A. **TITLE:**  Applied Computational Fluid Dynamics

B. **COURSE NUMBER:**  MECH 416

C. **CREDIT HOURS:**  3

D. **WRITING INTENSIVE COURSE:**  No

E. **COURSE LENGTH:**  15 weeks

F. **SEMESTER(S) OFFERED:**  Fall or Spring

G. **HOURS OF LECTURE, LABORATORY, RECITATION, TUTORIAL, ACTIVITY:**  Two 1-hour lectures and one two-hour lab

H. **CATALOG DESCRIPTION:**  This course introduces the student to modeling and analyzing fluid mechanics problems via the finite difference and finite volume method. Fundamentals of CFD theory, solution, procedures, techniques, and analysis are discussed. Topics include computational grid generation, fluid model setup, convergence and accuracy analysis, data interpretation, model validation and discussion of conclusions. Students will use CFD software to solve various fluid problems.

I. **PRE-REQUISITES/CO-REQUISITES:**
   b. Co-requisite(s): none

J. **GOALS (STUDENT LEARNING OUTCOMES):**  By the end of this course, the students will be able to:

<table>
<thead>
<tr>
<th>Course Objective</th>
<th>Institutional SLO</th>
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<tbody>
<tr>
<td>1. Define fluid application domain and create geometric model.</td>
<td>1. Communication</td>
</tr>
<tr>
<td>2. Create computational mesh</td>
<td>1. Communication</td>
</tr>
<tr>
<td>3. Assess fluid properties and boundary conditions</td>
<td>2. Critical Thinking</td>
</tr>
<tr>
<td>4. Evaluate appropriate fluid model to simulate the fluid applications.</td>
<td>2. Critical Thinking</td>
</tr>
<tr>
<td>5. Carry out the solution procedures and address convergence, stability, and accuracy analysis.</td>
<td>2. Critical Thinking 3. Professional Competence</td>
</tr>
<tr>
<td>6. Collect and analyze CFD data.</td>
<td>2. Critical Thinking</td>
</tr>
<tr>
<td>7. Perform model validation.</td>
<td>2. Critical Thinking</td>
</tr>
</tbody>
</table>

K. **TEXTS:**  None

L. **REFERENCES:**  None

M. **EQUIPMENT:**  Computer Lab

N. **GRADING METHOD:**  A - F
O. MEASUREMENT CRITERIA/METHODS:
- Exams
- Quizzes
- Labs
- Participation
- Projects

P. DETAILED COURSE OUTLINE:

I. Introduction to Computational Fluid Dynamics
   A. What is CFD
   B. Advantage of CFD
   C. Application of CFD
   D. Future of CFD

II. CFD Solution Procedures
   A. Introduction
   B. Problem Setup
   C. Computational Grid Generation
   D. Fluid Model Construction
   E. Fluid Properties and Boundary Conditions
   F. CFD Solver Processes
   G. Result Report and Visualization

III. Governing Equations for CFD
   A. Introduction
   B. Continuity Equation
   C. Momentum Equation
   D. Energy Equation
   E. Application Specific Equations
   F. Generic Form of the Governing Equations for CFD
   F. Physical Boundary Condition for Governing Equations

IV. CFD Techniques
   A. Introduction
   B. Discretization of Governing Equations
   C. Finite-Difference Method
   D. Finite-Volume Method
   E. Converting Governing Equations to Algebraic Equations
   F. Numerical Solution to Algebraic Equations

V. CFD Solution Analysis
   A. Introduction
   B. Consistency Analysis
   B. Stability Analysis
   C. Convergence Analysis
   D. Accuracy Analysis
   E. Computing Efficiency

Q. LABORATORY OUTLINE:
I. Introduction to CFD and Software Package (inside Inventor)

II. 2D Channel Flow

III. 3D Indoor Air Distribution

IV. Indoor Air Distribution - Air Diffuser

V. Indoor Air Quality - Pollution Dispersion

VI. Heat Transfer Coupled with Fluid Flow

VII. HVAC Simulation