TEACHING PLAN: FLUID MECHANICS

SCHOOL: SOET		ACADEMIC SESSION 2022-23	FOR STUDENTS' BATCH: 2021-2025
1	Course code	PCC-ME 211	
2	Course Title	FLUID MECHANICS	
3	Credits	3	
4	Learning Hours	Contact Hours: 45 Practical Teaching: 10 Project, Tutorial and Assessment: 15 Total hours: 70	
5	Course Objective	I. To learn about the Fluid properties, different type of fluid and their nature. II. To learn about flow measurement devices and understanding about hydrostatic law, principle of buoyancy and stability of a floating body. Also learn about the concept of hydrostatic force in dam. III. To learn about basic equation of kinematics and also study about the velocity and acceleration of fluid flow. IV. To study about basic law of fluid dynamics and measurement of flow rate, velocity of fluid flow from fluid dynamics measuring device. V. To study about the nature of flow, boundary layer and losses in pipes network and study about the dimensional analysis model similitude and their application	
6	Course Outcomes	1. To familiarize with the properties of fluids and fluid kinematics. 2. Apply Bernoulli's equation to fluid flow problems. 3. To understand the concept of dimensional analysis and incompressible flow. 4. Apply appropriate equations and principles to analyze pipe flow problems and turbulent flow. 5. Apply the boundary layer theory to determine lift and drag forces on a submerged body.	
7	Outline syllabus:		

7.01	Paper Code	Unit	Introduction	Reference number	Teaching methods
7.02	PCC-ME 211	I	**Fluid Properties and Fluid Statics:**Definition, Distinction between solid and fluid Modulesand dimensions, Properties of fluids - density, specific weight, specific volume, specific gravity,temperature, viscosity, compressibility, vapour pressure, capillary and surface tension. Pascallaw, absolute, gauge and vacuum pressures, Pressure measurements by manometers and pressuregauges. Archimedesprinciple, Hydrostaticlaw,Centreofpressure, stabilityoffloatingbodies. **FluidKinematics**:Flowvisualization,Linesofflow,Typesofflow,Velocityfieldandacceleration, Continuity equation (one and three dimensional differential forms), Equation ofstreamline,Streamfunction,Velocitypotentialfunction,Circulation, Flow net.	T1, R1	PPT, Seminar, Chalk & Talk
7.03		II	**Fluid Dynamics:**Definition,Equations of motion - Euler's equation along a streamline, Bernoulli's equation and its applications,Venturi-meter, Orifice meter, Pitot tube, Orifices, Mouthpieces, Notches and Weirs, Momentum theorem.	T1, R1	PPT, Seminar, Chalk & Talk
7.04		III	**Dimensional Analysis:** Dimensionless numbers- Reynolds, Froude, Mach, Weber and Euler, Applications of numbers, undistorted model, Distorted model, scale effect. **Incompressible Fluid Flow:** Viscous flow, Navier-Stoke's equation (Statement only), Shear stress, Pressure gradient relationship, Laminar flow between parallel plates, Laminar flow through circular tubes, Hagen Poiseulle's equation.	T1,R2, R3	PPT, Seminar, Chalk & Talk

7.05		IV	**Flow Through Pipes:** Friction loss, Darcy-Weisbach Formula, Minor and major losses, Hydraulic and energy grade lines, Flow through pipes in series and in parallel, Power transmission, Water hammer and cavitation. **Turbulent Flow:** Variation of friction factor with Reynolds number, Moody's diagram, Shear stress in turbulent flow, Prandtl Mixing length theory, Velocity distribution in smooth pipes and rough pipes, Resistance of smooth and rough pipe.	T1, R1,R2	PPT, Seminar, Chalk & Talk
		V	**The Boundary Layer:** Description of the boundary layer, Boundary Layer thickness, Von- Karman momentum integral equation, Coefficient of drag, Boundary layer separation and control, Flow around a body, Drag and lift, Drag on sphere and cylinder, Development of lift on a circular cylinder, Development of lift on an airfoil..	T1, R1,R3	PPT, Seminar, Chalk & Talk

8	**Course Evaluation**	
8.10	**CA: 20%**	
8.1	**Attendance**	5%
8.12	**Homework**	-
8.13	**Quizzes**	4 Quizzes, 5%
8.14	**Projects**	1 Project, 5%
8.15	**Presentation**	1 Presentation, 5%
8.16	**Any other**	--
8.2	**MTE(IA)**	20%
8.3	**End-term examination: 60%**	
9	**Text Books & References**	
9.1	**Text books**	1. YunusA. CengelandCimbala, FluidMechanics, TataMcGrawHill 2. FrankM.White,FluidMechanics,TataMcGrawHill.
9.2	**References**	1. Streeter V.L., K.W. Bedford and E.B.Wylie , Fluid Mechanics , Tata McGraw Hill 2. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley &Sons 3. Potter, Mechanics of Fluids, Cengage Learning. 4. John F. Douglas, Fluid Mechanics, Pearson Education 5. Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard Book House. 6. Som, S. K., &Biswas, G. Introduction to fluid mechanics and fluid machines, Tata McGraw- Hill. 7. Munson, B. R., Young, D. F., &Okiishi, T. H. Fundamentals of Fluid Mechanics, Wiley 8. Fluid mechanics by R.K. Bansal
9.3	**Video References**	1. https://www.youtube.com/watch?v=fa0zHI6nLUo&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm 2. https://www.youtube.com/watch?v=rr8LAljAeMs&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm&index=2 3. https://www.youtube.com/watch?v=NKpXpx_oDWM&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm&index=47 4.

Mapping of COs & POs

Course Outcome	Program Outcome												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	2	2	2		2	1	1	2	3	3	2	2
CO2	3	3	3	3	2	2	2		2	1	1	2	3	3	2	2
CO3	3	3	3	3	2	2	2		2	1	1	3	3	3	2	2
CO4	3	3	3	3	2	2	1		2	2	1	3	3	3	2	2
CO 5	3	3	3	3	2	2	2		1	1	1	2	3	3	2	2

QUESTION BANK

UNIT I

1. Define and explain the fluid properties.
2. Calculate specific weight, density, specific volume and specific gravity and if one litre of Petrol weighs 6.867N.
3. A plate having an area of 1m2 is dragged down an inclined plane at 450 to horizontal with a velocity of 0.5m/s due to its own weight. Three is a cushion of liquid 1mm thick between the inclined plane and the plate. If viscosity of oil is 0.1 PaS find the weight of the plate.
4. A glass tube 0.25mm in diameter contains Hg column with air above it. If □□= 0.51N/m, what will be the capillary depression? Take □□= - 40^0 or 140^0.
5. Calculate intensity of pressure due to a column of 0.3m of (a) water (b) Mercury (c) Oil of specific gravity-0.8.
6. Explain with neat sketch of different types of pressure gauges.
7. Write short notes on different types of Fluid flow with examples and neat sketches.
8. Explain Capillary phenomenon with neat sketches.
9. Determine the total force and location of centre of pressure for a circular plate of 2 m dia immersed vertically in water with its top edge 1.0 m below the water surface.
10. Define Archimedes Principle and Explain.
11. Derive expression for continuity equation for 3 dimensional flows.
12. (a). Derive relation between velocity potential and stream function.
    (b). Write a short note on flow net.

UNIT II

1. A horizontal venture meter with inlet diameter 30cm and throat diameter 15cm is used to measure the flow of water. The differential manometer connected to the inlet and throat is 20cm. Calculate the discharge. Take Cd= 0.98.
2. An oil of sp.gr. 0.8 is flowing through a venture meter having inlet diameter 20cm and throat 10cm. The oil mercury differential manometer shows a reading of 25cm. Calculate the discharge of oil through the horizontal venturi meter. Take Cd= 0.98.
3. The inlet and throat diameters of a horizontal venturimeter are 30cm and 10cm respectively. The liquid flowing through the venture meter is water. The pressure intensity at inlet is 13.734N/cm^2 while the vacuum pressure head at the throat is 37 cm of mercury. Find the rate of flow. Assume that 4% of the differential head is lost between the inlet and the throat. Find also the values of Cd for the Venturi meter.
4. Derive Bernoulli's equation from Euler's equation of motion.
5. Derive expression for discharge of venturimeter
6. Derive one dimensional momentum equation
7. What are the applications of Bernoulli's equation and give its uses.
8. Calculate the coefficient of velocity C_v if the actual velocity of jet is 5.1 m/s. Orifice is located 2m below the water surface in a tank.
9. Determine discharge through a internal mouthpiece (running free) if the area of mouthpiece is 0.15 m^2. The distance between the centre of mouthpiece and free water surface is 3.0 m.
10. Derive one dimensional momentum equation.

UNIT III

1. What is Hagen poiseuille's formula?
2. Explain Buckingham's theorem.
3. The resisting force (R) of a supersonic flight can be considered as dependent upon length of aircraft (l), velocity (V), air viscosity 'μ', air density 'ρ', and bulk modulus of air ' k'. Express the functional relationship between these variables and the resisting force.
4. A ship is 300 m long moves in sea water, whose density is 1030 kg/m3. A 1:100 model of this to be tested in a wind tunnel. The velocity of air in the wind tunnel around the model is 30 m/s and the resistance of the model is 60 N. Determine the velocity of ship in sea water and also the resistance of the ship in sea water. The density of air is given as 1.24 kg/m^3. Take the Kinematic viscosity of sea water and air as 0.012 stokes and 0.018 stokes respectively.
5. 4. A 7.2 m height and 15 m long spillway discharge 94 m^3/s, under a head of 2.0m. If a 1:9 scale model of this spillway is to be constructed, determine model dimensions, head over spillway model

and the model discharge. If model experience a force of 7500 N (764.53 Kgf), determine force on the prototype.

6. A quarter scale turbine model is tested under ahead of 12 m. The full scale turbine is to work under a head of 30 m and to run at 428 rpm. Find N for model. If model develops 100 kW and uses 1100 l/s at this speed, what power will be obtained from full scale turbine assuming its n is 3% better than that of model.
7. State the reasons for construction distorted model of rivers and discuss the various types of distortion in models. What are the merits and demerits of distorted models as compared to undistorted model?
8. Derive the relation using Buckingham's π theorem F = ρ U2D2f (μ/UD ρ), ND/U).
9. Using Buckingham's π theorem, show that the drag force FD = ρ L2V2φ (Re,M) which Re = ρ LV/μ; M = V/C; ρ = fluid mass density; L = chord length: V= velocity of aircraft; μ = fluid viscosity; C = sonic velocity = √K/ ρ where K = bulk modulus of elasticity.

UNIT IV

1. What is meant by energy loss in a pipe?
2. Explain the major losses in a pipe.
3. Explain minor losses in a pipe.
4. Derive the expression for head loss due to friction?
5. Find the head lost due to friction in a pipe of diameter 300 mm and length 50 m, through which water is flowing at a velocity of 3 m/s using (i) Darcy formula, (ii) Chezy's formula for which C = 60.
6. An oil of sp.Gr 0.9 and viscosity 0.06 poise is flowing through a pipe of diameter 200 mm at the rate of 60 lit/s. Find the head lost due to friction for a 500 m length of pipe. Find the power required to maintain this flow.
7. The difference in water surface levels in two tanks, which are connected by three pipes in series of lengths 300 m, 170 m and 210 m and of diameters 300 mm, 200 mm and 400 mm respectively, is 12m. Determine the rate of flow of water if co – efficient of friction are 0.005, 0.0052 and 0.0048 respectively, considering: (i) minor losses also (ii) neglecting minor losses.
8. Find the maximum power transmitted by a jet of water discharging freely out of nozzle fitted to a pie = 300 m long and 100 mm diameter with co efficient of friction as 0.01. The available head at the nozzle is 90 m.
9. A pipe line 60 cm diameter bifurcates at a Y- junction into two branches 40 cm and 30 cm in diameter. If the rate of flow in the main pipe is 1.5 m^3/s and mean velocity of flow in 30 cm diameter pipe is 7.5 m/s, determine the rate of flow in the 40 cm diameter pipe.
10. A pipe line of length 2000 m is used for power transmission. If 110.3625 kW power is to be transmitted through the pipe in which water having a pressure of 490.5 N/cm^2 at inlet is flowing. Find the diameter of the pipe and efficiency of transmission if the pressure drop over the length of pipe is 98.1 N/ cm2. Take f = 0.0065.

UNIT V

1. Briefly explain the boundary layer definitions.
2. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by u/U =y/δ, where u is the velocity at a distance y from the plate and u = U at y = δ, where δ = boundary layer thickness. Also calculate the value of δ*/θ.
3. For the velocity profile $u/U = 2 (y/\delta) - (y/\delta)^2$, find the thickness of boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide when placed in water flowing with a velocity of 150 mm/sec. Calculate the value of co - efficient of drag also. Take μ for water = 0.01 poise.
4. For the velocity profile for laminar boundary layer $u/U = 3/2 (y/\delta) - 1/2 (y/\delta)^3$ find the thickness of the boundary layer and the shear stress 1.5 m from the leading edge of a plate. The plate is 2 m long and 1.4 m wide and is placed in water which is moving with a velocity of 200 mm per second. Find the total drag force on the plate if μ for water = 0.01 poise.
5. Determine the thickness of the boundary layer at the trailing edge of smooth plate of length 4 m and of the width 1.5 m, when the plate is moving with a velocity of 4 m/s in stationary air. Take kinematic viscosity of air as 1.5×10^{-5} m^2.