TO: The Faculty of the College of Engineering
FROM: The Faculty of Agricultural and Biological Engineering
RE: New Course ABE 44000

The faculty of the Department of Agricultural and Biological Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

**ABE 44000** Cell and Molecular Design Principles
Sem. 2, Class 3. Lab 0. Cr. 3.
Requisites, Restrictions, and Attributes: (MA 265 AND MA 266) OR (MA 262 AND MA 303) AND BIOL 230 (or BIOL 231 or BIOL 221)

**Description:** This course examines the design principles underlying the organization and dynamics of biological networks with an emphasis on genetic/molecular circuits. Topics include the structure and tuning of network motifs and relationship to performance parameters such as robustness to internal noise, temporal response, noise filtering, bi-stability, pattern generation and temporal programs. Examples are presented from the study of natural systems and the design of new synthetic systems.

**Reason:** Biological circuit design is a foundational component of modern biological engineering with important industry applications in agricultural, environmental, and medical biotechnology. The course provides a foundation for engineering design of cells and genetic circuits. ABE 44000 is one aspect distinguishing the Cellular and Biomolecular specialization from the other BE specializations.

 Bernard A. Engel, Professor and Head
Agricultural and Biological Engineering Department
PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

DEPARTMENT: Agricultural and Biological Engineering
EFFECTIVE SESSION: Spring 2014

INSTRUCTIONS: Please check the items below which describe the purpose of this request:

☐ 1. New courses with supporting documents
☐ 2. Add existing course offered at another campus
☐ 3. Expiration of a course
☐ 4. Change in course number
☐ 5. Change in course title
☐ 6. Change in course credit type
☐ 7. Change in course attributes (department head signature only)
☐ 8. Change in instructional hours
☐ 9. Change in course description
☐ 10. Change in course requisites/restrictions
☐ 11. Change in semesters offered (department head signature only)
☐ 12. Transfer from one department to another

PROPOSED:

Subject Abbreviation: ABE
Course Number: 44000
Long Title: Cell and Molecular Design Principles
Short Title: Cell & Molecular Design Prin

EXISTING:

Subject Abbreviation: 
Course Number: 

TERMS OFFERED:

☐ Fall
☐ Spring
☐ Summer

CAMPUS(ES) INVOLVED:

☑ Lafayette
☐ Con Ed
☐ Pl. Wayne
☐ Indianapolis

CREDIT TYPE:

1. Fixed Credit Cr. Hrs: 3
2. Variable Credit Range: Minimum Cr. Hrs: (Check One) 3
Maximum Cr. Hrs: 3
3. Equivalent Credit: Yes

Course Attributes:

☐ 1. Pass/Not Pass Only
☐ 2. Satisfactory/Unsatisfactory Only
☐ 3. Repeatable
☐ 4. Credit by Examination
☐ 5. Special Fees

Course Description (Include Prerequisites/Restrictions):

This course examines the design principles underlying the organization and dynamics of biological networks with an emphasis on genetic/molecular circuits. Topics include the structure and tuning of network motifs and relationship to performance parameters such as robustness to internal noise, temporal response, noise filtering, bistability, pattern generation and temporal programs. Examples are presented from the study of natural systems and the design of new synthetic systems.

Course Learning Outcomes:

Understand, describe, and calculate quantitative features of biological networks. Create simple, mechanistic models of gene expression. Identify different types of network motifs in biological networks. Describe when particular motifs would be useful for specific types of biological functions. Analyze the dynamics and steady state behavior of simple transcriptional motifs or gene circuits. Tune the parameters of a genetic circuit to design a particular behavior such as a temporal program, an asymmetric filter, or a bistable switch. Design and characterize a transcriptional motif or genetic circuit to result in a particular function, behavior or feature such as robustness, noise filtering, or patterning. Understand the importance of and describe the basic requirements for generating oscillations in cells 1.

Received:

JUN - 6 2013
OFFICE OF THE REGISTRAR

MAY 23 2013
OFFICE OF THE REGISTRAR

OFFICE OF THE REGISTRAR

[Signatures and dates]
**PURDUE UNIVERSITY**
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

**DEPARTMENT**  Agricultural and Biological Engineering  **EFFECTIVE SESSION**  Spring 2013

**INSTRUCTIONS:** Please check the items below which describe the purpose of this request.

- [ ] 1. New course with supporting documents
- [ ] 2. Add existing course offered at another campus
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- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
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- [ ] 11. Change in semesters offered (department head signature only)
- [ ] 12. Transfer from one department to another

**PROPOSED:**

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<tr>
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<td>44000</td>
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<td>Long Title</td>
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**EXISTING:**

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<tr>
<td>Course Number</td>
<td></td>
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<tr>
<td>Long Title</td>
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**TERMS Offered**

- [ ] Fall
- [x] Spring
- [ ] Summer

**CAMPUS(ES) INVOLVED**

- [x] Calumet
- [ ] Cont Ed
- [ ] Tech Statewide
- [ ] Ft. Wayne
- [x] W. Lafayette
- [ ] Indianapolis

**COURSE ATTRIBUTES:** Check All That Apply

- [ ] 6 Registration Approval Type
- [ ] Department
- [ ] Instructor
- [ ] 7 Variable Title
- [ ] 8 Honors
- [ ] 9 Full Time Privilege
- [ ] 10 Off Campus Experience

**CREDIT TYPE**

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<td>Or</td>
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**Schedule Type**

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<th>Studio</th>
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**Weeks Offered**

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<th>% of Credit Allocated</th>
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**Cross-Listed Courses**

This course examines the design principles underlying the organization and dynamics of biological networks with an emphasis on genetic/molecular circuits. Topics include the structure and tuning of network motifs and relationship to performance parameters such as robustness to internal noise, temporal response, noise filtering, bi-stability, pattern generation and temporal programs. Examples are presented from the study of natural systems and the design of new synthetic systems.

**COURSE LEARNING OUTCOMES**

Understand, describe, and calculate quantitative features of biological networks. Create simple, mechanistic models of gene expression. Identify different types of network motifs in biological networks. Describe when particular motifs would be useful for specific types of biological functions. Analyze the dynamics and steady state behavior of simple transcriptional motifs or gene circuits. Tune the parameters of a genetic circuit to design a particular behavior such as a temporal program, an asymmetric filter, or a bistable switch. Design and characterize a transcriptional motif or genetic circuit to result in a particular function, behavior or feature such as robustness, noise filtering, or patterning. Understand the importance of and describe the basic requirements for generating oscillations in cells 1.

**Calumet Department Head**

**Calumet School Dean**

**Fort Wayne Department Head**

**Fort Wayne School Dean**

**Indianapolis Department Head**

**Indianapolis School Dean**

**North Central Faculty Senate Chair**

**Vice Chancellor for Academic Affairs**

**West Lafayette Department Head**

**West Lafayette College School Dean**

**West Lafayette Registrar**

OFFICE OF THE REGISTRAR
ABE 44000 Cell and Molecular Design Principles

COURSE CONTACT INFORMATION:

Name: Jenna Rickus  
Phone Number: 765-494-1197  
E-mail Address: rickus@purdue.edu  
Campus Address: MJIS 2029

Catalog Description: This course examines the design principles underlying the organization and dynamics of biological networks with an emphasis on genetic/molecular circuits. Topics include the structure and tuning of network motifs and relationship to performance parameters such as robustness to internal noise, temporal response, noise filtering, bi-stability, pattern generation and temporal programs. Examples are presented from the study of natural systems and the design of new synthetic systems.

Typically offered Spring. 3 credit hours.

Prerequisites:
(MA 265 AND MA 266) OR (MA 262 AND MA 303) AND BIOL 230 (or BIOL 231 or BIOL 221)

COLLEGE (AGRICULTURE) LEARNING OUTCOMES ADDRESSED BY THIS COURSE

- x Professional Preparation: Demonstrate proficiency in their chosen discipline that incorporates knowledge skills, technology, and professional conduct.
- x Scientific Principles: Demonstrate use of the scientific method to identify problems, formulate and test hypotheses, conduct experiments and analyze data, and derive conclusions.
- x Critical Thinking: Demonstrate critical thinking by using data and reasoning to develop sound responses to complex problems.
- Communication: Demonstrate the ability to write and speak with effectiveness while considering audience and purpose.
- Teamwork: Demonstrate the ability to work effectively as part of a problem-solving team.
- Cultural Understanding: Demonstrate knowledge of a range of cultures and an understanding of human values and points of view of other than their own.
- Social Science Principles: Demonstrate ability to apply social, economic, political, and environmental principles to living in a global community.
- Civic Responsibility: Demonstrate awareness of civic responsibility to community and society at large.
- Lifelong Learning: Demonstrate skills necessary for lifelong learning.

DEPARTMENTAL/PROGRAM LEARNING OUTCOMES ADDRESSED BY THIS COURSE

- x an ability to apply knowledge of mathematics, science, and engineering
- ability to design and conduct experiments, as well as to analyze and interpret data.
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
an ability to function on multidisciplinary teams
x an ability to identify, formulate, and solve engineering problems
an understanding of professional and ethical responsibility
an ability to communicate effectively
the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
a recognition of the need for, and an ability to engage in life-long learning
a knowledge of contemporary issues
x an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Course outline of Topics/Syllabus

Week.
1. Transcription networks
2. Simple Gene Regulation, Protein Half Life
3. Transcription Network Motifs
5. 1 node motif: Auto-regulation: Time response, robustness, bi-stability
6. 3 node motif: Feed-forward Loops: Noise Filter/Persistence Detector, Time response, Asymmetric Delay, Pulse Generation
7. 4+ node motifs: Multi-output FFLs, SIMS, DORS, Global Structure/Wiring diagrams
8. Developmental, Signaling, Cellular Networks
9. Midterm Review and Exam
10. Biological Oscillations
11. Robustness of Protein Circuits
12. Patterning in Development
13. Kinetic Proof Reading
14. Optimal Gene Circuit Design
15. Demand Rules for Gene Regulation

Reading List/Textbook

Example syllabus

ABE 44000 Cell and Molecular Design Principles

Required Textbook

Reference Text

Course Learning Objectives:
1. Understand, describe, and calculate quantitative features of biological networks.
2. Create simple, mechanistic models of gene expression.
3. Identify different types of network motifs in biological networks
4. Describe when particular motifs would be useful for specific types of biological functions.
5. Analyze the dynamics and steady state behavior of simple transcriptional motifs or gene circuits.
6. Tune the parameters of a genetic circuit to design a particular behavior such as a temporal program, an asymmetric filter, or a bistable switch.
7. Design and characterize a transcriptional motif or genetic circuit to result in a particular function, behavior or feature such as robustness, noise filtering, or patterning.
8. Understand the importance of and describe the basic requirements for generating oscillations in cells

Schedule of Topics is a tentative Plan, but deviations may be made through the semester as we progress.

Grading: 25% Homework/Lab Assignments
          25% Exam 1
          25% Exam 2
          25% Semester Project

Grading Scale:

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