Course No:	Course Name:	L-T-P-Credits	Year of Introduction
SB203	MECHANICS OF FLUIDS	3-1-0-4	2016

Prerequisites: -Nil

Course Objectives:

1. To provide a foundation in the fundamentals of fluid mechanics.
2. To provide practice in the analytical formulation of fluid mechanics problems.
3. To introduce the theory of surface gravity waves.
4. To introduce computational fluid dynamics.

Syllabus:

Basics- Properties of Fluids-Fluid Pressure- Pressure Measurement- Hydrostatic Forces on Surfaces-Buoyancy & Floatation-Fluid Kinematics-Flow Visualization - Fluid Dynamics –Viscous Incompressible Flows-Turbulent Flow Through Pipes-Flow around submerged bodies-Gravity Waves-Introduction to Computational Fluid Dynamics.

Expected Outcome:

Upon successful completion of the course, the student will be able to

1. determine the hydrostatic forces on submerged plane and curved surfaces.
2. understand buoyancy and stability
3. determine velocity, pressure and acceleration in incompressible and inviscid flows.
4. understand rotational and irrotational flows, stream functions and velocity potentials.
5. know the use of flow visualization techniques.
6. demonstrate understanding of laminar and turbulent flows through pipes, losses in pipes and solve simple problems.
7. demonstrate understanding of external fluid flow and the concepts of drag and lift.
8. demonstrate basic understanding of gravity waves and calculate wave parameters from given data.
9. demonstrate understanding of the fundamental concepts in computational fluid dynamics.

Text Books:

- Yunus A. Cenegel, John M. Cimbala; Fluid Mechanics- Fundamentals and Applications (in SI Units); McGraw Hill.
- Bansal R.K, Fluid Mechanics and Hydraulic Machines (SI Units); Laxmi Publications.

Reference Books:

- Pijush K. Kundu, Ira M. Cohen – Fluid Mechanics; Elsevier.
- S K Som, C Biswas; Indtroduction to Fluid Mechanics and Fluid Machines; Tata McGraw Hill.
- Frank M. White; Fluid Mechanics; Tata McGraw Hill.
- Kothandaraman C.P, Rudramoorthy R., Fluid Mehanics & Machinery; New Age Publishers.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Basics:** Fluids, *Application areas of Fluid Mechanics*, No-Slip condition, Brief History, Classification of Fluid Flows-Viscid, Inviscid; Internal, External; Compressible, Incompressible; Laminar, Turbulent; Natural, Forced; Steady, Unsteady; 1,2 & 3-D Flows; System & Control Volume.	3	15%

	Properties of Fluids: Property- Intensive & extensive properties; Principle of Continuum; Density & Specific gravity; Viscosity-Dynamic Viscosity, Newtonian & Non Newtonian Fluids, Viscosity & Momentum Transfer, Effect of Temperature on Viscosity, Significance of Kinematic Viscosity; Surface Tension; Compressibility & Bulk Modulus; Vapour Pressure-partial pressure, Cavitation.	3	
II	**Fluid Pressure:** Pressure at a point, Pascal's Law, Pressure Variation in a fluid at rest, Absolute, Gauge, Atmospheric and Vacuum Pressures.	1	15%
	Pressure Measurement (Theory Only)**:** *Manometers – Piezometer, U-Tube Manometer, Single Column Manometer; Differential Manometers- U-Tube Differential Manometer, Inverted U Tube Differential Manometer.*	1	
	Hydrostatic Forces on Surfaces: Total Pressure and Centre of Pressure; Vertical Plane Surface Submerged in Liquid; Horizontal Plane Surface Submerged in Liquid; Inclined Plane Surface Submerged in Liquid; Curved Surface Submerged in Liquid.	3	
	Buoyancy and Floatation: Buoyancy, Centre of Buoyancy; Metacentre-Metacentric Height, Analytical Method for Metacentric Height; Conditions of Equilibrium of Floating and Submerged Bodies- Stability of a Submerged Body, Stability of a Floating Body; Experimental Method for Determination of Metacentric Height; Oscillation of a Floating Body.	5	
FIRST INTERNAL EXAM			
III	**Fluid Kinematics:** Introduction; Lagrangian & Eulerian Method of Describing Fluid Motion; Rate of Flow; Continuity Equation in 1-D-Simple Numericals; Continuity Equation in 3-D; Velocity & Acceleration- Local Acceleration and Convective Acceleration	2	15%
	Velocity Potential Function and Stream Function; Equipotential Line; Line of Constant Stream Function; Flow Net; Relation Between Stream Function and Velocity Potential Function.	2	
	Types of Fluid Motion-Linear Translation, Linear Deformation, Angular Deformation, Pure Rotation; Vorticity; Vortex Flow- Forced Vortex Flow, Free Vortex Flow, Equation of motion for Vortex Flow, Equation of Forced Vortex Flow- Numerical Problems, Equation of Free Vortex Flow.	3	
	Flow Visualization: Streamlines & Streamtubes; Pathlines; Streaklines; Timelines; Refractive Flow Visualization Techniques; Surface Flow Visualization Techniques.	1	
IV	**Fluid Dynamics:** Introduction; Equations of Motion; Euler's Equation of Motion; Bernoulli's Equation from Euler's Equation, Assumptions made in the derivation of Bernoulli's Equation –Numerical Problems; Bernoulli's Equation for Real Fluid- Numerical Problems; The Momentum Equation, Moment of Momentum Equation – Numerical	7	15%

	Problems.		
SECOND INTERNAL EXAM			
V	**Viscous Incompressible Flows:** Introduction; Reynolds's Number; General Viscosity Law & Assumptions; Navier Stokes Equations; Flow of Viscous Fluid Through Circular Pipe – Numerical Problems; Flow of Viscous Fluid Between Two Parallel Plates- Numerical Problems; Loss of Head Due to Friction in Viscous Flow.	5	20%
	Turbulent Flow Through Pipes: Introduction; Reynold's Experiment; Frictional Loss in Pipe Flow; Hydrodynamically Smooth & Rough Boundaries; Resistance of Smooth & Rough Pipes; Loss of Energy in Pipes; Loss of Energy Due to Friction- Numerical Problems; Minor Energy Losses- Theory Only.	3	
	External Flow: Boundary Layer Flow –Laminar Boundary Layer, Turbulent Boundary Layer, Laminar Sub Layer, Boundary Layer Thickness; Separation of Boundary Layer; Force Exerted by a Flowing Fluid on a Stationary Body; Expression for Drag & Lift- Numerical Problems; Drag on a Sphere; Drag on a Cylinder; Development of Lift on a Circular Cylinder – Flow Pattern around cylinder when constant circulation is imparted to the cylinder, Flow over Cylinder due to constant circulation, Lift force acting on rotating Cylinder, Drag force acting on rotating cylinder, Expression for lift coefficients of rotating cylinder, Location of stagnation points in uniform flow field; Development of Lift on an Airfoil.	6	
VI	**Gravity Waves:** The wave Equation; Wave Parameters; Surface Gravity Waves; Features of Surface Gravity Waves- Pressure change due to wave motion, Particle path and streamline, Energy Considerations; Approximations for Deep and Shallow water.	9	20%
	Introduction to Computational Fluid Dynamics: Introduction and Fundamentals; Solution Procedure.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.