Name:

Enrolment No:

UPES

End Semester Examination, May 2023

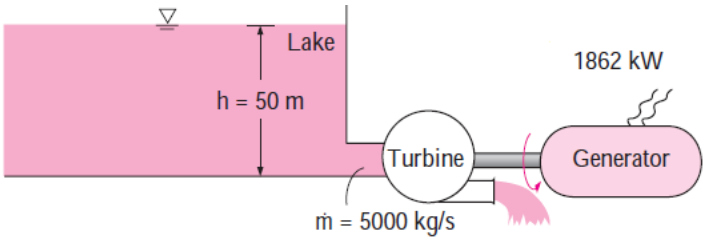
Course: Fluid Mechanics and Fluid Machines **Semester: IV**

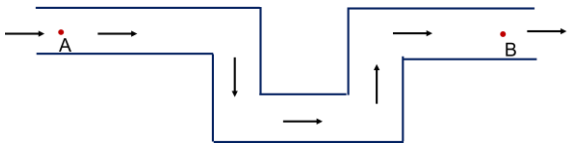
Program: B.Tech (Mechanical Engineering) **Time : 03 hrs.**

Course Code: MECH 2026 **Max. Marks: 100**

Instructions:

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	How the viscosity of fluids (liquids and gases) changes with temperature? Explain with proper reason.	**4**	**CO1**
Q 2	Define Reynolds Number. Write down its mathematical expression and its physical significance in fluid mechanics.	**4**	**CO2**
Q 3	An oil in a hydraulic cylinder (cylinder fitted with a piston) is compressed from its initial volume of 3 m^3 to 2 m^3. If the pressure inside the cylinder changes from 30 MPa to 120 MPa during this process of compression. Calculate the bulk modulus of elasticity of the oil.	**4**	**CO1**
Q 4	Using appropriate sketch, discuss the development of the boundary layer flow over a flat plate, and the different flow regimes.	**4**	**CO1**
Q 5	The water in a large lake is to be used to generate electricity by the installation of a hydraulic turbine–generator at a location where the depth of the water is 50 m (as shown in figure). Water is to be supplied at a rate of 5000 kg/s. If the electric power generated is measured to be 1862 kW, determine the overall efficiency of the turbine-generator. 	**4**	**CO4**

SECTION B (4Qx10M= 40 Marks)			
Q 6	a) Define streamlines, streaklines and pathlines. b) Consider the velocity field of a flow given by $u = y/(x^2 + y^2)$ and $v = -x/(x^2 + y^2)$. Calculate the equation of the streamline passing through the point (0, 5). [3 + 7 marks]	**10**	**CO1**
Q 7	a) What are the different sources of energy losses in a pipe flow? [3 marks] b) Water is flowing through a horizontal circular pipe. You are required to calculate the loss of energy head between the two points A and B, as shown in figure. Given: Pressure at points A and B are 12kPa and 10kPa, respectively. The diameter of the pipe at sections A and B are 4 cm and 5cm, respectively. The flow rate through the pipe is 0.5 m^3/minute. [7 marks] 	**10**	**CO3**
Q 8	Define displacement thickness and momentum thickness for a boundary layer flow. Find the displacement thickness and momentum thickness for the flow over a horizontal flat plate. The velocity distribution in the boundary layer is given by $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$, where δ is the thickness of the boundary layer. OR a) The drag coefficient of a car running at 80 km/h is to be determined experimentally in a large wind tunnel in a full-scale test. The frontal area of the car is 3 m^2. If the force acting on the car in the flow direction is measured to be 200N, determine the value of drag coefficient for this car. Density of air is 1.2 kg/m^3. b) If the same care is to be tested using a small-scale model (scale = 1:2), find out the wind speed at which the car should be tested in the wind tunnel. [4 + 6 marks]	**10**	**CO2**

Q 9	Define the followings and write the major differences between them: a) Turbines and Pumps b) Impulse and Reaction turbines c) Radial and axial flow turbines d) Francis and Pelton turbines	**10**	**CO4**
	SECTION-C **(2Qx20M=40 Marks)**		
Q10	a) Using potential flow theory for an inviscid and incompressible flow, derive the equations for stream function, and velocity field for the non-lifting flow over a circular cylinder and obtain the coordinates of the stagnation points. b) Comments on lift and drag forces acting on the cylinder for the inviscid, incompressible flow and compare these with the forces acting on the cylinder in a real flow (viscid flow). [15 + 5 marks] OR a) For a two-dimensional flow, the velocity components are given as $u = 2xy$ and $v = a^2 + x^2 - y^2$. Show that the velocity potential exists for the flow. Also derive the expression of velocity potential function. b) Derive the expression for velocity potential function and stream function for a source flow. c) Derive the equation for the equipotential lines and streamlines for a source flow and show that they are perpendicular to each other. [8 + 8 + 4 marks]	**20**	**CO3**
Q11	a) What is Strouhal number. What is its significance? Draw the Strouhal number vs Reynolds number curve for the flow over a circular cylinder. b) The smoke stake (chimney) of a chemical plant is 120 meter tall. The average diameter of the chimney is 10 meters. The first and second mode natural frequencies of the structure (chimney) are 1.5 Hz and 9 Hz. Calculate the wind speeds at which the resonance in the structure is likely to occur due to vortex-induced vibration. c) On a thin flat plate of 2m length x 1m width, experiments were conducted in a wind tunnel at a wind speed of 50 m/s. The plate is kept fixed at such an angle that the coefficients of drag and lift are 0.1 and 0.9, respectively. Determine the lift, drag and resultant force acting on the plate. [4 + 8+ 8 marks]	**20**	**CO2**