TO: The Engineering Faculty

FROM: The Faculty of the School of Mechanical Engineering

RE: Course Modification - ME 30800 Fluid Mechanics

The Faculty of the School of Mechanical Engineering has approved the following modification to an existing course. The format of ME 30900 will be altered from a total of 4 credits, including 3 credits of lecture and 1 credit of laboratory, to 3 credits of lecture only, with the 1 credit of laboratory assigned to a new dedicated laboratory course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM:

ME 30900 Fluid Mechanics, Sem. 1, 2, Lecture 1, Lab prep 1, Lab 1, cr. 4. Prerequisites: ME 20000, ME 26300, ME 27400, MA 26200, or MA 26500 and MA 26600, or MA 35000 and MA 36000 or equivalents.
Continuum, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Euler and Bernoulli equations, viscous flows, boundary layers, flow in channels and around submerged bodies, one-dimensional gas dynamics, turbomachinery.

TO:

ME 30800 Fluid Mechanics, Sem. 1, 2, Lecture 3, cr. 3. Prerequisites: ME 20000, ME 27400, MA 26200, or MA 26500 and MA 26600, or MA 35000 and MA 36000 or equivalents. Concurrent Prerequisites: ME 26300
Continuum description, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Bernoulli’s equation along a streamline and with head losses. Flow over submerged bodies, boundary layers. Viscous flows in pipes, turbomachinery, system performance. One-dimensional gas dynamics.

Reason: The lab component of the course has been split into a separate 1 cr course ME 30801 Fluid Mechanics Laboratory to allow for better enrollment load balancing in the existing ME undergraduate laboratory facilities. The material covered in ME 30900 (3 cr) Fluid Mechanics lecture course does not change, and the material covered in ME 30801 (1 cr) Fluid Mechanical Laboratory remains the same as the current laboratory component of the current/existing ME 30900 (4 cr) Fluid Mechanics lecture and laboratory course. An updated description of the modified ME 30900 (3 cr) Fluid Mechanics lecture course is outlined in the appended material below.

James D. Jones, Associate Professor and Associate Head
School of Mechanical Engineering
ME 30800
FLUID MECHANICS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Develop the ability to identify and classify the various types of flows one may encounter. [1]
2. Develop (from rigorous first principles) the control volume formulation of the basic laws with emphasis on conservation of mass and Newton’s 2nd law. [1]
3. Apply the control volume formulation of the basic laws to model physical systems. [1]

Fundamental Concepts (1.7 weeks)

1. Systems, control volumes (CVs), basic laws for a system
2. Flow visualization, Eulerian & Lagrangian descriptions
3. Pressure, density, manometry
4. Hydrostatics, buoyancy, forces on submerged surfaces
5. Stress, Newtonian fluid, viscosity

Basic Equations (3.3 weeks)

1. Relation between system and control volume derivatives (Reynolds Transport Theorem)
2. Integral form of basic equations for control volumes (CVs)
   - conservation of mass
   - conservation of linear momentum (inertial, differential and linearly accelerating CVs)
   - conservation of energy (Bernoulli’s equation with losses)
3. Differential analysis of fluid motion
   - conservation of mass
   - acceleration of fluid elements
   - Newton’s 2nd law for a fluid element
   - Navier–Stokes equations

Compressible Flow (1.7 weeks)

1. Review thermodynamics of ideal gas
2. Speed of sound, Mach cone
3. Stagnation and sonic conditions
4. Isentropic flow; area variations
5. Stationary normal shocks
6. Flow in converging-diverging nozzles

Dimensional Analysis and Similitude (1.0 weeks)

1. Determining dimensionless groups and relationships
   - Buckingham’s Pi theorem
   - Non-dimensionalizing basic differential equations
2. Flow similarity and model studies

Incompressible Flow (4.3 weeks)

1. Inviscid flow
   - Bernoulli’s equation
2. Viscous flow
   - Internal
     • fully developed laminar flow
     • flow in pipes and ducts, head loss
     • fluid machinery, system performance
   - Flow measurement
   - External
     • boundary layer flow
     • flow over immersed bodies
     • lift and drag
<table>
<thead>
<tr>
<th><strong>COURSE NUMBER:</strong> ME 30800</th>
<th><strong>COURSE TITLE:</strong> Fluid Mechanics</th>
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<tbody>
<tr>
<td><strong>REQUIRED COURSE OR ELECTIVE COURSE:</strong> Required</td>
<td><strong>TERMS OFFERED:</strong> Fall and Spring</td>
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<td><strong>RECOMMENDED TEXTBOOKS:</strong></td>
<td><strong>PRE-REQUISITES:</strong></td>
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<tr>
<td><strong>COORDINATING FACULTY:</strong> C. Wassgren &amp; P. Vlachos</td>
<td>MA 26200 – Linear Algebra and Differential Equations</td>
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<tr>
<td><strong>COURSE DESCRIPTION:</strong> Continuum description, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Bernoulli’s equation along a streamline and with head losses. Flow over submerged bodies, boundary layers. Viscous flows in pipes, turbomachinery, system performance. One-dimensional gas dynamics.</td>
<td><strong>COURSE OUTCOMES</strong> [Related ME Program Outcomes in brackets]:</td>
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<td><strong>ASSESSMENTS TOOLS:</strong></td>
<td>1. Develop the ability to identify and classify the various types of flows one may encounter. [1]</td>
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<td>1. Weekly homework.</td>
<td>2. Develop (from rigorous first principles) the control volume formulation of the basic laws with emphasis on conservation of mass and Newton’s 2nd law. [1]</td>
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<td>2. Exams.</td>
<td>3. Apply the control volume formulation of the basic laws to model physical systems. [1]</td>
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<td>3. Lecture quizzes.</td>
<td><strong>RELATED ME PROGRAM OUTCOMES:</strong></td>
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<td><strong>NATURE OF DESIGN CONTENT:</strong> None</td>
<td>1. Engineering fundamentals</td>
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<td><strong>PROFESSIONAL COMPONENT:</strong></td>
<td><strong>COMPUTER USAGE:</strong> Knowledge of word processing, spreadsheet software, and basic programming (for example, MATLAB) are necessary for homework assignments.</td>
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<tr>
<td>1. Engineering Topics: Engineering Science – 100%</td>
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<td>Engineering Design – 0%</td>
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<td><strong>COURSE STRUCTURE/SCHEDULE:</strong> Lectures – 3 days per week at 50 minutes</td>
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<td><strong>PREPARED BY:</strong> J. Chen (Updated by I. Christov)</td>
<td><strong>REVISION DATE:</strong> January 28, 2020</td>
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