

WORCESTER POLYTECHNIC INSTITUTE

February 13, 2018

To: The WPI Faculty
From: Mark Richman
Secretary of the Faculty

The sixth Faculty meeting of the 2017-2018 academic year will be held on **Tuesday, February 13, 2018** at **3:15 pm** in **Olin Hall 107**, with refreshments at 3:00 pm.

1. Call to Order M. Richman
 - Approval of the Agenda
 - Consideration of the Consent Agenda
(including Minutes from 1-18-18)

2. Provost's Report B. Bursten

3. Committee Business
 - Committee on Academic Operations (CAO) A. Zeng
 - February 2018 Undergraduate Student Graduation List

 - Committee on Graduate Studies and Research (CGSR) K. Troy
 - February 2018 Graduate Student Graduation List

4. Committee Reports
 - Committee on Financial and Administrative Policy (FAP) T. Dominko
 - Update on the 2016-17 WPI Faculty Compensation Study:
Is there a Disparity in Compensation by Gender?
 - Analysis of WPI's Administrative and Instructional Spending:
What the Integrated Postsecondary Education Data System (IPEDS) Tells Us

 - Committee on Academic Policy (CAP) M. Humi
Undergraduate Outcomes Assessment Committee (UOAC) L. Mathews
 - Motion to Include a New Undergraduate Learning Outcome
Addressing Global and Intercultural Competency (for discussion, only)

5. Old Business

6. New Business

7. Announcements

8. Adjournment

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WORCESTER POLYTECHNIC INSTITUTE

Faculty Meeting Minutes, January 18, 2018

Summary:

1. Call to Order
2. President's Report
3. Provost's Report
4. Committee Business: FAP/CGSR
5. Special Report: COAP/COG Working Group on Promotion
6. Announcements
7. Adjournment

Detail:

1. Call to Order

The fifth Faculty meeting of the 2017-2018 academic year was called to order at 3:20pm in Olin Hall 107 by **Prof. Richman** (ME). The meeting agenda and the consent agenda (including the minutes from December 12, 2017) were approved as distributed. Prof. Richman reminded all those in attendance to visit the Quorum after today's meeting to relax with friends and colleagues before going home for the day. He introduced Matthew Burgos, (Marketing Support Specialist/photographer) who was present to take photos of faculty members in action.

2. President's Report

President Leshin introduced WPI's new VP of Campus Planning and Facilities Management, Eric Beattie, and WPI's new Associate General Counsel, Jeff Schneider. President Leshin explained that after two full days of meetings, the planning part of the Annual Planning and Budget Process (APBP) has just been completed. A very high priority is to have the Foisie Innovation Studio and Messenger Hall ready to open at full capacity next fall. Focus is generally on accomplishing the goals of the Strategic Plan, especially in elevating our graduate programs and pursuing greater research opportunities. Attention always must be paid to managing risks to individuals and to the University. There is also a large focus on the Enterprise Transformation Project (ETP), which includes replacing the Banner system. Beyond the Strategic Plan, President Leshin explained that budget planning and capital planning are becoming more integrated. WPI is adding 140,000 square feet of space through new construction, rental and repurposing. President Leshin indicated that plans are underway to begin very soon a new comprehensive campaign that will allow us to pursue new opportunities for WPI students and faculty members. Finally, she expressed her appreciation to Profs. Dominko, Gaudette, and Richman for their active participation in this year's ongoing APBP, which for the first time included a presentation on faculty priorities for next year's budget.

3. Provost's Report

Provost Bursten congratulated Prof. Mattson (CBC), who was awarded a \$1.7M NIHR-35 grant late last year; Prof. Manning (BBT), who received a three-year \$300,000 Smith Family Award for Excellence in Biomedical Research; Prof. Agu (CS), who was recently awarded a \$1.2M NSF CAREER award concerning smartphone technology; and Prof. Titova (PH), who just this past week received an NSF CAREER award in photonics. Provost Bursten introduced Prof. Jing Xiao (CS/ME/RBE) as WPI's new Director of Robotics Engineering. Provost Bursten reflected on the high regard with which WPI is held by other schools in the Association of Independent Technological Universities (AITU). Finally, Provost Bursten pointed out that one limiting factor in providing global project experiences to all our undergraduates is the number of faculty members who are willing to serve as project center advisors. He encouraged all interested faculty members to speak with Dean Rissmiller to explore opportunities to participate.

4. Committee Business

Committee on Financial and Administrative Policy (FAP); Committee on Graduate Studies and Research (CGSR)

Prof. Dominko (BBT), for the Committee on Financial and Administrative Policy, and **Prof. Troy** (BME), for the Committee on Graduate Studies and Research, moved that the current language describing the Research Development Council (in Part Two, Section 5.B of the Faculty Handbook) be replaced by the language provided in the meeting materials. Prof. Dominko explained that the RDC was first approved by the Faculty in 1986 but has not

been updated since, and has not been an active source of research support since 2001. The FAP/CGSR proposal is to form a new RDC that will act as an advisory board to the VPR for strategic planning that will enhance research productivity and transformative research, administer internal reviews of limited submission proposals, administer internal research funding, and review and update our indirect cost return model. The RDC would develop an annual budget recommendation in support of maintenance of research equipment, multi-institutional research initiatives, internal research funding, and cost sharing. In addition, the RDC would coordinate research infrastructure requests in support of new faculty recruitment – including suggesting ways to be efficient in formulating start-up packages. The RDC would consist of eight research-active faculty members (one appointed by the Dean of Business, two each appointed by the Deans of Engineering and Arts & Sciences, one appointed by the VPR, one appointed by CGSR, and one appointed by COG). (See **Addendum #1** on file with these minutes.)

VPR Vernescu spoke in favor of the motion. He emphasized the existing need of the VPR for advice and assistance as our research enterprise becomes more complex. He offered two friendly amendments: to have the VPR staff (rather than the “Research Solution Institute staff”) provide the RDC with administrative and staff support; and to have RDC make recommendations regarding (rather than “administering”) pre-proposals for limited submissions and internal funding programs. **Prof. Dominko** and **Prof. Troy** accepted both friendly amendments with the understanding (with respect to the second friendly amendment) that the RDC will be the body whose recommendations would be those of authority. VPR Vernescu agreed that his intention was only to clarify that clerical tasks would be handled by such staff members as those in OSP.

Prof. Gaudette (BME) expressed his support for the motion because it gave faculty members another avenue to make their research needs known. His concern was whether the motion would result in a tangible budgetary commitment. **Prof. Dominko** explained that the policies in the Faculty Handbook do not exert budgetary authority, but that the proposed policy would position faculty members on the RDC to justify the investments that were needed to carry out the council’s stated mission. **President Leshin** agreed with Prof. Dominko, and pointed out that providing seed money was relatively inexpensive in view of the return, and that the RDC could also recommend ways to more efficiently reallocate existing institutional research support.

Prof. Rolle (BME) asked how the Research Solutions Institute (RSI) would interact with the RDC. **Prof. Dominko** thought that the RSI would help organize bigger research efforts among the faculty, which would complement the efforts of the RDC. The amended motion **passed**.

5. Special Report

Prof. Roberts (CHE), for the COAP/COG Working Group on Promotion, gave a detailed update of the Working Group’s efforts to establish a faculty mentoring system at WPI. She explained that the motivation for the work was provided by COACHE survey results, in which WPI’s promotion process in general, and the mentoring of associate professors and non-tenure track faculty members, in particular, (especially among women) was identified as a major institutional weakness. Prof. Roberts described three pilot programs either underway or in development: a Faculty Mutual Mentoring Program that has been in place for about two years; an NSF ADVANCE proposal (to help advance women to the full professor level in STEM fields) that is currently under review; and a recently awarded Women’s Impact Network (WIN) grant to provide mini-grants to female associate professors for professional development. Prof. Roberts outlined some of the challenges faced by mid-career faculty members: lack of motivation; doubt; vague expectations; lack of clear pathways; lack of support; increase in service responsibilities; and isolation. She described the template of a mid-career development plan that could be used by individual faculty members to help overcome these obstacles in a manner consistent with personal values, personal goals, and the University’s expectations. (See **Addendum #2** on file with these minutes.)

Prof. Gaudette (BME) asked if mentoring should be required of all associate professors, and if so, should that mentoring involve the Department Head. **Prof. Roberts** expressed a concern about the inconsistent nature of mentoring that currently takes place from department to department. She thought that it would be appropriate to provide a formal mechanism to reach out to all associate professors, but acknowledged that the extent to which those overtures are welcomed could only be decided by the individual faculty members.

Prof. Billiar (BME) asked if policies contemplated would be for both men and women, and by when. Prof. Roberts indicated that materials used at the first career workshop would be available for wider dissemination very soon.

President Leshin was in a favor of more formal rather than entirely optional mentoring procedures with appropriate flexibility built in to accommodate each individual case. **Prof. Roberts** suggested that the departments should perhaps at least have to document that they had met with each associate professor on some regular basis.

Prof. Demetry (ME) cited a policy at another university in which departments were not permitted to nominate a faculty member for promotion to full professor unless they had had met regularly with each professor first.

Prof. Gatsonis (ME) suggested that we put in place departmental promotion committees analogous to our departmental tenure committees with the responsibilities for annual meetings and reviews. **Prof. Roberts** explained that after tenure, the support needed for promotion might not come from within the faculty member's department. This point is particularly relevant at WPI, where a faculty member can both be nominated by someone and can choose an advocate for promotion who are outside his or her own department. She thought that an approach involving both departmental and out-of-department participation in mentoring might work best.

Prof. Wills (CS) made the point that as we continue to diversify our student population, it will become increasingly important to develop a mentoring system that helps to diversify our faculty.

Prof. Skorinko (SSPS) pointed out that the departmental model for mentoring presented special challenges in small departments that may not have many full professors to serve as mentors.

Provost Bursten was in favor of a more proactive rather than a more voluntary system of mentoring, with the stipulation that – with guidelines and approval of perhaps the Dean and/or the Department Head – the mentoring committee could be customized to fit each faculty member.

President Leshin urged the Faculty to act on this issue as soon as possible. **Prof. Roberts** hoped that the Working Group would have a recommendation for the Faculty by the end of this spring. She encouraged individuals to send their comments to the Work Group email alias at fame@wpi.edu.

6. Announcements

Dean Wobbe (UG Studies) announced, on behalf of the Global Impact Division (GID) Implementation Advisory Group, that the group has been asked to envision how to best restructure the IGSD. She indicated that invitations would soon be sent out for information sessions and open meetings (on January 30th at 11am, February 16th, and early again some time in D term) on this matter, and welcomed feedback and participation from all parties.

Prof. Rolle (BME) announced that the search for the Executive Director of Innovation and Entrepreneurship is well underway, with another round of interviews scheduled in the next few weeks. She encouraged participation and in the process.

Dean Rissmiller (IGSD) announced that the President's IQP Awards Day would be held on Feb. 2, at which five finalists would be presenting their projects to a group that includes former WPI President Jon Strauss. All members of the WPI community are free to attend all or some of the presentations.

Prof. Hansen (HUA), on behalf of Project Inclusion, encouraged faculty members to use item 5e on their annual reports to document any activities with which they have been involved that concerned diversity and pluralism.

7. Adjournment

Meeting adjourned at 4:45pm.

Respectfully submitted,

Mark Richman
Secretary of the Faculty

Addenda on file with these minutes:

- 1. Addendum #1 FAP-CGSR Presentation - Revisions to the Research Development Council – Jan 18 2018**
- 2. Addendum #2 COAP-COG Working Group on Promotion Presentation on Mentoring Jan 18 2018**

Date: February 13, 2018

To: WPI Faculty

From: Committee on Academic Operations (Prof. Zeng, Chair)

Re: Motion to approve the February 2018 undergraduate student graduation list

Motion: The Office of the Registrar reports that the following candidates have, as of February 5, 2018, completed all of the requirements for the degree designated in the department or program indicated and are eligible to receive that degree. Therefore, as Chair of the Committee on Academic Operations, I move that these students be approved for February 23, 2018 graduation.

Bachelor of Science

Aerospace Engineering:

Jack A. Agolli

Biomedical Engineering:

Mervyn Anderson Larrier, Jr.

Double Major

Joseph H. Switzer

Amishi Vairagade

Business:

Alexander Murphy

Concentration in General Business

Chemical Engineering:

Benjamin Nathan Drury

Alexander S. Ing

Minor: Materials

Tatiana Guerra Siebra Loureiro

Civil Engineering:

Margaret Rose Porter

Computer Science:

David C. D'Antonio

Heric Flores-Huerta, Jr.

Minor: Electrical and Computer
Engineering

Gina Gonzalez-Roundey

Anqi Lu

Minor: Mathematics

Tucker D. Martin

Double Major

Larisa Igorevna Motova

Computer Science cont.:

Shivangi Pandey

Matthew Wyatt Piazza

Minor: Electrical and Computer
Engineering

Minor: Robotics Engineering

Jingwei Shen

Trevor James Valcourt

Thanh Long X. Vu

Minor: Interactive Media and Game
Development

Shihao Xia

Steven Charles Yevchak

Electrical and Computer Engineering:

Jacob M. Aki

Minor: Computer Science

Michael Dale Caldwell

Minor: Computer Science

Denver E. Cohen

Jacob Mikolajczyk

Michael J. Paquette

Jake Henry Rivard

Cara Ann Seely

Environmental Engineering:

Annie Rose McDonald-Schwartz

Industrial Engineering:

Allison Ann Holmes

Akshay Satyanarayan Rao

**Interactive Media and Game
Development:**

Marco Duran
Kyle Joseph Stack

Management Engineering:

Conor Crowley
Concentration in Mechanical
Engineering

Management Information Systems:

Richard Falzone, Jr.
Leif Alexander Waugh

Mathematical Sciences:

Zhi Hui
Minor: Computer Science

Mechanical Engineering:

Cody Anthony Beckel
Joshua Thomas Donovan
Andrew Gregory
Michael John Griffin
Mervyn Anderson Larrier, Jr.
Double Major
Xiaozhu Liu
Yingjie Lu
Megan LeeAnn Mueller
Minor: Architectural Engineering
Christopher Alden Salomone
Zihan Zhu

Robotics Engineering:

Kezheng Dai
Benjamin Kanzler Gillette
Michael P. Hopkins
Tucker D. Martin
Double Major
Kevin Anthony Valente-Comas
Keshuai Xu

Date: February 13, 2018

To: WPI Faculty

From: Committee on Graduate Studies and Research (Prof. Troy, Chair)

Re: Motion to approve the February 2018 graduate student graduation list

Motion: The Office of the Registrar reports that the following candidates have, as of February 12, 2018, completed all of the requirements for the degree designated in the department or program indicated and are eligible to receive that degree. Therefore, as Chair of the Committee on Graduate Studies and Research, I move that these students be approved for February 23, 2018 graduation.

Doctor of Philosophy

Aerospace Engineering:

Haocheng Li
Zachary Ryan Taillefer

Biomedical Engineering:

Megan O'Brien Chrobak
Katrina Jacquelyn Hansen

Chemical Engineering:

Elaheh Kamaloo
Lindsay Dawn Lozeau

Chemistry:

Christopher J. Legacy

Civil Engineering:

Uma Maheswar Arepalli
Wenwen Yao

Computer Science:

Olga Poppe

Electrical and Computer Engineering:

Nader Bargshady
Zhilu Chen

Fire Protection Engineering:

William Jeffrey Ivans, Jr.

Manufacturing Engineering:

Guannan Guo
Andelle Dorri Carlson Kudzal
Yuan Lu

Materials Science and Engineering:

Sumedh Gostu
Yi Pan
Anbo Wang

Mechanical Engineering:

Sina Askarinejad

Physics:

Sashi D. Poudel

Master of Business Administration

Moses Shin Ancheta
Sean M. Burke
Susanne Marie Collado Ramos
Catherine Elizabeth Danko
Ashok Galla
Erika A.S. Hanlan
James Owen Hanlan
Morgan Andrew Kapp
Krishna Prasad Palika

Master of Engineering

Biomedical Engineering:

Peter Allen Colby
Theresa Jean Logan
Megan Elizabeth Mancuso
Alexander Paul Morin

Electrical and Computer Engineering:

Thomanoon C. Hongsmatip
Qiankun Li
Louie-John Vincenzo Mistretta

Power Systems Engineering:

Keith Shawn Britt
Ryan Kirby Leonard
Matthew Scott Maassen
Daniella Marie Shepard
Joseph Robert Swift III

Master of Mathematics for Educators

Samuel Robert Welch

Master of Science**Aerospace Engineering:**

Bryan John Adie
Nicholas C. Christie
Stephen Michael Harnais
Erik William Hatton
Yutong Li
Shane Martin Swanson
Zachary Raymond Wingerter

Applied Mathematics:

Zimu Li
Yi Yu

Biochemistry:

Ashima Singla

Biology and Biotechnology:

Ellen Christine Pierce

Bioscience Administration:

Namsok Cho
Larissa Marie Chudomel
Julie Dorothea Creighton
Daniel Wayland Gage
Dai Lin Shen

Biotechnology:

Diego A. Vargas Blanco

Chemical Engineering:

Kathryn Ann Collins

Civil Engineering:

Michael Joseph Dipalma

Computer Science:

Naishadh Amin
Kenneth Joseph Carlson
Tyler J. Colombo
Lia Elisabeth Esper
Fangyu Lin
Haneen Othman Metwalli
Kirthika Muthukumaran
Duc Minh Pham
Huayan Sun
Qiming Wang
Yaqiong Zhang

Data Science:

Shanhao Li
Yalei Peng
Tyler Ayanna Pietri-Bostick
Yanhong Huang Prusevich
Dennis Steven Silva, Jr.
Yuxuan Xia

Electrical and Computer Engineering:

Xu Chen
Kuldeep Singh Gill
Chen Li
Yu Li
Thinh Gia Ly
Jonas Paul Rogers
Bowen Sun
Zhitong Wu
Vincent Yam
Yongcong Zou

Environmental Engineering:

Anna Christina Franciosa
Tao Wang

Financial Mathematics:

Jiawei Li
Mian Zhang

Fire Protection Engineering:

Matthew John Branka
Sopheaktra Chhim
Lea Holly Dighello
Paul Joseph Esteve
Matthew R. Fegley
Michael James Friedman
Christopher John LeClair
Taeho Lee
Zhaozhao Meng
Amy May-Irene Misera
Jack Jay-Normand Murphy
Joseph Edward Ostrowski
Jillian Elizabeth Proulx
Christopher Angelo Scangas
Peter Christopher Tuma
Irene Uriarte Villanueva

Information Technology:

Deepika Beemanpally
Junyi Chen
Mohita A. Goplani
Saran Madan
Jinfu Meng
Abhra Mukherjee
Mengyi Qiu
Srujan Rode
Mengyun Tian
Xiao Xu
Xinjie Yu
Yanfen Yu

Interactive Media and Game Development:

Jiawei Sun

Management:

Arlina A. Anderson
Sha Fang
Keirstan Marie Field
Siyuan Li
Emily Jeanette Martin
Chengshi Shen
Lu Yang

Manufacturing Engineering Management:

Mirosław Popielarczyk

Manufacturing Engineering:

Ethan Michael Barrieau
Darrell J. Ferris
Conor Michael Naughton

Marketing and Innovation:

Guanjie Ma
Yuchen Yao

Marketing and Technological Innovation:

Minhuizhi Li

Materials Science and Engineering:

Matthew Vincen Carpenter
Junxiu Han
Chao Shen
Dapeng Xu

Mechanical Engineering:

Michael Randy Coraizaca
Ryan Craig Fanti
Kingsley Flomo
Jonathan Samuel Friedman
Binod Giri
Samuel Scott Hastings
Daniel John Mortarelli
Christopher Robert Parisi
Dhruvin Kirit Patel
Jorge Leonardo Paucar
Steven Kenworthy Reiman
Yao Shen
Kristi Shrestha
Garrett Craig Wafler
Zachary James Ziemba

Operations Analytics and Management:

Diana Flora Branch
Emily Elizabeth Doherty
Brian Eric Lundberg
Matthew James Marino
Shiyang Xia
Lin Yue
Yuhao Zheng

Operations Design and Leadership:

Madalyn Amber Moore
Priyanka Hemant Pardikar

Physics:

Atanu Bikash Chatterfee

Power Systems Management:

Gregory James Giustino
Edward Timothy Leung
Brian E. Sweeney

Robotics Engineering:

Fuchen Chen
Samyuktha Devadoss
Sumanth Nirmal Gavarraju
Meagan Elizabeth Hiatt
Monte Damaris Smith
Victoria C. Wu

System Dynamics:

Stefanie Elizabeth Anderson
Arash Golnam
James Edward Hacunda
Frederick Alton Kautz II
Yiyuan Ma

Systems Engineering:

Rachel Helen Arnold
Omar Barkawi
Lauren Ashley Baxter
Roy Scott Belhumeur
John L. Benton
Kevin Thomas Brown
Dillon Marcus Clark
Lorenzo Donnell Evans
Christine Elizabeth Filosa

Systems Engineering cont.:

William D. Hornbeck
Joshua Ryan Karavolis
Maggie Elizabeth Kendall
Peter Kendall Lavallee
Benjamin Andrew Levesque
Bryce Lyon Monahan
Tianna Elizabeth Quiambao-Panas
Nicholas Roy Rallis
Asad Raza
Nathan Andrew Rogers
Demetrius Ryan Scott
Adam J. Sederholt

(For discussion, only, at the February 13, 2018 Faculty Meeting))

Date: Feb 13, 2018

To: WPI Faculty

From: Committee on Academic Policy (Prof. Humi, Chair)

Re: Motion to replace WPI Undergraduate Learning Outcome #8

Motion: The Committee on Academic Policy Policy (CAP) recommends and I move that the current Undergraduate Learning Outcome #8 language be replaced (in both the Undergraduate Catalog and in Part Two, Section 2.B of the Faculty Handbook) by a learning outcome addressing global and intercultural competency, as described below.

Details of the motion:

Currently, WPI has ten undergraduate learning outcomes that were approved by the Faculty in 2004.

Graduates of WPI will:

1. have a base of knowledge in mathematics, science, and humanistic studies.
2. have mastered fundamental concepts and methods in their principal areas of study.
3. understand and employ current technological tools.
4. be effective in oral, written and visual communication.
5. function effectively both individually and on teams.
6. be able to identify, analyze, and solve problems creatively through sustained critical investigation.
7. be able to make connections between disciplines and to integrate information from multiple sources.
8. be aware of how their decisions affect and are affected by other individuals separated by time, space, and culture.
9. be aware of personal, societal, and professional ethical standards.
10. have the skills, diligence, and commitment to excellence needed to engage in lifelong learning.

CAP is proposing to **remove** the current outcome #8:

Graduates of WPI will be aware of how their decisions affect and are affected by other individuals separated by time, space, and culture.

That removal will be **replaced** with a new learning outcome specifically addressing global and intercultural competency:

Graduates of WPI will demonstrate global and intercultural competency by developing the capacity to identify, explain, and critically analyze the social, cultural, economic, and political forces that shape the self and others as they engage with local and global communities.

Rationale:

The world demands more than knowledge; it requires understanding across boundaries of nation, ethnicity, language, gender, religion, and class. The ability to recognize the meaning of commonalities and differences and then navigate them comes not from a single course or even a set of courses, but

rather from a life-long process. The WPI experience can provide the foundation to pursue this continuing exploration.

While the current undergraduate learning outcome #8 addresses competencies in this area that WPI graduates should achieve, it suffers from a lack of clarity and is difficult to assess. The proposed new learning outcome language is the result of extensive work by the Global and Multicultural Competency Taskforce¹, which was established by the Undergraduate Outcomes Assessment Committee (UOAC) in spring 2017 and submitted a final report to CAP and UOAC in fall 2017. One of the Taskforce's most significant conclusions was that "...the current learning outcome is not sufficiently specific as to be meaningful; is not aligned with current and best practice; and is not measurable for assessment purposes."

The Taskforce developed the new learning outcome language after extensive research into both scholarly and institutional definitions of the terms "intercultural competency" and "global competency", and current learning outcomes at peer institutions that address one or both of these competencies. Global and intercultural competency refers to the skills, knowledge, and dispositions enabling one to engage in open, peaceful, and productive interactions with diverse peoples and ideas on the basis of a shared respect for human dignity.

After much discussion, the Taskforce arrived at the proposed new language, which more accurately describes the skills and competencies that we wish our graduates to have. It is measureable ("will demonstrate...competency") and provides a mechanism by which competency can be assessed ("...the capacity to identify, explain, and critically analyze..."). The Taskforce recommended that the language of the new learning outcome include both global (referring to challenges that are not bound by geopolitical location but that affect people around the world) and intercultural (dynamics associated with interactions between people of different cultures) competency, because the curriculum at WPI allows multiple pathways to achieve the corresponding learning outcome. For example, participation in the Global Projects Program may be a good mechanism for the achievement of global competence, while other experiences (including coursework) may facilitate the sorts of study and experiences that foster intercultural competency.

Pathways to achieving the new learning outcome:

There are a number of mechanisms already in place at WPI whereby students engage in activities that are likely to help them achieve global and intercultural competency. These include, but are not limited to, participation in the Great Problems Seminars; completion of project work at one or more of the many off-campus project centers; and coursework, especially in the Humanities & Arts and Social Science & Policy Studies departments. The Taskforce recommended, and UOAC has discussed, other pathways for students to achieve the learning outcome, but at this time we are not proposing any curricular changes, new activities, or additional requirements for students. Our intent is to gather information on how successful our current requirements and opportunities are in helping students to achieve global and intercultural competency, and to use that information to explore opportunities for improvement as necessary.

Assessment:

When the faculty approved the original set of Undergraduate Learning Outcomes in 2004, they also approved an assessment plan. That plan identified data sources and criteria for measuring WPI student

¹ The members of the Taskforce were Michael Brooks ('19), Leslie Dodson, Michael Elmes, Aarti Madan, Anne Ogilvie, Jennifer Rudolph, Aaron Sakulich (Chair), and Seth Tuler.

achievement of this particular learning outcome. The full assessment plan will be accessible on the Faculty Governance website under the materials for the Undergraduate Outcomes Assessment Committee (UOAC).

The Task Force did not develop an assessment plan and UOAC will take up this next step in its work to revise the assessment plan for all of the learning outcomes.

For the original Outcome #8, the assessment used course completion in Humanities and Arts and the Social Sciences along with selected questions from the National Survey of Student Engagement (NSSE). The plan also asked for regular comparison between the mean response of WPI students (graduating seniors) and graduating seniors from our AITU peer institutions who participated in the NSSE survey on some relevant questions.

As a starting point, UOAC will continue to use the NSSE survey as part of the assessment for student achievement of the new learning outcome. We note that the NSSE Survey has changed significantly since the assessment plan was adopted in 2004 but the survey still includes relevant questions. For example, graduating seniors are asked:

During the current school year, about how often have you done the following?

- Included diverse perspectives (political, religious, racial/ethnic, gender, etc.) in course discussions or assignments.

During the current school year, about how often have you had discussion with people from the following groups?

- People of a race or ethnicity other than your own.
- People from an economic background other than your own
- People with religious beliefs other than your own
- People with political views other than your own.

Which of the following have you done or do you plan to do before you graduate?

- Participate in a study abroad program

The Undergraduate Outcomes Assessment Committee will also consider the following opportunities for assessing achievement of the global and intercultural competency learning outcome:

- Discussing with CAP and the IGSD the possibility of including global and intercultural competency as a learning outcome for the IQP
- Discussing with the Humanities & Arts and Social Science & Policy Studies departments the possibility of assessing global and intercultural competency in appropriate courses and some Inquiry Seminars and Practicums
- Using the AAC&U VALUE rubrics on Intercultural Competence and/or Global Learning to assess artifacts such as course assignments, project reports, and ePortfolios.
- Adding a question related to global and intercultural competency to the Student Report on IQP Learning and Advising, the Advisor Report on IQP Learning, and alumni surveys that address learning outcomes

Appendix: Consent Agenda Motions

Date: February 13, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Zeng, Chair)
Re: Motion to add BME 1004 Introduction to Programming in Matlab

Motion: On behalf of the Biomedical Engineering Department, the Committee on Academic Operation recommends and I move that BME 1004 Introduction to Programming in Matlab, as described below, be added.

Proposed Course Description:

BME 1004 Introduction to Programming in Matlab (Cat I)

This course will introduce basic and essential programming skills in modern engineering program language, Matlab, to all BME students. The course will include basic programming syntax, control structures, data structures (vectors, matrices, structures, cell arrays), 2D images, 3D image volumes, string manipulations, File I/O, figure plotting/visualization, image display, and basic graphical user interface (GUI) design.

Recommended background: none.

NOTE: The course does not count for engineering credits, but will fulfill the computer programming requirement for BME students.

Contact:	Prof. Songbai Ji
Preferred term:	C term
Expected enrollment:	100
Intended audience:	BME students.
Anticipated Instructor:	Prof. Songbai Ji
Alternate Course Instructor:	Prof. Kwonmoo Lee

Rationale:

Computer programming is essential for modern engineering, including Biomedical Engineering. The programming language, Matlab, is widely used in many engineering fields, including BME. Currently, BME students are advised to take a basic CS programming course (e.g., CS1004) which uses Python as the programming language. Unfortunately, most other courses that the BME students take in subsequent years that involve programming use Matlab instead (e.g., Data analysis BME 2211; Signal processing lab BME 3014, etc.). Therefore, there is a disconnection between their first undergraduate programming course (Python) and their subsequent applications in other courses (Matlab). There seems to be consensus among BME faculty members that keeping their programming experiences consistent throughout their undergraduate education will enhance their programming capabilities and strengthen the educational opportunities. By introducing Matlab early in their academic education, and further strengthening throughout their undergraduate in subsequent courses and labs, the students are expected to master or at least have a good grip of Matlab programming. This will enhance their qualification and competitiveness when they graduate for their future job needs and academic education. BME students will learn Matlab programming in BME 1004, but they will no longer be required to take a Computer Science course to meet the distribution requirement.

Learning Outcomes: The course will be composed of 28 lectures (4 lecture hours each week, for 7 weeks). Upon successful completion of the course, students are expected to become familiar with programming in Matlab and be able to:

1. Use Matlab to create programs to manipulate variables and data and perform simple mathematical calculations.

2. Understand how to effectively use the debugger to debug and correct programs.
3. Know when and how to utilize constructs (for loops, parfor loops, if, switch case) and data structures (struct, cell array, etc...) when solving various programming problems.
4. Basic work with images and image volumes.
5. Work with text files using File I/Os.
6. Create a GUI that contains graphic components with layouts to act as a template for creating any future GUIs.
7. Finding online Matlab resources to further sharpen their skills.

Resource Needs:

- Instructor: Part of the regular teaching load for Prof. Songbai Ji
- Alternate Course Instructor: Prof. Kwonmoo Lee
- Classroom: with whiteboard and/or computer/video projection equipment to accommodate up to 100 students.
- Computer Laboratory: yes – students could use their own laptop computers, but a computer lab would probably still be needed. The class will be assigned to multiple groups (≤ 30 students each; GH 012 is sufficient to accommodate) at different times and will be administered by the TA and PLAs. A total of 4–5 labs are anticipated.
- Library resources: no special needs.
- Information Technology: no special support
- Other: TA/PLA support will be provided by the departmental budget

Additional Clarifications:

The BME department have carefully considered the CAO concerns and addressed them as follows.

- (1) Classroom: We are not creating an “additional” large course – we propose to replace an existing large course that all of our BME student take with a new course. Therefore, we are not putting any additional burden on classroom resources on campus.
- (2) Software licenses: We have confirmed with the IT department (Siamak Najafi) that WPI has a site license agreement with Mathworks. Therefore, there are unlimited licenses available for all faculty, staff, and students to install Matlab software on their own computers.
- (3) We have consulted with the IT department who also offers a Matlab “crash course” – this is a rather intensive course about various features of Matlab. The course material is delivered in 3 two-hour sessions. There is no time left for the students to practice, and we do not consider this an appropriate substitute for BME freshmen who need to take a formal programming class.
- (4) We have consulted with the ME department (Profs. John Sullivan and Mehul Bhatia). Their ME 2312 (Introduction to computational solutions for engineering problems) course also covers Matlab programming. It is appropriate for the ME major as it covers a lot on statics, stress, and physics-mechanics related topics. However, it is not appropriate for our BME students.
- (5) We have consulted a number of BME undergraduate students on their expectations about Matlab proficiency and found that Junior and senior BME students are asking for more Matlab experiences throughout their courses, as they start to recognize this as an essential skill important for their professional career. Many students need to do a project that expect Matlab proficiently. Therefore, a programming course directly in Matlab would be important
- (6) Based on the last three offerings of BME 3014 and BME 2211 which rely on Matlab programming, students find it very challenging to transition from Python (which they learn in CS 1004) to Matlab programming when they need to use this programming

language in their BME courses and projects. This transition is an extra and unnecessary hurdle for the students.

Implementation: starting Academic Year 2018-19

Date: February 13, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Zeng, Chair)
Re: Motion to modify the BME Distribution Requirements

Motion: On behalf of the Biomedical Engineering Department, the Committee on Academic Operation recommends and I move that the BME distribution requirements be modified as described below.

Description of the Proposed Modifications:

The current BME requirements include:

4. Computer Science (Note 4) 1/3

Note 4: 1/3 unit in basic computer programming (CS 1004, or equivalent)

Modification #1: The proposed BME requirements would change Note 4 as follows*:

4. Computer Programming (Note 4) 1/3

Note 4: 1/3 unit in basic computer programming (BME 1004, or equivalent)

(*This change is being proposed concurrent with the request to approve a new BME 1004 course)

Modification #2: The proposed list of "COURSES QUALIFYING FOR ENGINEERING DISTRIBUTION AREAS" listed in the WPI UG catalog would change as follows:
(with added text **in bold italics**):

BME: All courses designated "BME" (except BME 1001, **BME 1004** and BME 3110) and CE, CHE, ECE, RBE, and ME courses at the 2000-level or above.

Rationale:

BME students will learn Matlab programming in BME 1004, but they will no longer be required to take a Computer Science course to meet the distribution requirement.

Because BME1004 does not count for engineering credits, it is added to the list of "COURSES QUALIFYING FOR ENGINEERING DISTRIBUTION AREAS" listed in the WPI UG catalog include this course explicitly to avoid potential confusions with other engineering courses that are listed in the UG catalog and qualify as engineering courses.

Implementation: starting with Academic Year 2018-19.

Date: February 13, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Zeng, Chair)
Re: Motion to add BME 2610 Introduction to Bioprocess Engineering

Motion: On behalf of the Biomedical Engineering Department, the Committee on Academic Operation recommends and I move that a new course, BME 2610 Introduction to Bioprocess Engineering, as described below, be added.

Proposed Course Description:

BME 2610, Introduction to Bioprocess Engineering (1/3 unit; Cat. I)

This course is an introduction to fundamental material and energy balances related to the field of Biomedical Engineering. The fundamentals of bioprocess engineering calculations and data analysis, and bioengineering processes and process variables will be covered. Students will learn to identify a system, define boundary conditions, and characterize the system processes to generate appropriate material and energy balances using the principles of conservation of mass and energy. Fundamentals and applications in the human body and biomanufacturing are examined. Specific examples may include an organ, multiple organs or the entire body, bioprocess instrumentation, individual or groups of cells, cell culture bioreactors, tissue engineered scaffolds, and drug delivery systems.

Recommended background: Basic knowledge of differential and integral calculus (e.g. MA 1021 and MA 1022 or equivalent), human biology (e.g., BB 1025 or equivalent), and chemistry (e.g. CH 1010 and CH1020 or equivalent).

Preferred term: A

Expected yearly enrollment: 60

Anticipated Instructor: Prof. Jeannine M. Coburn

Alternative Instructor: Prof. Raymond Page

Rationale:

The purposes of this course is to provide Biomedical Engineering students with an essential understanding of material and energy balances used in the field related to bioprocesses within the human body and for biomanufacturing. Developing an understanding of the analysis of bioprocesses related to the human body and biomanufacturing are essential practical skills for Biomedical Engineering.

Learning outcomes: To develop an understanding of engineering calculations and data analysis, bioengineering processes and process variables, material and energy balances related to Biomedical Engineering. An ability to use these principles to quantitatively analyze processes encountered in the field of Biomedical Engineering. By the end of the course the student should be able to:

- Understand the fundamental law of mass/material conservation
- Understand the fundamental law of *energy conservation*
- Define classification of processes such as steady state, transient, continuous and batch processes
- Learn the material balance equation and understand important terms such as input, output and accumulation
- Understand the difference between units, values and dimensions

- Learn the basics of flowchart development
- Understand the concept of degrees of freedom to solve material balance problems
- Learn by examples the method of analyzing and solving material *and energy* balance equations

Impact on Distribution Requirements and Other Courses: None; this course can be taken to fulfill the existing 2000 level course requirements.

Resource Needs:

- Instructor: Part of the regular teaching load for Prof. Jeannine Coburn
- Classroom: Standard classroom with whiteboard or chalkboard and computer/video projection equipment to accommodate up to 60 students.
- Laboratory: none required
- Library resources: no staff required
- Information Technology : no special support needed
- Other: TA and PLA support for grading and student consultation (will be provided by the Departmental budget)

Impact on Distribution Requirements and Other Courses: None; this course can be taken to fulfill the existing 2000 level course requirements.

Implementation Date: 2018-19 academic year

Date: February 13, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Zeng, Chair)
Re: Motion to modify the course description of BME4831 Drug Delivery

Motion: On behalf of the Department of Biomedical Engineering, the Committee on Academic Operation recommends and I move **that the** course description for BME 4831 Drug Delivery be modified as described below.

Current Course Description:

BME 4831 Drug Delivery (1/3 unit, Cat. I)

The course will provide knowledge about drug delivery systems as part of regenerative medicine strategies. The course will familiarize students with different biomaterial-based drug delivery systems that have been recently developed as part of tissue engineering strategies. Course work will include reading recent journal publications, group projects and presentations.

Recommended background: Biomaterials and tissue engineering (BME2811 or equivalent) and multivariable calculus (MA 1024 or equivalent).

Proposed Revised Course Description:

BME 4831 Drug Delivery (1/3 unit, Cat. I)

The course examines fundamental composition, structure, property and performance relationships in classical and novel drug delivery systems as part of disease treatment strategies (i.e. cancer, organ damage). Physiological barriers to drug delivery and methods to overcome these barriers are analyzed. The course will familiarize students with biomaterial-based drug delivery systems that have recently been developed. Topics include routes of drug administration, diffusion, Fick's law, pharmacokinetics/pharmacodynamics, drug modifications, materials for drug delivery (implantable, transdermal, injectable), antibody therapeutics, cells as drugs and drug delivery vehicles, and novel drug formulations and delivery systems.

Recommended background: Fundamental knowledge of biomaterials (e.g. BME 2811 or equivalent), multivariable calculus (e.g. MA 1024 or equivalent) and biological system function or cell function (e.g., BB 1035 or BB 2550 or equivalent).

Preferred term: D

Expected yearly enrollment: 40

Anticipated Instructor: Prof. Jeannine M. Coburn

Rationale:

The course description is being updated to better reflect the content being delivered. The course description is being broadened to include classical drug delivery systems and drug modifications to provide a framework as to why novel drug delivery systems are needed, biological barriers to drug delivery, and additional therapeutics needs for drug delivery systems (not limited to tissue engineering) as the course is being taught in a broadly applicable format.

Impact on Distribution Requirements and Other Courses: No changes

Resource Needs:

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

- Instructor: Part of the regular teaching load for Prof. Jeannine Coburn
- Classroom: Standard classroom with whiteboard and/or computer/video projection equipment to accommodate up to 40 students.
- Laboratory: none required
- Library resources: no staff required, occasional access to electronic journal articles
- Information Technology : no special support needed
- Other: TA support for grading and student consultation (same as current embodiment)

Implementation Date: 2018-19 undergraduate catalog

Date: February 13, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Zeng, Chair)
Re: Motion to add ECON 2126: Public Economics

Motion: On behalf of the Social Science and Policy Studies Department, the Committee on Academic Operations recommends and I move that ECON 2126: Public Economics, as described below, be added.

Proposed Course Description:

ECON 2126: Public Economics (Cat. II)

This course examines the economics of government expenditure and taxation. On the expenditure side, the course will review why governments often choose to be involved in the provision of healthcare, education, national defense, a clean environment, and infrastructure such as roads and bridges. It will also delve into the rationale behind programs such as social security. Regarding taxation, the course will cover income, consumption, and corporate taxes, including the use of corrective taxes to address market failures due to externalities. Within each topic, the relevant economic theories will be presented, and then students will practice applying the theories to real-world examples. As such, there will be plenty of opportunity to discuss policy implications and debate proposed policy changes.

Recommended background: Some introductory economics, such as Introductory Micro- or Macroeconomics (ECON 1110 or ECON 1120; or equivalent).

Students who completed ECON 212X: Public Economics cannot receive credit for ECON 2126: Public Economics.

Anticipated Instructor: Prof. Janice Yee

Rationale:

This course takes advantage of the expertise of Prof. Janice Yee. It also provides necessary and important content to Econ students on the role of the government in shaping economic outcomes. In particular, the course focuses on taxation and government expenditure. It is an important course for Econ majors in terms of content, and it provides them with another course option for fulfilling their program requirements (meeting Econ distribution requirements). The course also supports the Environmental and Sustainability Studies, and Science and Technology Policy programs. It can serve as a second course for fulfilling the university's social science requirement (in the event that the first course is an introductory economics course). Expected enrolment is 20 students, which is typical for 2000-level Econ courses.

This course was previously offered as ECON 212X: Public Economics:

1. Student feedback from course evaluations:

	B2014	A2016
Question:	mean (n)	mean (n)
1. My overall rating of the quality of this course is:	4.67 (3)	3.86 (7)
2. My overall rating of the instructor's teaching is:	4.67 (3)	4.13 (8)
9. The amount that I learned from the course was:	4.00 (4)	3.38 (8)
26b. Hours spent on this course outside of the classroom (weekly):	6-10 (3)	1-5 (7)

2. Course populations: In B term of 2014, the course had 6 students. In A term of 2016, there were 12 students.

3. Reflections for the Program Director (Alexander Smith): For B term of 2014, the course was put on the course schedule rather late (in A term of 2014) and the registration was of course somewhat low. Registration was double the amount in 2016. Prof. Yee conducted the course in a seminar-type format the first time, and this was highly successful (as evidenced by the high course evaluations). The delivery of the course was different the second time (it was a more traditional lecture format) and in addition, many of the students had not previously done an introductory economics class, creating a tension for Prof. Yee between giving the unprepared students the background knowledge they needed and teaching new and engaging material to those students who had an Economics background. The ratings were lower; however, they were within the normal range for Prof. Yee. The plan moving ahead is to make it crystal clear to students at the outset that getting caught up on background material will be their responsibility, and not the responsibility of the instructor. The course has been highly successful in attracting students to the Econ major and minor, and also for giving existing Econ students a good option for fulfilling Econ distribution requirements. The Econ program has more than doubled in size in the past 12 months (in terms of the total number of Econ major and minors), and giving these students good course options is imperative for providing them with a good student experience, and also for supporting the continued growth of the program.

Impact on Distribution Requirements and Other Courses: The course will help Econ majors and minors fulfill distribution requirements.

Resource Needs:

- The course uses the expertise of Prof. Janice Yee.
- A standard 30 person classroom, with basic AV setup.
- No laboratory space is required.
- No special library resources are required.
- No special information technology is needed.

Implementation Date: Implementation date for this action is the 2018-2019 Academic year.

Date: February 13, 2018
To: WPI Faculty
From: Committee on Academic Operations (Prof. Zeng, Chair)
Re: Motion to add BB 3050 Cancer Biology

Motion: On behalf of the Biology & Biotechnology Department, the Committee on Academic Operation recommends and I move, that BB 3050 *Cancer Biology*, as described below, be added.

Proposed Course Description:

BB 3050. CANCER BIOLOGY (Cat. I)

In this course, students will learn and apply advanced cellular and molecular biology concepts to understand causes and consequences of cancer cell transformation. Through an integration of primary literature and lecture material students will explore how research into basic mechanisms of cancer biology is used to identify therapeutic targets, and inform drug design. This course will cover discussion of the hallmarks of cancer including the deregulation of cell growth, cell death, and metabolism; corruption of genome stability, evasion of immune response, and metastatic potential.

Recommended background: A thorough understanding of genetics (BB 2920 or equivalent), molecular biology (BB 2950 or equivalent), and cell biology (BB 2550 or equivalent).

Anticipated Instructor: Amity Manning

Rationale:

This course will be a new upper level addition to the Biology & Biotechnology curriculum. In keeping with the current curricular design, this course will be both textbook and primary literature based. As such it will integrate concepts in genetics, molecular, and cellular biology, engage students in research-based discovery, and promote critical thinking and interpretation of published data. Its introduction in AY 18/19 is in part in anticipation of changes in course offerings resulting from pending faculty retirements.

Course Learning Outcomes:

Students who complete this course will

1. demonstrate an understanding of the integration of genetics, molecular, and cellular biology as it applies to cellular and organismal health.
2. provide examples of and explain cellular processes that may be corrupted in cancer contexts, and be able to rationalize potential causes of these defects and describe how they contribute to cancer.
3. be able to identify and find appropriate primary literature, read and interpret figures and results.
4. identify and explain common experimental approaches in cancer biology research.

Anticipated enrollment: For its initial offering, we will cap enrollment at 50 students. This may change in response to enrollment demand.

Impact on Distribution Requirements and Other Courses: As a new offering, there are no other programs or departments whose distribution requirements will be immediately impacted by this addition. We are introducing this as an upper level course with a robust list of concepts included as recommended background. Thus it is likely to attract students already majoring in the life sciences (BBT, BCB, CBC) or possibly some BME majors who have taken the requisite background courses.

Resource Needs: No new resources are required. This will become part of Professor Manning's regular undergraduate teaching opportunities.

Implementation Date: Implementation date for this action is the 2018-2019 academic year.

Date: February 13, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. K. Troy, Chair)
Re: Motion to add BME 592, BME 597, BME 5910, and BME 5920

Motion: On behalf of the Biomedical Engineering Department, the Committee on Graduate Studies and Research recommends and I move that BME 592 Healthcare Systems and Clinical Practice, BME 597 BME Professional Project, BME 5910 Master's Design Project, and BME 5920 Master's Clinical Preceptorship, as described below, be added.

Proposed Course Descriptions:

BME 592 Healthcare Systems and Clinical Practice (1 cr., letter grading)

This course fulfills the Clinical Competency requirement in Biomedical Engineering. The course will follow a seminar format, with healthcare professionals, faculty, and medical device industry experts serving as invited lecturers and case study presenters. The course is designed to introduce BME graduate students to clinical environments and practice, healthcare delivery systems, and communication with clinical stakeholders.

BME 597 BME Professional Project (up to 6 cr., letter grading)

This course fulfills the requirement for a Project-based Master's of Science degree in Biomedical Engineering. The Professional Project is carried out in combination with an industry experience, clinical preceptorship, or design project, with oversight and input from a WPI core faculty member. Goals and objectives for the project must be documented and approved by the core faculty member, in consultation with the sponsor. To complete the project, a capstone deliverable, representative of the experience, is required. Examples of deliverables include a device prototype, public presentation, online portfolio, or another format appropriate for the specific project. Students should register for a total of 6 credits of this course, in combination with 0 credits of BME 5900 (Master's Graduate Internship Experience), BME 5910 (Master's Design Project), or BME 5920 (Master's Clinical Preceptorship).

BME 5910 Master's Design Project (0 cr., pass/fail grading)

A Master's Design Project experience is designed to enhance the professional development of the graduate student who wishes to focus on design. Master's Design Projects may be pursued within any laboratory or other organization within or external to WPI. The project deliverable must be the design or prototype of a device. This course is subject to approval by the departmental designee and sponsor.

BME 5920 Master's Clinical Preceptorship (0 cr., pass/fail grading)

A Master's Clinical Preceptorship experience is designed to enhance the professional development of the graduate student who wishes to focus on clinical applications of BME. Clinical Preceptorships may be pursued at any organization providing clinical care, such as hospitals, physician offices, dentists, and veterinary clinics. This course is subject to approval by the departmental designee and external organization.

Rationale:

These courses are designed to satisfy requirements for the revised, competency-based, project-based Master of Science degree proposed by the Biomedical Engineering Department in an accompanying motion. The objectives of the BME Master of Science degree revision are to:

- 1) Embrace and elevate WPI's project-based, experiential curriculum that emphasizes real-world impact to the Master's degree level
- 2) Enable BME Master's students to design an individual program of study that builds on their academic and professional background and focuses on building technical depth and a professional mindset and skillset to become leaders and innovators in BME.

- 3) Better prepare students to meet their individual future career goals by allowing flexibility in meeting core requirements.

Impact on Degree Requirements: Proposed courses are designed to satisfy requirements for the revised BME M.S. degree. There is no impact on the BME Master of Engineering or Ph.D. degree requirements.

Resources and Anticipated Instructors: No new resources are required, as courses will be delivered as part of BME graduate program faculty teaching loads.

BME 592 will require a BME faculty coordinator who will invite and schedule guest lecturers. Guest lecturers will be drawn from alumni, MQP sponsors and clinicians at UMMS, Tufts Cummings School of Veterinary Medicine, and other clinical collaborators in the BME department. Anticipated BME 592 instructor: Marsha Rolle

Similar to BME 598. Directed Research, BME 599. Master's Thesis, and BME 699. Dissertation Research, BME 597 will require a designated academic advisor to supervise the project. Each student will register for BME 597 under the supervision of an appropriate project advisor, with guidance from the BME Graduate Studies Committee.

BME 5910 and BME 5920 are zero credit designations, similar to BME 5900 (internship or co-op) that will enable the student to define their means of fulfilling the Professional Project requirement for the Project-Based Master of Science degree track in BME. The student will be responsible for identifying a project advisor, clinical or industry sponsor, with guidance from the BME Graduate Studies Committee.

Implementation Date: AY 2018-2019

Date: February 13, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. K. Troy, Chair)
Re: Motion to revise the BME M.S. program degree requirements

Motion: On behalf of the Biomedical Engineering Department, the Committee on Graduate Studies and Research recommends and I move that the BME M.S. program degree requirements be revised as described below.

Description of Proposed Revisions of BME M.S. Degree Requirements:

Current Text (WPI Graduate Catalog, p. 44)

For the M.S.

A minimum of 30 credit hours is required for the Master of Science degree, of which at least 6 credit hours must be a thesis. Course requirements include 9 credits of biomedical engineering, 3 credits of life science, 3 credits of advanced mathematics, 3 credits of life science or advanced mathematics, and 6 credits of electives (any WPI graduate-level engineering, physics, math, biomedical engineering, or equivalent course, subject to approval of the department Graduate Studies Committee). Students are required to pass BME 591. Graduate Seminar twice.

Proposed Text:

For the M.S.

A minimum of 30 credit hours is required for the Master of Science degree, which may be met by satisfying the requirements for a Thesis-Based or Project-Based program of study. BME courses include BME 500-level or 4000-level courses (except BME 4300. MQP Capstone Design). Electives may include any WPI graduate-level engineering, physics, math, biomedical engineering, or equivalent course (500- or 4000-level), subject to the approval of the department Graduate Studies Committee. A maximum of 8 credits of coursework at the 4000-level may be applied to meet the requirements for the Master of Science degree.

M.S. (Thesis-Based)	30 credits
BME courses	15 credits
BME 599 (M.S. Thesis)	6 credits minimum
Electives	9 credits
M.S. (Project-Based)	30 credits
BME courses	15 credits
BME 597 (M.S. Project)	6 credits
Electives	9 credits

Thesis (6 credits, Thesis-Based M.S.)

The Thesis-Based M.S. program requires a minimum of 6 credits of **BME 599. Master's Thesis** and completion of an independent research project under the supervision of a Biomedical Engineering Program Faculty advisor. This option is well-suited for the student seeking to engage in deeper, open-ended inquiry into a research area, in preparation for advanced research training (e.g., Ph.D. degree) or research-focused career opportunities in a medical, academic, government, or industry laboratory setting.

Project (6 credits, Project-Based M.S.)

The Project-Based M.S. program enables students to engage in a focused, credit-based independent project experience that builds on their individual professional and academic experience. The program will facilitate development of experience, skillset, and mindset to contribute and lead in industry as engineers in a variety of biomedical engineering roles. The Project-Based M.S. program requires

completion of 6 credits of **BME 597. Professional Project**, and completion of a capstone deliverable representative of their integrated project experience (e.g., poster or platform presentation, department seminar, final presentation, online portfolio). The Project may include one or more integrated project-based experiences:

- 1) **BME 5900. Internship or Co-op.** Students may apply for an industry-based co-op or internship, and earn academic credit while using elements of the co-op or internship as the basis for satisfying the project requirement.
- 2) **BME 5910. Master's Design Project.** Students may work with a faculty advisor to design a device or prototype that meets a specific set of technical objectives.
- 3) **BME 5920. Clinical Preceptorship.** Students may work with faculty advisors in collaboration with clinicians (including medical, dental, veterinary) to design a device, system, or other product that creates value with positive impact on clinical practice.

In addition, the following requirements must be met for both Master of Science degree programs:

- **Technical Depth Requirement (15 credits minimum).** Thematically-related advanced engineering and science coursework in an area of technical focus within a Biomedical Engineering specialization.
- **Seminar Requirement.** Students must take BME 591. Graduate Seminar (0 credits) and pass it twice.
- **BME Core Competencies.** In addition to meeting the specified minimum credit requirements for the degree program, all Master of Science candidates must satisfy five (5) BME Core Competencies.
 - 1) **Mathematics.** Understanding and ability to apply fundamental principles of mathematics (e.g., statistics, numerical methods, or computational modeling).
 - 2) **Life science.** Understanding and ability to apply fundamental principles of life science (e.g., cell and molecular biology, physiology).
 - 3) **Clinical needs analysis and design.** Ability to communicate effectively with clinical stakeholders, understanding of healthcare systems, exposure to clinical environments and practice, understanding clinical needs and recognizing opportunities to improve healthcare delivery and practice.
 - 4) **Regulation and controls.** Understanding of regulations and standards applied to biomedical engineering design, manufacturing, and research (e.g., medical device design regulations, FDA regulations, engineering standards, QC/QA, GMP/GLP).
 - 5) **Value creation, innovation, technology commercialization.** Development and practice of innovation mindset and skillset to create value and recognize opportunities for innovation in the design and development of medical technologies; commercial and clinical translation of medical innovations that impact healthcare delivery and practice.

Core Competencies. To aid students in developing a Plan of Study, the following example courses that can fulfill each of the five (5) BME Core Competencies are provided. Alternative courses may be applied to fulfill competency requirements. Students need only take one (1) course to fulfill a given competency. Alternatively, waivers may be considered based on documented work experience, advanced degrees, majors, or minors that demonstrate advanced mastery in the core competency area. Course substitutions and waivers must be approved by the department Graduate Studies Committee.

Mathematics:

MA 511. Applied Statistics for Engineers and Scientists

MA 501. Engineering Mathematics

Life Science:

BME 560. Physiology for Engineers

BME 562. Laboratory Animal Surgery

BME 564. Cell and Molecular Biology for Engineers

Regulations and Controls:

BME 532. Medical Device Regulation
BME 595D. Medical Device Design Controls

Clinical Needs Analysis and Design:

BME 592. Healthcare Systems and Clinical Practice

Value Creation, Innovation, Technology Commercialization.

BME 595V. Value Creation and Innovation in BME Thesis Research
ETR 500. Entrepreneurship and Innovation
ETR 593. Technology Commercialization: Theory, Strategy and Practice
SYS 501. Concepts of Systems Engineering
SYS 502. Business Practice

Technical Depth Specializations and Example Courses. To aid students in developing a Plan of Study that fulfills the Technical Depth requirement, we provide the following examples. These lists are not exhaustive. Students may propose alternative courses and specializations, including thematically-related courses double-counted toward a WPI Graduate Certificate, to fulfill the Technical Depth requirement (subject to review and approval by the department Graduate Studies Committee).

Biomaterials and Tissue Engineering:

BME 531. Biomaterials in the Design of Medical Devices
BME/ME 550. Tissue Engineering
BME/ME 552. Tissue Mechanics
BME 555. BioMEMS and Tissue Microengineering
BME 583. Biomedical Microscopy and Quantitative Imaging
BME/ME 4814. Biomaterials
BME 4828. Biomaterials-Tissue Interactions
BME 4831. Drug Delivery
BME 4701. Cell and Molecular Bioengineering
CHE 521. Biochemical Engineering
MTE 509. Electron Microscopy
MTE 558. Plastics
MTE 511. Structure and Properties of Engineering Materials
MTE 512. Properties and Performance of Engineering Materials
MTE/MFE 5841. Surface Metrology
PH 561. Atomic Force Microscopy

Biomechanics and Medical Robotics:

BME 552. Tissue Mechanics
RBE 500. Foundations of Robotics
ME/RBE 501. Robot Dynamics
RBE 520. Biomechanics and Robotics
RBE 580. Biomedical Robotics
BME/ME 4504. Biomechanics
BME/ME 4606. Biofluids
BME 450X. Computational Biomechanics

Additional Technical Depth Courses:

BME 523/BME 4023. Biomedical Instrumentation
BME 581. Medical Imaging
BME 4011. Biomedical Signal Analysis
BME 4201. Biomedical Imaging

ECE 503. Digital Signal Processing
ECE 5106. Modeling of Electromagnetic Fields in Electrical & Biological Systems
CS 583/BCB 503. Biological and Biomedical Database Mining
CS 534. Artificial Intelligence
CS 539. Machine Learning
CS 545/ECE 545. Digital Image Processing

Rationale:

The proposed revisions are designed to embrace and extend WPI's project-based education model to BME graduate programs, and more clearly define the learning objectives and technical tracks that Master of Science students may pursue in Biomedical Engineering. The motivation for this proposal was to create a more distinctive, student-centered, personalized technical and professional development degree program that achieves the following objectives:

- 1) Focus recommended coursework in Biomedical Engineering into "technical depth" tracks aligned with faculty research and expertise, and provide more guidance for course selection.
- 2) Enable students to gain deeper understanding of business practices and technology commercialization, clinical practice, regulations, and controls in biomedical industries.
- 3) Emphasize project-based and competency-based learning, customized to student background and goals.
- 4) Allow students to incorporate a co-op, internship experience, clinical or design project, or thesis; and provide the skillset and mindset for students to seamlessly enter the workforce as high-performing technical experts, leaders, and innovators.

Impact on Degree Requirements: Proposed changes replace current degree requirements for the Master of Science degree.

Resources and Anticipated Instructors: New courses have been introduced and are being developed (BME 592, BME 597) within current faculty teaching loads. Additional adjunct faculty experts may be recruited to develop and teach new courses on specialized content and convert courses to offer online sections.

Implementation Date: AY 2018-19

Date: Feb 13, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Troy, Chair)
Re: Motion to convert three RBE courses into permanent courses

Motion: On behalf of the Robotics Engineering Program, the Committee on Graduate Studies and Research recommends and I move that *RBE 5XX / ME5XXX Soft Robotics*, *RBE 5XX / BME 5XX / MTE 5XX Smart Materials & Actuation*, and *RBE 5XX / ME 5XX Advanced Robotics - Parallel and Walking Mechanisms*, as described below, be added as permanent crosslisted courses.

Proposed Course Descriptions:

RBE 5XX / ME5XXX Soft Robotics (2 credits)

Soft robotics studies “intelligent” machines and devices that incorporate some form of compliance in their mechanics. Elasticity is not a byproduct but an integral part of these systems, responsible for inherent safety, adaptation and part of the computation in this class of robots. This course will cover a number of major topics of soft robotics including but not limited to design and fabrication of soft systems, elastic actuation, embedded intelligence, soft robotic modeling and control, and fluidic power. Students will implement new design and fabrication methodologies of soft robots, read recent literature in the field, and complete a project to supplement the course material. Existing soft robotic platforms will be available for experimental work.

Prerequisites: Differential equations, linear algebra, stress analysis, kinematics, embedded programming. RBE

RBE 5XX / BME 5XX / MTE 5XX Smart Materials & Actuation

This hands on course covers smart materials and actuation, with an emphasis on electroactive polymer (EAP) based materials and actuators, such as contractile EAPs, dielectric elastomers (DEAs), and ion-polymer metal composites (IPMCs). Piezoelectric materials and shape memory alloys (SMAs) are included in the course, as well as pneumatic actuation. Because smart materials and electroactivity are relatively new fields, the course involves literature reviews. Each team project will involve two different types of smart materials, where at least one smart material is electroactive. For the team projects, the class will be organized into groups, ensuring that each group had a mixture of different disciplines to promote lively discussion. Two papers will be required, one as a literature review and one about aspects of the team project. Much of the theory and applied research is yet to be done with smart materials, so this is a very creative course that implements design into the projects, which can include biomimicry.

RBE 5XX / ME 5XX Advanced Robotics - Parallel and Walking Mechanisms

Foundations and principles of parallel and walking mechanisms. Topics include advanced spatial/3D kinematics and dynamics of parallel manipulators and legged/walking mechanisms including workspace analysis, inverse and forward kinematics and dynamics, gait analysis of walking mechanisms, motion analysis of parallel mechanisms as well as legged and walking mechanisms, stability/balance analysis of walking mechanisms, and control of parallel manipulators and walking mechanisms. The course will be useful for solving problems dealing with parallel manipulators as well as multi-legged walking mechanisms including humanoid robots, quadruped robots, hexapod robots and all other types of legged walking mechanisms. A final term project would allow students to apply all this information to design, analyze, and

simulate parallel and walking mechanisms. Students taking this course are expected to have a background in kinematics and dynamics.

Rationale:

These special topics courses will soon reach the limit of the number of times they may be offered. To date they been offered as follows:

Course	Instructor	Cr	Term Sem	Campus On-Line	Offered
Soft Robotics	Onal Agheli (adjunct)	2	T	C L	D 14, D 16, Summer 16
Smart Materials & Actuation	Rasmussen (adjunct)	3	S	C	F 15, F 16, F 17
Adv. Rob. - Parallel & Walking Mech	Agheli (adjunct)	3	S	L	F15, S16, F16, S17

There are no plans to change the credits, term/semester-basis, or whether the course is offered on-campus or on-line. The courses have been popular with RBE graduate students as reflected in their course reviews (see the attached documents). We therefore recommend converting these Special Topics courses into permanent courses.

Additional Resources Required: None.

Implementation Date: Effective as soon as possible

Date: Feb 13, 2018
To: WPI Faculty
From: Committee on Graduate Studies and Research (Prof. Troy, Chair)
Re: Motion to add CS 541/ DS 541 Deep Learning

Motion: On behalf of the Department of Computer Science and the Data Science Program, the Committee on Graduate Studies and Research recommends and I move that CS 541/DS 541 Deep Learning, as described below, be added as a permanent course.

Proposed Course Description:

CS 541/DS 541. Deep Learning
3 Credits

This course will offer a mathematical and practical perspective on artificial neural networks for machine learning. Students will learn about the most prominent network architectures including multi-layer feedforward neural networks, convolutional neural networks (CNNs), auto-encoders, recurrent neural networks (RNNs), and generative-adversarial networks (GANs). This course will also teach students optimization and regularization techniques used to train them -- such as back-propagation, stochastic gradient descent, dropout, pooling, and batch normalization. Connections to related machine learning techniques and algorithms, such as probabilistic graphical models, will be explored. In addition to understanding the mathematics behind deep learning, students will also engage in hands-on course projects. Students will have the opportunity to train neural networks for a wide range of applications, such as object detection, facial expression recognition, handwriting analysis, and natural language processing.

Prerequisite: Machine Learning (CS 539), and knowledge of Linear Algebra (such as MA 2071) and Algorithms (such as CS 2223).

Frequency of Course Offering: The course will be offered once annually (fall semester is preferred) starting in AY18-19.

Rationale:

Demand for a course in “Deep Learning,” which refers to machine learning based on neural networks with many nested layers of computation, has increased during the past 3 years. The requests are from both undergraduate and graduate students in Computer Science, Data Science, and many other majors. The most prominent machine learning conferences, such as NIPS and ICML, consist largely of research on Deep Learning topics. Many top universities, including Stanford, offer courses specifically on Deep Learning, in addition to broader courses such as “Machine Learning” and “Artificial Intelligence”. The proposed CS 541/DS 541 Deep Learning course is expected to generate significant interest in students from CS, DS, RBE, and Mathematical Sciences, as well as BCB, LST and disciplines in sciences and in engineering in which machine learning can be applied.

At WPI, Deep Learning has been taught twice, in different forms, by Computer Science faculty:

- (1) In spring 2016 in CS566 “Graphical Models”, Prof. Joe Beck decided, based on overwhelming student support, to shift the focus of the course from probabilistic graphical models and Bayesian networks to Deep Learning. Upon doing so, enrollment increased from 12 to 16 students.
- (2) In spring 2017, Prof. Jacob Whitehill taught CS525 191N “Deep Neural Networks” as a Special Topics course. This course was completed for credit by 32 graduate and undergraduate students from Data Science (DS), Computer Science (CS), and Learning Science & Technologies (LST). In the student course evaluations, the overall rating of the course (question #1) was 4.76, and the overall rating of the instructor’s teaching (question #2) was 4.82.

Prof. Whitehill is currently (spring semester 2018) teaching a second offering of Deep Learning as a special topics course (CS 525 191D) with 50 registered students.

Impact on Degree Requirements: We propose to add this course to the *Artificial Intelligence* bin for the Computer Science breadth requirement (p. 76 of the current graduate catalog). This new course will count as a core course for the *Data Analytics and Mining* core competency area for Data Science (p. 88 of the current graduate catalog).

Resources: The expected enrollment for the class is 30 – 60 students annually. A number of faculty have already expressed interest in teaching this course, including: Prof. Joseph Beck, Prof. Xiangnan Kong, Prof. Randy Paffenroth, Prof. Carolina Ruiz, and Prof. Jacob Whitehill. This course should help to distribute the teaching load more equally among our other Machine Learning and Data Mining courses which currently tend to have large class sizes.

Implementation Date: CS 541/DS 541 will be offered in academic year 2018/2019.