FLUID MECHANICS AND HYDRAULICS

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAE003	Foundation	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

OBJECTIVES:

The course should enable the students to:

I. Illustrate about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
II. Derive the basic principles of a fluid-continuity, momentum, Euler and Bernoulli's equations.
III. Explain the concept of boundary layer theory and importance of Prandtl's boundary layer theory.
IV. Understand the flow through pipes and their losses for different geometries.

COURSE LEARNING OUTCOMES (CLOs):

1. Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.
2. Explain the hydrostatic forces on submerged bodies, variation with temperature and height with respect to different types of surfaces.
3. Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacentre height.
4. Define fluid kinematics and classification of flows, concepts of stream function and velocity potential function which provides solution for velocity and acceleration of fluid flow in real time applications.
5. Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.
6. Recognize the surface and body forces required for obtaining momentum equation and energy equation and explain types of derivatives utilized in various flow field conditions.
7. Develop Bernoulli's equation from Euler's equation and explain phenomenological basis of Navier – stokes equation which are widely used in aerodynamics and gas dynamics for real time problems.
8. Demonstrate Buckingham's π theorem and explain similarity parameters used for scale down models and explain flow measurements with dimensionless parameters.
9. Demonstrate for competitive exams, the concepts of boundary layer and qualitative description of boundary layer thickness and velocity profile on a flat plate.
10. Distinguish the pressure drag and skin friction drag and state the relation between the frictions of both the drags.
11. Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.
12. Discuss fully developed flow through pipes and variation with friction factor with Reynolds number.
13. Understand Moody's chart for identifying friction factor against Reynold's number for various values of roughness.
14. Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.
15. Explain the velocity triangles for turbine blades and centrifugal pumps.

UNIT-I	FLUID PROPERTIES AND FLUID STATICS	Classes: 10

Density, specific weight, specific gravity, surface tension and capillarity, Newton‘s law of viscosity, incompressible and compressible fluid, numerical problems; Hydrostatic forces on submerged bodies - Pressure at a point, Pascal's law, pressure variation with temperature and height, center of pressure plane, vertical and inclined surfaces; Manometers - simple and differential Manometers, inverted manometers, micro manometers, pressure gauges and numerical problems. Buoyancy - Archimedes principle, metacenter, Meta centric height calculations; Stability.

UNIT-II	FLUID KINEMATICS AND BASIC EQUATIONS OF FLUID FLOW ANALYSIS	Classes: 09

Stream line, path line, streak line, stream surface, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent flows, one dimensional approximation, examples of real 1-D flows, two dimensional approximation, 2-D flow in wind tunnel; Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows; Vortices, Irrotational flow, velocity potential function.

UNIT-III	FLUID DYNAMICS	Classes: 10

Basic laws for a system in integral form: Reynolds transport theorem, Conservation of mass, Newton‘s 2nd law; Application of the basic laws for a control volume; Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion: Continuity equation, Differential momentum equation, Surface and body forces, substantive derivative, local derivative and convective derivative, momentum equation, Euler's and Bernoulli's equation, phenomenological basis of Naviers- stokes equation, introduction to vortex flows, flow measurements : pressure, velocity and mass flow rate, viscosity, pitot-static tube, venturi meter and orifice meter, viscometers.

Statement of Buckingham‘s π- theorem, similarity parameters - Reynolds number, Froude number, concepts of geometric, kinematic and dynamic similarity, Reynolds number as a very approximate measure of ratio of inertia force and viscous force.

UNIT-IV	BOUNDARY LAYER THEORY AND PIPE FLOW	Classes: 08

Boundary layer - introductory concepts of boundary layer, large Reynolds number flows and Prandtl‘s boundary layer hypothesis Pressure drag and skin friction drag; Pipe flow - Reynolds experiment, Darcy‘s equation, major and minor losses in pipes and numerical problems. Flow between parallel plates, flow through long tubes –fully developed flow, Turbulent flow, variation of friction factor with Reynolds‘s Number, Moody's chart.

UNIT-V	TURBO MACHINERY	Classes: 08

Introduction and classification of fluid machines: Turbo machinery analysis; The angular momentum principle; Euler turbo machine equation; Velocity triangles; Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.

Text Books:

1. Shames I H, “Mechanics of Fluids: Kogakusha”, Tokyo, 7th Edition, 2007.
2. R. K Bansal, “Fluid mechanics and hydraulic machines”, Laxmi publications ltd, 9th Edition, 2011.
3. Robert W Fox, Alan T McDonald, “Introduction to fluid Mechanics”, John Wiley and Sons, 6th Edition, 1995.
4. Streeter V. L, Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 9th Edition, 1983.

Reference Books:

1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, “Theoretical Hydrodynamics”, MacMillan, 5th Edition, 1968.
3. Rathakrishnan. E, “Fundamentals of Fluid Mechanics”, Prentice-Hall, 5th Edition, 2007.
4. Som S. K, Biswas. G, “Introduction to fluid mechanics and fluid machines”, Tata McGraw-Hill, 2ndEdition, 2004.

Web References:

1. https://nptel.ac.in/courses/112105171/1
2. https://textofvideo.nptel.iitm.ac.in/112105171/lec1.pdf
3. https://www.fkm.utm.my/~syahruls/3-teaching/2-fluid-II/fluid-II-enote/32-pump-2.pdf
4. https://www.scribd.com/doc/16605891/Fluid-Mechanics

E-Text Books:

5.

1. https://bookboon.com/en/engineering-fluid-mechanics-ebook
2. https://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal
3. https://eprints.staffs.ac.uk/222/1/engineering-fluid-mechanics%5B1%5D.pdf
4. https://www.engr.uky.edu/~acfd/me330-lctrs.pdf