Course Code TEE 812	Credit Hours (Th-Pr) 3.0-0	**Advanced Fluid Dynamics (Elective)**	Contact Hrs/Wee k (Th-Pr) 3.0-0	Total Contact Hrs (Th-Pr) 45-0

Course Outline:

This course will cover principles of fluid dynamics: Tensors, model testing, description of flow fields, laws for mass, momentum and energy. Inviscid flow: Euler and Bernoulli equations, potential flow. Viscous flow: Navier-Stokes equations, boundary layers, turbulence. Element of Stability Theory. Turbulent Flows. Compressible Flows and Introduction to CFD.

Eligibility Criteria:

B.E in Mech., Elect (Power), Chemical, Industrial, Process

B.S (4-years) Or M.Sc. degrees in Physics

Recommended Books:

S. No.	Title	Author(s)	Assigned Code	Remarks
1.	Fluid Mechanics: Fundamentals and Applications	Yunus A. Cengel	YC	Text
2.	Introduction to Fluid Mechanics	Fox W. Robert, McDonald T. Alan	RM	Reference
3.	Fluid Mechanics	P. K. Kundu &I. M. Cohen	KM	Reference

Course Objectives:

The course is helpful for understanding of the relationship between the mathematics, the physics and the modeling of fluid mechanics. It will develop proficiency in the analysis of fluids systems with mathematical modeling, measurement tools, and computer technologies. The students can understand the application of fluid mechanics to thermal energy systems and other fluid phenomena.

Learning outcome:

The focus of the course is to solve problems in industry. The course is intended to provide students with the following benefits:

a. Understanding the concept of fluid and the models of fluids
b. Understanding the basic physical meaning of general equations
c. Understanding the concept of stream function and potential function
d. Ability to derive the equation for viscous flow, including laminar flow and turbulent flow
e. Ability to address such problems in engineering, and to solve the problems
f. Ability to cooperate with the team members

Topics Covered:

No.	Topics	Text Book	Contact Hours
1	Concepts and Fundamentals Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity, and stress field, Fluid statics, Fluid Kinematics.	YC,RM &KM	3
2	Governing Equations of Fluid Motion Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler’s equation, Bernoulli’s Equation	YC,RM &KM	4
3	Solutions of Navier-Stokes Equations Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows, Creeping flows	YC,RM &KM	4
4	Potential Flows Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag	YC,RM &KM	7
5	Laminar Boundary Layers	YC,RM	6

	Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation, Entry flow into a duct.	&KM	
6	Elements of Stability Theory Concept of small-disturbance stability, Orr-Sommerfeld equation, Inviscid stability theory, Boundary layer stability, Thermal instability, Transition to turbulence.	YC,RM &KM	5
7	Turbulent Flow Introduction, Fluctuations and time-averaging, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis, Turbulence modeling, Free turbulent flows.	YC,RM &KM	7
8	Compressible Flows Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Rankine-Hugoniot relations, Fanno and Rayleigh curve, Mach YC,RM &KM waves, Oblique shock wave, Prandtl-Meyer expansion waves, Quasi-one dimensional flows, Compressible viscous flows, Compressible boundary layers.	YC,RM &KM	7
9	Computational Fluid Dynamics (CFD) Boundary conditions, Basic discretization – Finite difference method, Finite volume method and Finite element method.	YC,RM &KM	4