TO: The Faculty of the College of Engineering
FROM: The Faculty of Agricultural and Biological Engineering
RE: New Course ABE 30700

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 30700 Momentum Transfer in Food and Biological Systems**
Sem. 1, Class 3. Lab 0. Cr. 3.
Requisites, Restrictions, and Attributes: ABE 20200, MA 26500, MA 26600

**Description:** Fluid statics, Newton’s law of viscosity, shell momentum balances, equations of continuity and motion, one dimensional flow problems, flow through porous media, velocity distributions with more than one independent variables, two dimensional flow through a channel, stream function, velocity potential, dimensional analysis, boundary layer, turbulent flow, Reynolds stress, form and skin friction, application of macroscopic momentum and mechanical energy balances to engineering problems.

Typically offered Fall. 3 credit hours. Prerequisite: ABE 20200, MA 26500, MA 26600

**Reason:** This course replaces CHE 37700 in the Biological Engineering plan of study. Development of a new laboratory course that complements this and two other courses along with increases in the number of students in the Biological Engineering program made it desirable for the Department faculty to teach the subject.


Bernard A. Engel, Professor and Head
Agricultural and Biological Engineering Department

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes #13
Date 5/10/2013
Chairman ECC [Signature]
Fluid statics, Newton’s law of viscosity, shell momentum balances, equations of continuity and motion, one dimensional flow problems, flow through porous media, velocity distributions with more than one independent variables, two dimensional flow through a channel, stream function, velocity potential, dimensional analysis, boundary layer, turbulent flow, Reynolds stress, form and skin friction, application of macroscopic momentum and mechanical energy balances to engineering problems.

Typically offered Fall. 3 credit hours. Prerequisite: ABE 20200, MA 26500, MA 26600

COURSE LEARNING OUTCOMES

Know the principles of fluid statics.
Know the principles of dimensional analysis for analysis of flow problems.
Know the characteristics and analysis of the flow of food and biological fluids.
Gain an understanding the principles of turbulent flow.
Know how to apply macroscopic mass and momentum balances to flow problems in food and biological systems.
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
☐ 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: 30700
 Long Title: Momentum Transfer in Food and Biological Systems
 Short Title: (Abbreviated title will be entered by the Office of the Registrar if omitted. 20 CHARACTERS ONLY)

EXISTING:

 Subject Abbreviation: 
 Course Number: 

TERMS OFFERED:

☑ Fall ☐ Spring ☐ Summer

CAMPUS(ES) INVOLVED:
☐ Calumet
☐ Cont Ed
☐ Ft. Wayne
☐ W. Lafayette
☐ Indianapolis

CREDIT TYPE

1. Fixed Credit: Cr. Hrs.:
   ☑ 3

2. Variable Credit Range:
   Minimum Cr. Hrs: 
   (Check One):
   ☑ Or
   Maximum Cr. Hrs: 
   Equivalent Credit: Yes ☑ No ☐

3. Schedule Type:
   Lecture:
   Recitation:
   Presentation:
   Lab Prep:
   Studio:
   Distance:
   Clinic:
   Experiential:
   Research:
   Ind. Study:
   Pract/Observ:

   Minutes Per Mtg:
   Meetings Per Week:
   Weeks Offered:
   % of Credit Allocated:

   Cross-Listed Courses:

COURSE ATTRIBUTES:

☑ 6 Registration Approval Type
☐ Department
☐ Instructor

☐ 7 Variable Title
☐ 8 Honors

☐ 9 Full-Time Privilege
☐ 10 Off Campus Experience

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

Fluid statics, Newton's law of viscosity, shell momentum balances, equations of continuity and motion, one dimensional flow problems, flow through porous media, velocity distributions with more than one independent variables, two dimensional flow through a channel, stream function, velocity potential, dimensional analysis, boundary layer, turbulent flow, Reynolds stress, form and skin friction, application of macroscopic momentum and mechanical energy balances to engineering problems.

Typically offered Fall. 3 credit hours. Prerequisite: ABE 20200, MA 26500, MA 26600

COURSE LEARNING OUTCOMES:

Know the principles of fluid statics.
Know the principles of dimensional analysis for analysis of flow problems.
Know the characteristics and analysis of the flow of food and biological fluids.
Gain an understanding of the principles of turbulent flow.
Know how to apply macroscopic mass and momentum balances to flow problems in food and biological systems.

Calumet Department Head Date
Calumet School Dean Date

Ft. Wayne Department Head Date
Ft. Wayne School Dean Date

Indianapolis Department Head Date
Indianapolis School Dean Date

North Central Faculty Senate Chair Date
Vice Chancellor for Academic Affairs Date

West Lafayette Department Head Date
West Lafayette College/ School Dean Date
West Lafayette Registrar Date
ABE 30700 Momentum Transfer in Food and Biological Systems

COURSE CONTACT INFORMATION:
Name: Ganesan Narsimhan  
Phone Number: (765)494-1199  
E-mail Address: narsimha@purdue.edu  
Campus Address: NLSN 2247

COLLEGE 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

an ability to use the techniques, skills, and modern engineering tools necessary for
engineering practice

Course outline of Topics/Syllabus

**Course Learning Objectives:**

Successful completion of the course will enable the students to:

1. Know the principles of fluid statics.
2. Know the principles of dimensional analysis for analysis of flow problems.
3. Know the characteristics and analysis of the flow of food and biological fluids.
4. Gain an understanding the principles of turbulent flow.
5. Know how to apply macroscopic mass and momentum balances to flow problems in
food and biological systems.

**Course Topics/Practices:**

1. Fluid statics
2. Shell momentum balances
3. Design equations for pipe flow
4. Equation of continuity and motion
5. Velocity profile for one dimensional flow problems
6. Velocity profile for unsteady state and two dimensional flow problems
7. Dimensionless analysis
8. Turbulent flow
9. Boundary layer
10. Form and skin friction
11. Macroscopic balances for flow problems

Reading List/Textbook

and Sons).

Library Resources

Introduction to Fluid Mechanics, by Whitaker (Prentice Hall)

Transport Phenomena in Biological Systems, 2nd edition, by G.A. Trukskey, F. Yuan, and D.F.
Katz, (Pearson Prentice Hall)
Example syllabus

**ABE 30700 Momentum Transfer in Food and Biological Systems**

**Textbook and/or other recommended material**

**Course Learning Objectives:**
Successful completion of the course will enable the students to:

1. Know the principles of fluid statics.
2. Know the principles of dimensional analysis for analysis of flow problems.
3. Know the characteristics and analysis of the flow of food and biological fluids.
4. Gain an understanding the principles of turbulent flow.
5. Know how to apply macroscopic mass and momentum balances to flow problems in food and biological systems.

**Grading Procedure:**

<table>
<thead>
<tr>
<th>Grading:</th>
<th>Homeworks</th>
<th>45%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quiz</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Exams</td>
<td>50%</td>
</tr>
</tbody>
</table>

Tentative scale for grades is as follows:

- > 97.5%   A+
- 92.5-97.5% A
- 90-92.5%  A-
- 87.5-90%  B+
- 82.5-87.5% B
- 80-82.5%  B-
- 77.5-80%  C+
- 72.5-77.5% C
- 70-72.5%  C-
- 67.5-70%  D+
- 62.5-67.5% D
- 60-62.5%  D-
- < 60%     F
<table>
<thead>
<tr>
<th>Weekly Syllabus for Lecture</th>
<th>Dates</th>
<th>Topic</th>
<th>Reading Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Week 1</td>
<td>Fluid statics</td>
<td>2.1, 2.2 W</td>
</tr>
<tr>
<td></td>
<td>Week 2</td>
<td>Manometers, buoyancy forces</td>
<td>2.4, 2.7 W</td>
</tr>
<tr>
<td></td>
<td>Week 2</td>
<td>Newtons Law of Viscosity</td>
<td>1.1, 1.2 BSL</td>
</tr>
<tr>
<td></td>
<td>Week 3</td>
<td>Convective momentum transport</td>
<td>1.7 BSL</td>
</tr>
<tr>
<td></td>
<td>Week 3</td>
<td>Shell Momentum Balances</td>
<td>2.1 BSL</td>
</tr>
<tr>
<td></td>
<td>Weeks 4,5</td>
<td>Shell Momentum Balances</td>
<td>2.2, 2.3 BSL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flow through falling film, tube and other examples</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Week 5</td>
<td>Divergence Theorem</td>
<td>3.3, 3.4 W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reynolds Transport Theorem</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Week 6</td>
<td>Equation of continuity</td>
<td>3.1, 3.2 BSL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equation of motion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weeks 7,8</td>
<td>One dimensional flow problems using equation of continuity-flow through pipes, couette flow, sedimentation of a sphere</td>
<td>3.6 BSL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exam I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weeks 8, 9</td>
<td>One dimensional flow problems using equation of continuity, lubrication flow, pulsating flow through an tube, viscosity of suspensions, Darcy’s law for flow through porous media</td>
<td>3.6 BSL, 5.2, 8.3 TYK</td>
</tr>
<tr>
<td></td>
<td>Week 9</td>
<td>Dimensional analysis</td>
<td>3.7 BSL</td>
</tr>
<tr>
<td></td>
<td>Weeks 9,10</td>
<td>Velocity distribution with more than one independent variable</td>
<td>4.1 BSL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unsteady flow near a moving plate, unsteady flow through a pipe, flow past a plate-boundary layer</td>
<td></td>
</tr>
<tr>
<td>Week</td>
<td>Topic</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Week 11</td>
<td>Stream function and velocity potential</td>
<td>4.2, 4.3 BSL</td>
<td></td>
</tr>
<tr>
<td>Weeks 11,12</td>
<td>Velocity profile in a boundary layer</td>
<td>4.4 BSL</td>
<td></td>
</tr>
<tr>
<td>Week 13</td>
<td>Turbulent flow, Reynolds stress</td>
<td>5 BSL</td>
<td></td>
</tr>
<tr>
<td>Week 14</td>
<td>Form and skin friction</td>
<td>6 BSL</td>
<td></td>
</tr>
<tr>
<td>Weeks 14,15</td>
<td>Macroscopic balances- frictional losses for pipeflow, flow of a liquid through an orifice, sudden expansion, liquid ejector pump</td>
<td>7 BSL</td>
<td></td>
</tr>
<tr>
<td>Week 16</td>
<td>Constitutive equation for Non-Newtonian fluids</td>
<td>Review</td>
<td></td>
</tr>
</tbody>
</table>