

WORCESTER POLYTECHNIC INSTITUTE
January 28, 2021

To: The WPI Faculty
From: Tanja Dominko
Secretary of the Faculty

The fifth Faculty meeting of the 2020-2021 academic year will be held on **Thursday, January 28th, 2021 at 3:15 pm via ZOOM.**

1. Call to Order
 - Approval of the Agenda
 - Approval of the Consent Agenda and the Minutes from 12-10-20
2. Committee Business
 - Committee on Governance**
 - **Motion to adopt tenure criteria for Professors of Teaching**
 - **Motion to revise Part One, Appendix D (The Roles Played by Tenured, Tenure-Track, and Non-Tenure Track Faculty in Carrying Out WPI's Mission) in the Faculty Handbook**
 - **Motion to add Guidance for Documenting and Assessing Activities Toward Tenure for Professors of Teaching to the Faculty Handbook**
3. Other Reports
 - Vice Provost for Research: Conflict of Interest disclosure – new requirements
 - COACHE faculty satisfaction survey
4. President's Report
5. Provost's Report
6. Secretary of the Faculty Report
7. New Business
8. Closing Announcements
9. Adjournment

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WORCESTER POLYTECHNIC INSTITUTE
Faculty Meeting Minutes
December 10, 2020

Summary:

1. Call to Order

- Approval of the Agenda
- Approval of the Consent Agenda and the Minutes from 11-5-20

2. Secretary of the Faculty Report

3. A Belated and Brief Convocation – Announcement of Trustee Awards from April 2020

4. Committee Business

Committee on Academic Operations

Motion to approve graduation list of undergraduate students eligible to receive a degree in January 2020

Committee on Graduate Studies and Research

Motion to approve graduation list of undergraduate students eligible to receive a degree in January 2020

Committee on Governance

Motion to establish Department of Integrative and Global Studies (DIGS)

Committee on Graduate Studies and Research

- Motion for MS program in Community Climate Adaptation (MS-CAA)
- Motion for BS/MS program in Community Climate Adaptation
- Motion to approve IGS course prefix
- Motions to approve new courses in DIGS
- Motion to establish a new Master of Science program in Cybersecurity (MS-SEC)
- Motion to establish a new Master in Computer Science program (MCS)
- Motions to approve new CS courses

5. President's Report

6. Provost's Report

7. New Business

8. Closing Announcements

9. Adjournment

Detail:

1. Call to Order

The fourth Faculty meeting of the 2020-2021 academic year was called to order at 3:15pm via ZOOM by **Prof. Dominko** (BBT). **Secretary of the Faculty Dominko** welcomed everyone and reminded them that the meeting was being recorded. The consent agenda including the minutes from the last faculty meeting were approved.

2. Secretary of the Faculty's Opening Remarks

Secretary of the Faculty Dominko claimed a point of personal privilege and spent a few minutes saying goodbye to a dear colleague and a friend, Prof. Glenn Gaudette.

Glenn and I started at WPI on the same day in May 2006. Since then, we have worked together on countless research projects and initiatives, developing opportunities for faculty and students alike, traveled to far away places more times than I can remember advocating for WPI and expanding collaborations, and shared our passions on faculty governance committees and on committees of the Board of Trustees.

Along the way we have forged a friendship that grew with each passing year, we depended on each other in the thick and thin of it, including this past year's challenges. We shared disagreeing perspectives at countless faculty governance committee meetings. But through it all we forged a bond of friendship that I will continue to honor and cherish as we say a brief goodbye.

There will be no booming laughter in the labs of Gateway Park every day indicating an imminent appearance of your always smiling face. Students will no longer corner you from left and right as you hurry through campus to yet another meeting. There will be no more conversations over a ubiquitous cappuccino at the sanctuary of the Quorum; there will be no more loud arguments and quiet less loud agreements. And it will be the absence of this all that will remind me of who we used to be that I will notice the most. The goodbye is bittersweet, my friend.

And on behalf of faculty governance, thank you for everything you have done over the years that made us better. We wish you the best of luck and much success on your new journey.

Prof. Richman (ME) shared his thoughts at the departure of Prof. Glenn Gaudette.

Typically, we take valuable time at faculty meetings to acknowledge our colleagues - either when they're about to retire, or after they've passed away. So - being a pessimist - when Tanja asked me to say a few words about Glenn, I immediately thought the worst.

That we are spending a few minutes today to pay tribute to Glenn Gaudette - who we all know is very much alive and far from the retiring type - is a statement about how much he has meant to all of us at WPI and how sorely he will be missed.

My purpose here is not to recite Glenn's full resume to you, in large part because if you just ask, he'll send the whole thing to you in a flash. In fact, he'll send it to you even if you don't ask. Just be patient - because the imbedded video of his appearance on "Bill Nye Saves the World" takes a while to transfer by email.

So very many of us have worked closely with Glenn on one meaningful activity or another through his broad range of campus involvements - whether he was sharing his research ideas, spreading his joy of teaching, defending his notion of shared governance, or just poking around campus looking for the next big challenge. The magic trick that he performed for all of us was that somehow he'd organized his time and arranged his priorities so that despite all the many hours he put in each day, he'd never let on that his plate was ever full. And if at the end of a conversation you had just one more thought to share, or one more creative idea to float, or one more plot to hatch, Glenn would always find time for dessert!

I could go on at length, but I will limit myself to one final observation. It is the debt we owe Glenn for the courage he showed in applying for the Provost's position several years ago when the outcome seemed all but predetermined. That single bold but lonely act served to legitimize the search at the time. But it also bolstered our confidence to know that when the time is right, we can look inward and make important decisions internally. But those of us who know Glenn well also understood that he was serious about his candidacy - in its own right. And with his typical energy and enthusiasm, Glenn laid out for us an appealing vision for WPI that emphasized its academic mission above all else – a vision that he has articulated as one of our outspoken and effective faculty advocates since he arrived at WPI sixteen years ago.

So naturally, Glenn, we are all sorry to see you leave WPI. But we are also thrilled for the opportunities that are now open to you as the Inaugural Chair of Engineering at Boston College. In the meantime, we will admire all the **value** you **created** for WPI while you were here. And we will be hard pressed to live up to the standard you have set.

Prof. Gaudette (BME) thanked everyone and added that it has been his pleasure and honor to work at WPI. He has learned so much from everyone and appreciates all that they have done for him. WPI is a special place and he will always cherish his time here.

3. A belated Convocation 2020

It is mid December 2020. As we reflect on the past year, many of the year's events will remain scorched onto our hearts and souls forever. Amidst the horrors of the past months, however, a few important and bright moments have held: we congratulated and celebrated our graduates with a virtual cap and gown ceremony in their honor in May – albeit from a gallery of our smiling faces captured on Zoom. We celebrated our successes and perseverance with reflection of C-term innovation, creativity and determination, and we recommended several of our colleagues for the Board of Trustees' awards – a tradition that has through faculty convocation claimed a prominent place on our academic calendar for years. But for the first time, we could not honor them at the time this past spring.

Let us set the table with fine china, polished silverware and crystal goblets. Let us arrange the flower centerpiece just so. And even if only in our imaginations, let's all take our seats and return waves and smiles across the table in anticipation. Let us pause and take in the accomplishments of our colleagues that have again made us proud to belong to the WPI family.

It is with honor that I introduce the recipients of the Board of Trustees awards for the academic year 2019-2020 recorded in the proceedings of the meeting of the Board by their unanimous votes.

**Board of Trustees' Award for
Outstanding Research and Creative Scholarship
Professor Jagan Srinivasan**

Professor Jagan Srinivasan, Associate Professor in the Department of Biology and Biotechnology, is a recognized leader in his field, with interdisciplinary research encompassing

neurobiology, molecular genetics, and chemical biology. Using the nematode *C. elegans* to understand the biology of the nervous system, he focuses on how the nervous system detects sensory information, often in the form of pheromones; encodes and interprets this information via neural circuitry; and mediates behavioral responses. His impact on the field of neuroscience has been profound: in the words of one researcher, he stands “at the forefront of this revolution.” With a \$1.6 million NIH grant, over 16 articles published in top-tier journals, an ability to generate novel disciplinary insights as well as to lead a multi-institutional collaborative research team, Prof. Srinivasan exemplifies the qualities of an outstanding researcher and scholar.

**Board of Trustees’ Award for
Outstanding Teaching
Professor Sarah Wodin-Schwartz**

Professor Sarah Wodin-Schwartz, Assistant Teaching Professor in the Department of Mechanical Engineering, has an infectious enthusiasm for engineering education, a highly innovative approach, and devotion to the success and wellbeing of her students. She demonstrates in many ways her passion for developing student understanding and interest. Whether integrating ethics into her engineering courses, revamping her labs and courses in pursuit of maximum student engagement, developing assignments that help students appreciate the environmental, social, and ethical impacts of engineering solutions on individuals and communities, delivering her now-famous “Hands-on Wednesdays,” or scavenging for chairs to seat the many students who visit her office hours, Professor Wodin-Schwartz demonstrates her commitment to student success. As one admiring student noted, “The greatest teachers prepare their students to flourish without their help, and Professor Wodin-Schwartz achieves that and more by forming a relationship with students and encouraging them to stretch the boundaries in their field.” Professor Wodin-Schwartz represents the best of our motto, “Theory and Practice.”

**Romeo L. Moruzzi Young Faculty Award
Professor Carlo Pincioli**

Professor Carlo Pincioli, Assistant Professor in the Department of Computer Science, is one of two winners of this year’s Romeo Moruzzi Award. In his robotics engineering courses, he strikes the delicate balance between rigorously teaching content and fostering an engaging learning environment by introducing elements of gamification. Structuring each class as a sequence of small units of increasing complexity units that collectively form a “quest” and encouraging discussion, he draws students into the content and elicits improved participation and comprehension over earlier iterations of the course. As one student remarked, “Robotics labs can be tedious and gruesome and students often feel overwhelmed. Professor Pincioli’s RBE 3002 was not like that at all. After completing each challenge, we felt accomplished. It was like a video game you didn’t want to stop playing.”

**Romeo L. Moruzzi Young Faculty Award
Professor Lisa Stoddard**

Professor Lisa Stoddard, Assistant Teaching Professor in the Global School and the Department of Social Science and Policy Studies, is one of two winners of this year’s Romeo Moruzzi Award

for her invaluable work to help students learn effective teamwork. Teamwork is at the heart of the WPI Plan, and is one of the top skills sought by employers. Yet despite nearly 50 years of institutional experience with project work, many faculty still struggle to help student teams perform in equitable and productive ways. Professor Stoddard addressed this problem head-on, developing a suite of tools to help facilitate student team dynamics and performance. One faculty colleague who introduced these tools to a project team noted that while using the tools, the team “discovered each other’s, and their own, strengths and weaknesses. From there, it became one of their goals to help each other develop in areas they wished to grow in and gave each more confidence.” A student wrote, “I surprised myself with what I may be able to offer in a team project.”

**Board of Trustees Award for Outstanding Academic Advising
Professor Gillian Smith**

Professor Gillian Smith, Associate Professor in the Department of Computer Science and the IMGD program, puts WPI’s mission into practice, conveying knowledge at the frontiers of academic inquiry for the betterment of society by providing expert guidance and inspiration to her students. Her students credit her for her “passion for inclusion and conscious design,” for challenging them to “examine ourselves to uncover our strengths and identify areas in which we need to grow.” As one grateful student wrote, “Professor Smith has acted as a guide for so many girls in the computer science department, and I couldn’t imagine my undergraduate career without her.”

**Chairman’s Exemplary Faculty Prize
Kris Boudreau and John Sullivan**

The Chairman’s Prize, which recognizes WPI faculty members who excel in all relevant areas of faculty performance, goes this year to two of our colleagues. The prize embodies key values of WPI including a balance between scholarship and teaching, as well as the importance of working across disciplinary boundaries. This year’s winners, Kristin Boudreau and John Sullivan, distinguish themselves by their continuous and unwavering commitment to the institution and its students. Professor Boudreau, a creative and highly regarded scholar who has published three single-authored books and numerous articles in several areas of American literature, served as Head of the Department of Humanities and Arts for 10 years, led the development of the humanitarian engineering course at WPI, working with faculty across disciplines (including Professor Sullivan) and disseminating this model and the concept of integrative learning, and has given extensive service to WPI. Professor John Sullivan’s research accomplishments include 151 publications, 2 US patents, and \$6.6 million in funding. His teaching accomplishments include work across disciplines as evidenced by joint appointments in multiple departments and award-winning published work with Professor Boudreau on humanitarian engineering. Former students comment on the importance of his mentorship to their careers, and we note with admiration that he received the Board of Trustees Faculty Advisor of the Year award in 2018. He has given extensive service to WPI, including as Interim and Associate Head of the Mechanical Engineering Department and Secretary of the Faculty. Former Interim President Phil Ryan described Professor Sullivan as a “pillar of principle and strength” during a time of turmoil for WPI. The leadership of Professors Boudreau and Sullivan over the years could not have been

more exemplary, a true embodiment of the commitment to the institution as scholars, teachers, and most importantly, community builders. Because of them both, WPI is better today than yesterday and will be better tomorrow than today.

**Denise Nicoletti Trustees' Award for
Community Service
Professor Tiffany Butler**

Tiffany Butler, Director of Multicultural Affairs and Assistant Teaching Professor in the Department of Biomedical Engineering, is known as the “go-to faculty member who understands, empathizes, and advocates for students.” In countless ways she provides material, intellectual, and emotional support for students from underrepresented populations (minority, LGBTQ, low-income, and first-generation). These include scholarships and research experiences within the Louis Stokes Alliance for Minority Participation at WPI, which she directs, in her more recent role as Director of Multicultural Affairs, and in her continuing role as professor and mentor. She has been an invaluable contributor to the Women’s Research and Mentoring program for pre-collegiate students, a WPI Faculty Learning Community on Social Justice, and the faculty governance task force on non-tenure-track faculty. In Worcester she serves on the Big Brothers, Big Sisters Advisory Board and brings biomedical engineering projects to elementary school classes. As her students attest, she has made a tremendous impact on the lives of many undergraduates who never imagined certain possibilities for themselves until they met Prof. Tiffany Butler.

4. Committee Business

CAO

Department Head Strong (FBS) introduced this motion on behalf of the Committee on Academic Operations (CAO).

The Office of the Registrar reports that the listed candidates have either completed all the requirements for the degree design designated in the department or program indicated or are expected to complete their degree requirements before December 30, 2020. She moved that pending final verification by the registrar, that all those on the list have in fact completed their requirements, that they be approved for December 30, 2020 graduation. Prof. Dominko asked Registrar Miles to jump in with her updated list of names for graduation. **Registrar Miles** shared this list.

This motion passed and the graduation list was approved.

CGSR

Prof. Rolle (BME) motioned on behalf of the Committee on Graduate Studies and Research (CGSR).

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, 2020. They therefore are or will be eligible to receive that degree. On behalf of the Committee on Graduate Studies and Research, she moved that pending final verification from the registrar that all those on the list have in fact

completed their degree requirements, they be approved for December 30, 2020 graduation. Registrar Miles shared the list and highlighted the two additions to the list.

This vote passed and the motion is considered approved and pending final verification.

COG

Prof. Boudreau (HUA) motioned on behalf of the Committee on Governance (COG) that the WPI faculty endorse the administration's proposal to create the Department of Integrative and Global Studies within the Global School at WPI.

She highlighted the process of proposal development that included numerous revisions by Global School faculty, Dean Rissmiller and Prof. Wobbe. Prof. Boudreau stated that the new department within the Global School will be a place for new academic programs to grow. She emphasized that the ownership of IQP and GPS programs that belong to the entire university is not addressed by this proposal. If in the future, provided this department is approved, there is a desire to include either of these two programs into the IGS department, a separate motion would be required.

Prof. Rissmiller (IGSD) congratulated all the award winners for their stunning set of accomplishments.

He described the IGS department motion and stated no real academic changes to what we have been doing in the past are being proposed. The motion speaks to an organizational change that will help bring coherence and identify to the faculty who have been working in interdisciplinary global studies in the GPS for a long time. These core programs are shared with all the faculty and all departments at WPI. None of the global programs can be accomplished without the participation of faculty from across the campus. At the moment we have 29 of our IQP centers that are alone advised by your colleagues from Humanities, Business, Math and Computer Science Departments. This doesn't begin to address the humanities project centers and IQP centers. We continue to need participation of all the faculty to be successful. Prof. Rissmiller added that this year we have addition of 38 advisors who are working on programs remotely all year long. These advisors are from departments around campus since the program needs to participation of anyone and everyone. Prof. Rissmiller stressed that the objective is not to set up any barriers to the participation of faculty from other departments in any way.

Prof. Wobbe (CBC) explained that when the Global School was established, we had five GPS faculty reporting to the Associate Dean of Undergraduate Studies and about 22 faculty reporting to the Dean of IGSD. Neither of these groups were in a traditional departmental structure, which required some language exceptions in the Faculty Handbook and resulted in some issues with standard procedures. This is because so much is conducted through the departmental structure. Not having a department head sometimes presented logistical challenges. Since these faculty colleagues have now been aggregated into the Global School, it makes sense to set it up as a traditional department. There are new academic programs which will be instituted, which would work better in a departmental structure. Prof. Wobbe pointed out that they will also have more tenure-track faculty, so the issue of development of faculty through the tenure and promotion process because more significant and having a traditional departmental structure would make it easier. There are safeguards apparent in a departmental structure that aren't guaranteed to faculty

in those groups. For example, department heads are regularly reviewed in a second, then fourth year process. Then, faculty and departments can provide feedback on the department heads. In the GPS groups, we are not guaranteed these opportunities. The faculty who are main contributors to both the GPS and IQP programs will continue to support those programs, but in addition there is a new graduate program that will be presented later during this meeting. WPI has long offered its undergraduates the opportunity to create individually designed interdisciplinary majors. This was overseen by the IGSD in the past, but we think it fits better in the departmental structure. The IGS department would take responsibility for those. Prof. Wobbe also added that the faculty in the IGS department have contributed in the past and hope to continue to various other academic programs. Prof. Wobbe explained that the name of the IGS reflects integrative learning of our GPS. We are not the only school to have an Integrative and Global Studies department or program, and both MIT and RPI have integrated these programs as well. This involves learning from multiple disciplines and using multiple perspectives to do problem solving. The term global makes sense in that the GPS, IQP and research that this group is interested in doing are addressing challenges that are associated with both global and local processes. The faculty of the proposed department have identified four key areas of research that they are interested in pursuing. In the past five years, they have contributed over 80 publications and more than \$3 million in funding. Prof. Wobbe added that they are looking forward to the potential to develop additional graduate programs and collaborating more on research.

Prof. Krueger (SSPS) congratulated all the award recipients today.

He stated his support for the IGS proposal in general but does have a couple of questions about some of the language. He stated that the point was made clear that the IQP is not going to be housed in IGS, but the language in the proposal does not make this clear. For example, on page 66 of the packet that talks about the core programs that are housed in the global school. It talks about the intellectual and programmatic background. Indeed, administratively the global school houses the IQP. It helps with housing arrangements, provides resources to center directors and things like that, but I don't think that these words capture the spirit of what Prof. Rissmiller was saying. Prof. Krueger proposed a friendly amendment that we strike the sentence that talks about the stable and intellectual and programmatic background of these programs and then add the phrase the programs are housed administratively in the global school.

Prof. Boudreau accepted the friendly amendment. Prof. Boudreau asked that the minutes of this meeting reflect that the IQP would continue to be housed in the Global School independently of the new department. This is not to say that the faculty in the department are not deeply entwined with the IQP, but since over half the faculty who advise in project centers are outside of the Global School, we needed to be very explicit that the program would continue to be owned by all faculty and would reside in the Global School. Prof. Rissmiller added that responsibility for the IQP resides with all faculty. Administratively, however, formation of the department will aid in significant administrative effort to assure smooth operations.

Prof. Sakulich (CEE) asked what the individual opinions of this proposal are from the faculty that would be part of this new department. Prof. Rissmiller stated that everybody was involved in long discussions over the title of the department and whether it would adequately represent their own research and teaching interests. He stated that all of them are happy to go forward but invited anyone to speak out if they disagreed. Prof. Sakulich mentioned that it is his

understanding that most people involved as non-tenure track may not be at this meeting or may not be comfortable speaking.

Prof. Wobbe (IGSD) stated that as a group, when we get together, the faculty that are the IGS faculty, the non-tenure track, the teaching faculty are the vast majority and she said they have had pretty open conversations. She agrees that they are in favor of a departmental structure and would feel a sense of disciplinary identity. She thinks becoming part of our real department is seen as a major stepping stone with the potential to become a part of growing degree granting academic programs. These faculty members are still very committed to the GPS and IQP programs, but also very eager to participate in graduate programs, which is not been something that they had access to in the past.

Prof. Krueger asked if they mean to say here that they would take responsibility for their own interdisciplinary programs as he doesn't see the need to have them oversee everybody's programs. In practice it's always been that the dean of the global school would take a proposal from the faculty and the student, but never really oversee or necessarily approve a proposal that was adopted and agreed upon by three faculty from other departments. Prof. Rissmiller stated that this is a process that's defined in the policies and published in the undergraduate handbook. The program comes to the dean for review and to help students identify faculty who might be their committee. Then when faculty agreed to be that committee, the proposal is sent on to the registrar. Then the registrar contacts those advisors as part of a degree audit for self-design majors. The idea here is just to leave that with the department head.

Prof. Oates (BBT) spoke in favor of this motion. She thinks it's a great idea to have integrative studies since it is a whole area of scholarship. She thinks that we will have faculty who have integrative studies as part of the academic affiliation beyond WPI that we allow to really become more involved in the society for integrative studies. This formalizes integrative and global programs and puts us at the forefront of a new area of academic study.

This motion passed.

CGSR

Prof. Rolle presented on behalf of CGSR.

She congratulated our new colleagues on the new IGS department.

She introduced **Prof. Strauss** who will be presenting a series of motions that have been discussed and approved through CGSR. There is a motion to create a new master's program in community climate and climate adaptation, a BS/MS option for the same, a new designation for courses in IGS department and several motions for new courses.

Prof. Rolle moved that a graduate program in community climate adaptation (CCA) be established by the coordinated efforts of faculty from the above-mentioned departments, which is actually the IGS Department, and the Civil Engineering Department. This program will award a Master of Science degree in community climate adaptation.

Prof. Strauss (IGSD) introduced this master's program as a joint effort between IGS and CEE. Prof. Strauss wanted to explain some answers to possible questions such as why this program now and why the Global School/WPI. Climate change is certainly one of the global challenges that we are exploring in the Global School, but it is important to note that it is not the problem that separates well into science. Climate change is an intensifier of a great number of problems that we already have. Since the problem has been approached, it now needs to be defined. Atmospheric Sciences have been working since the 1950s to define the parameters of global warming to develop models to see where we are headed. By the 1990s, we started to work out how to avoid the major impacts of climate change. This is when we started to see mitigation strategies, which focus on policy at the global or international scale. Prof. Strauss pointed out that these two domains have dominated graduate programs related to climate change over the last few decades and will continue. Now we are at a new phase which is dealing with consequences that have been predicted, but have not yet been a burden. This is where adaptation comes in.

This program is designed to help us move forward collaboratively working with communities to solve these pressing problems by climate scientists and climate policy professionals. Most of the people who have currently been working in communities to help them adapt to climate change have been coming out of disciplines that are not unique to climate adaptation, but are absolutely essential to creating and executing adaptation plans to respond to these challenges. Prof. Strauss added that the scholars and practitioners often work in areas that are related to infrastructure, hydrology, environmental engineering, geochemistry, renewable energy, social and cultural change, poverty, public health, inequality, risk management, and environmental planning. We have chosen this new degree program for the biggest department in collaboration with the CEE department to fill a growing niche that builds on WPI strengths and is grounded in human scale problem solving. The goal is to find ways of adapting to these new challenges. The documentation of climate changes as a problem is what you see in other grad programs focused on climate, but our proposed Community Climate Adaptation Program and the researchers who are teaching it focus on supporting local communities in ways to best adapt to the impacts of climate change under the constraints of their communities and regulatory environments.

Prof. Duddle (CEE) added that there are three primary objectives in this program. The first objective is understanding climate change impacts, which looks at the impacts on food on energy on water and social ecological systems in specific localities. The second is forging pathways to adaptation, which looks at alternative solutions to climate adaptation, where we are incorporating issues of socio, cultural, technical, economic and also ethical dimensions of the issue. The last is partnering for and enacting community change, which is focused on resilient community-based solutions that also address social justice concerns. It is a 30-course credit to degree. 10 of the credits are project based and the remaining our class based. The cohorts working on these projects would in the first cohort start in August 2021, though we look in the future to have cohorts could start either in August, or in January, each year. In addition to the Master of Science track, we have developed opportunities for the BS/MS to be completed in a five-year period. In the first semester of the CCA program there would be an orientation in the fall, which would provide a shared language because we have expectations that students would come from many different disciplines and we'd be looking to join together students from engineering, sciences, policy and humanities, etc. This orientation would take place to get everybody together and working in these cohorts. The first semester also has a seminar and global and local theory

methods classes and also climate essential classes. Again, these are all to get the same common knowledge for all of our students to be able to pursue their research projects. In the second term which is noted here in the spring and summer we have the GQ P which is the graduate qualifying project. This project builds upon IQP centers that we have already where students would travel with IQP groups and get started on their projects, but remain at the site through an extended period of time in order to work on their own projects. These groups would be also participating an online cohort discussion with groups that are at other projects centers at the same time. This is an eight-credit project during that extended period. In the fall, then of the subsequent year they would have additional requirements for a capstone class in comparative climate action that would bring all of this together. This would be a gap conference which is based on the research there each of the groups is doing as well as electives that could be in a topical area or in a method area and this would allow students to really explore the depth areas that are most of most interest to them. The courses in the fall, and also the capstone and conference courses in the spring allow for individual competencies to be realized by all of the students.

Prof. Stauss then explained that they worked with marketing to do an analysis and find that there are very, very few programs that include the strength of an engineering focus that we do with this program. And of course, none that have the kind of infrastructure with our project centers at WPI. We found that there was really great capacity for the movement of our program into this arena. Right now, we have five interested students both across the BS/MS and the MS program. If this is approved, then we would be bringing students to the application process in the coming term and then admitting them for next fall.

The motion passed.

Prof. Rolle motioned on behalf of CGSR that a BS/MS track be added to the graduate program and community climate adaptation be established by the coordinated effects of faculty. This represents an alternate track to the master degree and community climate adaptation.

Prof. Strauss added that this follows the structure that is in the catalog already for other courses. It is an alternative that allows students to get an early start.

The motion passed.

Prof. Rolle moved that the IGS designation be added to the course catalog for graduate credit. She also moved that the courses described on pages of the faculty meeting material, as distributed, be approved.

Both motions passed.

Prof. Rolle moved on behalf of CGSR that the following new graduate program Master of Science in Cybersecurity be added as described.

Prof. Shue (CS) explained that this motion is creating a new master's degree in cybersecurity. In this degree we are combining courses from computer science, ECE, and the Foisie School of Business. We are going to be adding one new class CS 5008 which is going to be a class that is

shared with the next program you're going to be hearing about. We're also creating a capstone experience for students in the program. This motion does include the BS/MS program as an option embedded in the motion. The general structure of the degree is that there will be an optional bridge. So, this is for students who are outside of the disciplines that we've talked about that need to acclimate to cybersecurity. Following that, which is an optional bridge, there is a technical core of three courses. One which is which is technology focused, the next which is human behavior focused and the final which focuses on business and how this applies to organizations. Following that there is a three-course depth in cybersecurity courses and then electives up to nine credits. After this there is a capstone or a thesis option. So, you can imagine that there are various paths to navigate for students who need the bridge. Prof. Shue then explained the rationale for creating a cybersecurity master's degree. It's a high demand area, we need more practitioners, we need more researchers in the area. The National Institutes of Standards and Technology have provided this little infographic citing all the different ways in which we need cybersecurity professionals. It is a high paying occupational field. There is a lot of demand that we're seeing for students interested in such degrees. At this point, we've gotten approval from the computer science department and the electrical and computer engineering department. Prof. Shue added that we've also received an endorsement for the program from the Foisie School of Business. We are planning to implement this in the next academic year, both on campus and potentially online.

President Leshin asked if Prof. Shue has thought about something along the lines of certifications rather than a master's degree since cybersecurity is such a fast-moving field. Prof. Shue mentioned that the Foisie Business School offers a graduate certificate in cybersecurity management, so this option is available.

Prof. Rao (BBT) asked what happens if a person does not want to do a capstone or a thesis. Prof. Shue stated that there is no way to avoid these requirements.

This motion passed.

Prof. Rolle moved on behalf of CGSR that the following new graduate program Master of computer science be added.

Prof. Heineman explained that the master of computer science degree is an applied terminal degree with 30 credits. There's no research and no thesis as part of it, but there is a required Capstone similar to what we just heard. There are these two new courses, one of which is shared with the cybersecurity one and a new one, which is the capstone in computer science. He added that it does allow for BS/MS option. The reason we envision this particular degree program is we have a large number of part time graduate students coming through who don't have the traditional background in computer science and oftentimes struggle in some of our courses that are geared for you to research even higher Ph. D levels. There's a good opportunity for having such a degree. With this there are two bridge courses that are optional. If you have no background, these are perfect for you. But if you have some background, then you should just jump right on in. After that you do these electives. Prof. Heineman explained that there are a number of focus areas to encourage specialization in a number of areas. At this point you complete the capstone experience. This is a good attractive offering for those who are intimidated

by the full master's program and don't know where to start. They have received approval in their department for this and they intend for it to roll out next year. There are negotiations for potential online as well as on-campus offerings.

A motion was made and seconded to extend the meeting for 15 minutes.

Prof. Ryder (BBT) asked if you can start without a computer science background, which would mean a master's in computer science would actually have less computer science in it than a bachelor's does. Prof. Heineman that there are many students who have an undergraduate degree in electrical engineering who could get a master's in computer science. There are even a lot of people who are working as professionals who were mechanical engineering, but got five year's experience working computer science. We are giving them ways to bridge courses.

President Leshin asked if a master of computer science is a standard name of a degree. Prof. Heineman explained that they did extensive research and there are at least five universities with this new degree which all look the same. It's not a Master's of Science Computer Science, but rather a Master's Computer Science degree. He expects that this terminology will stabilize in the next five years.

Prof. Rolle clarified that this is just for the three courses that will be added as a capstone for each of these two degrees you heard about and then a foundations course that would be on the path for the master of computer science. She then moved that the courses described on page 166 to 170 of the faculty meeting materials as distributed be added to the graduate catalog.

This motion passed.

5. President Leshin's Closing Remarks

President Leshin thanked everyone for all that they have done and added that she is proud of the level of engagement, innovation and the heart that everyone has brought to their work since the start of the pandemic. She mentioned that the students are just as grateful as she is.

President Leshin then reviewed recent outcomes of WPI's COVID testing. She reported that there were only 100 positive tests out of over 100,000 tests that have been conducted this year. Out of these, 25% of them were staff and 75% students. No faculty tested positive. This is a great testament to all that everyone has done to keep themselves and both colleagues and students safe. We will be reflecting over break to ensure that we can all stay just as safe in the spring.

She also congratulated the Trustee Award winners. She mentioned that the trustees have a deep understanding and appreciation of the critically important role of faculty in the life of this great institution. President Leshin has been working with the trustees on an integrated strategy to significantly improve the status of the colleagues on the TRT faculty. This strategy has three parts. The first part is around creating the teaching track tenure. The second part is having longer term contracts. The third part is the voice and full enfranchisement and participation in the governance of the institution. President Leshin wanted to ensure faculty that the trustees fully understood the goals of this project so there are no issues down the road. They are very

supportive of that integrated strategy. She added that she personally feels much more confident that we are going to get strong support and ultimately get to a place where we are all aligned. One of the issues why this hasn't been brought back this month is so that she could have some time to work through it with the board and make sure they had a clear understanding of the proposal.

President Leshin announced that the new Dean of Foisie Business School is Deborah Jackson. The positioning of our business school going forward is at the intersection of STEM, business, and humanities, which reflects her background. President Leshin thanked Steve Taylor of his work as the Interim Dean over the last few years.

She also said goodbye to Prof. Gaudette and wished him good luck. President Leshin also honored Prof. Weekes because this is her last Faculty Meeting. Both professors have held impressive leadership roles for WPI. Prof. Weekes is a pioneer at this institution. She was the first woman of color to be promoted to full professor at WPI. President Leshin mentioned that one of the signs of a great institution is when your people are recruited to leadership positions elsewhere. She closed by thanking both professors for their amazing work while at WPI. She also congratulated everyone on a great fall semester.

6. Provost Soboyejo's Closing Remarks

Provost Soboyejo thanked Prof. Dominko and President Leshin for their inspiring words. He was delighted to hear all the great things that our faculty have done and for which they are being recognized today. He congratulated all the award winners as well as Prof. Gaudette on his appointment as the inaugural Head of Engineering at Boston College. Provost Soboyejo stated that he truly appreciates the service that Prof. Gaudette has provided, the way that he has taught students, and the way that he has served the WPI community. Provost Soboyejo also thanked Prof. Weekes for her service. Prof. Weekes will always tell you what she thinks and he appreciates this quality as well as her dedication to WPI, specifically her dedication to what is right and what is best. Provost Soboyejo wished her the best in her new position.

Provost Soboyejo reflected on COVID-19. He thanked President Leshin for her leadership and thinking ahead during these critical times. Within two weeks, the entire WPI team was fully remote and the university was in full operation. This coronavirus revolution took us forward 10 years in terms of getting the university fully online with quality and commitment. We had a record breaking online on-site operation over the summer that was truly remarkable, a hybrid approach evolved, and we had a virtual launch of the global school. Provost Soboyejo was truly amazed by the innovation of our faculty developing virtual tools to teach labs and continue teaching the students.

Provost Soboyejo pointed out that great accomplishments are a consequence of the team effort between the board, President Leshin, the Faculty Governance Leaders, and the Faculty. We are all behind the goal of introducing teaching track to tenure for our current non-tenure track teaching colleagues. This will give full dignity to teaching faculty that contribute equally to the molding of a student and the greatness of our university. He is proud to be a part of this effort and he believes that in the coming year it will really make us a leader in higher education.

Provost Soboyejo took a moment to express his deepest appreciation to our staff and administration that have brought us to this point. He is amazed by the contributions from faculty to Student Affairs to IT, Talent and Inclusion, Legal Counsel, Advancement, and Marketing.

He wished everyone a happy holiday season and all the best in 2021.

7. New Business

None

8. Closing Announcements

None

9. Adjournment

Meeting was adjourned at 5:00pm by **Prof. Dominko**.

Respectfully submitted,
Tanja Dominko
Secretary of the Faculty

Addenda on file with these minutes:

None

CONSENT AGENDA MOTIONS

- CAO Revise the Entrepreneurship minor
- CAO Removing the Social Entrepreneurship minor
- CAO Convert ETR 2900 Social Entrepreneurship to a Cat. II course.
- CAO Description change for AB1531 – Elementary Arabic I
- CAO Description change for AB1532 – Elementary Arabic II
- CAO Description change for AB 1533 – Elementary Arabic III
- CAO Name change for ISE 2820
- CAO Category change for RE 2722 – Problems of Modern Believe
- CAO Removal of HI 2324
- CAO Addition of HI 2329
- CAO Addition of TH2219, Playwriting
- CAO Addition of ES 1500, Fundamentals of Systems Thinking

All CGSR motions are related to revision of AE graduate program and courses:

- CGSR Remove cross-listing of all current 10 AE/ME courses
- CGSR Remove all AE courses from AE listing
- CGSR Replace deleted AE courses with 22 revised and new courses
- CGSR Revise MS, BS/MS and PhD requirements and align with the new curriculum
- CGSR Revise AE 6999 PhD Qualifying Examination description.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to change distribution requirements for the Entrepreneurship minor, as approved by the FBS on 12/02/2020.

Motion: The Committee on Academic Operations recommends, and I move, that the distribution requirements for the Entrepreneurship (ETR) minor be modified as described below.

Proposed Distribution Requirements: (additions/corrections highlighted)

Entrepreneurship Minor

The minor requires the completion of two units of coursework as noted below.

1. Complete the following course:

BUS 2060 **Financial** Statements for Decision Making

2. Complete two (2) from the following list:

ETR 1100 Engineering Innovation and Entrepreneurship

ETR 2900 Social Entrepreneurship

ETR 2910 Economics and Entrepreneurship

ETR 3633 Entrepreneurial Selling

ETR 3915 Entrepreneurial Business Models

OBC 4367 Leadership, Ethics and Social Responsibility

3. Complete two (2) of the following courses:

BUS 2070 Risk Analysis for Decision Making

BUS 3010 Creating Value through Innovation

MKT 3640 Management of Process and Product Innovation

GOV 2313 Intellectual Property Law

ENV 2600 Environmental Problems in the Developing World

4. Required:

ETR 4930 Growing and Managing New Ventures

Rationale: Proposed changes to the entrepreneurship (ETR) minor offer a wider selection of courses to students. The addition of the three courses provide options for students interested in topics related to entrepreneurship, leadership, and social innovation. The ETR minor will continue to be available to all undergraduate students.

Implementation Date: Implementation date for this action is the 2021-22 Academic year.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to remove the Social Entrepreneurship minor from the undergraduate catalog, as approved by FBS on 12/02/2020.

Motion: The Committee on Academic Operations recommends, and I move, that the Social Entrepreneurship minor be removed from the undergraduate catalog.

Rationale: The minor continues to have low student enrollment. Several of the courses that were part of the distribution requirements for this minor have been added to the Entrepreneurship minor (see page 1). These courses are: *ETR 2910 Economics and Entrepreneurship*, *OBC 4367 Leadership, Ethics and Social Responsibility*, and *ENV 2600 Environmental Problems in the Developing World*.

AY	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Total	2	3	1	1	1	3	2	1

Impacts on students: The FBS is still committed to providing students with the theoretical underpinnings of leadership, entrepreneurship, and social innovation, so we think the addition of the above courses to the ETR minor helps to sustain this directive. Therefore, three of the specialized courses have been added to the Entrepreneurship minor distribution requirements. Students who have an interest in social entrepreneurship can opt for this minor.

Resource Requirements: None

Implementation: Implementation date for this action is the 2021-22 Academic year.

Date: January 28, 2021
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mathisen, Chair)
Re: Motion to change ETR 2900 Social Entrepreneurship to a Cat. II course, approved by FBS on 12/02/2020.

Motion: The Committee on Academic Operations recommends, and I move, that ETR 2900 Social Entrepreneurship be changed to a Cat. II course.

Existing title, description and course offering schedule:

ETR 2900 Social Entrepreneurship

Cat. I

This course will introduce students to the concept of social entrepreneurship and the ways in which social entrepreneurs are addressing complex social problems with their entrepreneurial ventures. Students will be exposed to the challenges and rewards of running a social enterprise. They will learn valuable business and entrepreneurial tools that can be applied to the design of sustainable social business models. Topics include social opportunity recognition and evaluation, business models in the social sector, social impact assessment, the double-bottom line, scalability of solutions, organizational forms and structures, and social venture financing. Suggested background: Familiarity with concepts of creativity, innovation, entrepreneurial and critical thinking, ethics, cross-cultural relations, and social problems (BUS 1010, BUS 1020, BUS 2060 or equivalent).

Proposed title, description and course offering schedule: Only propose to change to Cat. II and not change the course title or description.

Rationale: This course was originally designed to be one of the foundation courses of the Social Entrepreneurship minor. With low enrollment in the minor and a motion to discontinue offering the minor (see page 2), we think this course should change to Cat. II. This will provide more flexibility to students, who we think will continue being interested in this course especially as we build a stronger focus on corporate responsibility and social justice.

Impacts on students: This is one of several course options to be added to the distribution requirements of the Entrepreneurship (ETR) minor (see page 1), so offering it on alternating years will still allow for students to take this course to complete the ETR minor.

Resource Requirements: No additional resources required.

Implementation: Implementation date for this action is the 2021-22 Academic year. We suggest that the next offering for this course be AY 2022-2023.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to change the course description for AB1531, Elementary Arabic, as approved by the Humanities and Arts Department on November 6, 2020.

Motion: The Committee on Academic Operation recommends and I move, that the description for AB 1531 be changed, as described below.

New Course/Catalog Description: AB1531. Elementary Arabic I. Category I.

This course introduces students with no prior Arabic experience to Modern Standard Arabic and Darija, the Arabic dialect spoken in Morocco. The course sets the foundation for subsequent courses; it introduces students to pivotal aspects of Arabic, including the Arabic script and sound system. Along the way, students learn common vocabulary used in formal contexts, common phrases and greetings as well as aspects of Arab cultures.

This course is open to students with no Arabic language background; *this course is closed to native speakers of Arabic and heritage speakers except with written permission from the instructor.*

Recommended background: None.

Textbooks: Alif Baa: Introduction to Arabic Letters and Sounds (3rd edition) and Google slides (Darija)

Course: AB1531, Elementary Arabic I

Current Course Description: An intensive course to introduce the Arabic language to students with no background in Arabic. Oral language acquisition will stress structures and vocabulary required for basic communicative tasks. Emphasis will be on grammar, vocabulary, and writing system. Cultural aspects of Arabic-speaking countries introduced through course material. This course is closed to native speakers of Arabic and heritage speakers except with written permission from the instructor.

Contact: Prof. Mohammed El Hamzaoui

Implementation Date: Academic year 2021-22.

Preferred term: A2021

Enrollment cap: 18

Course type: lecture / discussion (student-centered pair & group activities)

Intended audience: Students who want to fulfill their HUA requirement through taking Arabic courses; students who want to minor in Arabic; students who want to fulfill their HUA requirement in Middle East and North Africa studies; and students who want to complete HUA

and/ or IQP projects at either the Morocco Project Center or the Sharjah Project Center in the UAE.

Anticipated instructor: Prof. Mohammed El Hamzaoui

Rationale: This will update language in the course description to better mirror course content and to facilitate transition between elementary Arabic courses and the newly proposed Intermediate Arabic courses.

Resource Requirement:

a) What currently available resources will be needed: a classroom.

b) What new resources will be needed: tutors to help students with homework, practice and course assignments. HUA does budget for tutors and has Arabic in the budget because of the previous courses.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to change the course description for AB1532, Elementary Arabic II, as approved by the Humanities and Arts Department on November 6, 2020.

Motion: The Committee on Academic Operation recommends and I move, that the description for AB 1532 be changed, as described below.

New Course/Catalog Description: AB1532. Elementary Arabic II. Category I.

This course continues students' exposure to and development of Modern Standard Arabic and Darija, the Arabic dialect spoken in Morocco; it is for students who can read and write using the Arabic script but have very basic understanding of vocabulary and syntax. New language structures, vocabulary and cultural concepts will be presented in communicative activities/materials in class and homework assignments; these activities will focus on receptive (reading & listening) and productive (writing & speaking) skills in Arabic.

Recommended background: AB1531 or instructor approval; *this course is closed to native speakers of Arabic and heritage speakers except with written permission from the instructor.*

Anticipated instructor: Prof. Mohammed El Hamzaoui

Course: AB1532

Title: Elementary Arabic II

Textbooks: Al-Kitaab: Part One (3rd edition)

Current Course Description: Continuation of AB 1531. Oral language acquisition will stress structures and vocabulary required for basic communicative tasks. Emphasis will be on grammar, vocabulary, and writing system. Cultural aspects of Arabic-speaking countries introduced through course material. This course is closed to native speakers of Arabic and heritage speakers except with written permission from the instructor. Recommended background: AB 1531.

Contact: Prof. Mohammed El Hamzaoui

Preferred term: B2021

Enrollment cap: 18

Course type: lecture / discussion (student-centered pair & group activities)

Intended audience: Students who want to fulfill their HUA requirement through taking Arabic courses; students who want to minor in Arabic; students who want to fulfill their HUA requirement in Middle East and North Africa studies; and students who want to complete HUA and/ or IQP projects at either the Morocco Project Center or the Sharjah Project Center in the UAE.

Rationale: This will update language in the course description to better mirror course content and to facilitate transition between elementary Arabic courses and the newly proposed Intermediate Arabic courses.

Resource Requirement:

a) What currently available resources will be needed: a classroom.

b) What new resources will be needed: tutors to help students with homework, practice and course assignments. HUA does budget for tutors and has Arabic in the budget because of the previous courses.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to change the course description for AB1533, Elementary Arabic III, as approved by the Humanities and Arts Department on November 6, 2020.

Motion: The Committee on Academic Operation recommends and I move, that the description for AB 1533 be changed, as described below.

New Course/Catalog Description: AB1533. Elementary Arabic III. Category I.

This course is a continuation of AB 1532. Emphasis will be on building and strengthening receptive and productive skills in both Modern Standard Arabic and Darija, the Arabic dialect spoken in Morocco. Grammatical structures covered in the previous courses along with new structures will be part of class activities as well as homework assignments. Cultural aspects of Arabic-speaking countries will be introduced through course materials including commonly used vocabulary and expressions.

Recommended background: AB1531 & AB1532 or instructor approval; *this course is closed to native speakers of Arabic and heritage speakers except with written permission from the instructor.*

Current Course Description: Continuation of AB 1532. Oral language acquisition will stress structures and vocabulary required for basic communicative tasks. Emphasis will be on grammar, vocabulary, and writing system. Cultural aspects of Arabic-speaking countries introduced through course material. This course is closed to native speakers of Arabic and heritage speakers except with written permission from the instructor. Recommended background: AB 1532.

Contact: Prof. Mohammed El Hamzaoui

Preferred term: C2021

Enrollment cap: 18

Course type: lecture / discussion (student-centered pair & group activities)

Intended audience: Students who want to fulfill their HUA requirement through taking Arabic courses; students who want to minor in Arabic; students who want to fulfill their HUA requirement in Middle East and North Africa studies; and students who want to complete HUA and/ or IQP projects at either the Morocco Project Center or the Sharjah Project Center in the UAE.

Anticipated instructor: Prof. Mohammed El Hamzaoui

Course: AB1533

Title: Elementary Arabic II

Textbooks: Al-Kitaab: Part One (3rd edition)

Implementation Date: 2021-2021 Academic Year

Rationale: This will update language in the course description to better mirror course content and to facilitate transition between elementary Arabic courses and the newly proposed Intermediate Arabic courses.

The Department of Humanities and Arts requests the approval of the change in course description to be effective starting C-2021. This request was approved by HUA department on 11-06-2020.

Resource Requirement:

a) What currently available resources will be needed: a classroom.

b) What new resources will be needed: tutors to help students with homework, practice and course assignments. HUA does budget for tutors and has Arabic in the budget because of the previous courses.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to change the title for ISE 2820 Intensive Reading for Non-native Speakers of English to Critical Reading for our World, as approved by the Humanities and Arts Department on November 20, 2020.

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

Existing title, description and course offering schedule:

ISE 2820. Intensive Reading for Non-native Speakers of English. 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.

Proposed title, description, and course offering:

ISE 2820. Critical Reading of our World. 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.

Explanation of Motion: This course has had low enrollment, but students who have taken the course describe extremely high levels of satisfaction and suggested the low enrollment was due to the name of the course, since “nobody likes to read anymore.” We believe this name change is appropriate, since this course includes a high interest reading (*The Autobiography of Malcolm X*) and critical discussions of injustice in the US and in students’ home countries. We believe this name change will also be effective in attracting students, as it suggests that that the readings in this course get at issues that go deeper than what are on the surface of the pages and lead to critical examinations of our societies.

Rationale: We propose this change in order to boost enrollment in this course and better describe the content of the course.

Impacts on students: No change in impact to students.

Resource Needs: No new resources are required.

Implementation Date: Academic year 2021-22.

Date: January 28, 2021

To: WPI Faculty

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

Re: Motion to change in category designation for RE 2722 from Cat I to Cat II

Motion: The Committee on Academic Operation recommends and I move, that RE 2722 Modern Problems of Belief be changed from Cat. I to Cat II designation, as approved by the Humanities and Arts Faculty on November 6, 2020.

Title, description and updated course offering schedule:

RE2722 Modern Problems of Belief Cat II

This course examines the ways in which religious problems of meaning have been encountered in the context of the eclipse of religion in Western culture from the Enlightenment to the present. The class emphasizes challenges presented to traditional belief systems by modern thought in areas such as the sciences, psychology, textual criticism, and historical events, as well as some religious responses to those challenges. How do religions respond to the limits of human intellectual capacity, limits of human endurance, and limits of moral comprehension?

Contact: Beth Eddy

Rationale: In the past three years the teaching staffing patterns in the RE part of PY/RE have changed each year due to new hires and department changes by faculty. We no longer have enough staff to teach it every year and meet all our RE curricular needs. Therefore, we plan to change the designation to Category II and offer the course every other year.

Impacts on students: No changes to other courses, programs, and distribution requirements are necessary. We anticipate no impact upon students.

Resource Needs:

The course will be taught with currently available faculty (Beth Eddy or Rebecca Moody). The proposed change would require no new classrooms or any other additional support.

Implementation Date: The course is being taught by Beth Eddy in D term 2021. We are proposing that it next be offered 2022-2023 and would like the change of category to take place in the 2021-2022 catalog, to be implemented in 2022-2023 and every other year thereafter. When staffing allows, we may offer it more frequently.

Date: January 28, 2021
To: WPI Faculty
From: Committee on Academic Operations (Prof. Mathisen, Chair)
Re: Motion to add ES 1500, Fundamentals of Systems Thinking, as approved by Systems Engineering Faculty and ECE Faculty on 11 November 2020

Motion: The Committee on Academic Operations recommends and I move that the experimental course ES 150X, *Fundamentals of Systems Thinking* (described below) be added as ES 1500 (Cat. I) with the same title.

Course/Catalog Description: ES 1500, *Fundamentals of Systems Thinking*, Category I
Systems Thinking is a holistic approach to problem solving that recognizes that system behavior and performance are the result of underlying structures. Systems Thinking provides tools that enable program managers, systems engineers, scientists, economists, and business managers to identify, understand, and control systems in order to improve system performance. The Systems Thinking analysis accounts for feedback and resistance to change often exhibited by real world systems. In this course, students will study system identification and delineation, causal loops and feedback diagrams, stock-and-flow diagrams, system leverage points, delays and oscillations, mental models and unintended consequences, and behavior patterns; and use these concepts to improve the performance of engineering, business, and complex social systems. The course will explore great system failures, how they might have been avoided, and how we can learn from them. Finally, students will learn how Systems Thinking explains the occasional irrational behavior of individuals, departments, businesses, and governments. Examples covered in this course may include the failure of strictly technological “fixes” to social issues (as in the government’s installation of wells in Togo in the 1980s,) the 2008 financial meltdown, the failure of the Lockheed L-188 Electra Turboprop Airplane, the failure of the Tacoma Narrows Bridge (“Galloping Gertie”) in 1940, the decline of many commercial fisheries around the world, the failure and success of companies like Research In Motion and Apple, and the unintended consequences of combating drug-related crime.

Recommended background: None.

Anticipated Instructors: Jamie P. Monat, Matthew Amissah

Rationale for Adoption: The course ES 150X was taught on an experimental basis twice (C-2019 and C-2020) to 20 students each time. Student interest in the course and topics covered were strong and end-of-course student evaluations were positive:

END-OF-COURSE STUDENT EVALUATIONS

Term	Enrollment	Q1	Q2	Q9	Expected Grade	Ave. Hours Spent Outside Class
2019 C	20	4.9	5.0	4.9	12 A; 2 B	2.4 (Range 1-15)
2020 C	20	4.6	4.8	4.5	12 A; 3 B;	2.5 (Range 1-

STUDENT COMMENTS: See Appendix B

Many WPI department heads, as well as our Provost, support the conversion to a permanent course; their comments are presented in Appendix C. The Systems Engineering Program faculty and management are also in unanimous support and have sufficient resources to enable the permanent conversion.

Intended Audience: The course has very broad benefit for all engineering students as well as some Liberal Arts and Business students. The course has proven attractive to a wide variety of majors in Industrial Engineering; Computer Science; Mechanical Engineering; Aeronautical Engineering; ECE; Chemistry; Robotics; Writing; Bioinformatics; and Society, Technology, and Policy studies. Future enrollment is anticipated to be ~25 students per course offering. The course provides support for the ECE curriculum, specifically for the broadening of the ECE curriculum to include a pathway for students who do not want to follow a traditional circuits/devices/electronics pathway. The course would also represent a foundational course for a Systems Engineering/Systems Thinking minor. It might also make student transitions to ECE 2010 and ECE 2799 easier. However, it has very broad application to all science and engineering disciplines, as well as to business and humanities.

Course Rationale: The purposes of this course are to introduce all WPI engineering students (and possibly liberal arts and business school students) to the basic concepts of Systems Thinking and in addition to comply with recent ABET changes. Recent changes to the student outcomes for ABET Criteria 3 require that students demonstrate an ability to identify, formulate, and solve *complex engineering problems* by applying principles of engineering, science, and mathematics. ABET has also added a definition section which defines *complex engineering problems* to include one or more of the following characteristics: involving wide-ranging or conflicting technical issues, having no obvious solution, addressing problems not encompassed by current standards and codes, involving diverse groups of stakeholders, including many component parts or sub-problems, involving multiple disciplines, or having significant consequences in a range of contexts. Additional outcomes include demonstrating an ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors, and an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. The Systems Thinking approach can benefit many scientific, engineering, and business activities and can be an important part of every student's background at WPI. This course complements two other introductory courses in the System Dynamics group: *Introduction to System Dynamics Modeling* (SD 1510) and *Games for Understanding Complexity* (SD 1505). Unlike SD 1510, which approaches Systems Thinking through simulation, and SD 1505, which focuses on dealing with complexity through playing and creating serious games, the proposed course will introduce students to more qualitative concepts of Systems Thinking and provide a foundational basis for

further studies in system dynamics, systems engineering, and all engineering, scientific, and business disciplines, inasmuch as they all would benefit from a Systems Thinking approach.

Learning Objectives:

Upon completing this course, students will be able to:

- Identify systems vs. collections and describe them concisely and accurately with diagrams
- Define and describe Systems Thinking, and articulate the differences between Systems Thinking and linear thinking
- Identify and describe systemic structures (the relationships among system components) and the mental models and underlying forces that generate them
- Develop simple causal loop and stock-and-flow diagrams to describe systems
- Describe at least 5 system archetypes and recognize them in engineering, business, and social settings
- Understand that systems are dynamic and be able to identify the basic elements of system dynamic computer models
- Identify real social, economic, business, and engineering systems and execute a basic analysis of them using Systems Thinking tools

A sample course syllabus is provided in Appendix A.

Implementation Date: C-Term 2020-2021 (24 students have already registered for this course for January-March 2021)

Resources Required: Prof. Monat has taught this course twice and has an interest in continuing to teach the course. Profs. Gannon and Amissah are also qualified to teach it. No new resources are required. No labs are required.

Appendix A. SAMPLE SYLLABUS

Introduction and Description:

Why did the 2009 economic bailout fail to have the intended impact on the U. S. economy? Why did the widespread use of DDT in the 1960s have a devastating effect on our environment? Why have our commercial fishing policies wiped out the fishing industry? Why do companies like Research in Motion, Bank of America, and Netflix so badly misjudge their customers? Why do our foreign policy decisions often do more harm than good? Why did Randy Moss leave the New England Patriots? These are classic examples of failures in Systems Thinking.

Today's complex problems can rarely be addressed using linear or purely technological thinking. Complex systemic issues such as climate change, terrorism, cyber warfare, business profitability, poverty, hunger, religious conflicts, resource management, and clean air and water often involve sociological, psychological, political, economic, environmental, and ethical issues; these ancillary issues *and their interrelationships* often dominate system performance.

Systems Thinking is holistic (integrative) thinking instead of analytic (dissective) thinking; it is the opposite of linear thinking; and it is the recognition that systemic behavior and performance patterns are the result of underlying structures which, in turn, are based on often incorrect mental models. Systems Thinking provides an arsenal of tools that enable program managers and systems engineers to better identify, understand, and control systems in order to improve their performance.

In this course, students will study system identification and delineation, causal loops and feedback, system leverage points, mental models and unintended consequences, and behavior patterns; and use these concepts to improve the performance of engineering, business, and complex social systems. The course will explore great system failures, how they might have been avoided, and how we can learn from them. Examples may include the failure of strictly technological "fixes" to social issues (as in the government's installation of wells in Togo in the 1980s,) the 2008 financial meltdown, the failure of the Lockheed L-188 Electra Turboprop Airplane, the failure of the Tacoma Narrows Bridge ("Galloping Gertie") in 1940, the decline of many commercial fisheries around the world, the failure and success of companies like Research In Motion, Polaroid, and Apple, and the unintended consequences of combating drug-related crime. Finally, students will learn how Systems Thinking explains the occasional irrational behavior of individuals, departments, businesses, and governments.

Teaching Pedagogy:

Readings, papers, quizzes, and a term project comprise the primary learning vehicles for this course. The term project will require the development of a PowerPoint presentation that explains Systems Thinking to high school students. For each class, you will be expected to have read all required assignments and completed all assigned homework so that you are prepared with any questions.

Course Learning Objectives---Upon Completing this Course, Students Will be Able to:

- Identify systems vs collections.

- Define “System” and “Systems Thinking.”
- Identify and define system components and interrelationships using appropriate tools.
- Explain system behavior using the Iceberg Model.
- Develop Behavior-Over-Time, Causal Loop, and Stock-and-Flow diagrams to describe systems.
- Be aware of the dynamic behavior of systems over time.
- Use Systems Thinking principles to prevent failure of and deficiencies in engineered systems such as the Tacoma Narrows bridge, the Vdara Hotel, and the Lockheed L-188 Electra turboprop airplane.
- Explain how and why today’s complex problems can rarely be addressed using purely technical solutions.

Course Materials:

- Required Texts:
 - Kim, Daniel H., Introduction to Systems Thinking, Pegasus Communications, 1999, ISBN 1-883823-34-X. Excellent, concise overview. Posted on Canvas.
 - Meadows, Donella H., Thinking in Systems: A Primer, Chelsea Green Publishing, 2008, ISBN 978-1603580557. (Required sections posted on Canvas).
- Required Papers:
 - Monat, J. P., and Gannon, T.F., “What Is Systems Thinking? A Review of Selected Literature Plus Recommendations,” *Am. J. of Systems Science*, 4:2, 2015 (posted on Canvas).
- References:
 - Senge, Peter, *The 5th Discipline*, Crown Business, 2006, ISBN 978-0385517256
 - Monat, Jamie P. and Gannon, Thomas F., *Using Systems Thinking to Solve Real-World Problems*, College Publications, 2017, ISBN 978-1-84890-235-0
 - Software: *Stella Architect* by isee Systems (provided by WPI)
- Laptop computer and online access to the Internet during every class.

Class Assignments:

You will be assigned readings, projects, homework problems, or a take-home quiz for each class. A team-based term project (6-10 minute PowerPoint presentation) explaining Systems Thinking to high school students will also be required by the end of the course. Except where specifically permitted, *collaboration on homework, quizzes, and papers is strictly forbidden*: you must work these on your own. We have determined that this approach yields the best learning.

Evaluation:

Your final grade will be determined as follows:

- | | |
|--|-----|
| • Term Project (team) (entire course) | 25% |
| • Class Participation (expected at every lecture) | 10% |
| • Presentation on the Limits of Technology (team) (week 2) | 15% |

- Quiz on BOT, CLD, S & F (individual) (week 3) 10%
- Paper on the Iceberg Model (individual) (week 4) 20%
- Paper on Systems Thinking Failures in Engineering Design (team) (weeks 5-6) 20%

Grading Policy: C is for work that is acceptable; B is for good work; A is for excellent work. Work that is turned in late will be marked down 10% for each day (or fraction thereof) late. There will be no exceptions unless discussed with the instructor *prior to* receiving the homework or project.

Attendance and Class Decorum Expectations: Excellent attendance is important and essential for you to learn the material as there are topics to be discussed during class that are *not* addressed in the readings. Attendance of all class sections is expected. Use of cell phones during class is strictly forbidden. In-class discussion and debate are required and are graded; however all students and instructors must be treated respectfully at all times.

Students with Disabilities:

If you need course adaptations or accommodations because of a disability, or if you have medical information to share with me, please either e-mail me at jmonat@wpi.edu or telephone me at 978-897-3420 as soon as possible. Students with disabilities who believe that they may need accommodations in this class are encouraged to contact the Office of Disability Services (ODS) as soon as possible to ensure that such accommodations are implemented in a timely fashion. This office is located in the West St. House (157 West St), (508) 831.4908.

Academic Integrity:

Please become familiar with the *Student Guide to Academic Integrity at WPI* (available on the course website.) Except where specifically permitted, *collaboration on homework, quizzes, and papers is strictly forbidden*: you must work these on your own.

Consequences for violating the Academic Honesty Policy include earning a zero on the assignment, failing the course, or being suspended or expelled from WPI.

Appendix B. STUDENT COMMENTS FROM END-OF-COURSE EVALUATIONS OF 2 PAST OFFERINGS

- The course has more projects than others and real practices of the material we learned in class.
- Many examples to help understand the concepts
- Class well structured

I like how the professor was always engaging and encouraged student participation. The class was also very well taught and as a result I learned a ton about systems thinking. I also feel that this was information that will be relevant to me for the rest of my life and definitely useful to me in the future.

I liked the application of the material we learned in class to every day life. I also enjoyed professor Monat's interest in the class material and his ability to relate the material to real world examples.

New class was handled well and the subject matter was made relevant to all majors. Subject intrigued me and always had me interested in each class.

Systems Thinking is an extremely exciting field that is often overlooked at WPI. It was great to have a course that studies this topic that is relevant in all our lives.

This course is one of the best course I have taken in my WPI career. It was very interesting and the professor was exceptionally caring and professional while also building a relationship with students. Work load, the instructor's enthusiasm and the subject of the course were all extremely like-able.

Amazing course!

Fascinating course, should be required for most majors, gives you important insights about how many things in the world work, and how to avoid pitfalls in products/designs you make.

I liked how we had projects and papers over exams. I think they lead to less stress, more enjoyment, and better understanding and learning of the material.

It's a fascinating subject and one I think can apply to many fields, not just civil engineering.

Subject material was interesting, and participation was encouraged. Monat makes the lectures interesting and applied the topic to examples outside of the class.

The class environment was great: it was friendly and conversation came naturally instead of being forced. The discussions and games we played made class time more engaging.

Appendix C. WPI DEPARTMENT HEAD COMMENTS

Jamal Yagoobi, ME: “I am in support of converting ES150x (Fundamentals of Systems Thinking) to a permanent WPI course. A few years ago, the ME External Advisory Board had advised us on the importance of learning about “systems engineering” topic at the graduate and undergraduate levels. Thus, learning about system engineering will prepare our students well to solve complex socio-economic problems with technical considerations.”

Steve Taylor, Industrial Engineering and Management Engineering: “It looks like a good course to me and yes I am happy to support it. I would imagine that once it passes CAO, it would end up in the consent agenda and not come up for discussion and vote in the faculty meeting. But if it does, I will speak up in favor of it.

In my experience, the primary reason people object is around resources – so the claim of no new resources needed in the proposal feels awkward. We may not need to hire someone new to teach it, but we would need to NOT teach something else in order to have you (or someone else) teach it? We often talk about what won’t be taught or why we have the additional capacity to teach a new course (like a faculty getting tenure and moving from a 3 course load to a 4 course load or changing another course to a category 2, etc).”

Rick Brown, ECE: “Systems Thinking provides students with tools to solve complex socio-economic problems. Based on ES150X’s interdisciplinary appeal and excellent course evaluations in the first two experimental offerings, I support converting this course to permanent status.”

Wole Soboyejo, Provost: “Thank you for reaching out to me. I am delighted by the progress that you have made in the course. I am also very happy with the student responses to the course. I will be happy to speak and write in support of the request to make the Fundamentals of System Thinking Course into a permanent course. Please let me know how I can be of help.”

Craig Wills, CS: Craig was not willing to make a statement of support because he is not familiar with the course, but thinks that the student comments speak for themselves. He says, “I appreciate that you have received positive feedback from CS students who have taken the course. However, I’m not in a position to have first-hand knowledge of the course and therefore do not feel comfortable in providing a statement about it. I would suggest that you can include student comments as those are first-hand documentation for the course.”

Carrick Eggleston, CE: “Hello again- I read this over and I see no reason why I should not support this course, especially since with a total of 40 students who have taken the Course so far, nearly 7% were CEE students. Of course, I would very much like to see examples of infrastructure within broader systems as a major Theme for our department. This is a good start, especially if CE students are taking the course.

So, by way of a few sentences in support:

“The Fundamentals of Systems Thinking course is relevant to many fields, from social science to engineering. Increasingly, I and my colleagues are using systems thinking and systems modeling in our teaching and research - for example, when I taught GE 2342 in

C term 2020, I used systems models extensively in illustrating how the Earth System works. In Civil Engineering, much of our field is coupled to the broader social, climate, water, economic, and energy systems within which infrastructure operates. Moreover, our broadly-defined infrastructure and built environment are in large part the purpose to which many of new and emerging “smart world” and other data tools will be applied. The bottom line is that if we are to meet the challenges at the nexus of climate/energy/water/food/health systems, we will need to recognize how systems of the built environment interacts with more broadly defined natural and social systems. To put it another way, reaching net zero carbon emissions in the next generation, with so many of today's buildings and other infrastructure still operating, will require fundamentally rethinking and retrofitting our built environment In ways many of us have not yet imagined. Systems thinking is crucial to informing the needed imagination.”

Kristen Billiar, Biomedical Engineering: “The BME Undergraduate Curriculum Committee supports making ES150X a permanent WPI ES course as BME students would benefit from the integrative nature of thinking taught in the course.”

Nikolaos Gatsonis, AE: “Is this still in the que? I will be happy to support it but no need for written statement. I am copying to a CAO member to register my support.”

Original Experimental Course Proposal

To: Amy Zeng, Chair, Committee on Academic Operations

From: Jamie P. Monat, Thomas F. Gannon, and Bob Swarz, Systems Engineering Program, ECE

Re: Motion to add experimental course ES 150X *Fundamentals of Systems Thinking*, approved by Systems Engineering Program faculty on 24 November 2017.

Date: 21 February 2018

The Systems Engineering Program requests the approval of the following experimental course (ES 150X, *Fundamentals of Systems Thinking*) in Academic Years 2018-19 and 2019-20

Contact: Prof. Jamie P. Monat

Preferred term: C

Enrollment cap: 25

Course type: Lecture; freshman level introduction

Intended audience: If the course becomes permanent: potentially all engineering students as well as some Liberal Arts and Business students

Anticipated Instructor: Profs. Jamie Monat (1st offering); Tom Gannon

Course/Catalog Description: ES 150X, *Fundamentals of Systems Thinking*

Systems Thinking is a holistic approach to problem solving that recognizes that system behavior and performance are the result of underlying structures. Systems Thinking provides tools that enable program managers, systems engineers, scientists, economists, and business managers to identify, understand, and control systems in order to improve system performance. The Systems Thinking analysis accounts for feedback and resistance to change often exhibited by real world systems. In this course, students will study system identification and delineation, causal loops and feedback diagrams, stock-and-flow diagrams, system leverage points, delays and oscillations, mental models and unintended consequences, and behavior patterns; and use these

concepts to improve the performance of engineering, business, and complex social systems. The course will explore great system failures, how they might have been avoided, and how we can learn from them. Finally, students will learn how Systems Thinking explains the occasional irrational behavior of individuals, departments, businesses, and governments. Examples covered in this course may include the failure of strictly technological “fixes” to social issues (as in the government’s installation of wells in Togo in the 1980s,) the 2008 financial meltdown, the failure of the Lockheed L-188 Electra Turboprop Airplane, the failure of the Tacoma Narrows Bridge (“Galloping Gertie”) in 1940, the decline of many commercial fisheries around the world, the failure and success of companies like Research In Motion and Apple, and the unintended consequences of combating drug-related crime.

Recommended background: None.

Rationale: The purposes of this course are to introduce all WPI engineering students (and possibly liberal arts and business school students) to the basic concepts of Systems Thinking and in addition to comply with recent ABET changes. Recent changes to the student outcomes for ABET Criteria 3 require that students demonstrate an ability to identify, formulate, and solve *complex engineering problems* by applying principles of engineering, science, and mathematics. ABET has also added a definition section which defines *complex engineering problems* to include one or more of the following characteristics: involving wide-ranging or conflicting technical issues, having no obvious solution, addressing problems not encompassed by current standards and codes, involving diverse groups of stakeholders, including many component parts or sub-problems, involving multiple disciplines, or having significant consequences in a range of contexts. Additional outcomes include demonstrating an ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors, and an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

The Systems Thinking approach can benefit many scientific, engineering, and business activities and can be an important part of every student’s background at WPI. This course complements two other introductory courses in the System Dynamics group: *Introduction to System Dynamics Modeling* (SD 1510) and *Games for Understanding Complexity* (SD 1505). Unlike SD 1510, which approaches Systems Thinking through simulation, and SD 1505, which focuses on dealing with complexity through playing and creating serious games, the proposed course will introduce students to more qualitative concepts of Systems Thinking and provide a foundational basis for further studies in system dynamics, systems engineering, and all engineering, scientific, and business disciplines, inasmuch as they all would benefit from a Systems Thinking approach.

Learning objectives:

Upon completing this course, students will be able to:

- Identify systems vs. collections and describe them concisely and accurately with diagrams
- Define and describe Systems Thinking, and articulate the differences between Systems Thinking and linear thinking
- Identify and describe systemic structures (the relationships among system components) and the mental models and underlying forces that generate them
- Develop simple causal loop and stock-and-flow diagrams to describe systems

- Describe at least 5 system archetypes and recognize them in engineering, business, and social settings
- Understand that systems are dynamic and be able to identify the basic elements of system dynamic computer models
- Identify real social, economic, business, and engineering systems and execute a basic analysis of them using Systems Thinking tools

Resource Needs:

The course will be taught in-load by the WPI faculty. If WPI faculty are not available, it should be possible to identify adjunct instructor(s) to teach the course. The course will be taught in existing classrooms. No special laboratory facilities or IT support are required.

Assessment:

The course will be assessed via:

1. Student feedback in the form of end-of-course student evaluations, especially questions 1, 2, 9, and 26.
2. Instructor reflections and feedback upon course completion (e.g., did the course meet the learning objectives or outcomes of what it is designed to address?)
3. Feedback from deans and department heads.

Date: January 21, 2021

To: WPI Faculty

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

Re: Motions for revision to AE graduate courses and degrees

Motion 1. The Committee on Graduate Studies and Research recommends and I move that the following courses, currently cross-listed with the prefix “AE/ME” in the Graduate Catalog (pp. 31-33 of the 2020-21 Graduate 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,” listings of the Graduate Catalog. Additions in underline, deletions in strikethrough. The motion was approved by the AED on 11/24/2020.

AEROSPACE ENGINEERING

1. ~~AE/ME~~ 5101 Fluid Dynamics
2. ~~AE/ME~~ 5104 Turbomachinery
3. ~~AE/ME~~ 5105 Renewable Energy
4. ~~AE/ME~~ 5107 Applied Fluid Dynamics
5. ~~AE/ME~~ 5108 Introduction to Computational Fluid Dynamics
6. ~~AE/ME~~ 6108 Intermediate Computational Fluid Dynamics
7. ~~AE/ME~~ 5220 Control of Linear Dynamical Systems
8. ~~AE/ME~~ 5221 Control of Nonlinear Dynamical Systems
9. ~~AE/ME~~ 5380 Foundations of Elasticity
10. ~~AE/ME~~ 5381 Applied Elasticity

Rationale

The newly established AE Department has set as initiatives to grow its graduate on-campus program and launch an online program in Fall of 2021. These initiatives were presented to the WPI faculty during the discussion and approval of the AE department in Spring of 2020. To accomplish them, a major revision of the AE graduate program and course offerings is required. The revision of the AE graduate programs is accomplished by 5 interrelated motions:

Motion 1 uncross-lists all current 10 AE/ME courses. These cross-listed courses were developed and designed to serve either the AE or ME students, but they can no longer serve the needs of the AE department.

Motion 2 drops from the Aerospace Engineering listings these 10 uncross-listed AE courses along with 10 existing AE courses.

Motion 3 introduces 22 courses which represent consolidation and revisions of existing ones as well as addition of new courses that reflect recent directions in the AED. These AE courses have aerospace-specific content and will allow us to serve the needs of the on-campus and online students. Specifically: (a) 20 have new or revised course descriptions over existing ones, new numbering, and are aligned with the new five curricular areas of the AED: Fluid Dynamics; Propulsion and Energy; Flight Dynamics; and Controls; Material and Structures; General Engineering Topics. (b) 2 new courses provide Graduate Internship Experience (AE 5900) and (AE 6900) for our MS and PhD students respectively.

Motion 4 introduces revisions to the MS, BS/MS and Ph.D. degree requirements and aligns them with the new curriculum. This revision will make our current graduate programs modern, relevant to the priorities of the new AE department, and competitive with other AE graduate programs.

Motion 5 introduces a revised AE 6999 PhD Qualifying Examination description.

Resources and Anticipated Instructors

None.

Impact on Degree Requirements

There is no impact on distribution requirements for the AE program from uncross-listing the 10 AE/ME courses. Motion 3 introduces new AE courses and Motion 4 makes the necessary revisions to degree requirements.

Furthermore, there is no impact on the ME program from Motion 1. The uncross-listed AE/ME courses will remain with the ME prefix under the ME listings in the Graduate Catalog. The ME program has many options over these 10 ME courses as it will retain the sole authority over them. Specifically:

- AE/ME 5380 Foundations of Elasticity and AE/ME 5381 Applied Elasticity have been offered in alternate years and are core subjects in mechanics. ME faculty have taught them as ME 5380 and ME 5381 on several occasions, as recently as of summer 2020.
- AE/ME 5101 Fluid Dynamics and AE/ME 5107 Applied Fluid Dynamics have been offered in alternate years and are core thermofluids subjects. The ME program has faculty who can teach the ME 5101 and ME 5107.
- AE/ME 5104 Turbomachinery is another thermofluids course which has been offered by the ME program as ME 5104 as recently as C Term 2020.
- AE/ME 5105 Renewable Energy has been developed and offered by AE faculty exclusively. If the ME program drops the ME 5105, ME students can take the new AE 5234 Sustainable Energy as an elective.
- AE/ME 5108 Intro to Comp. Fluid Dynamics is a course developed by AE faculty, primarily for AE graduate students. The ME program has been offering a similar course (ME 5001 Applied Numerical Methods in Engineering) and has faculty that can teach ME 5108.
- The courses in controls AE/ME 5220 and AE/ME 5221 were developed and taught exclusively by AE faculty, primarily for AE graduate students. For example, the most recent offering of AE/ME 5220 and ME/AE5221 had only 2 and 3 ME students enrolled, respectively. If the ME program drops ME 5220 and ME 5221, ME students can continue taking the new AE, RBE, ECE or MFE courses in Controls as electives.
- AE/ME 6108 Computational Fluid Dynamics was never offered by AE or ME faculty, so removing the cross-listing has no practical impact on either program.

Implementation Timeline

Implementation date for this action is the 2021-2022 Academic year.

Motion 2: The Committee on Graduate Studies and Research recommends and I move that the following course description be removed from the AE course description in the Graduate Catalog (pg. 31 of the AY 2020-21 Graduate Catalog). This effectively drops the courses from the AE listings. Additions in underline, deletions in ~~striketrough~~. The motion was approved by the AED on 11/24/2020.

1. ~~AE 5101 Fluid Dynamics~~
2. ~~AE 5104 Turbomachinery~~
3. ~~AE 5105 Renewable Energy~~
4. ~~AE 5107 Applied Fluid Dynamics~~
5. ~~AE 5108 Introduction to Computational Fluid Dynamics~~
6. ~~AE 6108 Intermediate Computational Fluid Dynamics~~
7. ~~AE 5220 Control of Linear Dynamical Systems~~
8. ~~AE 5221 Control of Nonlinear Dynamical Systems~~
9. ~~AE 5380 Foundations of Elasticity~~
10. ~~AE 5381 Applied Elasticity~~
11. ~~AE 5102 Advanced Gas Dynamics~~
12. ~~AE 5106 Air Breathing Propulsion~~
13. ~~AE 5110 Introduction to Plasma Dynamics~~
14. ~~AE 5111 Spacecraft Propulsion~~
15. ~~AE 5222 Optimal Control of Dynamical Systems~~
16. ~~AE 5223 Space Vehicle Dynamics and Control~~
17. ~~AE 5224 Air Vehicle Dynamics and Control~~
18. ~~AE 5382 Aeroelasticity~~
19. ~~AE 5383 Composite Materials~~
20. ~~AE 5090 Graduate Aerospace Engineering Colloquium~~

Rationale

The list includes all AE courses. They will be replaced by new courses introduced in Motion 3.

Resources and Anticipated Instructors

None.

Impact on Degree Requirements:

There is no impact on distribution requirements for the aerospace engineering program, or other programs. The 20 AE courses dropped with this motion will be replaced by 22 AE courses added with Motion 3.

Implementation Timeline

Implementation date for this action is the 2021-2022 Academic year.

Motion 3: The Committee on Graduate Studies and Research recommends, and I move that the following course descriptions be added in the AE course description in the Graduate Catalog (pp. 31-33 of the 2020-21 Graduate Catalog). The motion was approved by the AED on 12/9/2020.

Fluid Dynamics

AE 5131 Incompressible Fluid Dynamics

(2 credits)

This course presents topics in incompressible fluid dynamics at the introductory graduate level. Topics are chosen from: continuum fluids; kinematics and deformation for Newtonian fluids; integral and differential form of the mass conservation, momentum and energy equations; potential flows; unidirectional steady incompressible viscous flows; unidirectional transient incompressible viscous flows; boundary layers; vortical flows. Students cannot receive credit for this course if they have taken AE/ME 5101 “Fluid Dynamics” or AE/ME 5107 “Applied Fluid Dynamics.”

AE 5132 Compressible Fluid Dynamics

(2 credits)

This course presents applications of compressible fluid dynamics at an introductory graduate level. Topics are chosen from: conservation laws; propagation of disturbances; compressible flow with friction; method of characteristics, analysis and design of supersonic nozzles, diffusers, and inlets; transonic and supersonic thin-airfoil theory; three-dimensional compressible flows; compressible boundary layers; hypersonic flows; unsteady compressible flows. Students cannot receive credit for this course if they have taken AE 5093 ST: Applied Compressible Fluid Dynamics.

AE 5133 Kinetic Theory of Gases and Applications

(2 credits)

The course presents kinetic theory of gases and its application to equilibrium flows and nonequilibrium flows at the introductory graduate level. Fundamental topics are chosen from: equilibrium kinetic theory; binary collisions; the Boltzmann equation; transport theory and equations. Application topics are chosen from: free molecular aerodynamics; shocks; non equilibrium flows. Students cannot receive credit for this course if they have taken AE/ME 5102 “Advanced Gas Dynamics”.

AE 5134 Plasma Dynamics

(2 credits)

The course introduces concepts of partially ionized gases (plasmas) and their role in a wide range of science and engineering fields. Fundamental topics include: motion of charged particles in electromagnetic fields; equilibrium kinetic theory; collisions; transport theory; fluid equations; magnetohydrodynamic models; sheaths. Application topics are chosen from: plasma diagnostics; plasma discharges; spacecraft/environment interactions, and plasma-assisted materials processing. Students cannot receive credit for this course if they have taken AE/ME 5110 “Introduction to Plasma Dynamics”.

Propulsion and Energy

AE 5231 Air Breathing Propulsion

(2 credits)

This is an introductory graduate level course that covers principles of operation, design, and performance analysis of air-breathing propulsion engines. Topics will be chosen from: jet propulsion theory; cycle analysis of turbojets, turbofans, and ram compression engines; gas dynamics of inlet and nozzle flows; thermochemistry and chemical equilibrium; combustor modeling; hypersonic propulsion; and operation of detonation engines. Students cannot receive credit for this course if they have taken AE 5106 “Air Breathing Propulsion”.

AE 5232 Spacecraft Propulsion

(2 credits)

This course introduces concepts needed to evaluate the performance of the most commonly used electric and chemical spacecraft propulsion systems. Fundamental topics in electric propulsion include plasma generation and ion acceleration, magnetic field design, and beam neutralization. Applications include electrostatic ion and Hall thrusters. Fundamental topics in chemical propulsion include propellant thermochemistry and ideal performance. Applications include bipropellant and monopropellant chemistry, catalyst-bed, and nozzle design considerations. Discussion of each class of thruster will be supplemented with specific examples of flight hardware. Students cannot receive credit for this course if they have taken AE/ME 5111 “Spacecraft Propulsion”.

AE 5233 Combustion

(2 credits)

This course introduces the principles that govern the conversion of chemical energy to thermal energy in reacting flows or combustion. Topics will be chosen from: chemical thermodynamics; chemical kinetics; transport phenomena; conservation equations; deflagrations; detonations; and diffusion flames. The course will also include discussions on energy landscape; combustion in propulsion and power generation devices; and pollutant formation. Students cannot receive credit for this course if they have taken AE5093 ST “Principles of Combustion”.

AE 5234 Sustainable Energy Systems

(2 credits)

The course provides an introduction to sustainable energy systems, outlining the challenges in meeting the energy needs of humanity and exploring possible solutions. Specific topics include: the current energy infrastructure; historical energy usage and future energy needs; electricity generation from the wind; ocean energy (marine hydrokinetic energy; wave energy); tethered energy systems, energy for transportation; fuel cells; solar-photovoltaic systems; geo-thermal and solar-thermal energy; energy storage; and engineering economics. Students cannot receive credit for this course if they have taken AE/ME 5105 “Renewable Energy”.

Flight Dynamics and Controls

AE 5331 Linear Control Systems

(2 credits)

This course covers analysis and synthesis of control laws for linear dynamical systems. Fundamental concepts including canonical representations, the state transition matrix, and the properties of controllability and observability will be discussed. The existence and synthesis of

stabilizing feedback control laws using pole placement and linear quadratic optimal control will be discussed. The design of Luenberger observers and Kalman filters will be introduced. Examples pertaining to aerospace engineering, such as stability analysis and augmentation of longitudinal and lateral aircraft dynamics, will be considered. Assignments and term project (if any) will focus on the design, analysis, and implementation of linear control for current engineering problems. The use of Matlab®/Simulink® for analysis and design will be emphasized. Recommended background: Familiarity with Matlab®. Students cannot receive credit for this course if they have taken AE/ME 5220 “Control of Linear Dynamical Systems”.

AE 5332 Nonlinear Control Systems (2 credits)

Overview of stability concepts and examination of various methods for assessing stability such as linearization and Lyapunov methods. Introduction to various design methods based on linearization, sliding modes, adaptive control, and feedback linearization. Demonstration and performance analysis on engineering systems such as flexible robotic manipulators, mobile robots, spacecraft attitude control and aircraft control systems. Theoretical foundations of machine learning via adaptive functional estimation of dynamical systems. Control synthesis and analysis is performed using Matlab®/Simulink®. Prerequisites: Fluency with the theory of linear dynamical systems and control (AE 5331 or similar). Fluency with Matlab®. Students cannot receive credit for this course if they have taken AE/ME 5221 “Control of Nonlinear Dynamical Systems”.

AE 5333 Optimal Control for Aerospace Applications (2 credits)

This course covers the synthesis of optimal control laws for linear and nonlinear dynamical systems, with a strong focus on aerospace engineering applications. Topics covered include: necessary conditions for optimal control based on the Pontryagin Minimum Principle will be introduced, and including cases of fixed and free terminal time and boundary conditions; will be discussed. Feedback optimal control will be discussed, and the Hamilton-Jacobi-Bellman equation will be introduced. The special case of linear quadratic optimal control; basic numerical techniques such as pseudospectral optimization; and modern machine learning techniques such as reinforcement learning. will be discussed. Examples throughout the course will be based on air- and space vehicle applications, such as flight trajectory optimization. Assignments and term project (if any) will introduce basic numerical techniques and introduce software packages for optimal control. Prerequisites: Fluency with the theory of linear dynamical systems and control (AE 5331 or similar) and with MATLAB programming. Students cannot receive credit for this course if they have taken AE 5222 “Optimal Control”.

AE 5334 Spacecraft Dynamics and Control (2 credits)

Overview of spacecraft orbital and rotational motion. Overview and sizing of actuating devices such as gas jet, electric thrusters, momentum wheels and magnetic torquers. Overview and selection of sensing devices such as sun sensors, magnetometers, GPS, IMUs. Formulation of spacecraft maneuvers as control design problems. Estimation techniques for orbit determination and attitude estimation. Static attitude determination methods. Kalman filtering for attitude estimation. Fundamentals of orbit determination. Attitude control based on Lyapunov methods.

Case studies on feedback attitude regulators and algorithms for linear and nonlinear attitude tracking. Design and realization of attitude and orbital control schemes using Matlab®/Simulink®. Prerequisites: Fundamentals of spacecraft orbital motion and attitude dynamics at the undergraduate level. Fluency with the theory of linear dynamical systems and control (AE 5331 or similar) and with Matlab® programming. Students cannot receive credit for this course if they have taken AE 5223 “Space Vehicle Dynamics and Control”.

AE 5335 Autonomous Aerial Vehicles
(2 credits)

This course discusses the foundations of autonomy of aerial vehicles including fixed-wing aircraft and quadrotor aircraft. Topics covered include: localization using inertial sensors, GPS, and computer vision; extended Kalman filtering for localization; trajectory planning; feedback guidance for trajectory tracking; and low-level autopilot control design. Whereas this course will review aircraft dynamics, familiarity with this topic at an undergraduate level is beneficial. Prerequisites: dynamics and control of linear systems (AE 5331 or similar); fluency with MATLAB or Python programming. Students cannot receive credit for this course if they have taken AE 5224 “Air Vehicle Dynamics and Control”.

Materials and Structures

AE 5431 Solid Mechanics for Aerospace Structures
(2 credits)

This course is an introductory graduate level course. Fundamental topics will be chosen from the following: three-dimensional states of stress; measures of strain; plane stress and plane strain; thermoelasticity; Airy stress function; and energy methods. Applied topics will be chosen from the following: bending and shear stresses on unsymmetric cross-sections; bending of composite beams; bending of curved beams; torsion of thin-walled noncircular cross sections; and failure criteria. Students cannot receive credit for this course if they have taken AE/ME 5380 “Foundations of Elasticity” or AE/ME 5381 “Applied Elasticity”.

AE 5432 Composite Materials
(2 credits)

This course covers the anisotropic constitutive behavior and micromechanics of composite materials, and the mechanics of composite structures at an introductory graduate level. Topics covered will be chosen from: classification of composites (reinforcements and matrices), anisotropic elasticity, composite micromechanics, effect of reinforcement on toughness and strength of composites, laminate theory, statics and buckling of laminated beams and plates, statics of laminated shells, residual stresses and thermal effects in laminates. Students cannot receive credit for this course if they have taken AE 5383 “Composite materials”.

AE 5433 Aeroelasticity
(2 credits)

This course provides a graduate-level introduction to static and dynamic aeroelasticity, for conventional aircraft. Students will be presented with analytical and computational techniques used to model and simulate aeroelasticity. Topics covered will be chosen from: divergence; aileron reversal; airload redistribution; sweep effects; unsteady aerodynamics; and flutter of

wings. Prerequisite: AE 4712 or equivalent course. Students cannot receive credit for this course if they have taken AE/ME 5382 “Aeroelasticity”.

AE 5434 Computational Solid Mechanics
(2 credits)

This course presents finite element methods with applications to structures and structural dynamics at introductory graduate level. It focuses on linear elasticity and topics covered will be chosen from: introduction on numerical methods in solids mechanics; variational methods of approximation; formulation of finite elements and interpolation functions; assembly and solution processes; isoparametric formulation; stress recovery procedures; locking phenomenon; and dynamic problems. The course requires completion of several FEM projects and knowledge of a computer programming language.

AE 5435 Fracture Mechanics
(2 credits)

This course focuses on the analytical techniques and applications of fracture mechanics at introductory graduate level. In particular, there is an emphasis on cracks in linear elastic and elasto-plastic materials encountered in high integrity aerospace structural applications. Topics covered will be chosen from: stress concentration and stress singularity near cracks, computation of stress intensity factors and asymptotic K fields, linear elastic fracture mechanics, energy methods, stability of crack propagation, cohesive fracture, basics of plasticity theory, plastic zone, small-scale yielding (SSY), HRR asymptotic fields, mixed mode fracture and elasto-plastic crack growth.

General Aerospace Engineering Topics

AE 5031 Applied Computational Methods for Partial Differential Equations
(2 credits)

The course provides at an entry graduate level the theory and practice of finite difference and finite elements methods for partial differential equations (PDEs) encountered in fluid dynamics and solid mechanics. Topics covered include: classification of partial PDEs and characteristics; direct and iterative solution methods for solution of algebraic systems; finite difference and finite element spatial discretization; temporal discretization; consistency, stability and error analysis; explicit and implicit finite differencing and finite element schemes for linear hyperbolic, parabolic, elliptic PDEs. The course requires completion of several projects using MATLAB. Students cannot receive credit for this course if they have taken AE/ME 5108 “Computational Fluid Dynamics”.

AE 5032. Aerospace Engineering Seminar
(0 credits)

The Seminar is a degree requirement for all graduate students and is offered during A, B, C, and D term. The Seminar consists of presentations by experts on technical and broader professional topics. Presentations are also offered by graduate students on topics related to their directed research, dissertation, or industrial experiences. The Seminar is offered in pass/fail mode based on attendance.

AE Research Courses

AE 5900. Graduate Internship Experience
(0-3 credits)

A graduate internship is available for MS students in accordance to WPI rules (pg. 17 Graduate Internship Experience.)

AE 6900. Graduate Internship Experience
(0-3 credits)

A graduate internship is available for Ph.D. students in accordance to WPI rules (pg. 17 Graduate Internship Experience.)

Rationale

Motion 3 introduces 22 courses that represent consolidation and major revision of existing ones as well as addition of new courses. These new AE courses have aerospace-specific content and will allow us to serve the needs of the on-campus and online students. Specifically: (a) 20 have new or revised course descriptions over existing ones, new numbering, and aligned with the new five curricular areas of the AED: Fluid Dynamics; Propulsion and Energy; Flight Dynamics; and Controls; Material and Structures; General Engineering Topics. (b) 2 courses provide Graduate Internship Experience (AE 5900) and (AE 6900) for our MS and PhD students, respectively.

A summary is provided in the table below, where “Minor Revision” indicates change in numbering and/or title and minor revisions in the course description. “Major Revision” indicates new course numbering, new title and a heavily revised course description and “New” indicates a new course.

Existing Course	New Course Number, Title, and Description	Type
1. AE 5101 Fluid Dynamics	1. AE 5131 Incompressible Fluid Dynamics	Major Revision
2. AE 5104 Turbomachinery		
3. AE 5105 Renewable Energy	2. AE 5234 Sustainable Energy Systems	Minor Revision
4. AE 5107 Applied Fluid Dynamics		
5. AE 5108 Introduction to Computational Fluid Dynamics	3. AE 5031 Applied Computational Methods for Partial Differential Equations	New Course
6. AE 6108 Intermediate Computational Fluid Dynamics		
7. AE 5220 Control of Linear Dynamical Systems	4. AE 5331 Linear Control Systems	Minor Revision
8. AE 5221 Control of Nonlinear Dynamical Systems	5. AE 5332 Nonlinear Control Systems	Minor Revision
9. AE 5380 Foundations of Elasticity	6. AE 5431 Solid Mechanics for Aerospace Structures	New Course
10. AE 5381 Applied Elasticity		

11. AE 5102 Advanced Gas Dynamics	7. AE 5133 Kinetic Theory of Gases and Applications	Major Revision
12. AE 5106 Air Breathing Propulsion	8. AE 5231 Air Breathing Propulsion	Minor Revision
13. AE 5110 Introduction to Plasma Dynamics	9. AE 5134 Plasma Dynamics	Minor Revision
14. AE 5111 Spacecraft Propulsion	10. AE 5232 Spacecraft Propulsion	Minor Revision
15. AE 5222 Optimal Control of Dynamical Systems	11. AE 5333 Optimal Control for Aerospace Applications	Minor Revision
16. AE 5223 Space Vehicle Dynamics and Control	12. AE 5334 Spacecraft Dynamics and Control	Minor Revision
17. AE 5224 Air Vehicle Dynamics and Control	13. AE 5335 Autonomous Aerial Vehicles	Major Revision
18. AE 5382 Aeroelasticity	14. AE 5433 Aeroelasticity	Major Revision
19. AE 5383 Composite Materials	15. AE 5432 Composite Materials	Minor Revision
20. AE 5090 Graduate Aerospace Engineering Colloquium	16. AE 5032 Aerospace Engineering Seminar	Major Revision
	17. AE 5132 Compressible Fluid Dynamics	New Course
	18. Combustion	New Course
	19. AE 5434 Computational Solid Mechanics	New Course
	20. AE 5435 Fracture Mechanics	New Course
	21. AE 5900. Graduate Internship Experience	New Course
	22. AE 6900. Graduate Internship Experience	New Course

Implementation Date

Implementation date for this action is the 2021-2022 Academic year.

Resource Needs

No additional resources are needed. The 22 courses included in this motion (a) replace 20 courses dropped with Motion 2, (b) add 2 Graduate Internship Experience courses. Therefore, there is no net increase in the number of courses taught by AE faculty. The new courses (content, enrollment, student reviews etc) will be reviewed regularly following AE's formal continuous improvement process.

Impact on Degree Requirements

There is no impact on currently enrolled AE students as a result of Motion 3. The MS, BS/MS and Ph.D. distribution requirements for incoming students to reflect Motion 3 are presented in Motion 4.

Motion 4: The Committee on Graduate Studies and Research recommends, and I move that the Degree description in the Graduate Catalog be modified as follows. Additions in underline, deletions in ~~strikethrough~~. The motion was approved by the AED on 12/9/2020.

Degree Requirements (Graduate Catalog 2020-21 pg. 28)

The AE degrees are based on coursework and Research as shown in Table 1 and Table 2. There are ~~three~~ five curricular areas of study: Fluid Dynamics; ~~and~~ Propulsion and Energy; Flight Dynamics and Controls; Materials and Structures; General Engineering Topics.

~~Each area of study consists of a Core and Breadth components as shown in Table 1.~~

~~Fluids and Propulsion~~

Core

~~AE 5101/ME 5101. Fluid Dynamics (2 credits) or~~

~~AE 5107/ME 5107. Applied Fluid Dynamics~~

~~AE 5106. Air Breathing Propulsion (2 credits) or~~

~~AE 5111. Spacecraft Propulsion (2 credits)~~

Breadth

~~AE 5102. Advanced Gas Dynamics (2 credits)~~

~~AE 5105/ME 5105. Renewable Energy (2 credits)~~

~~AE 5108/ME 5108. Introduction to Computational Fluid Dynamics~~

~~AE 5110. Introduction to Plasma Dynamics (2 credits)~~

~~AE 6108/ME 6108. Intermediate Computational Fluid Dynamics (2 credits)~~

~~Dynamics and Control~~

Core

~~AE 5223. Space Vehicle Dynamics and Control (2 credits) or~~

~~AE 5224. Air Vehicle Dynamics and Control (2 credits)~~

~~AE 5220/ME 5220. Control of Linear Dynamical Systems (2 credits)~~

Breadth

~~AE 5221/ME 5221. Control of Nonlinear Dynamical Systems (2 credits)~~

~~AE 5222. Optimal Control of Dynamical Systems (2 credits)~~

~~Materials and Structures~~

Core

~~AE 5383. Composite Materials (2 credits)~~

~~AE 5380/ME 5380. Foundations of Elasticity (2 credits) or~~

~~AE 5381/ME 5381. Applied Elasticity (2 credits)~~

Breadth

~~AE 5382. Aeroelasticity (2 credits)~~

Table 1. AE Curricular Areas and Courses

Fluid Dynamics

AE 5131. Incompressible Fluid Dynamics (2 credits)

AE 5132. Compressible Fluid Dynamics (2 credits)

AE 5133. Kinetic Theory of Gases and Applications (2 credits)

AE 5134. Plasma Dynamics (2 credits)

Propulsion and Energy

AE 5231. Air Breathing Propulsion (2 credits)

AE 5232. Spacecraft Propulsion (2 credits)

AE 5233. Combustion (2 credits)

AE 5234. Renewable Energy (2 credits)

Flight Dynamics and Controls

AE 5331. Linear Control Systems (2 credits)

AE 5332. Nonlinear Control Systems (2 credits)

AE 5333. Optimal Control for Aerospace Applications (2 credits)

AE 5334. Spacecraft Dynamics and Control (2 credits)

AE 5335. Autonomous Aerial Vehicles (2 credits)

Materials and Structures

AE 5431. Solid Mechanics for Aerospace Structures (2 credits)

AE 5432. Composite Materials (2 credits)

AE 5433. Aeroelasticity (2 credits)

AE 5434. Computational Solid Mechanics (2 credits)

AE 5435. Fracture Mechanics (2 credits)

General Aerospace Engineering Topics

AE 5031. Applied Computational Methods for Partial Differential Equations (2 credits)

AE 5032. Aerospace Engineering Seminar (0 credits)

Table 2. AE Research Courses

AE 5098. Directed Research (credits TBD)

AE 5900. Graduate Internship Experience (1-3 credits)

AE 6900. Graduate Internship Experience (1-3 credits)

AE 6098. Pre-Dissertation Research (credits TBD)

AE 6099. Dissertation Research (credits TBD)

M.S. Degree (Graduate Catalog 2020-21 pg. 28)

~~The Master of Science degree requires the completion of 30 graduate credit hours. Students may complete up to 8 credits of directed research (AE 5098). The distribution of credits is as follows: 18 graduate credits in AE courses, with a minimum of 2 credits in each of the three AE Core Areas of Study (includes a maximum of 8 credits of directed research—AE 5098)~~

~~• 8 graduate credits of free electives in or outside AE~~

~~• 3 graduate credits in applied mathematics (MA 4551, MA 4733, MA 4631, MA 4632, MA 501, MA 507, MA 511, MA 514, MA 521 or any other course with the approval of AE graduate committee)~~

- 1 graduate credit in the Graduate Colloquium in Aerospace Engineering (AE 5090) Prior to registering for directed research AE 5098, the student must have completed at least 6 graduate credits in AE courses.

The Master of Science degree requires the completion of 30 graduate credit hours. The distribution of credits is as follows:

- 20 graduate credits in Aerospace Engineering
 - A minimum of 2 graduate credits in each of the five AE Curricular Areas: Fluid Dynamics; Propulsion and Energy; Flight Dynamics and Controls; Materials and Structures ; General Aerospace Engineering Topics
 - A maximum of 8 graduate credits in AE Research, of which up to 3 may be in Graduate Internship Experience (AE 5900) and the remaining in Directed Research (AE 5098)
 - 0 graduate credits for four terms in Aerospace Engineering Seminar (AE 5032)
- 10 8 graduate credits in electives
 - 8 graduate credits in free electives inside or outside AE
 - 3 2 graduate credits in applied mathematics (MA 501, MA 511 or any other course with the prior approval of AE graduate committee)

TOTAL 30 Credits

The Combined B.S./M.S. Program [Graduate Catalog 2020-21 pg. 28]

~~The AE Program offers a combined B.S./M.S. program for currently enrolled WPI undergraduates. The M.S. degree requires the completion of 30 graduate credit hours. For students admitted in the B.S./M.S. program, a maximum of 8 graduate credits may be counted toward both the undergraduate and graduate degrees. Doublecounted graduate credits must be in courses, including graduate level independent study and special topics. A maximum of four (4) credits can be double counted in courses from Engineering, Basic Science or Mathematics which must be at the 4000 level. A grade of B or better is required for any course to be counted toward both degrees. Acceptance into the B.S./M.S. program means that the candidate is qualified for graduate school, and signifies approval of the graduate courses listed for credit toward both the undergraduate and graduate degrees. Acceptance into the B.S./M.S. program means that the candidate is qualified for graduate school, and signifies approval of the graduate courses listed for credit toward both the undergraduate and graduate degrees.~~

The AE Program offers a combined B.S./M.S. program for currently enrolled WPI undergraduates. The M.S. degree requires the completion of 30 graduate credit hours.

The distribution of credits is as follows:

- 20 graduate credits in Aerospace Engineering
 - A minimum of 2 graduate credits in each of the five AE Curricular Areas: Fluid Dynamics; Propulsion and Energy; Flight Dynamics and Controls; Materials and Structures ; General Aerospace Engineering Topics
 - A maximum of 8 graduate credits in AE Research, of which up to 3 may be in Graduate Internship Experience (AE 5900) and the remaining in Directed Research (AE 5098)

- 0 graduate credits for four terms in Aerospace Engineering Seminar (AE 5032)
- 10 graduate credits in electives
 - 8 graduate credits in free electives inside or outside AE
 - 2 graduate credits in applied mathematics (MA 501, MA 511, or any other course with the prior approval of AE Graduate Committee)
- For students admitted in the B.S./M.S. program, a maximum of 8 graduate credits may be double counted toward both the undergraduate and graduate degrees. Double counted graduate credits must be in courses, including graduate-level independent study and special topics. A maximum of four 4 out of the 8 credits can be double-counted in 4000-level courses from Engineering, Basic Science or Mathematics. A grade of B or better is required for any course to be double counted toward both degrees.

Acceptance into the B.S./M.S. program signifies approval of the graduate courses listed for credit toward both the undergraduate and graduate degrees

Ph.D. Degree (Graduate Catalog 2020-21 pg. 28)

Students are admitted to the Ph.D. program in Aerospace Engineering and must retain a full-time status up to admission to must retain a full-time status by registering for a minimum of 8 credits per semester or a part-time status by registering for a minimum of 4 credits per semester, until they reach the maximum number of credits required by the program. Failure by a student to maintain full-time status or part-time status for one semester will be considered insufficient progress and may result in the removal of the student from the Ph.D. program. Any student pursuing the Ph.D. must establish residency by being in full-time status for at least one continuous academic year.

The course of study leading to the Ph.D. degree in aerospace engineering requires the completion of 90 credits beyond the bachelor's degree, or 60 credits beyond the master's degree.

For students proceeding directly from B.S. degree to Ph.D. degree, the 90 graduate credits should be distributed as follows:

- 30 graduate credits in ~~courses~~ coursework
 - ~~16~~ 18 graduate credits in AE courses (incl. Special Topics, ~~and~~ ISP, and Graduate Internship Experience)
 - 8 graduate credits in courses in or outside of AE
 - ~~3~~ 2 graduate credits in applied mathematics (~~MA 4551, MA 4733, MA 4631, MA 4632, MA 501, MA 507, MA 511, MA 514, MA 521~~ or any other course with the approval of AE graduate committee)
 - 2 graduate credits in computational methods (AE 5031, or any other course with the approval of the AE graduate committee)
- ~~3~~ graduate credits in the Graduate Colloquium in Aerospace Engineering (AE 5090)
- 30 graduate credits in Dissertation Research (AE 6099)
- 30 graduate credits in
 - Additional coursework
 - Additional Dissertation Research (AE 6099)
 - Supplemental Research (AE 5098, AE 6098)

- 0 graduate credits for 1 term in AE 6999 Ph.D. Qualifying Examination
- 0 graduate credits for all terms during residency in AE 5032 Aerospace Engineering Colloquium

TOTAL 90 credits

For students proceeding from Master's to Ph.D. degree, the 60 credits should be distributed as follows:

- 12 graduate credits in AE courses (incl. Special Topics, ~~and~~-ISP, and Graduate Internship Experience)
- 30 graduate credits in Dissertation Research (AE 6099)
- ~~16~~ 18 graduate credits in
 - courses in or outside of AE
 - Dissertation Research (AE 6099)
 - Supplemental Research (AE 5098, AE 6098)
- ~~1~~ graduate credit in the Graduate Colloquium in Aerospace Engineering (AE 5090)
- 0 graduate credits for 1 term during residency in AE 6999 Ph.D. Qualifying Examination
- 0 graduate credits for all terms during residency in AE 5032 Aerospace Engineering Seminar

TOTAL 60 credits

Ph.D. Qualifying Exam and Admission to Candidacy

Admission to Candidacy will be granted when the student has satisfactorily passed the Ph.D. Qualifying Examination (AE 6999). The Qualifying Examination is intended to measure each student's fundamental knowledge in two Curricular Areas to be chosen by the student from the following: Fluid Dynamics; Propulsion and Energy; Flight Dynamics and Controls; and Materials and Structures. The AE 6999 Ph.D. Qualifying Examination is graded using a Pass/Fail system as determined by a) the results from the written Candidacy Test in the two Curricular Areas chosen by the student and b) the student's performance in graduate courses taken at WPI in the same two Curricular Areas.

The written Candidacy Test is typically offered during the first week of B and/or D term. A student will be tested on material from two (2) graduate courses of their choice in one AE Curricular Area and on material from one (1) graduate course of their choice in a second AE Curricular Area. In the term preceding the written Candidacy Test, a student must inform the Graduate Coordinator about their selection of the two Curricular Areas and the three courses. The written Candidacy Test is graded using the Satisfactory/Not Satisfactory Performance (SP/NP) grading system and has no retake.

If a student fails to register or fails to earn a Pass in the AE 6999 Ph.D. Qualifying Examination prior to completion of 18 credits after admission to the Ph.D. program, the student must withdraw from the Ph.D. program by end of the B term or D term of the year registered for the Qualifying Examination.

Rationale

The revisions with Motion 4 align the degree requirements with the new curriculum established with Motions 1-3.

Implementation Date

Implementation date for this action is the 2021-2022 Academic year.

Resource Needs

No additional resources are needed.

Impact on Distribution Requirements

There will be no impact on total distribution requirements for MS, BS/MS and Ph.D. as a result of this motion.

Motion 5: The Committee on Graduate Studies and Research recommends, and I move that the following course description be revised in the AE course description in the Graduate Catalog (pp. 31-33 of the 2020-21 Graduate Catalog). Additions in underline, deletions in ~~strikethrough~~. The motion was approved by the AED on 12/9/2020.

AE 6999. Ph.D. Qualifying Examination
(0 credits)

~~The written Qualifying Examination is intended to measure the fundamental ability of students admitted in the Ph.D. program in the three Core Areas of Study: fluids and propulsion; dynamics and control; materials and structures. The Qualifying Examination is given in the first week of D term and, if required, a retake of the Qualifying Examination is given in the middle of D Term. For students who enter the Ph.D. program in the fall, the Qualifying Examination must be taken after three terms. For students who enter the Ph.D. program in the spring, the Qualifying Examination must be taken after five terms. The Qualifying Examination is graded using a Pass/Fail system with Pass/Fail grading in each of the three Core Areas of Study. A student may attempt the retake Qualifying Exam for the Core Areas of Study failed during the Qualifying Examination. A student must earn a Pass in all three Core Areas of Study in order to earn a Pass in the Qualifying Examination. Admission to candidacy is granted when a student has satisfactorily passed the AE 6999. Ph.D. Qualifying Examination. Requirements: students must be enrolled in the Aerospace Engineering graduate program seeking a Ph.D. degree and must have the appropriate background in the three Core Areas of Study.~~

Admission to Candidacy will be granted when the student has satisfactorily passed the Ph.D. Qualifying Examination (AE 6999). The Qualifying Examination is intended to measure each student's fundamental knowledge in two Curricular Areas to be chosen by the student from the following: Fluid Dynamics; Propulsion and Energy; Flight Dynamics and Controls; and Materials and Structures. The AE 6999 Ph.D. Qualifying Examination is graded using a Pass/Fail system as determined by a) the results from the written Candidacy Test in the two Curricular Areas chosen by the student and b) the student's performance in graduate courses taken at WPI in the same two Curricular Areas.

The written Candidacy Test is typically offered during the first week of B and/or D term. A student will be tested on material from two (2) graduate courses of their choice in one AE Curricular Area and on material from one (1) graduate course of their choice in a second AE Curricular Area. In the term preceding the written Candidacy Test, a student must inform the Graduate Coordinator about their selection of the two Curricular Areas and the three courses. The written Candidacy Test is graded using the Satisfactory/Not Satisfactory Performance (SP/NP) grading system and has no retake.

If a student fails to register or fails to earn a Pass in the AE 6999 Ph.D. Qualifying Examination prior to completion of 18 credits after admission to the Ph.D. program, the student must withdraw from the Ph.D. program by end of the B term or D term of the year registered for the Qualifying Examination.

Rationale

The revised course description aligned with the new degree requirements approved in Motion 4.

Implementation Date

Implementation date for this action is the 2021-2022 Academic year.

Resource Needs:

No additional resources are needed.

Impact on Degree Requirements:

There will be no impact on distribution requirements as a result of this motion

COMMITTEE BUSINESS

Date: January 28, 2021

To: WPI Faculty

From: Committee on Governance (Prof. Boudreau, Chair)

Re: Motion to adopt tenure criteria for Professors of Teaching

Motion: The Committee on Governance recommends and I move that tenure criteria be adopted for Assistant, Associate, and Full Professors of Teaching, and that the tenure criteria be added to Section Two, Part 1.A of the Faculty Handbook, as described below.

Description of the Motion:

The motion establishes tenure criteria for Assistant, Associate, and Full Professors of Teaching to be added to Section Two, Part 1.A of the Faculty Handbook. The proposed tenure criteria are as follows:

Tenure Criteria for Professors of Teaching

Preamble:

The mission and distinctiveness of WPI depends on the essential contributions of teaching-intensive faculty who continuously innovate and improve upon our student-centered educational programs and practices. In part, WPI recognizes the long-term value of these faculty members through a category of tenured and tenure-track teaching-intensive Professors of Teaching, thus providing these faculty members with the highest level of academic freedom and institutional commitment. These positions are part of WPI's broader commitment to inclusive excellence and development and retention of faculty talent aligned with WPI's institutional mission.

Criteria:

Assistant, Associate, and Full Professors of Teaching are expected primarily to contribute to the *teaching mission*¹ of WPI. Therefore the tenure criteria for these faculty members are focused on the quality of their teaching, their broader contributions to WPI's overall teaching mission, and their demonstrated and potential contributions to a broader community of educators, practitioners, and/or scholars within or beyond WPI, especially when it clearly enhances the effectiveness of the candidate's teaching and/or furthers a general understanding of effective teaching practices. Consideration is also given to each candidate's level of active engagement with and service to WPI and/or the broader professional communities. The candidate's activities should demonstrate the capacity for continued excellent performance.

Professors of Teaching are expected to contribute in three categories: teaching practice; continuing professional growth and currency; and service. These categories are defined below.

¹ *The WPI teaching mission is distinguished by inquiry-based learning, open-ended problem solving, and integrative and interdisciplinary thinking. A WPI education balances personal responsibility with cooperation, collaboration, and mutual respect, and encourages critical reflection, sound decision making, and personal growth. WPI prepares*

Teaching Practice: Excellent undergraduate and/or graduate teaching - whether it is delivered in the classroom, through project advising, or via online or blended courses - is a necessary but not sufficient requirement for obtaining tenure as a Professor of Teaching at WPI. Teaching practice is excellent when it is of *high quality* and has *significant impact* on WPI students and curriculum.

In any teaching setting, faculty members must communicate in compelling ways that demonstrably enhance the educational growth of their students. Effective teachers develop students as creative thinkers, life-long learners, and effective communicators able to use evidence with logic, clarity, and persuasion. Effective teachers draw on many skills to support student learning that may include but are not limited to the following (as needed):

- Expertise in and enthusiasm for the subjects taught and projects advised;
- Clear and effective communication of concepts and material taught;
- Awareness of the strengths, weaknesses, and educational needs of their students;
- Development of general strategies for the successful educational advancement of all students;
- Ability to make suitable adjustments to content, organization, and pacing of course and project work to support student learning and engagement;
- Development of inclusive strategies that ensure the success of a more diverse student population;
- Devotion to personalized professional mentorship of students and/or advisees, including as Insight and academic advisors.

Continuing Professional Growth and Currency: Continuing professional growth and currency is a necessary but not sufficient requirement for obtaining tenure as a Teaching Professor at WPI. Professional growth refers to developing knowledge, acquiring skills, and/or accumulating experiences that enhance WPI's educational mission and visibility. Currency refers to making intellectual contributions to and remaining active in professional communities both within and beyond WPI.²

Professors of Teaching are *committed* to meaningful professional growth and currency that has *significant impact* on teaching and learning networks and support systems, on approaches to and understanding of teaching and learning, and/or on one's own scholarly discipline and/or scholarly communities.

Professors of Teaching seek opportunities for ongoing professional growth and currency, especially in ways that inform their own teaching experiments and innovations and disseminate this knowledge to others within and outside of WPI. Professional growth and currency for these purposes takes on many forms that may include but are not limited to the following (as appropriate):

- Assessing and improving courses, projects, curricula, and pedagogy, and sharing their own pedagogical and scholarly discoveries as these emerge;
- Questioning existing teaching boundaries and experimenting with ideas that overcome the

² Currency is not defined by any product or artifact, including peer reviewed journal articles or extramural funding.

- constraints of current teaching practice;
- Remaining active as scholars through the scholarship of discovery, teaching and learning, integration, application and practice, or engagement;
 - Continuing to learn about developments in the field of education to enhance their practice of teaching and educating others of their innovations within and/or outside of WPI;
 - Remaining current in their disciplines and incorporating recent developments in the field into their course teaching and project advising;
 - Understanding student learning and developing creative new approaches to teaching when needed to improve student learning;

Service: Service is a necessary but not sufficient requirement for obtaining tenure as a Professor of Teaching at WPI. The institution flourishes when faculty are fully engaged not only in their classrooms and project advising but also in the lives of the institution, the local community, and professional organizations. Effective faculty members exploit opportunities to contribute to these various communities.

Statement of Support

Teaching and Research Track (TRT) Faculty

October 5, 2020

We, the Teaching and Research Track (TRT) Faculty, wish to express our strong support of the proposed draft for *Tenure Criteria for Professors of Teaching* dated September 25, 2020, and the *Guidance for Documenting and Assessing Activities Toward Tenure*, dated September 16, 2020. We believe these drafts describe a clear, rigorous, and achievable path towards tenure that maintains the current high standards we have set for ourselves and inspires us to do our best work for our students, the institution, and our fields of study. Implementation of this tenure track will show that WPI values our work and expects us to continue to contribute to the institution's mission, now as equal members of the faculty and with the security of academic freedom that tenure confers.

The teaching path to tenure addresses academic freedom and full inclusion in faculty governance for a subset of TRTs. For those TRTs not participating in the teaching path to tenure (because they are not offered or do not choose this path) we believe that secure, longer-term contracts offer the protections needed to achieve a suitable level of academic freedom necessary to vote openly and honestly. Should the teaching path to tenure be established, it will then be critical for the administration to deliver these secure contracts expeditiously. In turn, we expect faculty governance will move swiftly to define all full-time TRTs as Faculty, with the enfranchisement and privileges the status as Faculty guarantees.

We urge you to support the *Tenure Criteria for Professors of Teaching* and the *Guidance for Documenting and Assessing Activities Toward Tenure*. WPI is on the cusp of eliminating the current two-tiered system that relegates TRT's to second-class status and pioneering a way for full representation and participation of all members of the faculty.

Sincerely,

TRT Faculty Council (on behalf of the vote of the TRT Faculty)

Althea Danielski (HUA)

Destin Heilman (CBC)

Ryan Madan (HUA)

Rebecca Moody (HUA)

Geoff Pfeifer (GS)

Zoe Reidinger (BME)

Lou Roberts (BBT)

Lisa Stoddard (SSPS)

Rationale:

The teaching path to tenure we describe here acknowledges the central role that teaching faculty currently play in our academic mission, and - through the proposed tenure criteria - offer definitions of teaching and professional excellence. These definitions reflect best practices at WPI and elsewhere, they identify clearer and more explicit standards for teaching excellence than are available in WPI's current tenure criteria, and they specify the broad range of activities appropriate to the professional growth of our teaching faculty.

1. Rationale for expanding the type of tenured and tenure track ranks to include Assistant, Associate, and Full Professors of Teaching:

There are four primary rationales:

WPI's Institutional Values: Since its founding and now as much as ever, WPI prides itself on its primary mission of educating students. These values drove the bold educational innovations that WPI introduced in 1970. Today, a tenure track to teaching is not only consistent with these stated values, it will also strengthen us as WPI continues to improve, expand, and develop new programs by relying heavily on the efforts of our innovative teaching faculty. Given their vast and important contributions, without which we could deliver neither our core nor our signature academic programs, our teaching faculty deserve equitable treatment relative to their traditional tenured and tenure-track faculty colleagues.

Institutional Commitment: WPI has invested increasingly in promoting excellence in teaching and learning and supporting instructional effectiveness, student learning, and innovation in the curriculum and teaching practice. Faculty hired to teaching-intensive positions have also invested heavily in the institution, developing themselves professionally, joining experimental teaching and advising teams, and contributing greatly to excellence in teaching and advising at all levels, including major courses and MQPs, general education courses including GPS, HUA, and IQP, and academic advising. Most have devoted as much time and professional care to their development as teachers as they would if they were on a tenure track. Given the central role played by our teaching faculty in delivering on our educational mission, WPI should match the individual commitments made by our long-term teaching faculty with a reciprocal institutional commitment to them.

Academic Freedom: Academic freedom at a university is the bedrock of the pursuit of truth and knowledge, of the freedom to be creative, experiment, and take risks, and of the latitude to participate critically in open debate. And tenure is the bedrock of academic freedom. Academic freedom applies not only to research, but also to teaching and to all other activities expected of university professors, and therefore it should be extended to our teaching faculty. Tenure for teaching is particularly critical now, when more than half of our academic credits are delivered by our teaching faculty and as WPI seeks to advance its reputation as a leader in the art, science, and practice of college teaching - encouraging continual growth in teaching effectiveness and enhancement of student learning, developing learning innovations, and fostering our culture of student learning assessment to guide improvements in teaching practice and curricular change. These goals can only be

achieved by a faculty free to take risks in their classrooms, in their project advising, and as they experiment with new forms of educational deliveries.

Tenure also protects faculty members who take part in the shared governance of WPI, enabling them to freely and fully participate on committees and in institutional discussions, deliberations, and debates over policies, programs, and strategic plans in their departments and campus wide. For these reasons, paths to tenure for teaching faculty should be provided to and are just as important for those teaching faculty who, in the judgment of their peers, accept all these responsibilities.

Inclusion and Equity: Broader inclusion and equitable treatment of the teaching faculty will ensure that the experiences, identities, beliefs, and diverse backgrounds and roles of these faculty members enhance the perspectives that contribute to positive change on campus. Such equality will demonstrate the value these faculty members bring and the supported they can expect as vital contributors to WPI's future success. Tenure and the enhanced professional identity it carries will support WPI's strategic commitments to diversity and inclusion and to faculty development.³ Tenure tracks for teaching will strengthen WPI's efforts to attract and retain excellent faculty who will contribute in diverse ways to WPI's unusual teaching mission.

There are four clear benefits:

Institutional visibility and reputation: By adopting a teaching path to tenure, WPI will burnish its reputation as a leader and innovator in higher education —this time, by addressing an obdurate problem in higher education that other institutions have not yet solved. By solving the problem in our own context, we will publicly demonstrate the value WPI places on teaching and learning as we proudly invest in the innovative and outstanding instruction that has made WPI successful. By meeting rigorous standards for effective teaching practice, innovative teaching contributions, and active professional growth, our teaching faculty will engage in activities that will bring external recognition to the institution.

Professionalization of the teaching faculty: A path to tenure will grant teaching faculty the professional identity and professional esteem they currently lack. This identity comes not only from job security, but also from the recognition of tenured colleagues within and beyond WPI. It develops when an individual is held to shared and respected standards of practice (including ambitious and transparent criteria for hiring, tenure, and promotion), undergoes reputable peer evaluations, has access to institutional support for professional growth, and assumes greater intellectual independence than is possible in relative isolation off the tenure track.

Retention and recruitment of excellent teaching faculty: A tenure path for our excellent teaching faculty will dramatically improve their work conditions, enhance their professional status, and increase their investment in the University. These factors, in turn, will increase our chances of retaining the very best of them and will increase their productivity and job satisfaction while they are here. By conducting national searches for

P³ Elevate Impact, 14-15.

new tenure-track teaching faculty in a landscape in which most other institutions can offer only non-tenure track positions, we will be able to recruit the best from among the growing national pool of qualified individuals whose strengths align with the mission of educating our students.

Unity of the faculty: A curriculum and campus culture like WPI's, requiring collaboration in teaching, project advising, research, and governance, functions at greater strength with a unified faculty. By expanding the tenure ranks to our many outstanding teaching faculty, we strengthen all the functions of the faculty, unify our practices, policies, and procedures regarding hiring, evaluation, tenure, and promotion, and reaffirm our commitment to education with the acknowledgement that faculty members are equal partners, regardless of their different roles.

2. Rationale for the proposed Tenure Criteria for Professors of Teaching:

Just as the expectations we have of our teaching professors are distinct from expectations for traditional tenure-track faculty, so too should tenure criteria reflect these differences. Accordingly, the proposed tenure criteria for Professors of Teaching refer to teaching and emphasize professional growth as it is related to teaching. These criteria are meant to be *realistic*—that is, based on current teaching-related expectations for teaching faculty with heavier teaching loads, rather than on unfair new expectations. The criteria are also *rigorous*, reflecting clearer and more exacting standards for teaching excellence in practice and in professional growth. (Guidance for documentation of the tenure candidate's activities toward tenure is included in a separate motion and includes a variety of ways to demonstrate and judge the extent to which those standards are met.) Finally, these standards are *aspirational*, driving teaching faculty to reach higher than they might have done without the expectation and support of an ongoing peer-review process and a community of peers.

Rather than creating a new and very different job description, the teaching path to tenure we describe here acknowledges the central role that teaching faculty currently play in our academic mission. The proposed criteria take scholarly activities into account in a substantive way, but include a broader array of activities that are appropriate for the professional growth of our teaching faculty. This position is consistent with WPI's values as an institution that excels at creating and instilling knowledge and that holds high standards for excellence and innovation in both research and teaching.

Institutional Goals Concerning the Balance of Faculty Composition:

General Principles:

Goals concerning the make-up, composition, and balance of the WPI faculty should be set collaboratively between the President, the Provost, the Deans, the Department Heads, and the faculty through its Faculty Governance representatives and its TRT Council representatives. The goals should be based on WPI's teaching and research mission, the University's priorities and aspirations, and its institutional resources and strategy. These goals should be revisited periodically through campus-wide discussions that either affirm the soundness of the prevailing

goals or develop an understanding and a consensus concerning the reasons and the ways they need to shift.

Specifically, the balance applies to two proportions:

- The first proportion approximates the desired and intended balance between traditional (teaching-research) tenured tenure-track faculty, on the one hand, and the entire teaching faculty (consisting of tenured and tenure-track Professors of Teaching, Professors, TRT Teaching Professors, Professors of Practice, Instructors and Lecturers).
- The second proportion approximates the desired and intended balance between the tenured and tenure-track Professors of Teaching and the remaining non-tenure track teaching faculty (consisting of TRT Teaching Professors, Professors of Practice, Instructors and Lecturers).

Proposed Institutional Balances

In fall 2019, for example, there were 264 TTT faculty members at WPI and 128 full time teaching faculty members. WPI's current goal is to increase the number of traditional TTT faculty to approximately 300 within the next four years. The current faculty make-up embodies today's healthy balance required to carry out WPI's combined teaching and research mission, while the proposed expansion of the traditional TTT faculty is consistent with our goal to further enhance the impact of our research.

With respect to the first proportion, a sound working institutional goal consistent with our current state and direction is to maintain a full-time faculty that is made up of approximately **70 percent** (300/428) traditional tenured and tenure-track (dual mission teaching-research) faculty and **30 percent** (128/428) teaching-mission faculty (consisting of tenured-and tenure track Professors of Teaching, TRT Teaching Professors, Professors of Practice, Instructors and Lecturers).

With respect to the second proportion, we have had several discussions between the faculty and the administration about the number of teaching intensive tenure lines that could and should be opened over a three-year period. The three-year period consists of AY 2021-22, AY 2022-23, and AY 2023-24. These discussions balance considerations of institutional values, institutional commitment, academic freedom, equity and inclusion, institutional flexibility, and the degree of security required for full participation of the teaching faculty in faculty governance. In addition, based on their knowledge of and a thorough survey conducted among the teaching faculty, the TRT Council has provided a well-founded estimate of the number of those faculty members who would be both interested in and see themselves as qualified for placement on a teaching intensive tenure-track as described by the proposed criteria.

Based on this information, a reasonable working three-year goal consistent with administration, TTT faculty, and TRT faculty input is to maintain a full-time teaching faculty that is made up of approximately **40 percent** tenured and tenure track Professors of Teaching and **60 percent** non-tenure track teaching faculty consisting of TRT Teaching Professors, TRT Professors of Practice, and TRT Instructors and Lecturers. It is understood that throughout this three-year period,

tenured and tenure-track faculty members would be appointed in fall 2021, fall 2022, and fall 2023. Consequently, the intention is to reach this three-year goal by fall 2023.

The stated commitments and goals should be revisited periodically through campus-wide discussions, and - while the goals are described quantitatively - there is flexibility in the understanding that they are not exact and can be reconsidered when necessary.

Implementation:

Any implementation plan should be consistent with our five-year institutional goals (proposed above) and should ensure that the institution is served well, that our tenure process remains rigorous, and that our teaching faculty are treated fairly.

General Implementation Principles:

- Decisions about *the number* of tenure-track lines to be opened each year for Professors of Teaching will be made by the Provost with substantial input from the Deans, Department Heads, Department Tenure Committees based on a thorough assessment of the their current teaching faculty, and from the TRT Council based on their knowledge of their own constituency, and monitored by the Provost's office and faculty governance for overall for consistency with institutional goals.
- Decisions about *who will be placed on available tenure lines* will be made collaboratively by Department Heads, DTCs, Academic Deans, Provost, and the individual TRT faculty members themselves. These considerations will include:
 - Past accomplishments of each faculty member;
 - Readiness and/or potential of each faculty member to meet the tenure criteria with an appropriate probationary period;
 - Appropriate balance between senior and junior teaching faculty.
- Decisions about *the length of individual probationary periods* will be recommended to the Provost by the Dean based on a collaboration between the individual faculty member, the Department Head, and the DTC, and the Dean.
- Teaching faculty who are not placed on a tenure-track will receive new secure longer- term contracts (as yet to be determined).
- Resources must be made available to help CTAF to expand its charge and its workload without detriment to the faculty and Faculty Governance staff and without risk to the effective functioning of WPI's tenure review process. Time must be given to CTAF beginning in spring 2021 to revise its processes for tenure reviews to accommodate its expanded charge, including the possible revision of the DTC composition and process.

Overview of Related Governance Processes:

Primary Actions

To be considered for a vote at the January 28 faculty meeting:

- Current Motion: Adopt tenure criteria for those Assistant, Associate, and Full Professors of Teaching.
- Two Related Motions:
 - Adopt guidelines for documenting and assessing activities toward tenure for Professors of Teaching;
 - Revise Part One, Appendix D (THE ROLES PLAYED BY TENURED, TENURE-TRACK, AND NON-TENURE TRACK FACULTY IN CARRYING OUT WPI'S MISSION) of the Faculty Handbook.

Next Actions (to follow in order):

- Feb. 2021 to March 2021: Work with Administration and TRT Council to establish secure contracts for teaching faculty members not placed on tenure-track;
- Feb. 2021 to May 2021: Modify faculty governance processes to provide full governance participation to faculty members who are secure through tenure, the tenure-track, or secure contracts.

Date: January 28, 2021

To: WPI Faculty

From: Committee on Governance (Prof. Boudreau, Chair)

Re: Motion to revise Part One, Appendix D (The Roles Played by Tenured, Tenure-Track, and Non-Tenure Track Faculty in Carrying Out WPI's Mission) in the Faculty Handbook

Motion: The Committee on Governance recommends and I move that the text and title of Part One, Appendix D (The Roles Played by Tenured, Tenure-Track, and Non-Tenure Track Faculty in Carrying Out WPI's Mission) be updated in the Faculty Handbook as described below.

Description of the Motion:

The motion updates the existing Part One, Appendix D of the Faculty Handbook, whose current function is threefold: 1) to describe the respective roles played by the tenured and tenure-track (TTT) faculty and by the (non-tenure-track, NTT) teaching and research track (TRT) faculty; 2) to define an institutional commitment (expressed in terms of credits to be delivered by the TTT faculty) in order to maintain an appropriate balance between the TTT and (NTT) TRT faculty; and 3) to provide for an annual report to the faculty detailing the numbers in and the academic credit delivered by each category of faculty.

In its place, this motion inserts a unified account of WPI's mission across the domains of teaching and research; it sets an institutional goal for the balance between traditional TTT dual mission teaching-research faculty and teaching mission faculty (i.e. TTT Professors of Teaching, NTT Teaching Professors, NTT Professors of Practice, and NTT Instructors/Lecturers); it sets an institutional goal for the balance between TTT teaching-mission faculty (i.e. Professors of Teaching) and NTT teaching intensive faculty (i.e. Teaching Professors, Professors of Practice, and Instructors/Lecturers); and it maintains the annual report to the faculty to be given in terms of the numbers of faculty members in each category rather than in terms of credits delivered by each.

Original Text: (to be replaced)

APPENDIX D: THE ROLES PLAYED BY TENURED, TENURE-TRACK, AND NON-TENURE TRACK FACULTY IN CARRYING OUT WPI'S MISSION

The tenured and tenure track Faculty at WPI play the primary role in fulfilling the University's academic mission, and are committed to shaping WPI's educational programs and to delivering a significant majority of the academic credit offered to WPI students. Consistent with this principle, the University is committed to maintaining a tenured and tenure-track Faculty of sufficient size to allow each tenured and tenure-track faculty member the time to carry out his or her responsibilities to both teach and engage in scholarship at the highest level. WPI meets this commitment by ensuring that the numbers of tenured and tenure-track Faculty at WPI increase at a rate that is commensurate with the University's growth and strategic needs.

WPI also recognizes the importance of the roles played by non-tenure track faculty both as engaging teachers and active scholars. Through their teaching, non-tenure track faculty members enhance new and existing educational programs. Through their research, the non-tenure track

faculty complement and expand the range of scholarly expertise otherwise available on campus. Overall, the non-tenure track faculty provide the flexibility to respond to opportunities that help WPI sustain and build upon its reputation for academic excellence.

Early each fall, the Provost will provide a report to the Committee on Governance detailing the numbers (and full-time equivalents) in each category of faculty, and the percentages of academic credit delivered by each category of faculty across the institution, and within each department, division, and school (including Corporate and Professional Education). In collaboration with the Provost, the Committee on Governance will disseminate a final report to the Faculty and present the results for open discussion at a Faculty meeting during the same year.

Proposed New Text: (to be added)

APPENDIX D: THE ROLES AND BALANCE OF THE FACULTY IN CARRYING OUT WPI'S MISSION

(Approved by the WPI faculty, January 28, 2021)

WPI's mission to create, discover, and convey knowledge at the frontiers of technological academic inquiry requires a faculty that conducts both research and teaching at the highest levels.

Consistent with this mission, the University is committed to maintaining an appropriate balance of faculty members who combine both research and teaching, and faculty members who primarily serve the educational mission as teachers and experts in pedagogy, course design, and course delivery. WPI meets this commitment by aiming to balance its faculty as follows: 70 percent tenured and tenure-track (TTT) dual mission teaching-research faculty⁴ and 30 percent teaching mission faculty⁵.

WPI's initial three-year goal is to balance its teaching mission faculty (by fall 2023) as follows: 40 percent tenured or tenure-track and 60 percent non-tenure-track, with an openness to further increasing the fraction of tenured or tenure-track teaching mission faculty in the years that immediately follow.

These appropriate balances are and will be based on WPI's teaching and research mission, its priorities and aspirations, and its institutional resources and strategy.

The University is committed to maintaining a faculty of sufficient size and balance to allow faculty members the time required to develop professionally and to carry out their responsibilities at the highest level. WPI meets this commitment by ensuring that the number of faculty members at WPI increase in their proper balance at a rate that is commensurate with the University's growth and strategic needs.

⁴ The TTT dual-mission teaching-research faculty consists of Assistant, Associate, and Full Professors.

⁵ The teaching-mission faculty consist of the following: tenured and tenure-track (TTT) Assistant, Associate, and Full Professors of Teaching; and non-tenure track (NTT) Assistant Teaching Professors, Associate Teaching Professors, Full Teaching Professors, Professors of Practice, Instructors/Lecturers, and Senior Instructors/Lecturers.

The University should periodically revisit these commitments and goals through campus-wide discussions that either affirm their soundness or develop an understanding and a consensus concerning changes in mission, priorities, resources, or strategy that would require them to change. While the goals are described quantitatively to provide clarity, there is flexibility in the understanding that they are not exact and can be reconsidered when necessary.

Early each fall, the Provost will provide a report to the Committee on Governance detailing the numbers of faculty in each category across the institution and within each department, division, and school. In collaboration with the Provost, the Committee on Governance will disseminate a final report to the Faculty and present the results for open discussion at a Faculty meeting during the same year.

Rationale:

Appendix D was added in 2011 to clarify faculty roles and define an institutional commitment regarding the balance between the TTT and NTT faculty. This commitment was necessary once the faculty voted to abolish the “3- and 5-year rule” that limited time in service for non-tenure-track faculty members. It was intended to help WPI maintain a strong presence of traditional TTT dual-mission faculty even as the institution relaxed its restrictions on and welcomed longer-term commitments to the NTT faculty.

Today, as we implement a new teaching-intensive path to tenure, WPI’s commitment to both research and teaching at the highest levels depends on maintaining the right balance between dual-mission TTT teaching-research faculty and teaching-mission faculty, and by including a significant number of teaching faculty members within our TTT ranks. The appropriate balance should be based on WPI’s teaching and research mission, the University’s priorities and aspirations, and its institutional resources and strategy.

Specifically, the balance applies to two proportions:

- The first proportion approximates the desired and intended balance between traditional (teaching-research) tenured and tenure-track faculty, on the one hand, and the entire teaching faculty (consisting of tenured and tenure-track Professors of Teaching, TRT Teaching Professors, Professors of Practice, Instructors and Lecturers).
- The second proportion approximates the desired and intended balance between the tenured and tenure-track Professors of Teaching and the remaining non-tenure track teaching faculty (consisting of TRT Teaching Professors, Professors of Practice, Instructors and Lecturers).

In fall 2019, for example, there were 264 TTT faculty members at WPI and 128 full time teaching faculty members. WPI’s current goal is to increase the number of traditional TTT faculty to approximately 300 within the next four years. The current faculty make-up embodies today’s healthy balance required to carry out WPI’s combined teaching and research mission, while the proposed expansion of the traditional TTT faculty is consistent with our goal to further enhance the impact of our research.

With respect to the first proportion, a sound working institutional goal consistent with our current state and direction is to maintain a full-time faculty that is made up of approximately **70 percent** (300/428) traditional tenured and tenure-track (dual mission teaching-research) faculty and **30 percent** (128/428) teaching-mission faculty (consisting of tenured-and tenure track Professors of Teaching, and TRT Teaching Professors, Professors of Practice, Instructors and Lecturers).

With respect to the second proportion, we have had several discussions between the faculty and the administration about the number of teaching intensive tenure lines that could and should be opened over a three-year period. The three-year period consists of AY 2021-22, AY 2022-23, and AY 2023-24. These discussions balance considerations of institutional values, institutional commitment, academic freedom, equity and inclusion, institutional flexibility, and the degree of security required for full participation of the teaching faculty in faculty governance. In addition, based on their knowledge of and a thorough survey conducted among the teaching faculty, the TRT Council has provided a well founded estimate of the number of those faculty members who would be both interested in and see themselves as qualified for placement on a teaching intensive tenure-track as described by the proposed criteria.

Based on this information, a reasonable working three-year goal consistent with administration, TTT faculty, and TRT faculty input is to maintain a full-time teaching faculty that is made up of approximately **40 percent** tenured and tenure track Professors of Teaching and **60 percent** non-tenure track teaching faculty consisting of TRT Teaching Professors, TRT Professors of Practice, and TRT Instructors and Lecturers. It is understood that throughout this three-year period, tenured and tenure-track teaching-mission faculty members would be appointed in fall 2021, fall 2022, and fall 2023. Consequently, the intention is to reach this three-year goal by fall 2023. The proposed version of Appendix D also includes an openness expressed by the administration to further increase the fraction of tenured or tenure-track teaching mission faculty over a longer period of time.

The proposed version of Appendix D also makes clear that the stated commitments and goals should be revisited periodically through campus-wide discussions and that while the goals are described quantitatively, there is flexibility in the understanding that they are not exact and can be reconsidered when necessary.

Date: January 28, 2021

To: WPI Faculty

From: Committee on Governance (Prof. Boudreau, Chair)

Re: Motion to add Guidance for Documenting and Assessing Activities Toward Tenure for Professors of Teaching to the Faculty Handbook

Motion: The Committee on Governance recommends and I move that *Guidance for Documenting and Assessing Activities Toward Tenure for Professors of Teaching* be added to Section Two, Part 1.A of the Faculty Handbook (following the Tenure Criteria for Professors of Teaching), as described below.

Description of the Motion:

The following guidance would be placed in the Faculty Handbook (Section Two, Part 1.A) to follow the separate Tenure Criteria for Professors of Teaching:

Guidance for Documenting and Assessing Activities Toward Tenure for Professors of Teaching:

For Documentation and Assessment of Teaching Practice: When reviewed for tenure, each candidate is expected to submit a teaching portfolio that best demonstrates excellent teaching as measured by the *quality* and *impact* of their teaching skills and activities. The teaching portfolio typically includes a thoughtful statement about the candidate's teaching practices, accomplishments, and approach, as well as sample materials that demonstrates teaching quality and impact.

Teaching activities may include but are not limited to the following:

- Courses delivered, designed, and/or redesigned in any format for undergraduate, graduate, or continuing education students;
- Major Qualifying Projects, Interactive Qualifying Projects, and HUA Inquiry Seminars and Practicums advised or co-advised;
- Dissertations, theses, and research projects advised and co-advised;
- Independent studies supervised;
- Project centers developed, directed, or co-directed;
- Students and research trainees advised or mentored.

The *quality* of each candidate's teaching activities will be assessed for supporting evidence such as - but not limited to - the following:

- Course and project goals that are clear and appropriately challenging, and content that is appropriate to the goals;
- Course activities that are well planned and reflect an effective approach to helping students learn;
- Experiments with new pedagogical techniques;
- Modifications to existing courses based on well-grounded rationale;
- Efforts to support the success of diverse students and students with a range of learning styles;
- Statements and self-reflections demonstrating how one's learning design is grounded in current educational research;

- Use of feedback from students and faculty peers;
- Leadership demonstrated at project centers.

The *impact* of each candidate's teaching activities on students, on curriculum, and on teaching practice (through one's own teaching practices and/or those of their WPI colleagues or their department) will be assessed for supporting evidence such as – but not limited to - the following:

- Student learning outcomes assessment, student engagement, program outcomes, student well-being, and other measures of student success;
- Changes in program curriculum;
- Assessments demonstrating that course, project or program improvements have led to gains in student learning in the short term and/or over time;
- Influence on faculty peers (evidenced in the form of letters and/or rubrics, including from project co-advisors);
- Student reflections on their experiences in MQPs, IQPs, and HUA Inquiry Seminars and Practicums;
- Student reflections on their experiences in dissertation, thesis, or research projects;
- Feedback from project sponsors;
- Relevant awards, honors, or positive media coverage;
- Evaluations by students (through student course evaluations and surveys of former students).

For Documentation and Assessment of Continuing Professional Growth and Currency: When reviewed for tenure, each candidate is expected to submit materials that best demonstrate their *commitment* to and the *impact* of their continuing professional growth and currency, including how it enhances the effectiveness of the candidate's teaching and/or furthers a general understanding of effective teaching practices.

Commitment to continuing professional growth and currency can be documented in a combination of many ways that may include but are not limited to engaging in the following activities:

- Leadership by example, through continued innovation in approach and enhancement of one's own teaching methods;
- Teaching collaborations with other faculty, particularly in new approaches, areas, or pedagogies;
- Development of methods of assessment that better measure educational outcomes;
- Record of active scholarship (of Discovery, Teaching and Learning, Integration, Application and Practice, or Engagement);
- Research collaborations with other faculty, including those regarding teaching practices, theories, or outcomes;
- Involvement in professional and academic creative output, inclusive of performance, visual, and written art forms;
- Organizing and/or participating in teaching institutes, professional workshops, or professional conferences;

- Proposals submitted and grants awarded for funding related to teaching improvements or experiments, scholarship, or fellowships;
- Participation as a mentor in programs within or outside of WPI;
- Participation in competitive external professional development programs;
- Service as a reviewer on national, regional, or local grants panels;
- Completion of professional short courses;
- Earned professional certifications.

The *impact* of professional growth and currency may be on approaches to and understanding of teaching and learning, on teaching and learning networks and support systems (through delivery of workshops, seminars, mentorship, training; involvement in communities of practice, etc.); or on one's own scholarly discipline and/or scholarly communities. Such impact can be documented in a combination of many ways that may include but are not limited to the following:

- New courses, curricula and/or academic programs based on emerging new fields, topics of contemporary relevance and/or interdisciplinary connections between emerging and/or existing areas (including data on enrollments and students positively affected);
- Significant revisions to existing curricula and/or academic programs based on the changing content of a disciplinary field, the emergence of a new field, and/or interdisciplinary connections between emerging and/or existing areas that had not previously been available to WPI students (including data on enrollments and students positively affected);
- Demonstrably effective new or improved techniques or strategies to engage students in in the classroom, via online delivery, or project advising;
- Dissemination of new or improved teaching approaches, techniques and strategies to colleagues at WPI and beyond;
- Adaptation of approaches, techniques, and strategies by other faculty, programs, and institutions;
- Feedback on teaching innovations from faculty peers.
- Feedback on scholarship from peers in the scholarly community and/or beneficiaries of the scholarly work.
- Invited keynotes and other invitations to speak or share teaching materials or scholarly work personally or in a public venue, conference, or workshop;
- Relevant awards, honors, or positive media coverage.

For Documentation and Assessment of Service: Commitment to service can be documented in many ways, including but not limited to engagement in some of the following activities:

- Service to WPI (faculty governance and ad-hoc committees, assistance to administrative offices);
- Service to the candidate's department (curriculum committees, MQP area coordinators, faculty recruitment, seminar series participation and coordination);
- Service to the local community (board and committee membership in social service and cultural institutions, local government participation);

- Service to the profession (participation in national and international committees and panels, in local chapters of professional societies, in conference organization).

Rationale:

Although the guidance for documentation and assessment outlined here is separate from the proposed tenure criteria for Professors of Teaching, it is organized in parallel to those criteria. As a result, the guidance is separated into the main categories of Teaching Practice (sub-divided into *quality* and *impact*), Continuing Professional Growth and Currency (sub-divided into *commitment* and *impact*), and Service.

The itemized lists provided in this proposal are to suggest to tenure candidates and tenure committees the range of specific activities, efforts, and outcomes that are consistent with the tenure criteria for Professors of Teaching. For the purposes of assembling, organizing, and evaluating a tenure dossier, the guidance is arranged according to the following sensibility:

In the category of teaching practice, the candidate's teaching activities (and whatever artifacts may be produced as a result of those activities) are separated and distinguished from the *quality* and *impact* of those pedagogical efforts. The *quality* of teaching practice is then described not by a list of artifacts, but by examples of positive features of one's teaching approach. In documenting quality, the candidate is expected to submit evidence that best demonstrates these or any other positive features of their teaching practices. The *impact* of teaching practice is then measured separately by demonstrable and documentable effects that the one's efforts have had on others who have been exposed to or are knowledgeable about those efforts.

In the category of continuing professional growth and currency, the candidate's *commitment* to continuing professional growth and currency may be documented by specific tangible activities, efforts, and artifacts produced in professional activities beyond teaching practice. The *impact* of this work is measured by demonstrable and documentable effects that one's efforts in this broad professional category have had on curricula, programs, fields of study, and relevant professional communities.

In the category of service, the candidate's commitment may be documented by specific tangible activities, and – if the candidate so chose – could include artifacts that demonstrate the quality of such efforts.

At the same time, there is also an understanding that the boundaries between these categories are not rigid, and as a result items listed in one place may also serve to demonstrate achievement in another.