ME461: COMPUTATIONAL FLUID DYNAMICS
CREDITS = 5 (L=3, T=0, P=2)

Course Objective: To solve fluid flow problems using computational methods.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory		Practical		Total Marks
				ESE	CE	ESE	CE	
3	0	2	5	70	30	30	20	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction**: Mass, momentum and energy equations; convective forms of the equations and general description.	04
2	**Classification and Overview of Numerical Methods:** Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods.	04
	Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of F.D. method.	06
3	**Finite Volume Technique**: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.	04

Unit No.	Topics	Teaching Hours
	<u>Finite Element Methods:</u> Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.	05
4	**<u>Methods of Solution:</u>** Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.	04
	<u>Time integration Methods</u>: Single and multilevel methods; redictor corrector methods; stability analysis; Applications to transient conduction and advection diffusion problems.	05
5	**<u>Numerical Grid Generation:</u>** Numerical grid generation; basic ideas; Transformation and mapping.	04
	<u>Navier-Stokes Equations:</u> Explicit and implicit methods; SIMPLE type methods; fractional step methods.	04
6	**<u>Turbulence modeling</u>:** Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.	04
	TOTAL	**44**

List of References:

1. John D. Anderson, "*Computational Fluid Dynamics-The basics with Applications"*, *International Edition*, McGraw-Hill, 1995.
2. John F. Wendt, "*Computational Fluid Dynamics"*, *Third Edition*, Springer, 2009.
3. Klaus Hoffmann, steven, "*Computational Fluid Dynamics-"*, *Fourth Edition,* Volume 1,2 and 3, Engg Education System USA, 2000.
4. Anil W Date, "Introduction to *Computational Fluid Dynamics-"*, *Fourth Edition*, Cambridge Univ Press, 2005.
5. T. J. Chung*, "Computational Fluid Dynamics", Second Edition, Cambridge Univ. Press, 2010.*
6. *S.V. Patankar, "Numerical Heat Transfer and Fluid Flow" Second Edition,Taylor and Fransis Publication,1980.*

Course Outcomes (COs):

1. Interpret basic laws of conservation.
2. Evaluate boundary value problem.
3. Investigate problems using basic computational methods.
4. Formulate fluid flow problem using various mathematical methods.
5. Discretize the flow field space.
6. Select suitable turbulence model