

AE 4040 – Computational Fluid Dynamics

Hours: 3-0-3

CATALOG DESCRIPTION (25 words or fewer):

Discretization of PDEs, stability and accuracy considerations, iterative and time/space marching schemes, aerospace applications.

PREREQUISITES:

AE 3021 or AE 3030

COURSE OBJECTIVES: Provide students with an introduction to numerical methods and understanding of various computational aerodynamics approaches. Provide experience with tools utilized in CFD analysis and an understanding of the role of CFD in engineering analysis.

LEARNING OUTCOMES:

Students will be able to:

- 1) describe the differences between equation sets and numerical capabilities of common CFD methodologies;
- 2) effectively utilize CFD grid generation software;
- 3) effectively conduct CFD analysis associated with aerospace applications;
- 4) effectively utilize CFD flow visualization software.

TOPICAL OUTLINE:

	Topic	<u>Hrs</u>
I.	Introduction	
	Experimental, theoretical and numerical approaches	2
	Verification, validation and certification	1
II.	Governing Equations	
	Governing equations: Navier-Stokes, Euler, full potential, and linearized potential equation	2
	Non-dimensionalization	½
	Mathematical classification of equations	1
III.	Linear Theory Aerodynamic Analysis	
	Panel method	1½
	Vortex lattice method	1
	Integral boundary layer method overview	½
	Use of XFOIL and AVL codes	2
	Pressure and skin friction integration to obtain forces	½
IV.	Discrete Modeling	
	Taylor series expansions	2
	Consistency, convergence, stability, convergence history, and criteria	3

V.	Computational Grids	
	Generalized transformation	2
	Basic requirements, structured topologies, unstructured terminology	2½
	Grid generation methods: algebraic, elliptic, hyperbolic, unstructured	1½
	3D grid generation	3
	Use of POINTWISE	
	Grid quality evaluation	
VI.	Euler Equation Solution and Flow Visualization	
	Runge-Kutta schemes	2
	Roe's approximation Riemann solver	1
	Flux limiters, Total Variation Diminishing software (TVD)	2
	Use of STAR-CCM+ or NASCART-GT	2
	Use of TECPLOT	2
VII.	Navier-Stokes Solution	
	Use of FLUENT	2
	Solution accuracy evaluation	2
	Boundary conditions: viscous wall, inflow/outflow	1
	Exams and reviews	5
	Total	45