

**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 442 (must be cleared with University Enrollment Services) 4. Instructor \_\_\_\_\_

5. Course Title Biofluid and Biosolid Mechanics

Recommended Abbreviation (Optional) Biofluid Biosolid Mech  
(Limited to 32 Characters including spaces)

6. First time this course is to be offered (Semester/Year): Spring 2008

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 fluid and solid mechanics in the context of the human circulatory system. Principal equations are derived from differential analysis of fluid flow, and models of characteristic flow conditions are fully analyzed. Biosolid mechanics, vessel biomechanics, and hemodynamic analysis of the circulation system will also be discussed. Prerequisites: BME 352, BME 354.

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: [Signature] Date 12/10/07  
Department Chairman/Division Director

Approved by: [Signature] Date 12/11/07  
Dean

\_\_\_\_\_  
Date \_\_\_\_\_  
Dean of Graduate School (when required)

\_\_\_\_\_  
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.

**BME 442 BIOFLUID & BIOSOLID MECHANICS**

**SPRING 2008**

**Instructor:** Julie Y. Ji, Ph.D.  
Office: SL-220J  
Phone: 317- 278-2275  
E-mail: [jjj@iupui.edu](mailto:jjj@iupui.edu)

**Class:** Tue and Thur, 10:30 – 11:45 AM, SL-???

**Office Hours:** TBA

**Prerequisite:** BME 352/354

**Textbook:** KB Chandran, AP Yoganathan. SE Rittgers, *Biofluid Mechanics: the Human Circulation*, Taylor & Francis 2007

**Reference Textbooks:**

DF Young, BR Munson, TH Okiishi, and WW Huebsch, *A Brief Introduction to Fluid Mechanics, 4th Edition*, John Wiley & Sons 2007  
WM Deen, *Analysis of Transport Phenomena*, Oxford 1998  
CR Ethier, CA Simmons, *Introductory Biomechanics*, Cambridge 2007

**Course Description:**

This course explores fluid and solid mechanics in the context of the human circulatory system. Principal equations are derived from differential analysis of fluid flow, and models of characteristic flow conditions are fully analyzed. Biosolid mechanics, vessel biomechanics, and hemodynamic analysis of the circulation system will also be discussed.

**Instructional Goals:**

After completion of this course students should be able to:

1. Understand basic physical properties of fluids. [a]
2. Evaluate force and pressure balances acting on fluid. [e]
3. Derive conservation of mass and linear momentum. [a]
4. Derive and apply Navier-Stokes equations. [a]
5. Able to solve classic flow models. [e]
6. Analytically approach and solve fluid flow problems. [k]
7. Evaluate stress and strain analysis of solids. [e]
8. Understand physiology of the human circulation system. [l]
9. Appreciate vascular disease mechanisms (atherosclerosis). [l]
10. Apply fluid mechanics to blood flow models. [m]
11. Evaluate and design biofluid mechanics problems (project). [b]

**Content:** Topics to be covered in this course can be primarily divided into 3 parts, with an emphasis on fundamental principles of fluid mechanics. This course will present an integrated introduction to basic fluid mechanics. Understanding basic physical properties of fluids and analyzing force and pressure balances are fundamental to solving engineering problems. Conservation of mass and linear momentum are derived from basic differential analysis of fluid flow. Problems-solving approaches and concepts are

explored for classic fluid dynamic models. Second part of this course will include an introductory to solid mechanics, with discussions on mechanics of materials stresses and strains, and viscoelasticity. Final part of this course will cover integration of fluid and solid mechanics in the human circulation systems. Principles of fluid and solid mechanics are used in the context of blood rheology, vessel biomechanics, and vascular implants.

**Outline of Topics:** (roughly by lectures, order may vary)

I. Principles of fluid mechanics

1. Introduction: basic terms defined, viscosity
2. Fluid statics: pressure and force balances
3. Fluid kinematics: velocity, acceleration fields
4. Control volume analysis, Reynolds Transport Theorem
5. Differential analysis of fluid flow
6. Conservation of Mass and Linear Momentum (continuity, momentum equations)
7. Viscous flow – Navier-Stokes Equations
8. Couette flow, Poiseuille flow
9. Dimensional analysis
10. Low Reynolds number flow – Stokes or creeping flow
11. High Reynolds number – Bernoulli Equation
12. Rotational, irrotational flow
13. Viscous flow in pipe
14. Boundary layer

II. Solid mechanics

15. Introduction to solid mechanics – elasticity, stress and strain
16. Analysis of thin, thick-walled cylindrical tube
17. Blood vessel mechanics
18. Special topic – Equilibrium equation
19. Special topic – Viscoelasticity
20. Special topic – Properties of biomaterials

III. Biomechanics of the human circulation

21. Rheology of blood
22. Pressure-flow relationships in blood
23. Static and steady flow – Applications of Bernoulli equation
24. Static and steady flow – Rigid tube model, entrance length
25. Unsteady and non-uniform models, Windkessel model, pulsatile flow condition
26. Hemodynamics of atherosclerosis, curvatures and bifurcation of vessels

<b>Grading:</b>	Homework (10)	20%
	Exam 1	20%
	Exam 2	20%
	Group Project	10%
	Final Exam	30%

**Notes:**

- There will be occasional guest lectures, with reading materials to be distributed separately.
- There will be approximately 1 homework assignment a week, usually given out on Wednesday and due the following Wednesday.
- Homework should be based on individual efforts.
- Projects may be group efforts – more instructions to come.
- No cell phones in class.

REQUEST FOR ADDITION, EXPIRATION,  
OR REVISION OF A COURSE

DEPARTMENT Biomedical Engineering

EFFECTIVE SESSION Spring 2007

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

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> 1. New course with supporting documents | <input type="checkbox"/> 7. Change in course attributes              |
| <input type="checkbox"/> 2. Add existing course                             | <input type="checkbox"/> 8. Change in instructional hours            |
| <input type="checkbox"/> 3. Expiration of a course                          | <input type="checkbox"/> 9. Change in course description             |
| <input type="checkbox"/> 4. Change in course number                         | <input type="checkbox"/> 10. Change in course requisites             |
| <input type="checkbox"/> 5. Change in course title                          | <input type="checkbox"/> 11. Change in semesters offered             |
| <input type="checkbox"/> 6. Change in course credit/type                    | <input type="checkbox"/> 12. Transfer from one department to another |

PROPOSED:

EXISTING:

TERMS OFFERED

Check All That Apply:

Subject Abbreviation BME Subject Abbreviation \_\_\_\_\_  
 Course Number 442 Course Number \_\_\_\_\_  
 Long Title Biofluid and Biosolid Mechanics  
 Short Title Biofluid Biosolid Mech  
 Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)

Summer  Spring  Fall

CAMPUS(ES) INVOLVED

Calumet  Ft. Wayne   
 Indianapolis  N. Central   
 W.Lafayette  Cont Ed   
 Tech Statewide

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   
 4. Thesis Credit: Yes  No

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 352 and BME 354. This course explores fluid and solid mechanics in the context of the human circulatory system. Principal equations are derived from differential analysis of fluid flow, and models of characteristic flow conditions are fully analyzed. Biosolid mechanics, vessel biomechanics, and hemodynamic analysis of the circulation system will also be discussed.

Calumet Undergrad Curriculum Committee	Date	Calumet Department Head	Date	Calumet School Dean	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Chancellor	Date
<i>[Signature]</i>	12/10/07	<i>[Signature]</i>	12/10/07		
Indianapolis Department Head	Date	Indianapolis School Dean	Date	Undergrad Curriculum Committee	Date
North Central Department Head	Date	North Central Chancellor	Date	Date Approved by Graduate Council	
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Graduate Council Secretary	Date
Graduate Council Area Committee Chair	Date	Graduate Dean	Date	West Lafayette Registrar	Date