

**WORCESTER POLYTECHNIC INSTITUTE**  
**March 16, 2017**

**To:** The WPI Faculty

**From:** Mark Richman  
Secretary of the Faculty

The seventh Faculty meeting of the 2016-2017 academic year will be held on **THURSDAY, March 16, 2017** at 3:15 pm in **Olin Hall 107**, with refreshments at 3:00 pm.

1. Call to Order M. Richman
  - Approval of the Agenda
  - Approval of Consent Agenda and Minutes from 2-14-17
2. Opening Announcements M. Richman
3. President's Remarks L. Leshin
4. Provost's Remarks B. Bursten
5. Committee Business
  - Committee on Academic Policy (CAP) M. Humi
  - Committee on Governance (COG) T. Dominko
    - Motion to revise the Membership of the Undergraduate Outcomes Assessment Committee (UOAC) – for brief discussion, only
  - Committee on Graduate Studies and Research (CGSR) K. Troy
    - Motion to change Graduate Certificate and Advanced Graduate Certificate program policies
6. Committee Report
  - Committee on Governance (COG) M. Richman
    - Report on WPI's TTT/NTT Credit-Delivery Balance (for open discussion)
7. New Business
8. Closing Announcements
9. Adjournment

**TABLE OF CONTENTS**  
**Faculty Meeting Materials, March 16, 2017**

	Page
1. Faculty Meeting Minutes: February 14, 2017	3
2. Committee Business	
Committee on Governance (COG)	
Committee on Academic Policy (CAO)	
• Motion to revise the Membership of the Undergraduate Outcomes Assessment Committee (UOAC)	6
Committee on Graduate Studies and Research (CGSR)	
• Motion to change Graduate Certificate and Advanced Graduate Certificate Program policies	8
3. Appendix: Consent Agenda Motions	10
CAO Motion:	
- to add a zero-unit AE 4090 Aerospace Engineering Colloquium	11
- to modify the Aerospace Engineering distribution requirements	13
- to add CHE 4410 Chemical Process Safety Design	14

**WORCESTER POLYTECHNIC INSTITUTE**  
**Faculty Meeting Minutes**  
**February 14, 2017**

**Summary:**

1. Call to Order
2. Opening Announcements
3. President's Remarks
4. Committee Business: CAO, CGSR, COAP
5. Adjournment

**Detail:**

1. Call to Order

The sixth Faculty meeting of the 2016-2017 academic year was called to order at 3:20pm in OH 107 by **Prof. Richman** (ME). The meeting agenda and the consent agenda (including the minutes from January 19, 2017) were approved with one item from CGSR (concerning campus-wide policy changes on graduate certificates and advanced certificates) removed by Prof. Richman for full discussion (with two-week notice) at the March 16 Faculty meeting.

2. Opening Announcements

**Prof. Richman** (ME) announced that the ballots for COG, CTAF, and COAP had been distributed and are due back by noon on February 21<sup>st</sup>. He encouraged everyone to participate in the voting process. He also indicated that COG had been working on ballots for the remaining standing committees by reaching out to many members of the Faculty to gauge their interest in serving. He asked anyone interested in serving to contact any member of COG.

**Dean Heinricher** (UG Stud.) announced that all full-time faculty members would soon see emails asking that they complete the on-line COACHE survey by April 15, and he encouraged all those faculty members to do so.

3. President's Remarks

**President Leshin** thanked David Bunis (General Counsel), Dean Camesano, and all faculty members for their support as WPI works through the issues that have arisen for us from the Executive Order on immigration, and indicated that we are remaining vigilant as any new developments may arise.

**President Leshin** urged all faculty members to attend the Faculty Achievement celebration on February 23<sup>rd</sup>. The event is scheduled to coincide with the Trustees' (On-campus) Retreat from Feb. 21 to Feb. 24. President Leshin described the topics at the two plenary sessions that will be held at the Retreat: an overview from WPI's federal relations firm on the opportunities (such as federal investments in infrastructure, and strengthening of manufacturing and defense) and the challenges that they anticipate in Washington; and a very preliminary projection of where WPI might be (in terms of student, faculty, and staff size) in five years including consideration of the enhancements that might be need in our infrastructure.

4. Committee Business

CAO

**Prof. Sturm** (MA), for the Committee on Academic Operations, moved that the undergraduate student graduation list (previously distributed) be approved for February 24, 2017 graduation. (See **Addendum #1** attached to these minutes.) The motion **passed**.

CGSR

**Prof. Troy** (BME), for the Committee on Graduate Studies and Research, moved that the graduate student graduation list (previously distributed) be approved for February 24, 2017 graduation. (See **Addendum #2** attached to these minutes.) **Prof. Richman** provided an Addendum from the Registrar to accompany the motion, with five Ph.D. students and four master's students added to and one master's student removed from the original list. (See **Addendum #3** attached to these minutes.) The motion **passed**.

## COAP

**Prof. Hansen** (HUA), for the Committee on Appointments and Promotions, moved that the existing “Promotion: Criteria for Promotion in Academic Rank” (Handbook, Part Two, Section 1.D, page 2-7) be replaced with the proposed criteria described in the meeting materials distributed - with two modifications accepted as friendly amendments. The first modification was to insert the following underlined text: “Service is a critical responsibility of all tenured faculty, and thus evidence of service at a level appropriate to the rank is expected.” The second modification was to insert the following underlined text: “Typical elements in a teaching portfolio include a reflective statement of the candidate’s approach to teaching and learning, samples of teaching materials and teaching innovations, and measures of teaching effectiveness or materials that demonstrate student learning.”

**Prof. Hansen** reviewed the proposal and COAP’s rationale. (See **Addendum #4** attached to these minutes.) The current criteria require high quality teaching, high quality scholarship, and leadership in either teaching or scholarship. By contrast, the proposed criteria require high quality teaching and scholarship as well as scholarly contributions with a positive external impact. Scholarly work needs to be disseminated but includes teaching (and project advising) and service activities that have positive external impact. The required “appropriate level of service” is contextual to each candidate’s unique contributions. The proposal also describes the documentation in and the standards for evaluation of the promotion dossier, and points out the need for reviewers to be aware of the potential for bias at every stage of review.

**Prof. McNeill** (ECE) asked if the Administration’s sentiments about the proposal were known. **President Leshin** indicated that she had not had any detailed conversations with the Provost concerning the proposed criteria, but that the brief discussions they have had are entirely consistent with the proposal, which in her view is itself consistent with how they believe the current criteria can be applied, as well.

**Prof. Boudreau** (HUA) wanted clarification on types of dissemination the President and the Provost would accept as legitimate grounds for impact beyond peer-reviewed publications and funded research. **President Leshin** was anxious to see the creative ways in which faculty members will document their cases, but explained that, in project advising for example, contributions would have to be beyond the normal activities required of an adviser. **Prof. Hansen** explained that COAP is committed to applying these criteria in ways that assesses the impact of all contributions. **President Leshin** expressed the hope that the process we have undertaken to fix WPI’s promotion problem has established an awareness of the campus-wide efforts needed to help faculty members make professional decisions that will lead to successful promotion.

**Prof. Jiusto** (IGSD) asked if a process would be put in place so that an unsuccessful promotion candidate would receive constructive feedback. **Prof. Hansen** indicated that the concern about feedback to the candidate will be addressed in a separate motion concerning promotion procedures that he hoped could be brought to the Faculty before the end of the current academic year.

**Prof. Rulfs** (BBT) asked for concrete examples of the ways positive impact can be demonstrated under the proposed criteria beyond peer-reviewed publications and funded research. **Prof. Hansen** responded that supporting materials would be locally situated to a person’s particular background, and – for the scholarship of teaching, for example, - could include making on-campus or off-campus presentations, making teaching materials available on-line, and making contributions to the Center for Project Based Learning.

**Prof. Dominko** (BBT) asked what specific recommendations made by the Task Force on Promotion at WPI were incorporated into COAP’s current proposal. **Prof. Hansen** pointed to the recommendation by the Task Force that a candidate could through service activities demonstrate leadership for promotion, and explained that COAP rejected this idea based largely on feedback received on index cards collected after a promotion presentation made by COAP at the January 2016 Faculty meeting. Instead COAP pursued ideas from Ernest Boyer that were raised at an open meeting in September 2017. Prof. Dominko asked if COAP had adopted any of the recommendations made by the Task Force. Prof. Hansen indicated that the notion of scholarly contributions was an important part of the work of the Task Force.

**Prof. Rudolph** (HUA), recognizing that no list would be exhaustive, agreed with Prof. Rulfs that for clarity and long-term continuity it was important to include in the proposal an explicit list of possible ways that a candidate could demonstrate scholarly impact.

**Prof. El-Korchi** (CEE/FPE) thought that the proposed criteria could be interpreted very narrowly or broadly, and he suggested that we need to ensure that the different interpretations don't create an uneven transition as we adjust to the new criteria. **Prof. Hansen** thought that we will significantly improve the current state of promotion if the criteria are clear and if we provide proper mentoring to our colleagues. He agreed that it will take some time to fix the promotion problem.

**Prof. Gatsonis** (ME) thought that, rather than by revising the criteria, COAP could have solved the problem by making the promotion process – including the oversight role played by Departments and the communication between COAP and the candidate – more explicit and transparent. Prof. Gatsonis also thought that the definition of scholarship in the proposal was convoluted and difficult to interpret, and agreed with others that, instead of defining scholarship, it would be more helpful to list some of the common ways in which evidence of scholarship could be provided. He also suggested adding ways to provide evidence of high quality teaching and service. **Prof. Hansen** did not think that the proposal was unusual in its complexity and thought that it would be understandable to all constituencies.

**Prof. Boudreau** (HUA) was still struggling with the distinction between dissemination, on the one hand, and demonstrations of external impact, on the other. She did not think that it was possible to capture the range of possibilities in a list, but thought that the proposal should include an explicit negative statement that examples of impact should not be limited to peer-reviewed publications and funding. **Prof. Hansen** thought that these concerns were addressed by the statement in the proposal that: "Traditional measures to assess quality do not necessarily accommodate all areas of teaching, scholarship, and service." He pointed out that each candidate can present his or her unique case in the dossier.

**Prof. Burnham** (PH) moved the question. The motion was seconded and **passed**.

The main motion was voted on by paper ballot and **passed**.

#### 5. Adjournment

The meeting adjourned at 4:35pm.

Respectfully submitted,

Mark Richman  
Secretary of the Faculty

#### **Addendum on file with these minutes:**

- 1. Addendum #1 CAO - Undergraduate Student Graduation List - February 24, 2017**
- 2. Addendum #2 CGSR - Graduate Student Graduation List – February 24, 2017**
- 3. Addendum #3 CGSR - Addendum to Graduate Students Graduation List – February 24, 2017**
- 4. Addendum #4 COAP - Presentation on criteria for Promotion to full Professor – February 24, 2017**

**Date:** March 16, 2017

**To:** WPI Faculty

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

**Re:** Motion to revise the membership of the Undergraduate Outcomes Assessment Committee (UOAC)

**Motion:** The Committee on Governance (COG) and the Committee on Academic Policy (CAP) recommend, and we move that the current language describing UOAC membership (in Part One, Bylaw One, Section X of the Faculty Handbook) be revised, as described below.

**Description of the Proposed Modifications to Part One, Bylaw One, Section X:** (with added text in **bold** and deleted text ~~struck through~~):

X. The Undergraduate Outcomes Assessment Committee (UOAC) consists of the following members: four Faculty Members elected for staggered, three-year terms, a member appointed annually by the Committee on Academic Policy (CAP) from among ~~its elected~~ **the Faculty Members**, one undergraduate student appointed by the Student Government Association, a representative of the Provost's Office, ~~and ex-officio the Director of the Center for Educational Development, Technology, and Assessment~~ **Morgan Teaching and Learning Center (ex-officio), and the Director of Institutional Research (ex-officio)**. One of the four elected Faculty Members shall be elected from the Faculty at-large. The other three shall be elected by the entire Faculty but shall be chosen from among the following departmental groupings: One chosen from the Engineering programs; one chosen from the Natural Sciences, Math or Computer Science; and one chosen from ~~Management, The Foisie School of Business,~~ **Social Science and Policy Studies, or IGSD.**

The UOAC shall function as a permanent subcommittee of CAP. It shall report to CAP and forward recommendations for Faculty action to CAP for its consideration and possible recommendation to the Faculty.

The UOAC is responsible for:

- a. proposing policy with regard to WPI's undergraduate learning outcomes;
- b. identifying and facilitating procedures for assessing those outcomes;
- c. coordinating outcomes assessment activities on campus;
- d. communicating assessment results; and
- e. formulating academic policy recommendations based on its assessment activities.

The Committee is not responsible for the assessment of departmental majors or programs, but for the identification and assessment of learning outcomes that arise from the undergraduate curriculum broadly defined, including assessment of the first year program.

**Rationale:**

The motion updates the Faculty Handbook with regard to new titles and offices and adds the Director of Institutional Research to the membership of UOAC. In spring 2016, WPI hired its first Director of Institutional Research. Her responsibilities include supporting the Committee and the Dean of Undergraduate Studies in the assessment of undergraduate learning and the documentation of learning for both NEASC and ABET accreditation. It is expected that the

Director of Institutional Research will work closely with UOAC to improve our learning outcomes, design methods for assessment of those outcomes, analyze data, and communicate performance on learning outcomes to the faculty.

The Undergraduate Outcomes Assessment Committee believes strongly that the Director of Institutional Research (IR) should be an *ex-officio* member of UOAC. The Director of IR will be more than a source of data for UOAC; this person's knowledge and ability to design assessment strategies and help carry out committee decisions are essential to the effective functioning of the committee. When the Assessment Plan for Institutional Learning Outcomes was approved by the Faculty in April 2005, it called for the Provost's Office to designate an "Assessment Coordinator" who would have responsibility for data collection and coordination. An Assessment Coordinator was never appointed, and the absence of this expertise has been a challenge for UOAC for more than a decade.

When the new position of Director of Institutional Research was under discussion at WPI, UOAC was a strong advocate since IR offices play a central role in assessment of learning outcomes at most institutions. Naming the Director as an *ex-officio* member of the committee will formalize her commitment of time to assessment work deemed important by the Faculty as part of her professional responsibilities. In this way, the Faculty and the quality of our undergraduate curriculum will benefit from greater assurance of this support in the future.

A specific example that illustrates the importance of the Director of IR to a well-functioning outcomes assessment system follows. In recent years many WPI constituencies have discussed the value of developing a periodic survey of recent alumni, and UOAC would like to lead that effort for purposes of outcomes assessment. While the current membership of the committee has some expertise in assessment design and implementation, the consistent participation of an assessment professional like the Director of Institutional Research would be invaluable in that process. As a member of the committee, it will be natural and appropriate for the Director to coordinate an alumni survey in collaboration with the other members of the committee.

Finally, we understand that it is desirable for faculty governance committees to have a majority of faculty members among their membership. The addition of the Director of IR to the committee would still leave the committee with a 6:3 ratio of faculty members to others on the committee. Also, UOAC is a standing sub-committee of CAP, which must approve all UOAC supported motions. The ratio of faculty members to others on CAP is 6:3, and three of the non-faculty members on UOAC and CAP are students.

In addition, the proposal would delete the requirement that the UOAC member appointed by CAP actually be an elected member of CAP. Making this change would give CAP the latitude to appoint a CAP member or other faculty member with the interest, expertise and time to serve on UOAC. UOAC has found that the liaison duties are infrequent and the Dean of Undergraduate Studies, who serves on both CAP and UOAC, also acts as a liaison between the committees.

**Date:** March 17, 2017  
**To:** WPI Faculty  
**From:** Committee on Graduate Studies and Research (K. Troy, Chair)  
**Re:** Motion to change Graduate Certificate and Advanced Graduate Certificate program policies

**Motion:** The Committee on Graduate Studies and Research recommends and I move that the Graduate Certificate and Advanced Graduate Certificate Programs section of the WPI Graduate Catalog be modified as described below.

**Description of Proposed Modifications to Graduate Catalog:** (p.7 of the 2016-2017 Graduate Catalog under the heading **Graduate and Advanced Graduate Certificates**, and subheading **Admission and Matriculation**)

*Current Wording:*

Admission to a certificate program is granted by the faculty of the sponsoring department through the Graduate Admissions Office. A student accepted into a master's or doctoral program cannot retroactively apply to a certificate program. Only two courses taken prior to application to a certificate program may be counted toward a certificate program. If a student goes beyond the second course as a non-degree student, then those courses cannot be applied to a graduate certificate. A Graduate or Advanced Certificate will not be awarded without acceptance into a program.

*Proposed Wording: (with additions in underline, deletions ~~struck through~~)*

Admission to a certificate program is granted by the faculty of the sponsoring department through the Graduate Admissions Office. A student accepted into a master's or doctoral program ~~cannot retroactively~~ may apply to a certificate program only after the graduate committee of the degree (MS or PhD) granting program or department approves, and as long as all of the following conditions are met:

- 1) Admitted master's or doctoral program students may be awarded one certificate for which course credits are used to satisfy requirements for both the graduate degree (MS or PhD) and the Graduate Certificate or advanced graduate certificate.
- 2) Graduate course credits used to satisfy the graduate certificate or advanced graduate certificate and graduate degree (MS or PhD) requirements cannot also be counted toward a third credential, such as a Graduate Certificate, Advanced Graduate Certificate, graduate or undergraduate degree.
- 3) No more than one-third of course credit applied to a Graduate Certificate or advanced Graduate Certificate or graduate degree can be earned by transfer credit.

Only two graduate courses taken prior to application to a certificate program may be counted toward a certificate program. If a student goes beyond the second course as a non-degree student, then those courses cannot be applied to a Graduate Certificate. A Graduate or Advanced Certificate will not be awarded without acceptance into a certificate program.

**Rationale:**

Many WPI graduate degree programs are broad and multi-disciplinary. Students applying to a specific engineering, science, or business graduate degree program may have interests applied to a variety of disciplines, such as Innovation and Technology Management, Data Science, Systems Engineering,

Bioinformatics, and Robotics. Enabling students to apply for and double count courses toward their degree program and a graduate certificate or advanced graduate certificate, will allow students to demonstrate on their transcript that they have satisfied the requirements to earn a specialized degree in a focused disciplinary field, in addition to earning a graduate degree in their major field of study.

**Impact on Degree Requirements:** There is no anticipated impact on graduate degree requirements or Graduate Certificate requirements. The motion simply gives students the option to design a focused program of study that will enable application of elective course credits earned through graduate degree programs toward a certificate in a specific field. Students are required to apply to the Graduate Certificate program, thus the quality and quantity of students earning the certificate remains under the control of the individual certificate-granting programs. By restricting students to earning a single certificate and retaining the requirement that students apply to the certificate after taking no more than two courses, the spirit of the original policy is retained in that students are not allowed to “retroactively” apply for certificates for which they have satisfied the requirements (in addition to the requirements for the degree program in which they are enrolled).

Note that items 2 and 3 in the suggested catalog revision above are already consistent with existing university policy, but are restated in this section for clarity.

**Resources and Anticipated Instructors:** No new resources required.

**Implementation Date:** Implementation date for this action is the 2017-2018 academic year.

**Appendix: Consent Agenda Motions**

**Date:** March 16, 2017  
**To:** WPI Faculty  
**From:** Committee on Academic Operations (Prof. Iannacchione, Chair)  
**Subject:** Motion to add a zero-unit AE 4090 Aerospace Engineering Colloquium

**Motion:** On behalf of the Aerospace Engineering Program, the Committee on Academic Operation recommends and I move that a zero-unit course AE 4090 Aerospace Engineering Colloquium (described below) be added.

### **Proposed Course Description**

*AE 4090 Aerospace Engineering Colloquium (0 units, Cat. I)*

This pass/fail graduation requirement is intended for students with ongoing or completed project experience (ISP, IQP, MQP) and is offered under the supervision of an Aerospace Engineering faculty. The Aerospace Engineering Colloquium convenes once per week, every A, B, C, and D term. Students are required to register for a minimum of two terms during which they are expected to make presentations on their ongoing or previously completed project experience (ISP, IQP, or MQP). Students are also required to attend Colloquium seminars by experts on subjects such as engineering ethics, professionalism, career guidance, and library research skills.

Recommended Background: students majoring in Aerospace Engineering with ongoing or completed project experience (ISP, IQP, or MQP.)

### **Anticipated Instructor**

A faculty member from the AE Program will be the instructor of record for this Colloquium during A, B, C and D terms.

### **Rationale:**

The proposed zero-unit Colloquium follows the structure currently used by the zero-unit, MA4216 Actuarial Colloquium.

The Aerospace Engineering Program has held weekly meetings for several years on an informal, unofficial basis, with students attending if they have no course conflicts. The weekly, Friday afternoon meetings have been very successful in helping students develop professional communication skills, which culminate with Project Presentation Day, during which student groups present their projects to a panel of judges in a conference style meeting. Employers have noted and are impressed that newly hired AE graduates are very comfortable with technical presentations. Much of this preparation is a result of the regular practice the students receive presenting progress to their peers and AE faculty over three academic terms. However, because students do not register for these informal meetings they do not appear on their Bannerweb schedule. This makes it difficult to ensure that students have the Friday afternoon time block open.

The Colloquium addresses all these issues and allows us to introduce and assess the ABET-required outcomes “(f) an understanding of professional and ethical responsibility,” and “(g) an ability to communicate effectively.” First, the Colloquium will provide a vehicle with which students are introduced on the subject of engineering ethics, library research tools, and skills related to resume preparation and interviewing. By having a formal Colloquium we will be able to demonstrate in ABET reports that students are receiving instruction in topics addressing these areas critical to their future and professional success. Second, the Colloquium addresses the “communication” outcome. Students will be required to make short presentations related to their MQP, IQP, ISP, and research or industrial experiences. Students will receive feedback and questions from the faculty in attendance as well as their peers. Requiring registration for a minimum of two terms out of four terms allows flexibility in scheduling.

Assessment will consist of recording attendance and the quality of the presentations.

**Implementation Date:** Implementation date for this action is the 2017-2018 Academic year.

**Resource Needs:** An instructor from the AE Program already supervises the (informal) Friday meetings as part of his teaching load. No additional resources are required as this will be part of the nominal load of the instructor of record.

**Impact on Distribution Requirements:** There is no impact on the distribution requirements as the Colloquium has zero-credit and this arrangement merely formalizes current practice.

**Date:** March 16, 2017  
**To:** WPI Faculty  
**From:** Committee on Academic Operations (Prof. Iannacchione, Chair)  
**Subject:** Motion to modify the Aerospace Engineering distribution requirements

**Motion:** On behalf of the Aerospace Engineering Program, the Committee on Academic Operations recommends and I move that the program distribution requirements for the Aerospace Engineering Major be modified as described below.

**Description of Proposed Modifications:** (Additions are indicated with an underline. Deletions are indicated with ~~overstrike~~)

<b>REQUIREMENTS</b>	<b>MINIMUM UNITS</b>
1. Mathematics and Basic Sciences (Notes 1,2,3,4)	4
2. Engineering Science and Design (Includes MQP) (Notes 5,6, <u>9</u> )	6
.	
3. <u>Aerospace Engineering Colloquium</u>	<u>0</u>
.	

**NOTES:**

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9. Must include an activity in professional and ethical responsibility, and communication (Fulfilled by a minimum of two terms of the zero-unit Aerospace Engineering Colloquium 4090)

**Rationale:**

ABET requirements include the following two outcomes: “(f) an understanding of professional and ethical responsibility,” and “(g) an ability to communicate effectively.” These requirements are currently partially addressed through informal meetings held every Friday, in which MQP students present updates to their peers and AE faculty. We propose to convert these informal meetings to a zero-unit pass/fail Aerospace Engineering Colloquium to be introduced in a separate motion. The AE Colloquium will have formalized content that addresses the two ABET outcomes. The zero-unit Aerospace Engineering Colloquium will be offered during A, B, C and D terms and will be open to students with current or completed project experience (ISP, IQP or MQP). By requiring AE majors to take a minimum of two terms of the Colloquium we can ensure that the outcomes are met by those who pass the Colloquium.

**Implementation Date:** Implementation date for this action is the 2017-2018 Academic year.

**Date:** March 16, 2017  
**To:** WPI Faculty  
**From:** Committee on Academic Operations (Prof. Iannacchione, Chair)  
**Re:** Motion to add CHE 4410 Chemical Process Safety Design

**Motion:** On behalf of the Chemical Engineering Department, the Committee on Academic Operation recommends and I move that CHE 4410 Chemical Process Safety Design, as described below, be added.

**Proposed Course Description:**

*CHE 4410 Chemical Process Safety Desig (Cat.II).*

Application of chemical engineering design principles to the design of the process safety and environmental controls of a major chemical plant. Students work in groups to produce a preliminary practical flowsheet, equipment design and controls, and economic analysis, all associated with chemical process safety components within a plant. The course will also include an introduction to modeling of off-site impacts.

*Recommended background:* familiarity with techniques and procedures of chemical engineering design (CHE 4403), working knowledge of thermodynamics, heat, mass and momentum transfer, inorganic and organic chemistry, chemical kinetics and reactor design.

This course meets the requirements for a core course and a Capstone Design course in chemical engineering. Students may not receive core credit for both CHE 4404 and CHE 4410.

**Anticipated Instructor:** Stephen Kmiotek, Prof. of Practice, or other qualified ChE faculty.

**Rationale:**

The chemical industry has witnessed several significant chemical process safety incidents, including explosions at several chemical plants near WPI, such as the now closed ChemDesign in Fitchburg, an ink manufacturer in Danvers, and Dow Chemical's North Andover facility. In response to incidents such as these, OSHA and USEPA have established regulations that, if implemented by sites, reduce the risk for such incidents.

Furthermore, as a result of a significant runaway reaction incident at a US chemical facility, the Chemical Safety Board investigation found that process hazard analysis and process safety education was lacking in the undergraduate ChE curriculum in the US. They recommended that ABET and AIChE require that for accreditation, students must have some understanding of process hazards. That caused AIChE to change their program criteria to read: "The curriculum must include the engineering application of the basic sciences to the design, analysis, and control of chemical, physical, and/or biological processes, including the hazards associated with these processes." (<http://www.abet.org/DisplayTemplates/DocsHandbook.aspx?id=3143>)

To respond to these ABET and AIChE requirements, the ChE department introduces chemical process safety in the sophomore curriculum and then specifically addresses the analysis and control of hazards in the Chemical Plant Design courses, ChE4403 and 4404. This course would significantly strengthen the department's efforts to satisfy this criterion by adding an integrative, capstone experience in chemical process safety.

The process safety regulations require chemical facilities to design process safety systems and conduct engineering evaluations of the impacts of potential incidents. These requirements are not currently addressed elsewhere in the curricula. This course is specifically intended to address these gaps by conducting a capstone design project of the chemical process safety systems within a plant. The design includes all aspects of a traditional plant design, including the preparation of flow and control diagrams, equipment sizing, operability concerns, and economic analysis, but focuses on the design of the process safety systems of a portion of the plant instead of covering the production unit operations of the entire plant. So, for example, the course may cover the design of a specific reactor containing a toxic and/or flammable chemical and its pressure relief system. To accomplish this, the vessel system, including materials of construction and temperature and pressure rating would be determined, the quantity and characteristics of gas/vapor generated from an incident would be determined, and the design of the relief system to protect people, the environment, and the assets would then be designed. In addition, the fire protection, the environmental protection systems, and the systems to safely vent releases would be designed. However, the course would not address the design of the entire plant, the heat exchange network, the separation systems, etc. The course would also include an introduction to dispersion modeling for atmospheric releases, including overpressurization hazards from explosions.

Furthermore, with current enrollments and the limitations on class size during the Capstone Design course, CHE 4404, half of senior students would have to defer this project to D term of their senior year. This course provides a second option for students. Both courses have enrollment caps of approximately 40-50. Professor Starr is supportive of providing this offering and assisted in developing the syllabus and content.

This course is to be a one-term undergraduate core course, being 1/3 unit. It can be counted towards an Environmental Concentration in Chemical Engineering.

#### **Metrics for Student Evaluations:**

This course is a Capstone Design project and no tests were given either time CHE 441X was taught; the object of the class is for conducting a capstone design. Weekly homework assignments consistent with portions of the design were assigned, but represented a minor portion of the grade.

No students received an NR in the class. In fact, students were highly engaged, participated extensively, and submitted complete, thorough, well-thought out, practical designs. Design reports were on the order of 100 pages, which would be typical for this scope in industry. No design contained impractical or improbable elements or features. All designs met the goal of ABET's and AIChE's directive. As a registered professional engineer, I would be comfortable certifying all the designs that were submitted.

#### **Evaluation of the Experimental Course**

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

Table 1: Average Student Evaluations

Year	# Students Enrolled	# Responses	Q1	Q2	Q9
B-2015	41	30	4.8	4.8	4.4
B-2016	38	22	4.7	4.8	4.5

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

Table 2: Average Number of Hours Spent Outside of Class

Year	1-5	6-10	11-15	16-20	>20
B-2015	24%	41%	24%	8%	3%
B-2016	23%	50%	27%	0%	0%

In addition, students were asked to provide specific feedback as to the perceived value of the class to their professional preparation, how the class could be improved, etc. These questions were asked in context of internships and co-ops that many students participated in, so it was based, at least in part, on their experience and not whether they simply found the material interesting.

After the first year, students specifically requested greater instruction on reading and interpreting applicable design codes and greater instruction on physical design of routine unit operations (such as tanks, pumps, etc.) which were not covered in Design I.

In the second year, both these suggestions were addressed, with sections added to both code compliance and physical design of simple systems. Comments from the second year are provided below:

*I found the project to be very interesting and more targeted towards the type of work we'd be doing in the real world. I enjoyed learning about areas that might not be immediately considered when designing a plant, but that are very important. It was an interesting blend of complex design calculations and simple "common sense" fixes that require a new mindset to figure out.*

*I liked how we could apply real design concepts and get a feel of the "real world" safety specifications through our project.*

*I really enjoyed having exposure to the safety side of my major. I think the class taught a lot of practical things that we need to do in industry that I did not get from my other major classes. I also think it is valuable to have a class where we replace a part of a system and bring it to code as opposed to designing a new system from scratch because the latter will most likely be more common.*

*One of the best classes I have ever taken. Learned a lot about safety management, which is a topic I believe everyone should understand.*

*We were learning about real life safety design which is something I will find very useful in my field professor kmiotek is great. he's so helpful and involved. he wants his students*

*to ask questions and understand. he's passionate about what he's teaching and passes it onto the class. it's a great class and the project was wicked interesting.*

*While I found process safety very interesting, I wish there was a way that students could learn both Process Safety and general plant design (like in the Design II class). Maybe offering the two classes in different terms so a student could potentially take both classes if they wanted to, or offering a way to audit one class or the other could help this*

*Prof. Kmiotek offered a unique opportunity to learn about an aspect of chemical engineering and design that aren't usually covered in the other ChE required classes. I feel that I have a new way of looking at processes and design challenges.*

During preparation of the experimental course, the course content, schedule and syllabus were reviewed by members of the Fire Protection Engineering Department to ensure content was consistent with their curriculum and needs and to ensure that ChE students entering the FPE program would be appropriately prepared. Following the delivery of the course for two years, the course content, schedule and syllabus were reviewed with process safety faculty at Texas A&M University, well known for their process safety program, and with engineers at ARUP, an international firm that provides process safety support to industry. The content of CHE 441X was determined to be consistent with the Texas A&M safety course content, except that CHE 441X focused on design elements, as intended, whereas the Texas A&M course content focused more on regulatory /management requirements and toxicology, as it has a different focus. Both ARUP and Texas A&M commented on the need to include process safety in prospective design (rather than prescriptive analysis of existing designs, which is what the Texas A&M system tends toward) and were both supportive of the course.

We have not yet had an ABET review to determine if the course content meets AIChE and ABET recommendations. However, given Prof. Kmiotek's years of experience designing and installing process safety management systems at Dow and elsewhere, we are confident the system meets current standards.

**Implementation Date:** Implementation date for this action is the 2017-2018 Academic year. Although this is a Cat. II course, we plan to offer it every year for the foreseeable future.

**Resource Needs:** Prof. Kmiotek, or other qualified ChE faculty, will teach this Cat II course as part of his/her normal teaching load. At present, our Professor of Practice, Steve Kmiotek is our only qualified faculty member, but we anticipate training one of our recently hired faculty members over time. We are also identifying industrial collaborators who could teach the course as adjuncts, if necessary. A classroom suitable for 50 students with normal AV equipment is required. No other resources are required.

**Impact on Distribution Requirements and Other Courses:** CHE 4410 can be used as a capstone design core course toward the Chemical Engineering Distribution requirements. Note 3 of the distribution requirements shown on page 61 of the current catalog should be changed as shown by italicized and underlined additions to read "..., 1/3 unit of capstone design experience (e.g. CHE 4404 or CHE 4410), ..." Similarly, note 4 on the same page should include the new course in the list of core courses as "...CHE 4402, CHE 4403, CHE 4404 (or CHE 4410), CHE

4405.” The course can also be used towards an Environmental Concentration in Chemical Engineering and should be added to the list of approved courses on page 62 of the current catalog, between CHE 4402 and ES 3302 under Chemical Engineering with Environmental Concentration.