MA 584 Statistical Methods in Genetics and Bioinformatics
BCB 510 Bioinformatics and Computational Biology Seminar

Relevant Biology and Biotechnology courses:
BBT 561 Model Systems: Experimental Approaches and Applications
BBT 581/ BCB 501 Bioinformatics
BB570/CH 555 Cell Signaling

Relevant Biomedical Engineering courses:
BME 550 Tissue Engineering
BME 555 BioMEMS and Tissue Micro engineering
BME 560 Physiology for Engineers
BME 583 Biomedical Microscopy and Quantitative Imaging

Relevant Chemistry and Biochemistry courses:
CH 538 Medicinal Chemistry
CH 541 Membrane Biophysics
CH 555D Drug and Regulations
CH 555R Drug Safety and Regulatory Compliance
CH 555/PH597 Cell Mechanics
CH 555/BB570 Cell Signaling

Relevant Computer Science courses:
CS 5007 Introduction to Applications of Computer Science with Data Structures and Algorithms
CS 5084 Introduction to Algorithms: Design and Analysis

CS 528 Mobile and Ubiquitous Computing
CS 534 Artificial Intelligence
CS 539 Machine Learning
CS 541/DS 541 Deep Learning
CS 542 Database Management Systems
CS 546 Human-Computer Interaction
CS 548 Knowledge Discovery and Data Mining
CS/RBE 549 Computer Vision
CS/SEME 565 User Modeling
CS/SEME 566 Graphical Models for Reasoning under Uncertainty
CS/SEME 567 Empirical Methods for Human-Centered Computing
CS 573 Data Visualization
CS 584 Algorithms: Design and Analysis
CS 585/DS 503 Big Data Management
CS 586/DS 504 Big data Analytics

Relevant Data Science courses:
DS 501 Introduction to Data Science
DS 502/MA 543 Statistical Methods for Data Science

Relevant Mathematical Sciences courses:
MA 508 Mathematical Modeling
MA 543/DS 502 Statistical Methods for Data Science
MA 510/CS 522 Numerical Methods
MA 511 Applied Statistics for Engineering and Scientists
MA 542 Regression Analysis
MA 546 Design and Analysis of Experiments
MA 550 Time Series Analysis
MA 556 Applied Bayesian Statistics

5. New Course Descriptions

The following courses are all 3 credit graduate courses, unless otherwise noted. Additional information about these courses is provided in the accompanying new course motions.

NEU 501 Neuroscience
Course Description: In this course, students will develop an understanding of neurobiology at several levels, from the physiology of individual neurons, through the functioning of neural circuits, and finally to the behavior of neural systems such as vision, motion, and memory. Topics covered include spatial orientation and sensory guidance, neuronal control of motor output, neuronal processing of sensory information, sensorimotor integration, neuromodulation, circadian rhythms and cellular mechanisms of learning and memory. Furthermore, students will learn about artificial intelligence and machine learning approaches to creating computational models of the brain using artificial neural networks and deep learning. The class will be based on lectures accompanied by in-class activities and will include weekly discussion of papers from the scientific literature. The class will focus on a guiding theme, such as

neurotransmitter systems, with emphasis on research of human neurological problems, such as schizophrenia, addiction, and neurodegenerative disorders.

Note: This new graduate-level course will be developed and taught by Jagan Srinivasan, Associate Professor, Biology and Biotechnology, with guest lectures by Carolina Ruiz, Associate Professor, Computer Science.

NEU 502 Neural Plasticity
Course Description: Neuronal connections strengthen and weaken with learning, memory, or other events; a phenomenon called synaptic plasticity. In this course, we explore the underlying biological, biophysical and biochemical changes responsible for plasticity. This course covers the structure and organization of neuronal connections, the neurotransmitter receptors that line these structures, the signaling pathways that are mediated in synapses, the mechanical processes that underlie protraction and retraction, and the pharmacological agents that stimulate or block these changes. Students are required to have had an undergraduate level course in biology and biochemistry.

Note: This new course will be developed and taught by Suzanne Scarlata, Professor, Chemistry and Biochemistry.

NEU 503 Computational Neuroscience
Course Description: Computational neuroscience explores the brain at many different levels, from single cell activity, to small local network computation, to the dynamics of large neuronal populations across the brain. This course will introduce students to a multifaceted array of approaches that span biology, physics, mathematics and computer science as well as facilitate the integration of modeling (on both the single molecule and neuron level) and quantitative techniques to investigate neural activity at these different levels. Where possible, this course has a tripartite organization. First, the theory is presented from a text or journal article. Second, students read and critique a paper that uses the technique. Finally, simulations and/or problem sets are assigned to fix the knowledge learned in the course. Pertinent examples will be drawn from research done by WPI students and faculty.

Note: This new course will be developed and taught by developed and taught by Rob Dempski, Associate Professor, Chemistry and Biochemistry and Dmitry Korkin, Associate Professor, Computer Science.

NEU 504 Advanced Psychophysiology
Course Description: This course will provide an in-depth understanding of what psychophysiology is and the common methods used to understand psychophysiological responses. Common psychophysiological methods will be discussed in-depth, such as sympathetic and parasympathetic nervous system, facial electromyography, electroencephalography (EEG), respiration, blood pressure, pulse rate, skin temperature, electrodermal responses, cortisol, and other neuroendocrine monitoring methods. The social, cognitive, emotional, and motivational responses to different psychological events will be explored in detail. Computational methods will be described from the fields of artificial intelligence, machine learning, and mobile computing for capturing, processing and discovering patterns in physiological and behavioral data. In addition, the course will examine how biofeedback works in educational, clinical, and experimental settings. Students may not receive credit for both PSY2502 and NEU504.

Note: This new graduate course will be developed and taught by Angela Rodriguez, Assistant Professor, Social Science and Policy Studies, with guest lectures from Carolina Ruiz, Associate Professor, Computer Science.

NEU 505 Brain-Computer Interaction
Course Description: This course will explore the current state of brain sensing and its application to human-computer interaction research. This course covers brain function, sensing technology, machine learning methods, and applications of brain-computer interfaces in various domains. This course aims for students to (1) obtain the background to conduct research in brain-computer interaction and human-computer interaction; (2) understand the literature in the field of brain sensing for human-computer interaction research; (2) understand the various tools used in brain sensing, with a focus on functional near-infrared spectroscopy (fNIRS) research; (3) understand the steps required to use real-time brain sensing data as input to an interactive system; (4) understand the domains and contexts in which brain-computer interfaces may be effective; (5) understand the open questions and challenges in brain-computer interaction research today.

Note: This new graduate course will be developed and taught be Erin Solovey, Assistant Professor, Computer Science.

6. Program Assessment

The proposed program makes use of existing resources at WPI as well as leverages new faculty hires in the area of Neuroscience that have already been authorized. However, we intend to continue to grow and shape the program over time to increase its competitiveness, relevancy and attractiveness to both prospective students and to prospective employers.

We plan to adopt a process to continuously assess the needs and interests of our student applicant pool and our existing student population. This will include interviewing students about their interests, their perception of our program, as well as tracking their subsequent employment.

We are committed to using an external review committee for assessment of the program. This committee will be composed of individuals outside of WPI from nationally-recognized neuroscience programs and will be charged with conducting an assessment to assure the health of the program. We plan to undertake the first external assessment of the program on year 6^{th} of the program and intend to execute on the recommendations derived from this assessment committee to ensure the sustained growth of the program.

7. Resources and Anticipated Instructors:

A business plan has been drafted for this proposed program that factors in the administrative costs (administrative and laboratory staff, and program operating budget) as well as faculty costs to run the program. The program will have two dedicated faculty lines (which had previously received authorization and are set to be hired by AY 2019-2020). The business plan also considers salary costs for the six other existing full-time tenure-track faculty who will teach one course a year in the program. Core courses required by the degree program will be developed by existing faculty by enhancing

existing curriculum in biology, chemistry, computer science and psychology. Based on the plan, it is expected that the program will break even in Year 3 and then produce a margin that is consistent with other financially viable WPI graduate programs in the years thereafter.

We anticipate an initial enrollment of 5 graduate students in the first year. We expect to increase enrollment annually as the program ramps up, with a projected 25 students by AY 2024-2025.

8. Program Management

There will be one program director responsible for overseeing the program. In addition, there will be one associate director from an alternate core discipline associated with Neuroscience. A set of core faculty, the Faculty Steering Committee, will oversee the offering of the program and its growth. We expect that a number of faculty from each of the involved core disciplines will serve on the Faculty Steering Committee, inclusive of the program director and associate director. Initially the set of faculty taking on these roles are:

Neuroscience Program Director:
Jagan Srinivasan, Biology and Biotechnology (appointment is renewable each academic year)

Faculty Steering Committee:
Robert Dempski, Chemistry and Biochemistry
Joseph Duffy, Biology and Biotechnology
Songbai Ji, Biomedical Engineering
Jean King, Biology and Biotechnology and Dean of Arts & Sciences
Dmitry Korkin, Computer Science
Benjamin Nephew, Biology and Biotechnology
Angela Rodriguez, Social Sciences and Policy Students (Psychology)
Carolina Ruiz, Computer Science
Suzanne Scarlata, Chemistry and Biochemistry
Jeanine Skorinko, Social Sciences and Policy Students (Psychology)
Erin Solovey, Computer Science
Jagan Srinivasan, Biology and Biotechnology

Affiliated Faculty:

Joseph Duffy, Biology and Biotechnology
Natalie Farny, Biology and Biotechnology
Jean King, Biology and Biotechnology
Elizabeth Ryder, Biology and Biotechnology
Jagan Srinivasan, Biology and Biotechnology
Luis Vidali, Biology and Biotechnology

Dirk Albrecht, Biomedical Engineering
Kris Billiar, Biomedical Engineering
Songbai Ji, Biomedical Engineering
Kwonmoo Lee, Biomedical Engineering

Yitzhak Mendelson, Biomedical Engineering
Haichong Zhang, Biomedical Engineering

Shawn Burdette, Chemistry and Biochemistry
Robert Dempski, Chemistry and Biochemistry
Arne Gericke, Chemistry and Biochemistry
Suzanne Scarlata, Chemistry and Biochemistry

Lane Harrison, Computer Science
Xiangnan Kong, Computer Science
Dmitry Korkin, Computer Science
Rodica Neamtu, Computer Science
Carolina Ruiz, Computer Science
Erin Solovey, Computer Science
Craig Wills, Computer Science

Scott Barton, Humanities & Arts
Frederick Bianchi, Humanities & Arts
Rich Falco, Humanities & Arts

Andrea Arnold, Mathematical Sciences
Luca Capogna, Mathematical Sciences
Mayer Humi, Mathematical Sciences
Sarah Olson, Mathematical Sciences
Dalin Tang, Mathematical Sciences
Min Wu, Mathematical Sciences
Zheyang Wu, Mathematical Sciences
Vadim Yakovlev, Mathematical Sciences

Marko Popovic, Physics
Izabela Stroe, Physics
Lyubov Titova, Physics
Erkan Tuzel, Physics

Michael Elmes, School of Business

James Doyle, Social Science & Policy Studies
Angela Rodriguez, Social Science & Policy Studies
Jeanine Skorinko, Social Science & Policy Studies

Implementation Date: The proposed program would go into effect in the Academic Year 2020-2021, and would be added to the catalog at that time.

- AY 2018-2019: Recruitment for two initial neuroscience faculty (search previously authorized)
- AY 2018-2019 (Fall): Program approval by WPI faculty

- AY 2018-2019: Design and develop set of courses,
  1. NEU 501 Neuroscience
  2. NEU 502 Neural Plasticity
  3. NEU 503 Computational Neuroscience
  4. NEU 504 Advanced Psychophysiology
  5. NEU 505 Brain-Computer Interaction
- AY 2018-2019: Develop web presence and program description
- AY 2018-2019 (Spring): Announce program to prospective students
- AY 2019-2020 (Fall): New faculty members join program
- AY 2019-2020 (Spring): Admission of applicants into the program
- AY 2020-2021 (Fall): Start up the program with first students, above courses offered
- AY 2020-2021: Design and develop courses to enrich offerings
- AY 2021-2022: Offer second year of program with extended course offerings.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, co-Chair)
Re: Motion to approve NEU designation for Neuroscience courses

Motion: On behalf of the *Neuroscience Program*, the Committee on Graduate Studies and Research recommends and I move to add a new course designation, NEU, to be associated with neuroscience courses that are proposed as part of the new Neuroscience graduate program.

Proposed New Course Designation:
NEU Neuroscience

Rationale:
NEU is the most appropriate course designation; NS is currently used for Naval Science.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, co-Chair)
Re: Motion to approve a new course, NEU 501 "Neuroscience".

Motion: On behalf of the *Neuroscience Program*, the Committee on Graduate Studies and Research recommends and I move that the following new graduate course be added to the WPI Graduate Catalog, as described below.

Proposed Course/Catalog Description:
NEU 501 ***Neuroscience***
3 credits
In this course, students will develop an understanding of neurobiology at several levels, from the physiology of individual neurons, through the functioning of neural circuits, and finally to the behavior of neural systems such as vision, motion, and memory. Topics covered include spatial orientation and sensory guidance, neuronal control of motor output, neuronal processing of sensory information, sensorimotor integration, neuromodulation, circadian rhythms and cellular mechanisms of learning and memory. Furthermore, students will learn about artificial intelligence and machine learning approaches to creating computational models of the brain using artificial neural networks and deep learning. The class will be based on lectures accompanied by in-class activities and will include weekly discussion of papers from the scientific literature. The class will focus on a guiding theme, such as neurotransmitter systems, with emphasis on research of human neurological problems, such as schizophrenia, addiction, and neurodegenerative disorders. (Prerequisites: An understanding of cell biology and human anatomy.)

Rationale: The nervous system underlies every aspect of our behavior, including *sensation, movement, emotion, and cognition*. Biology may not have 'laws' in the same way that physics and chemistry do, but there are underlying concepts that you will see emerging repeatedly across many different fields in biology. The Biology & Biotechnology Department has recently agreed to emphasize five important concepts. In Neurobiology, we will be especially aware of concepts 2, 3, and 5:

1. All living things evolve based on heritable genetic variation.
2. Biological systems obey the principles of chemistry and physics.
3. Simple biological units can assemble into more complex systems with emergent properties.
4. Biological systems function by the actions of regulatory systems.
5. Scientific inquiry follows a process of observation and hypothesis testing.

Course details: The course is structured into four major units.
In addition, the course provides an introduction to computational models inspired by the brain.

Unit I. Introduction
- A. Anatomy of the nervous system
- B. Neuronal circuit organization
- C. Structure of the neuron

Unit II. Functional unit of the brain: the neuron
- A. Resting and action potential
- B. Mechanism of synaptic transmission

Unit III. Plasticity and brain development

A. Development of the nervous system
B. Brain Development

Unit IV. Sensory and motor systems

A. Remote sensing: vision
B. Sensing on contact
C. The motor system

Unit V. Artificial intelligence and machine learning

A. Brain-inspired computational models
B. Perceptrons and artificial neural networks
C. Deep learning
D. Applications of machine learning to vision and natural language processing

Impact on Degree Requirements: This course will provide students with state-of-the-art knowledge and research directions in the structure and function of the nervous system and in computational approaches to model the brain. This course will be one of five core courses in the Neuroscience Graduate Program.

Resources and Anticipated Instructors: This course will be developed and taught by Prof. Jagan Srinivasan, Biology and Biotechnology Department, with guest lectures from Prof. Carolina Ruiz, Computer Science Department. No additional resources are needed.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, co-Chair)
Re: Motion to approve a new course, NEU 502 "Neural Plasticity".

Motion: On behalf of the *Neuroscience Program*, the Committee on Graduate Studies and Research recommends and I move that the following new graduate course be added to the WPI Graduate Catalog, as described below.

Proposed Course/Catalog Description:
NEU 502 ***Neural Plasticity***
3 credits
Neuronal connections strengthen and weaken with learning, memory, or other events; a phenomenon called synaptic plasticity. In this course, we explore the underlying biological, biophysical and biochemical changes responsible for plasticity. This course covers the structure and organization of neuronal connections, the neurotransmitter receptors that line these structures, the signaling pathways that are mediated in synapses, the mechanical processes that underlie protraction and retraction, and the pharmacological agents that stimulate or block these changes. (Prerequisites: An undergraduate level course in general biology and biochemistry.)

Rationale: The outline of the course is provided below.
Plasticity, development and learning

Molecular basis of neural connectivity
Non-synaptic plasticity and changes in neuronal activity
Synapse breakage, neurite pruning and synapse formation

Injury, disease and neurodegeneration
Novel approaches to disease treatment

Impact on Degree Requirements: This course will provide students with state-of-the-art knowledge and research directions in the structure and function of the nervous system. This course will be one of five core courses in the Neuroscience Graduate Program.

Resources and Anticipated Instructors: This course will be developed and taught by Prof. Suzanne Scarlata, Chemistry and Biochemistry Department. No additional resources are needed.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, co-Chair)
Re: Motion to approve a new course, NEU 503, "Computational Neuroscience"

Motion: On behalf of the *Neuroscience Program*, the Committee on Graduate Studies and Research recommends and I move that the following new graduate course be added to the WPI Graduate Catalog, as described below.

Proposed Course/Catalog Description:
NEU 503 *Computational Neuroscience*
3 credits
Computational neuroscience explores the brain at many different levels, from single cell activity, to small local network computation, to the dynamics of large neuronal populations across the brain. This course will introduce students to a multifaceted array of approaches that span biology, physics, mathematics and computer science as well as facilitate the integration of modeling (on both the single molecule and neuron level) and quantitative techniques to investigate neural activity at these different levels. Where possible, this course has a tripartite organization. First, the theory is presented from a text or journal article. Second, students read and critique a paper that uses the technique. Finally, simulations and/or problem sets are assigned to fix the knowledge learned in the course. Pertinent examples will be drawn from research done by WPI students and faculty. (Prerequisites: General knowledge of cell biology is recommended, including a biology laboratory course and a course in introductory programming).
Rationale: The ultimate goal of the course is to expose students to conceptual frameworks for how electrical activity is organized in the brain, how complex activity underpins behavior and ultimately how resilience/disturbances in these networks can lead to brain health and disorders. Topics to be covered include:

- Neurons, synapses and circuits: membrane properties, the Nernst potential, derivation of the Hodgkin-Huxley model, action potential generation, action potential propagation, probabilistic models for ion channel gating, synaptic currents, excitatory and inhibitory network dynamics, firing rate models, neural coding.
- Measuring, perturbing and analyzing brain networks: Deep brain stimulation, Imaging functional networks with MRI EEG and Non-invasive Brain stimulation.
- Network Disorders: Parkinson's Disease; Schizophrenia, Major Depressive Disorder and Autism Spectrum Disorders.
- Computational network analysis and disease bioinformatics methods for neurological disorders.

No textbook is required. Readings and homework problems are selected from a number of different texts. Course requirements will include homework assignments containing a combination of analytical and numerical-based problems, a longer-term modeling project and oral presentations.

Impact on Degree Requirements: This course will provide students with state-of-the-art knowledge and research directions in brain activity and complex brain behavior. This course will be one of five core courses in the Neuroscience Graduate Program.

Resources and Anticipated Instructors: This course will be co-taught by Prof. Robert Dempski, Chemistry and Biochemistry Department, and Prof. Dmitry Korkin, Computer Science Department. No additional resources are needed.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, co-Chair)
Re: Motion to approve a new graduate course NEU 504 *Advanced Psychophysiology*

Motion: On behalf of the *Neuroscience Program* the Committee on Graduate Studies and Research recommends and I move that the following new graduate course be added, as described below.

Proposed Course/Catalog Description:
NEU 504 *Advanced Psychophysiology*
3 credits
This course will provide an in-depth understanding of what psychophysiology is and the common methods used to understand psychophysiological responses. Common psychophysiological methods will be discussed in-depth, such as sympathetic and parasympathetic nervous system, facial electromyography, electroencephalography (EEG), respiration, blood pressure, pulse rate, skin temperature, electrodermal responses, cortisol, and other neuroendocrine monitoring methods. The social, cognitive, emotional, and motivational responses to different psychological events will be explored in detail. Computational methods will be described from the fields of artificial intelligence, machine learning, and mobile computing for capturing, processing and discovering patterns in physiological and behavioral data. In addition, the course will examine how biofeedback works in educational, clinical, and experimental settings.

Rationale: Psychophysiology helps us understand the biological bases to human behavior and relates directly to the brain and provides mechanisms to understand the mind-body connection. It will provide a foundational aspect to understanding some of the psychological underpinnings in relation to neuroscience.

Impact on Degree Requirements: This course will provide students with state-of-the-art knowledge and research directions in brain behavior, psychophysiological responses and computational methods for identifying behavioral patterns. This course will be one of five core courses in the Neuroscience Graduate Program.

Resources and Anticipated Instructors: This course will be taught by Prof. Angela Rodriguez, Social Science and Policy Studies Department, with guest lectures from Prof. Carolina Ruiz, Computer Science Department. No additional resources are needed.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.
As an interdisciplinary program, this course will be a core component to the Psychological Science aspect to the program.

Date: December 6, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Scarlata, co-Chair)
Re: Motion to approve a new course, NEU 505 "Brain-Computer Interaction".

Motion: On behalf of the *Neuroscience Program*, the Committee on Graduate Studies and Research recommends and I move that the following new graduate course be added to the WPI Graduate Catalog, as described below.

Proposed Course/Catalog Description:
NEU 505 *Brain-Computer Interaction*
3 credits
This course will explore the current state of brain sensing and its application to human-computer interaction research. This course covers brain function, sensing technology, machine learning methods, and applications of brain-computer interfaces in various domains. This course aims for students to (1) obtain the background to conduct research in brain-computer interaction and human-computer interaction; (2) understand the literature in the field of brain sensing for human-computer interaction research; (2) understand the various tools used in brain sensing, with a focus on functional near-infrared spectroscopy (fNIRS) research; (3) understand the steps required to use real-time brain sensing data as input to an interactive system; (4) understand the domains and contexts in which brain-computer interfaces may be effective; (5) understand the open questions and challenges in brain-computer interaction research today. (Prerequisites: A basic understanding of algorithms.)

Rationale: This course will explore the current state of brain sensing and its application to human-computer interaction research. Students will read important research papers on relevant topics, including background on brain function, sensing technology, machine learning methods, and applications of brain-computer interfaces in various domains. Coursework will involve reading and critiquing research papers each week, as well as leading 1-2 discussions of research papers. There will be a required term-long project. The scope and focus of the project will vary, depending on the interests and backgrounds of the students in the class.

Classes will consist of student presentations and discussions on recent research on brain sensing and human-computer interaction on various topics, including:

- introduction to brain sensing in human-computer interaction
- brain sensing devices (fNIRS, EEG, fMRI, etc.)
- signal processing, feature selection, machine learning approaches for classifying brain data
- direct control vs. passive BCI
- BCI for disabled
- what can we realistically measure?

- experimental designs for exploring brain sensing for HCI

- brain sensor data as input to interactive systems, as a user interface evaluation method, as neurofeedbeck, and many application domains (education, driving, video games, human-robot interaction, communication, control, human computation, etc.)

- human values, ethics, privacy as it relates to BCI

Impact on Degree Requirements: This course will provide students with state-of-the-art knowledge and research directions in brain sensing and its application to human-computer interaction research. This course will be one of five core courses in the Neuroscience Graduate Program.

Resources and Anticipated Instructors: This course will be taught by Prof. Erin Solovey, Computer Science Department. No additional resources are needed.

Implementation Date: Implementation date for this action is the 2019-2020 academic year.