AMITY UNIVERSITY
UTTAR PRADESH

Course Title: COMPUTATIONAL FLUID DYNAMICS **Credit Units: 05**

L	T	P/S	SW/ FW	TOTAL CREDIT UNITS
3	1	2	-	5

Course Code: to be decided

Course Level: UG

Course Objectives

This course will introduce the discretization techniques to solve the essential flow equations like N-S equation and RANS which are in complex partial differential forms. Techniques to model the entire flow domain into regular and irregular grid system and adopting the suitable boundary condition to solve them. This course will also teach the common errors and solution instabilities in numerical analysis of any flow problem.

Pre-requisites: Aerodynamics - I & II

Course Contents/Syllabus:

	Weightage (%)
Module I : Governing Equations and Boundary Conditions	**18**
Descriptors / Topics*:* General introduction about the scope of the subject, Models of flow, Concept of substantial derivative and divergence of velocity, Different Types of Flows, Integral form of conservation equations, Differential form of conservation equations, Navier-Stokes and Euler Equations, Classification of partial differential equations using Cramer's Rule, General behaviour of different classes of PDEs and their impact on physical computational fluid dynamics.	
Module II : Discretization Techniques	**24**
Descriptors/Topics : Basic discretization techniques, Introduction to Finite Differences, Difference Equations, Explicit and Implicit approaches, concept of stability.	
Module III : Transformation and Grid Generation	**18**
Descriptors/Topics : General transformation of equations, Metrics and Jacobians, Form of governing equations suited for CFD, Stretched grids, Boundary-fitted coordinate systems-Elliptic grid generation, Adaptive grids, Some modern developments in grid generation.	
Module IV : Simple CFD Techniques	**20**

Descriptors/Topics : Lax-Wendroff technique, Maccormack's technique, Relaxation technique, Pressure correction technique, Philosophy of pressure correction method. Numerical procedure for SIMPLE algorithm, Boundary conditions for pressure-correction method. Brief discussion of some computer graphic techniques used in CFD.	
Module V : Introduction to Finite Volume Method	**20**
Descriptors/Topics : The finite volume method for one-dimensional steady state diffusion problems and for two-dimensional steady state diffusion problems, The finite volume method for one-dimensional convection and diffusion, The central differencing scheme, The upwind differencing scheme. The pressure-velocity coupling.	

Student Learning Outcomes:

- Explain partial differential, Navier strokes and Euler equations of the flow over the body.
- Describe disretization techniques, equation transformation and grid generation.
- Apply different CFD techniques to assess pressure, pressure coefficient, forces and moments over different aerodynamic shapes**.**

Pedagogy for Course Delivery: Session Plan / course-material uploading, Class-room teaching associated with assignments**,** presentations**,** quiz, viva-voce and evaluation.

Lab/ Practicals details, if applicable:

List of Experiments:

- Modeling a 2-d object with structured mesh using GAMBIT software.
- Modeling a 2-d object with unstructured mesh using GAMBIT software.
- Modeling a 3-d object with structured mesh using GAMBIT software.
- Solving a simple 2-d flow problem using Fluent software.
- Solving a simple axisymmetric flow problem using FLUENT software.

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total
80	**20**	**100**

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment - 30					End Term Examination
Components (Drop down)	**A**	**CT**	**S/V/Q**	**HA**	**70**
Weightage (%)	5	10	8	7	70

Lab/ Practical/ Studio Assessment:

	Continuous Assessment/Internal Assessment				End Term Examination	
Components (Drop down	**PR**	**LR**	**V**	**A**	**EXP**	**V**
Weightage (%)	10	10	5	5	35	35

Text & References:

- John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, Mc Graw Hill, 1995.
- H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics – The Finite Volume Method, Pearson Education. 2007.
- D.C. Wilcox, Turbulence Modelling for CFD, 1993.
- S.V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill,1981.
- Patrick Knupp and Stanly Steinberg, Fundamentals of Grid Generation, CRC Press, 1994.

Any other Study Material:

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