M.E Semester: 2 Mechanical Engineering (Thermal Engineering)
Subject Name: COMPUTATIONAL FLUID DYNAMICS

A. Course Objective

- To present a problem oriented in depth knowledge of Computational Fluid Dynamics
- To address the underlying concepts and methods behind of Computational Fluid Dynamics

B. Teaching / Examination Scheme

<table>
<tr><td colspan="2">SUBJECT</td><td colspan="4">Teaching Scheme</td><td rowspan="3">Total Credit</td><td colspan="5">Evaluation Scheme</td><td rowspan="3">Total
Marks</td></tr>
<tr><td rowspan="2">CODE</td><td rowspan="2">NAME</td><td>L</td><td>T</td><td>P</td><td>Total</td><td colspan="2">THEORY</td><td>IE</td><td>CIA</td><td>PR. / VIVO</td></tr>
<tr><td>Hrs</td><td>Hrs</td><td>Hrs</td><td>Hrs</td><td>Hrs</td><td>Marks</td><td>Marks</td><td>Marks</td><td>Marks</td></tr>
<tr><td>METH202</td><td>Computational Fluid Dynamics</td><td>3</td><td>0</td><td>2</td><td>5</td><td>4</td><td>3</td><td>70</td><td>30</td><td>20</td><td>30</td><td>150</td></tr>
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C. Detailed Syllabus

1. Introduction & Basic concepts: Introduction of CFD, Types of fluids and basic equations of flow, Conservation of mass, Newton's Second law of Motion, Governing equations of fluid flow, Navier-Stokes equations, Boundary layer equations, Expanded form of N-S equations, Conservation of energy principle, Special form of N-S equations, Classification of second order partial differential equations, Initial and boundary conditions, Governing equations in generalized coordinates. Review of essentials of fluid dynamics.
2. Differential Equations & Discretization: Elementary Finite Difference Equations, Basic aspects of Finite Difference Equations, Errors and Stability Analysis, Discretization, Application to heat conduction and convection, Problems on 1-D and 2-D steady state and unsteady state conduction, Problem on Advection phenomenon, Incorporation of Advection scheme.
3. Introduction to Finite Element Philosophy: Basics of finite element method, stiffness matrix, isoperimetric elements, formulation of finite elements for flow & hear transfer problems.
4. Introduction to Finite Volume Philosophy: Integral approach, discretization & higher order schemes, Application to Complex Geometry.
5. Introduction to solutions of viscous incompressible flows using MAC and simple algorithm.
6. Solutions of viscous incompressible flows by stream function, vorticity formulation. Two dimensional incompressible viscous flow, estimation of discretization error, applications to curvilinear geometries, derivation of surface pressure & drag.

D. Lesson Planning

Sr.No.	Date/Week	Unit No.	% Weightage	Topic No:
1	1st ,2ed ,3ed	Unit 1	20 % .	1
2	4th ,5th ,6th	Unit 2	20 %	2
3	7th ,8th ,9th	Unit 3	20 %	3
4	19th ,11th ,12th	Unit 4	20 %	4,5
5	13th ,14th ,15th	Unit 5	20 %	6

E. Instructional Method & Pedagogy

1. At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
2. Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations.
3. Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.

4. One/Two internal exams may be conducted and total/average/best of the same may be converted to equivalent of 30 marks as a part of internal theory evaluation.
5. Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
6. Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.
7. The course includes a laboratory, where students have an opportunity to build an appreciation for the concept being taught in lectures.
8. Experiments shall be performed in the laboratory related to course contents.

- **Experiment list:**

1. Exercise on pin-fin analysis
2. Exercise on 1-D steady state heat conduction
3. Exercise on 1-D unsteady state heat conduction
4. Exercise on 2-D steady state heat conduction
5. Exercise on 2-D unsteady state heat conduction
6. Exercise on heat transfer by convection
7. Exercise on fluid flow
8. Exercise on irregular geometry

F. **Students Learning Outcomes**

- The student can identify different areas of of Computational Fluid Dynamics
- Can find the applications of all the areas in day to day life.

G. **Recommended Study Materials**

- **Text & Reference Books:**

1. Anderson D.A., Tannehilj.c.Pletcher R.H." Computational fluid mechanics & heat transfer" Hemisphere publishing corporation,. Newyork, U.S.A2004.
2. Anker S.V., "Numerical heat transfer & flow" Hemisphere corporation, 2001
3. H.K.verstag&W.Malalsekra," An introduction to computational fluid dynamics" Longman-2000
4. Carnahan B, "Applied numerical method" John Wiley & Sons-2001.
5. Patankar, " Numerical heat transfer & Fluid Flow", Mc.GrawHill.,2002
6. Murlidhar K., Sunderrajan T., "Computational Fluid Mechanics and Heat Transfer", Narosa Publishing House.
7. Date A. W., "Introduction to Computational Fluid Dynamics", Cambrige Uni. Press, 2005.
8. Ferziger J. H., Peric M., "Computational Methods for Fluid Dynamics", Springer, 2002.