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| **COURSE NUMBER:** Vm320 | **COURSE TITLE:** Fluid Mechanics |
| **CREDIT: 3** | **PREREQUISITES:** Vm235 and Vm240 and (Vv256 or Vv286) |
| **TEXTBOOKS/REQUIRED MATERIAL:**<br>Fluid mechanics, 4th edition, by Pijush K. Kundu, Ira M. Cohen | **PREPARED BY:** Lipo Wang<br>**DATE OF PREPARATION:** Oct. 8, 2013<br>**DATE OF UC APPROVAL:** Oct. 30, 2013 |
| **INSTRUCTOR(S):** Lipo Wang, Qiang Zhang, Chien-pin Chen | **SCIENCE/DESIGN:** |
| **CATALOG DESCRIPTION:**<br>Fluid statics; conservation of mass, momentum ,and energy in fixed and moving control volumes; steady and unsteady Bernoulli's equation; differential analysis of fluid flow; dimensional analysis and similitude; laminar and turbulent flow; boundry layers; lift and drag; introduction to commercial CFD packages; applications to mechanical, biological, environmental, and micro-fluidic systems. | **COURSE TOPICS:**<br>1. Fluid properties, fluid forces, and flow regimes.<br>2. Fluid statics.<br>3. Flow kinematics.<br>4. Conservation of mass, momentum and energy in fixed, deforming, and moving control volumes.<br>5. The steady and unsteady Bernoulli equation along and normal to a streamline.<br>6. Similitude, dimensional analysis, and modeling; important nondimensional groups in fluid mechanics.<br>7. Conservation of mass and momentum expressed through differential analysis.<br>8. Viscous flow in pipes and channels (laminar and turbulent flow regimes, the Moody chart, headloss equation).<br>9. External flow 9boundary layer concept, lift and drag, pressure and friction drag, streamlining and drag reduction.<br>10. Introduction to commercial CFD package.<br>11. Sample applications to mechanical biological, environmental, and microfluidic systems. |
| **COURSE STRUCTURE/SCHEDULE**: Lecture: twice per week, 90 minutes each; Laboratory: one per week, 3 hrs | |

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| **COURSE OBJECTIVES [Course Outcomes in brackets]** | 1. To teach basic fluid properties (density, viscosity, bulk modulus), flow forces (pressure, shear stress, surface tension), and flow regimes (laminar/turbulent, compressible/incompressible, steady/unsteady) [1, 2, 3, 4, 5].<br>2. To teach how force is transmitted in static fluids [2, 3].<br>3. To teach conservation of mass, momentum, and energy in fixed, deforming, and moving control volumes [3, 4].<br>4. To teach the use and limitations of steady and unsteady Bernoulli equation along and normal to a streamline [4].<br>5. To teach conservation of mass and momentum through differential analysis in simple geometries [6].<br>6. To teach techniques of dimensional analysis, similitude, and modeling, and introduce the important nondimensional groups in fluid mechanics [1, 5, 6].<br>7. To teach application of the above concepts to internal and external flows, and introduce the boundary layer concept, lift and drag, flow separation, and drag reduction fundamentals [5, 6, 7].<br>8. To teach the use of commercial CFD packages [1, 2, 6, 7].<br>9. To teach examples of applications of above concepts in mechanical, biological, environmental, and microfluidic systems [1, 8]. |
| **COURSE OUTCOMES [Program Outcomes in brackets]** | After completing Vm320, students should be able to have:<br>1. Ability to identify or predict the flow regime in a given engineering system based on consideration of the governing nondimensional groups [a, e].<br>2. Ability to calculate the hydrostatic forces and moments on planar and curved submerged and floating surfaces [a].<br>3. Ability to construct an appropriate (fixed, deforming, or moving) control volume for a given engineering system and apply the principles of conservation of mass, momentum, and energy to this control volume [a, k].<br>4. Ability to decide when appropriate to use ideal flow concepts and the Bernoulli equation [a].<br>5. Ability to present data or governing equations in nondimensional form, design experiments, and perform model studies [a, b, k].<br>6. Ability to solve for internal flow in pipes and channels through simple solutions of the NavierStokes equations, the Moody chart, the headloss equation, or commercial CFD packages [a, e, k].<br>7. Ability to solve for external flow, evaluate lift and drag, know when there is possibility of flow separation, apply streamlining concepts for drag reduction by using experimental correlations or commercial CFD packages [a, e, k].<br>8. An understanding of how fluid mechanics applies to mechanical, biological, environmental, and microfluidic systems [h, j]. |
| **ASSESSMENT TOOLS [Course Outcomes in brackets]** | Homework [1-8]<br>Midterm and final Exam [1-8] |