January 4, 2017

MEMORANDUM

TO: Darryll Pines
   Dean, A. James Clark School of Engineering

FROM: Elizabeth Beise
       Associate Provost for Academic Planning and Programs

SUBJECT: Proposal to Modify the Master of Engineering - Bioengineering Option (PCC Log No. 16019)

On December 15, 2016, the Senate Committee on Programs, Curricula and Courses approved the proposal to modify the Master of Engineering – Bioengineering Option. A copy of the proposal is attached.

The change is effective Spring 2017. Please ensure that the change is fully described in the Graduate Catalog and in all relevant descriptive materials.

MDC/
Enclosure

cc: Andrew Harris, Chair, Senate PCC Committee
    Barbara Gill, Office of Enrollment Management
    Reka Montfort, University Senate
    Chip Denman, Division of Information Technology
    Pam Phillips, Institutional Research, Planning & Assessment
    Anne Turkos, University Archives
    Linda Yokoi, Office of the Registrar
    Alex Chen, Graduate School
    William Fourney, A. James Clark School of Engineering
    George Syrmos, Office of Advanced Engineering Education
THE UNIVERSITY OF MARYLAND, COLLEGE PARK
PROGRAM/CURRICULUM/UNIT PROPOSAL

Please email the rest of the proposal as an MSWord attachment
to pcc-submissions@umd.edu.

Please submit the signed form to the Office of the Associate Provost
for Academic Planning and Programs, 1119 Main Administration Building, Campus.

College/School: ENGR
Please also add College/School Unit Code-First 8 digits: 01320101
Unit Codes can be found at: https://hypprod.umd.edu/Html_Reports/units.htm

Department/Program: Office of Advanced Engineering Education
Please also add Department/Program Unit Code-Last 7 digits: 1322302

Type of Action (choose one):
- Curriculum change (including informal specializations)
- Curriculum change for an LEP Program
- Renaming a program or formal Area of Concentration
- Addition/deletion of formal Area of Concentration
- Suspend/delete program

*Italics indicate that the proposed program action must be presented to the 4th University Senate for consideration.*

Summary of Proposed Action:

Changes to the curriculum of the existing Master of Engineering in Bioengineering (PMBI) program through the Office of Advanced Engineering Education.

Departmental/Unit Contact Person for Proposal: George Syrmos

APPROVAL SIGNATURES - Please print name, sign, and date. Use additional lines for multi-unit programs.

1. Department Committee Chair: Keith Herd
2. Department Chair: George Syrmos
3. College/School PCC Chair: Emanuele S. Bucci 9/28/16
4. Dean: Peter Kofinas/Designee
5. Dean of the Graduate School (if required): 11/21/16
6. Chair, Senate PCC: Andrew Harris 11/4/16
7. University Senate Chair (if required): 11/4/16
8. Senior Vice President and Provost: Elizabeth J. F. Reist 11/4/2017
Proposal for a Program Curriculum Modification for the existing Master of Engineering in Bioengineering (PMBI) Program

1. Identification of and rationale for the changes.

Currently, the M.Eng. students and the BIOE Ph.D. students take the same Bioengineering courses, however their backgrounds and objectives differ greatly. As such, we would like to better align our courses and programs to ensure we are meeting the expectations and educational needs of both populations. Creating two separate groupings of courses for these populations will allow us to provide better learning outcomes for the M.Eng. students, as the new courses will be designed specifically to support their needs and will move away from the highly theoretical and mathematical foci of the Ph.D. courses. While maintaining some emphasis on theory, as it is relevant to the field, the M.Eng focused courses will be more application oriented and highly relevant to industry applications. M.Eng. students will be able to apply the knowledge they are gaining through their courses directly into their careers in real time.

2. Current (old) requirements

- Master of Engineering in Bioengineering Current Requirements:
  - 30 credits/10 courses. No research/thesis.
  - 6 core courses
    - BIOE601 Biomolecular and Cellular Rate Processes (3)
    - BIOE602 Cellular and Tissue Biomechanics (3)
    - BIOE604 Cellular and Physiological Transport Phenomena (3)
    - BIOE612 Physiological Evaluation of Bioengineering Designs (3)
    - BIOE631 Biosensor Techniques, Instrumentation, and Applications (3)
    - BIOE632 Biophotonic Imaging and Microscopy (3)
  - 4 technical electives
    - Preapproved
      - BIOE603 Quantitative Cell Physiology (3)
      - BIOE610 Instrumentation in Biological Systems (3)
      - BIOE611 Advanced Tissue Engineering (3)
      - BIOE640 Polymer Physics (3)
      - BIOE645 Advanced Engineering Start Up Ventures (3)
      - BIOE650 Quantitative Physiology of the Cell (3)
      - BIOE653 Advanced Biomaterials (3)
    - Other
      - ENPM672 Fundamentals for Thermal Systems (3) foundation course with advisor approval
    - Other courses with advisor approval

3. Proposed (new) requirements

- Master of Engineering in Bioengineering New Requirements:
  - 30 credits/10 courses. No research/thesis.
  - 3 core courses
    - Modeling of biological systems
    - Application of Biomaterials
    - Biological transport phenomena
  - 7 technical electives
    - Preapproved (Students choose 7 of 9)
      - Synthetic biology
      - Bioinformatics
      - Tissue engineering
      - Biosensors
      - Imaging
      - Biostatistics
      - Biomedical device development
      - Biomechanics and mechanobiology
      - Physiology for Bioengineers
    - Other
4. **A sample program under the proposed requirements.**

The M.Eng. students include both part-time and full-time students and, as such, the program is designed to accommodate both of these student groups.

The table below is a sample program for a full-time student. Part-time students would take these same courses at a rate of 1-2 courses per semester.

<table>
<thead>
<tr>
<th>Sample Program – Full time</th>
<th>Course status</th>
</tr>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
<td></td>
</tr>
<tr>
<td>Modeling of Biological Systems</td>
<td>**</td>
</tr>
<tr>
<td>BIOE 689D Application of Biomaterials</td>
<td>Rolling out in Fall 2016</td>
</tr>
<tr>
<td>Biological transport phenomena</td>
<td>**</td>
</tr>
<tr>
<td>Biomechanics and mechanobiology</td>
<td>**</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
<td></td>
</tr>
<tr>
<td>Synthetic Biology</td>
<td>**</td>
</tr>
<tr>
<td>Biostatistics</td>
<td>**</td>
</tr>
<tr>
<td>Tissue Engineering</td>
<td>**</td>
</tr>
<tr>
<td>Biosensors</td>
<td>**</td>
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<tr>
<td><strong>Summer</strong></td>
<td></td>
</tr>
<tr>
<td>Bioinformatics</td>
<td>**</td>
</tr>
<tr>
<td>Imaging</td>
<td>**</td>
</tr>
</tbody>
</table>

** - new courses. All of these new courses are derivative from existing courses. BIOE will employ adjunct instructors/lecturers, but will provide them with a developed course plan.

5. **List of new courses associated with the new requirements**

- All of the new courses are derivative from existing BIOE courses, reworked to support the needs of the M.Eng. students. BIOE will employ adjunct instructors/lecturers to teach these courses and will provide them with a suggested course plan.
- Courses can be taken in any order and have no prerequisite course requirements.
- All new courses listed in the "Proposed (new) requirements" area, above, will be offered initially as BIOE689: Special Topics in Bioengineering (3 credits) and after the first offering will then be moved, through the VPAC process, to permanent numbers.

6. **List of courses being deleted from the current program requirements**

- All BIOE courses currently associated with the degree program are being deleted from explicit listing under the Master of Engineering in Bioengineering program requirements (note: these courses will still function as courses offered through BIOE for current M.S. and Ph.D. students and
are not being deleted from the system completely). These courses will still be acceptable as electives for the M.Eng. program with advisor approval.

- BIOE601 Biomolecular and Cellular Rate Processes (3)
- BIOE602 Cellular and Tissue Biomechanics (3)
- BIOE604 Cellular and Physiological Transport Phenomena (3)
- BIOE612 Physiological Evaluation of Bioengineering Designs (3)
- BIOE631 Biosensor Techniques, Instrumentation, and Applications (3)
- BIOE632 Biophotonic Imaging and Microscopy (3)
- BIOE603 Quantitative Cell Physiology (3)
- BIOE610 Instrumentation in Biological Systems (3)
- BIOE611 Advanced Tissue Engineering (3)
- BIOE640 Polymer Physics (3)
- BIOE645 Advanced Engineering Start Up Ventures (3)
- BIOE650 Quantitative Physiology of the Cell (3)
- BIOE653 Advanced Biomaterials (3)

7. Fulfillment of Required Curriculum

- BIOE plans to roll out the 12 courses within the following time table:
  - Fall 2016 – 1 course
  - Spring 2017 – 2 courses
  - Fall 2017 – 3 courses
  - Spring 2018 – 3 courses
  - Fall 2018 – 3 courses

- Students enrolling prior to the effective date of this curriculum change will be grandfathered and will have the option to complete the current course requirements (note: students are able to take any newly developed courses, as well, with advisor approval).

- Students enrolling after the curriculum change approval will be under the new requirement, but the advisor will exercise a high level of flexibility for students to take courses from the old requirements, if needed, to supplement the new courses until they are all fully developed.
Hi Jenna,

Yes, I support the four proposals.

Thanks so much –

John

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John P. Fisher
Fischell Family Distinguished Professor & Department Chair
Fischell Department of 3ioengineering
University of Maryland
2330D Jeong H. Kim Engineering Building
College Park, MD 20742
Phone: 301.314.2188
Email: jpfisher@umd.edu
Web: http://teblumd.net
Dear John,

If you support these four PCC proposals, would you please email be back stating we have your support? We understand Keith signed off; however Peter K. would like some type of verification we have your support as chair.

Thank you,
Jenna

-------- Forwarded message --------
From: Jenna Bucci <jdolan@umd.edu>
Date: Mon, Sep 19, 2016 at 3:55 PM
Subject: PCC Proposals
To: Peter Kofinas <kofinas@umd.edu>
Cc: George Syrmos <syrmos@umd.edu>, "Keith E. Herold" <herold@umd.edu>, Jenna Bucci <jdolan@umd.edu>

Hi Peter,

Would you please review the following PCC proposals from OAEE / Bioengineering? These graduate programs require your signature (on the Dean's signature line). They are straight forward and appear to have all of the required information.

If you do not have any questions/concerns please sign off (as the Dean) and email it back to me. I will then sign off as college PCC chair, and forward them to the Office of Academic Planning.

Jenna B.
Bioengineering MEng/Graduate Certificate Program Learning Objectives

These bioengineering programs are designed to support working professionals who want to enhance their skills relating primarily to biotech industry jobs. As such, they focus on applications of bioscience and bioengineering knowledge. Learning objectives include:

1) a working knowledge of bioscientific/bioengineering theory
2) a working knowledge of mathematical tools, including the ability to apply mathematical tools to specific problems in bioscience/bioengineering
3) the ability to combine knowledge from a broad range of disciplines and to apply that knowledge to solutions of specific technical problems
4) the ability to implement research and development programs as part of a technical team

The following list of learning objectives for the bioengineering PhD and MS research programs is provided to shed light on the differences between the Professional programs and the research programs.

Bioengineering PhD/MS Program Learning Objectives

These programs are research programs. As such, they focus on bioscience and bioengineering fundamentals. Learning objectives include:

1) an in-depth understanding of bioscientific/bioengineering theory
2) the ability to understand mathematical concepts including the ability to apply mathematical methods to new bioscientific/bioengineering problems that may arise during research
3) the ability to combine knowledge from a broad range of disciplines and to synthesize that knowledge into new scientific/engineering theories
4) the ability to conceive and design research programs to better understand scientific observations
5) the ability to innovate bioengineering solutions to research problems

Outcomes Assessment

Master of Engineering and Graduate Certificate in Engineering Level

OAEE manages two graduate programs – the Professional Master of Engineering (ENPM) and the Graduate Certificate in Engineering (GCEN) and within each program are many academic options with separate program codes. At the graduate level, the University of Maryland, and in turn our programs, are held to the Middle States Accreditation standards. In order to continue maintaining that
accreditation, we have Graduate School-approved Assessment Methods, Criteria, and Results that we track and report in a graduate outcomes assessment on a regular basis. This data is reported to the Graduate School as a conglomeration of all academic option program codes within the ENPM and GCEN programs, respectively. Some of the program assessment criteria demonstrate more general outcomes surrounding overall knowledge of advanced principles in engineering based on things like retention in the program and cumulative GPA. However, other program assessment areas more specifically address learning outcomes in particular topic areas. For instance, each semester instructors of ENPM courses are asked to include a question on their final project or examination that requires each individual student to demonstrate an understanding of a fundamental principle in engineering relevant to each course topic area. The Office of Advanced Engineering Education then compiles and tracks this data by course. When reported to the Graduate School, and in turn Middle States, we provide one data point on the percentage of students able to demonstrate an understanding of a fundamental principle in engineering for the overall ENPM and GCEN programs, respectively. However, because this data is actually tracked and compiled on a semester basis by course, within our office we are also able to see trends in student learning outcome success in specific courses, as well as within blocks of courses associated with a particular academic option within one of our programs. (Assessment Methods, Criteria & Results sheets included in original proposal)

MEng Course Re-Design

The new courses we are designing for this program are primarily derived from existing courses. Thus, regular faculty have a direct role in the origin of those courses. From that origin, the courses are being and will be re-tooled to focus on the specific needs and learning objectives of the MEng student cohort.

We have started the process this semester (Fall 2016) and it involved several meetings between the MEng program advisor and the adjunct faculty member to discuss the course design. These sessions were designed to communicate our vision of the program and to assess whether or not the instructor has an appropriate course philosophy for the MEng program. All new courses for this program will be reviewed by the Bioengineering Academic Affairs Committee following the same review procedure used for new courses in the Bioengineering MS and PhD programs.

The primary variable which will determine course and program quality is the “quality” and mind-set of the instructors. Thus, we will put a major effort into selecting instructors with a mind-set that blends academic rigor with the MEng program learning objectives. So far, the instructors have been chosen from our own PhD graduates who are working in local industry. These graduates are ideal for this program since they understand both the academic and industry perspectives. Since they were trained in our program, we feel confident that they understand and emulate a positive respect for academic rigor.

Going forward, we will implement reviews of all of the instructors in the form of unannounced classroom visits by the MEng program advisor. Observations from these visits will be combined with student surveys with the objective of maintaining and enhancing course quality.