Office of the Registrar
FORM 40 REV. 9/06

# PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(100-400 LEVEL)

Print Form

DEPARTMENT Biomedical Engineering EFFECTIVE SESSION Fall 2009

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

- [X] 1. New course 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
- [ ] 11. Change in semesters offered (department head signature only)
- [ ] 12. Transfer from one department to another

| PROPOSED: | EXISTING: |
|---|---|
| Subject Abbreviation BME | Subject Abbreviation |
| Course Number 461 | Course Number |
| Long Title Transport Processes in Biomedical Engineering | |
| Short Title Transport Proc in BME | |

Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)

TERMS OFFERED
Check All That Apply:
[X] Summer [X] Fall [X] Spring

CAMPUS(ES) INVOLVED
- [ ] Calumet
- [ ] Cont Ed
- [ ] Ft. Wayne
- [X] Indianapolis
- [ ] N. Central
- [ ] Tech Statewide
- [ ] W. Lafayette

CREDIT TYPE
1. Fixed Credit: Cr. Hrs. 3
2. Variable Credit Range: Minimum Cr. Hrs
(Check One) To [ ] Or [ ]
Maximum Cr. Hrs.
3. Equivalent Credit: Yes [ ] No [X]
4. Thesis Credit: Yes [ ] No [X]

COURSE ATTRIBUTES: Check All That Apply
1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
Maximum Repeatable Credit: [ ]
4. Credit by Examination [ ]
5. Designator Required [ ]
6. Special Fees [ ]
7. Registration Approval Type
Department [ ] Instructor [ ]
8. Variable Title [ ]
9. Remedial [ ]
10. Honors [ ]
11. Full Time Privilege [ ]
12. Off Campus Experience [ ]

| Instructional Type | Minutes Per Mtg | Meetings Per Week | Weeks Offered | % of Credit Allocated | Delivery Method (Asyn. Or Syn.) | Delivery Medium (Audio, Internet, Live, Text-Based, Video) |
|---|---|---|---|---|---|---|
| Lecture | 75 | 2 | 15 | | | |
| Recitation | | | | | | |
| Presentation | | | | | | |
| Laboratory | | | | | | |
| Lab Prep | | | | | | |
| Studio | | | | | | |
| Distance | | | | | | |
| Clinic | | | | | | |
| Experiential | | | | | | |
| Research | | | | | | |
| Ind. Study | | | | | | |
| Pract/Observ | | | | | | |

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES):

P: BME 334. This course explores engineering principles in mass and other transport processes in biological systems. Topics covered include diffusion, convection, reaction kinetics, transport in porous and fluid mediums, etc. Mathematical models of transport are developed and applied to biomedical problems and physiological systems such as the kidney/renal and oxygen/arterial systems.

| | | | |
|---|---|---|---|
| Calumet Department Head | Date | Calumet School Dean | Date |
| Fort Wayne Department Head | Date | Fort Wayne School Dean | Date |
| Indianapolis Department Head 4/15/09 | Date | Indianapolis School Dean 4-15-09 | Date |
| North Central Department Head | Date | North Central Chancellor | Date |
| West Lafayette Department Head | Date | West Lafayette College/School Dean | Date |
| | | West Lafayette Registrar | Date |

OFFICE OF THE REGISTRAR

**New Course Request** **Indiana University** Indianapolis Campus

Check Appropriate Boxes: Undergraduate credit ☑ Graduate credit ☐ Professional credit ☐

1. School/Division School of Engineering and Technology 2. Academic Subject Code BME
3. Course Number 461 (must be cleared with University Enrollment Services) 4. Instructor _____
5. Course Title Transport Processes in Biomedical Engineering

   Recommended Abbreviation (Optional) Transport Proc in BME
   (Limited to 32 Characters including spaces)
6. First time this course is to be offered (Semester/Year): Fall 2009
7. Credit Hours: Fixed at 3 or Variable from _____ to _____
8. Is this course to be graded S-F (only)? Yes ____ No ☑
9. Is variable title approval being requested? Yes ☐ No ☑
10. Course description (not to exceed 50 words) for Bulletin publication: This course explores engineering principles in mass and other transport processes in biological systems. Topics covered include diffusion, convection, reaction kinetics, transport in porous and fluid mediums, etc. Mathematical models of transport are developed and applied to biomedical problems and physiological systems such as the kidney/renal and oxygen/arterial systems.

    Prerequisite: BME 334
11. Lecture Contact Hours: Fixed at 3 or Variable from _____ to _____
12. Non-Lecture Contact Hours: Fixed at 0 or Variable from _____ to _____
13. Estimated enrollment: 25 of which 0 percent are expected to be graduate students.
14. Frequency of scheduling: yearly Will this course be required for majors? yes
15. Justification for new course: New BME undergraduate curriculum
16. Are the necessary reading materials currently available in the appropriate library? yes
17. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials.
18. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant.
19. A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by:

_____ Date 4/15/09
Department Chairman/Division Director

_____ Date _____
Dean of Graduate School (when required)

Approved by:

_____ Date _____
Dean

_____ Date _____
Chancellor/Vice-President

_____ Date _____
University Enrollment Services

After School/Division approval, forward the last copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.

UPS 724

University Enrollment Services Final—White; Chancellor/Vice-President—Blue; School/Division—Yellow; Department/Division—Pink; University Enrollment Services Advance—White

# BME 461 TRANSPORT PROCESSES IN BIOMEDICAL ENGINEERING

**FALL 2009**

**Instructor**: TBD
Office:
Phone:
E-mail:

**Class**: Tue and Thur, 1:30 – 2:45 PM, SL-216

**Office Hours**: TBA

**Prerequisite**: BME 334

**Textbook**:

1. G Truskey, F. Yuan, D. Katz, *Transport Phenomena in Biological Systems,* 2nd ed., Pearson 2004
2. A Transport text book for engineers, such as:
   S Middleman, *An Introduction to Mass and Heat Transfer*, Wiley 2006
   R. Bird, W. Stewart, E. Lightfoot, *Transport Phenomena*, Wiley 2006

**Reference Textbooks:**

WM Deen, *Analysis of Transport Phenomena*, Oxford 1998
RM Berne, MN Levy, BM Koeppen, and BA Stanton, *Physiology*, C.V. Mosby, 5th edition 2003

**Course Description**:

This course explores engineering principles in mass and other transport processes in biological systems. Topics covered include diffusion, convection, reaction kinetics, transport in porous and fluid mediums, etc. Mathematical models of transport are developed and applied to biomedical problems and physiological systems such as the kidney/renal and oxygen/arterial systems.

| **Grading**: | | |
|---|---|---|
| | Homework | 20% |
| | Exam 1 | 25% |
| | Exam 2 | 25% |
| | Final Exam | 30% |

**Notes**:

- Weekly homework assignments will be a mix of analytical and numerical (e.g. MATLAB) problems
- Additional reading materials will be distributed separately
- No cell phones in class
- Class participation and effort are factors in your final grade

**Outline of Topics for 28 Lectures**

Diffusion

1. Introduction to class, conservation of mass and energy
2. Fick's law of binary diffusion, Diffusion coefficient, random walk, Stokes-Einstein equation
3. Diffusion in 1-D, Cartesian, cylindrical, and spherical coordinates, boundary conditions
4. Diffusion limited reactions: protein binding on cell surfaces

Diffusion plus Convection

5. Transport by convection: Mass, molar fluxes, conservation of mass (Cartesian, cylindrical, spherical)
6. Dimensional analysis, Peclet number
7. Diffusion with Convection, boundary layer
8. Mass transfer coefficient
9. Transport in porous media: porosity, tortuosity, available volume
10. Transport and diffusion in porous media

Transport with Biological Reaction, in Physiology

11. Chemical kinetics and reaction mechanism: rates, mechanisms, first, second, reversible,
12. Enzyme kinetics, Michaelis-Menten kinetics, quasi-steady state
13. Receptor ligand binding kinetics
14. Oxygen-hemoglobin kinetics
15. Oxygen delivery, Krogh cylinder model of oxygen transport
16. Kidney renal physiology, tubular transport, ion channels
17. Glomerular filtration, permeability, hydraulic pressure
18. Hemodialysis
19. Osmotic pressure, Starling's law
20. Electrolyte transport, Nernst-Planck equation

Thermodynamics, Heat Transfer

21. Thermodynamics basics
22. Energy balance, heat transfer
23. Thermal conductivity, conduction in biological systems
24. Thermal convection, fluid flow in biological systems
25. Conduction with convection – biological models
26. Temperature and pressure dependence of diffusivities
27. Applications of heat and mass transport
28. Review Lecture

**Instructional Goals**:

After completion of this course students should be able to:

1. Apply and solve mass diffusion equations. [a,e]
2. Apply and solve heat transfer equations. [a]
3. Understand and apply conservation of mass and energy balance. [a,e]
4. Understand and apply basic principles of thermodynamics [a]
5. Use appropriate boundary conditions to heat and mass transfer problems. [a]
6. Apply diffusion and transport equations to biological processes. [a]
7. Describe transport processes in physiological systems such as the renal system in the kidney, using engineering principles and mathematical analysis of transport. [l]
8. Use numerical methods to solve differential equations in transport. [e,k,m]
9. Apply conservation principles to transport processes. [a]
10. Understand and apply models of transport and enzyme kinetics. [c,l]

Print Form

# PURDUE SCHOOL OF ENGINEERING & TECHNOLOGY
# OUTCOMES AND ASSESSMENT DATA SHEET

This is an internal document to identify and record expected outcomes and anticipated assessment strategies for all courses taught within the School of Engineering and Technology. Submissionn of this form, as noted below, is required and must accompany all new course and course change requests. Copies of this form should also be retained within the department and kept on file with the outline or syllabus for each course.

Course Number: BME 461 Course Title: Transport Processes in Biomedical Engineering

Procedure:

First, identify all instructional outcomes expected for this course, and then select all ABET outcomes which are consistent with those anticipated objectives from TABLE 1 below.

**TABLE 1 - ABET OUTCOMES**

| ENGINEERING - EAC Criteria #3 | # |
|---|---|
| An ability to apply knowledge of mathematics, science, and engineering | a |
| An ability to design and construct experiments as well as to analyze and interpret data. | b |
| An ability to design a system, component, or process to meet desired needs. | c |
| An ability to function on multi-disciplinary teams. | d |
| An ability to identify, formulate and solve engineering problems. | e |
| An understanding of professional and ethical responsibility. | f |
| An ability to communicate effectively. | g |
| The broad education necessary to understand the impact of engineering solutions in global societal context. | h |
| A recognition of the need for and ability to engage in life-long learning. | i |
| A knowledge of contemporary issues. | j |
| An ability to use the techniques, skill and modern engineering tools necessary for engineering practice. | k |

Subsets for each of the six IUPUI Principles of Undergraduate Learning (PUL) are given on the reverse side in TABLE 2. Using a number corresponding to each ABET outcome identified from TABLE 1 above to select a column, place a "" or "X" mark in the applicable TABLE 2 row(s) cell for each PUL. Courses will often address multiple ABET outcomes and ABET outcomes frequently will overlap more than one PUL subset. Thus, it is expected completed data sheets may contain marks in several cells thereby indicating the course simultaneously satisfies multiple Principles of Undergraduate Learning while fulfilling its intended ABET objective(s).

After completing TABLE 2, briefly define or explain how the course outcomes or objectives will be evaluated within the context of the departmental assessment program in the space below:

Course objectives will be assessed by student performance on homework, exams, and written assignments. Individual assignments linked to specific course and ABET outcomes will be used to assess achievement of those outcomes.

Submitted By: Karen Alfrey Date: 18 February 2009

# TABLE 2 - MATRIX OF EXPECTED COURSE OUTCOMES

(Suggestion - while completing Table 2, place a copy of the ABET outcomes from Table 1 along side for easy cross referencing.)

| PRINCIPLES OF UNDERGRADUATE LEARNING - " Require all students to demonstrate an ability to:" | ENGINEERING OUTCOMES - EAC CRITERIA #3: items (a) to (k) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1(a) - Express ideas and facts effectively in written formats | | | | | | | | | | | |
| 1(b) - Comprehend, interpret, and analyze texts | | | | | | | | | | | |
| 1(c) - Communicate orally in one-on-one and group settings | | | | | | | | | | | |
| 1(d) - Solve problems that are quantitative in nature | x | | | | x | | | | | | |
| 1(e) - Make efficient use of information resources and technology for personal and professional needs | x | | | | | | | | | | x |
| 2(a) - Analyze complex issues and make informed decisions | x | | | | x | | | | | | |
| 2(b) - Synthesize information in order to arrive at reasoned conclusions | x | | | | x | | | | | | |
| 2(c) - Evaluate the logic, validity, and relevance of data | x | | | | x | | | | | | |
| 2(d) - Solve challenging problems | x | | x | | x | | | | | | |
| 2(e) - Use knowledge and understanding to generate and explore new questions | x | | | | x | | | | | | x |
| 3(a) - Apply knowledge to enhance personal lives | x | | | | x | | | | | | |
| 3(b) - Apply knowledge to meet professional standards and competencies | | | | | | | | | | | |
| 3(c) - Apply knowledge to further the goals of society | | | | | | | | | | | |
| 4(a) - Demonstrate substantial knowledge and understanding of at least one field of study | x | | x | | x | | | | | | x |
| 4(b) - Compare and contrast approaches to knowledge in different disciplines | | | | | | | | | | | |
| 4(c) - Modify their approach to an issue or problem based on the contexts and requirements of particular situations | | | | | x | | | | | | x |
| 5(a) - Compare and contrast the range of diversity and universality in human history, societies, and ways of life | | | | | | | | | | | |
| 5(b) - Analyze and understand the interconnectedness of global and local concerns | | | | | | | | | | | |
| 5(c) - Operate with civility in a complex social world | | | | | | | | | | | |
| 6(a) - Make informed and principles choices regarding conflicting situations in their personal and public lives and to forsee the consequences of these choices | | | | | | | | | | | |
| 6(b) - Recognize the importance of aesthetics in their personal lives and to society | | | | | | | | | | | |