UNIVERSITY FACULTY SENATE FORMS

Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. For more information, call the Faculty Senate Office at 831-2921.

Submitted by: __Douglas J. Buttrey_____phone number__**831-2034**___

Department: _Chemical and Biomolecular Engineering_email_address **dbuttrey@udel.edu**

Date: _____October 24, 2013_____

Action: _____Revise major in Chemical Engineering_____
(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc.)

Effective term_____14F_____
(use format 04F, 05W)

Current degree____BChE_____
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

Proposed change leads to the degree of: _____ BChE_____
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

Proposed name:_____Bachelor of Chemical Engineering_____
Proposed new name for revised or new major / minor / concentration / academic unit (if applicable)

Revising or Deleting:

Undergraduate major / Concentration:_____Chemical Engineering_-_CHEG__
(Example: Applied Music – Instrumental degree BMAS)

Undergraduate minor:_____
(Example: African Studies, Business Administration, English, Leadership, etc.)

Graduate Program Policy statement change:_____
(**Must attach** your Graduate Program Policy Statement)

Graduate Program of Study:_____
(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

Graduate minor / concentration:_____

Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, highlighting the changes made to the original policy document.

List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?
(Be aware that approval of the curriculum is dependent upon these courses successfully passing through the Course Challenge list. If there are no new courses enter "None")

Two new courses required in the revised curriculum both provide support for the Educational Goals of our department as specified in our ABET accreditation document and posted on our department website. In particular, these two new courses provide important support for the 3rd of our 4 overall goals: "To educate graduates who will be able to apply their knowledge of Chemical and Biomolecular Engineering, including their problem solving, analytical, design, and communication skills, in the private or public sectors and/or in the pursuit of more advanced degrees."

1. CHEG 304 (3 credits) **Random Variability in Chemical Processes**

> Fundamental approach to characterization and analysis of randomly varying phenomena. Students will learn to apply the basic principles, methods, and tools in probability and statistics for solving engineering problems involving random phenomena. Applications will include chemical process analysis, manufacturing, system reliability, and design of experiments. COREQ: MATH302 or MATH305

Chemical Engineering is a quantitative discipline requiring consideration of uncertainties and risks. Having a rigorous course in statistics as a requirement in the core curriculum provides direct support to all of the core subject material.

2. CHEG 431 (3 credits) **Chemical Processes Analysis**

> Design of chemical processes with a focus on distillation columns, recycle loops and other mass contactors. Process simulations are developed using ASPEN software. Operating and capital costs are analyzed and safety and environmental impacts are considered.

Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education: http://www.ugs.udel.edu/gened/

Goal 1: The revised curriculum involves extensive skill development in oral and written communication, quantitative reasoning, and information technology. In addition to the general education courses, most of the core courses require project reports in which the writing proficiency is evaluated in addition to technical content. Oral presentations are required in CHEG 345, CHEG 443, and CHEG 432. Information technology is used extensively throughout the major as students use programs such as Python, MatLab, MiniTab, FLUENT, Aspen, and others.

Goal 2: Chemical engineering continually exercises critical thinking to solve complex problems.

Goal 3: Students experience a mix of assignments with some done independently and others done in a group setting. The CHEG 345 Junior Laboratory and CHEG 445 Senior Laboratory, as well as the CHEG 443 (which will be changed to CHEG 431) and CHEG 432 Chemical Process Analysis sequence, involve extensive collaborative work leading to group reports and presentations.

Goal 4: Ethical considerations and responsibility to self, community, and society are incorporated throughout the core curriculum and particularly emphasized in the laboratories and Senior Design.

Goal 5: In addition to the general education coursework, diverse ways of thinking are encountered in comparing solutions to complex problems, especially design problems for which there is no single answer.

Goal 6: Students are regularly challenged with problems that are of importance to society. Solutions to many of these problems, such as those related to climate change, will extend well beyond the time in the program and are expected to lead to lifelong engagement.

Goal 7: Integrating academic knowledge with experiences beyond the classroom is inherent to engineering in general, and is therefore well exercised by the CHEG major.

Goal 8: In addition to the general education coursework, creativity and intellectual expression are important components of the challenging design activities in which the students are engaged.

Goal 9: Students understand that the foundations of the US rely heavily on our advanced technology. The significance of cultural diversity is apparent as students work collaboratively with students with different backgrounds and cultural roots to solve problems.

Goal 10: Many students in the CHEG program often take part in Study Abroad or in Engineers without Borders. The program has a significant number of international students as well, so that all students are aware of diverse perspectives that these students bring to the program. Many of the engineering problems that we consider and the corporations that we engage during design activities are multinational.

Identify other units affected by the proposed changes:
(Attach permission from the affected units. If no other unit is affected, enter "None")

None.

Describe the rationale for the proposed program change(s):
(Explain your reasons for creating, revising, or deleting the curriculum or program.)

We are revising the program in several ways:

(1) We are eliminating CHEG 320, which consisted of a collection of disparate topics (process economics, environmental assessment, and ethical considerations) that are best distributed among other courses in the curriculum.

(2) Economic considerations are incorporated into the laboratory courses (CHEG 345 and CHEG 445) and into the design sequence (CHEG 431(new) and CHEG 432).

(3) The new Chemical Process Analysis (CHEG 431) replaces Mass Transfer Operations (CHEG 443), retaining critical content from CHEG 443 while eliminating unnecessary topics to make room for important economic, environmental and ethical content from the former CHEG 320 course. Both old and new courses are 3 credits so this doesn't alter the overall credit count.

(4) During our last periodic evaluation by the Accreditation Board for Engineering and Technology (ABET) in 2011, we were encouraged to require a course in engineering statistics in our curriculum and our faculty also believe that our students should all be well versed in basic probability and statistics as applied to our discipline. For this reason, we are creating a new required 3-credit course, Probability and Statistics for Chemical Engineers (CHEG 304); this addition to our curriculum is offset by the elimination of CHEG 320 which was also 3 credits, so the overall credit count is unchanged. The CHEG 304 course will be taken in the second semester of the sophomore year. Note that CHEG 304 will have a corequisite of MATH 302 or MATH 305 since a knowledge of ordinary differential equations will be expected. For this reason and because of the use of chemical engineering examples, we cannot make use of other statistics courses on campus.

(5) Since CHEG 304, positioned in the sophomore year, replaces CHEG 320 as a requirement in the junior year, we are interchanging the course slot with one of our technical elective courses. This retains

the same number of credits in the sophomore and junior years. As a result, the numbering sequence of our technical electives is altered (see curriculum side-by-side in the next section).

Program Requirements:
(Show the new or revised curriculum as it should appear in the Course Catalog. If this is a revision, be sure to indicate the changes being made to the current curriculum and **include a side-by-side comparison** of the credit distribution before and after the proposed change.)

The revised curriculum as it should appear in the Course Catalog is shown below with the new courses indicated in bold.

DEGREE: BACHELOR OF CHEMICAL ENGINEERING
MAJOR: CHEMICAL ENGINEERING

CURRICULUM		**CREDITS**
Parenthesized figures indicate year (1 = freshman, 2 = sophomore, 3 = junior, 4 = senior) and semester (F = fall, S = spring).		
UNIVERSITY REQUIREMENTS		
ENGL 110	Critical Reading and Writing (minimum grade C-)	3 (1F)
First Year Experience (FYE)		0-4
Discovery Learning Experience (DLE)		3
Breadth Requirements		12
Multicultural Course(s)		3
MAJOR REQUIREMENTS		
College of Engineering Breadth Requirements		21
The College of Engineering requires 21 total Breadth Requirement credits (9 credits in addition to the University Breadth Requirements.)		

- If chosen carefully, up to 3 credits from each of the University Breadth Requirement categories may be used to simultaneously satisfy the College of Engineering Breadth Requirements for this major.
- Of the 21 credits, 6 credits must be at the Upper Level (usually 300-level or higher) as designated on the College of Engineering Breadth Requirement list.
- Of the 21 credits, 3 credits may be used to satisfy the University Multicultural Requirement (recommended for timely progress toward degree completion.)
- All Breadth Requirement coursework must be passed with a minimum grade of C-.

Core Courses

CHEG 112	Introduction to Chemical Engineering	3 (1S)
CHEG 231	Chemical Engineering Thermodynamics	3 (2F)
CHEG 304	**Probability and Statistics for Chemical Engineers**	**3(2S)**
CHEG 325	Chemical Engineering Thermodynamics	3 (2S)
CHEG 332	Chemical Engineering Kinetics	3 (3F)
CHEG 341	Fluid Mechanics	3 (3F)
CHEG 342	Heat and Mass Transfer	3 (3S)
CHEG 345	Chemical Engineering Laboratory I	3 (3S)
CHEG 401	Chemical Process Dynamics and Control	3 (4F)
CHEG 431	**Chemical Process Analysis**	**3 (4F)**

CHEG 432	Chemical Process Analysis (DLE)	3 (4S)
CHEG 445	Chemical Engineering Laboratory II	3 (4F)

Students with a minimum GPA of 3.2 or those with approval from both the CHEG 473 course instructor and the student's research advisor may replace CHEG 445 with CHEG 473. Eligible students may also replace CHEG 445 with UNIV 401.

CHEM 111	General Chemistry	3 (1F)
CHEM 112	General Chemistry	3 (1S)
CHEM 220	Quantitative Analysis	3 (2F)
CHEM 221	Quantitative Analysis Laboratory	1 (2F)
CHEM 331	Organic Chemistry	3 (3F)
CHEM 332	Organic Chemistry	3 (3S)
or CHEM 527	Introductory Biochemistry	
CHEM 333	Organic Chemistry Laboratory I (lecture only)	1 (3F)
CHEM 444	Physical Chemistry	3 (2S)
CHEM 445	Physical Chemistry Laboratory I	1 (2S)

The student has the option of taking two credits of CHEM 333 Organic Chemistry Laboratory (laboratory and lecture) and not taking CHEM 445 Physical Chemistry Lab I.

CISC 106	General Computer Science for Engineers	3 (1F)
EGGG 101	Introduction to Engineering (FYE)	2 (1F)
MATH 242	Analytic Geometry and Calculus B	4 (1F)
MATH 243	Analytic Geometry and Calculus C	4 (1S)
MATH 305	Applied Mathematics for Chemical Engineering	3 (2S)
MSEG 302	Materials Science for Engineers	3 (2F)
PHYS 207	Fundamentals of Physics I	4 (1S)
PHYS 208	Fundamentals of Physics II	4 (2F)

TECHNICAL ELECTIVES

Students must complete a minimum of 24 credits of General Technical and Chemical Engineering Elective courses. The student must take five General Technical Electives (15 credits) and three Chemical Engineering Electives (9 credits) OR take four General Technical Electives (12 credits) and four Chemical Engineering Electives (12 credits).

General Technical Electives 12-15

The purpose of the technical electives is to advance the scientific or engineering background of the chemical engineers. The technical electives program consists of a minimum of nine credits taken from the College of Engineering and the College of Arts and Sciences (see below). At least two courses (six credits) must be at the intermediate level (generally 300-600). Students should select their technical electives in the spring of sophomore year to avoid scheduling conflicts. Students should formulate an academic plan for their technical and Chemical Engineering electives with the assistance of their academic advisor.

The technical elective program is under constant review by the faculty. An updated list is available in the department office, and a formal mechanism exists to make substitutions coupled with the Chemical Engineering Technical Electives to obtain a technical concentration.

Chemical Engineering Electives 9-12

The curriculum provides three Chemical Engineering Electives in the senior year. In addition, the student can exchange one of the General Technical Electives provided in the senior year for a Chemical Engineering Elective. These courses are intended to provide some flexibility in selecting a Chemical Engineering program at the advanced level. Students should decide with the assistance of their advisor if they should conduct a program of independent research and then

choose their course elective(s). Chemical Engineering Electives are defined as follows: any 400-level non-core Chemical Engineering course; UNIV 401/UNIV 402 Senior Thesis (directed by a Chemical Engineering faculty); any 600- or 800-level course in Chemical Engineering. Courses at the 600 and 800-level are graduate courses open, with the consent of the instructor, to students with senior standing. Only 6 credits may be taken as research credit fulfilling the Chemical Engineering Elective requirements.

CREDITS TO TOTAL A MINIMUM OF **126**

A side-by-side view of the current and revised curricula are included on the next page.

CHEMICAL ENGINEERING CURRICULUM

Current

Fall Term				Spring Term			
First Year							
EGGG	101	Introduction to Engineering (FYE)	2	CHEG	112	Introduction to Chemical Engineering	3
CHEM	111	General Chemistry	3	CHEM	112	General Chemistry	3
MATH	242	Analytic Geometry & Calculus B	4	MATH	243	Analytic Geometry & Calculus C	4
CISC	106	General Computer Science for Engineers	3	PHYS	207	Fundamentals of Physics I	4
ENGL	110	Critical Reading and Writing	3	Breadth Requirement Elective 1			3
			15				17
Second Year							
CHEG	231	Chemical Engineering Thermodynamics	3	CHEG	325	Chemical Engineering Thermodynamics	3
CHEM	220	Quantitative Analysis	3	CHEM	444	Physical Chemistry	3
CHEM	221	Quantitative Analysis Laboratory	1	CHEM	445	Physical Chemistry Laboratory	1
PHYS	208	Fundamentals of Physics II	4	MATH	305	Applied Math for Chemical Engineering	3
MSEG	302	Materials Science for Engineers	3	Technical Elective 1			3
Breadth Requirement Elective 2			3	Breadth Requirement Elective 3			3
			17				16
Third Year							
CHEG	332	Chemical Engineering Kinetics	3	CHEG	342	Heat and Mass Transfer	3
CHEG	341	Fluid Mechanics	3	CHEG	345	Chemical Engineering Laboratory I	3
CHEM	331	Organic Chemistry I	3	**CHEG**	**320**	**Engineering Economics and Risk Analysis**	3
CHEM	333	Organic Chemistry Laboratory	1	CHEM	332	Organic Chemistry or	3
Technical Elective 2			3	CHEM	527	Introduction to Biochemistry	
Technical Elective 3			3	Breadth Requirement Elective 4			3
			16				15
Fourth Year							
CHEG	**443**	**Mass Transfer Operations**	3	CHEG	432	Chemical Process Analysis (DLE)	3
CHEG	401	Chemical Process Dynamics and Control	3	CHEG Elective 2			3
CHEG	445	Chemical Engineering Laboratory II	3	CHEG Elective 3			3
CHEG Elective 1			3	Technical Elective 4 or CHEG Elective 4			3
Breadth Requirement Elective 5			3	Breadth Requirement Elective 6			3
			15				15

Total Credit Hours 126

CHEMICAL ENGINEERING CURRICULUM

Beginning Fall 2014

Fall Term				Spring Term			
First Year							
EGGG	101	Introduction to Engineering (FYE)	2	CHEG	112	Introduction to Chemical Engineering	3
CHEM	111	General Chemistry	3	CHEM	112	General Chemistry	3
MATH	242	Analytic Geometry & Calculus B	4	MATH	243	Analytic Geometry & Calculus C	4
CISC	106	General Computer Science for Engineers	3	PHYS	207	Fundamentals of Physics I	4
ENGL	110	Critical Reading and Writing	3	Breadth Requirement Elective 1			3
			15				17
Second Year							
CHEG	231	Chemical Engineering Thermodynamics	3	CHEG	325	Chemical Engineering Thermodynamics	3
CHEM	220	Quantitative Analysis	3	**CHEG**	**304**	**Random Variability in Chemical Processes**	3
CHEM	221	Quantitative Analysis Laboratory	1	CHEM	444	Physical Chemistry	3
PHYS	208	Fundamentals of Physics II	4	CHEM	445	Physical Chemistry Laboratory	1
MSEG	302	Materials Science for Engineers	3	MATH	305	Applied Math for Chemical Engineering	3
Breadth Requirement Elective 2			3	Breadth Requirement Elective 3			3
			17				16
Third Year							
CHEG	332	Chemical Engineering Kinetics	3	CHEG	342	Heat and Mass Transfer	3
CHEG	341	Fluid Mechanics	3	CHEG	345	Chemical Engineering Laboratory I	3
CHEM	331	Organic Chemistry I	3	CHEM	332	Organic Chemistry or	3
CHEM	333	Organic Chemistry Laboratory	1	CHEM	527	Introduction to Biochemistry	
Technical Elective 1			3	Breadth Requirement Elective 4			3
Technical Elective 2			3	CHEG Elective 1			3
			16				15
Fourth Year							
CHEG	**431**	**Chemical Process Analysis**	3	CHEG	432	Chemical Process Analysis (DLE)	3
CHEG	401	Chemical Process Dynamics and Control	3	CHEG Elective 3			3
CHEG	445	Chemical Engineering Laboratory II	3	Technical Elective 3			3
CHEG Elective 2			3	Technical Elective 4 or CHEG Elective 4			3
Breadth Requirement Elective 5			3	Breadth Requirement Elective 6			3
			15				15

Total Credit Hours 126