ME 4342 Computational Fluid Dynamics (Elective)

Catalog Description: ME 4342 Computational Fluid Dynamics (2-3-3)
Prerequisites: ME 3340 Fluid Mechanics, ME 3345 Heat Transfer.
An introduction to computational fluid dynamics (CFD) in mechanical engineering. The use of modern CFD software to build, solve, and visualize fluid-flow models. Exploration of various flow models to gain a deeper understanding of the principles of fluid mechanics. An introduction to the theory and numerical techniques of the finite element method. Individual student projects exploring and analyzing a complex fluid-flow system and communicating the results in a written report.

Textbook: No textbook.

Topics Covered:

1. Introduction to the use of modern CFD software, including geometry building, mesh generation, solution techniques, and flow visualization.
2. The investigation of various fluid flow systems aimed at a deeper understanding of the basic principles of fluid mechanics.
3. Experience with some of the difficulties that one may encounter in CFD, such as geometry simplification, mesh problems, convergence problems, multiple solutions, etc.
4. An introduction to the theory and practice of the finite element method. Experience with writing a simple finite element solver for an ordinary differential equation in MATLAB.
5. An individual CFD project selected from a set contributed by the instructor or from the student's own experience. A written project report is required.

Course Outcomes:

Outcome 1: Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.

1.1 The student will demonstrate the ability to use modern CFD software tools to build flow geometries, generate an adequate mesh for an accurate solution, select appropriate solvers to obtain a flow solution, and visualize the resulting flow field.

1.2 The student will demonstrate the ability to analyze a flow field to determine various quantities of interest, such as flow rates, heat fluxes, pressure drops, losses, etc., using flow visualization and analysis tools.

Outcome 2: Improve the student's understanding of the basic principles of fluid mechanics.

2.1 The student will demonstrate an ability to recognize the type of fluid flow that is occurring in a particular physical system and to use the appropriate model equations to investigate the flow.

2.2 The student will demonstrate an ability to describe various flow features in terms of appropriate fluid mechanical principles and force balances.

Outcome 3: Provide the student with a basic understanding of the theory, principles, and practice of the finite element method.

3.1 The student will demonstrate an understanding of the basic theory behind the approximations used in the finite element method.

3.2 The student will write his/her own MATLAB program to numerically solve a simple second-order ordinary differential equation using the finite element method.

Outcome 4: Improve the student's research and communication skills using a self-directed, detailed study of a complex fluid-flow problem and to communicate the results in written form.

4.1 The student will demonstrate the ability to simplify a real fluid-flow system into a simplified model problem, to select the proper governing equations for the physics involved in the system, to solve for the flow, to investigate the fluid-flow behavior, and to understand the results.

4.2 The student will demonstrate the ability to communicate the results of this detailed fluid-flow study in a written format.

Correlation between Course Outcomes and Program Educational Outcomes:

ME 4342												
	Mechanical Engineering Program Educational Outcomes											
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k	l
Course Outcome 1.1	X				X				X		X	X
Course Outcome 1.2	X				X				X		X	X
Course Outcome 2.1	X				X							X
Course Outcome 2.2	X				X		X					X
Course Outcome 3.1	X										X	X
Course Outcome 3.2	X										X	X
Course Outcome 4.1	X				X						X	X
Course Outcome 4.2	X						X					X

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