Name: **Enrolment No:**	

UPES

End Semester Examination, May 2025

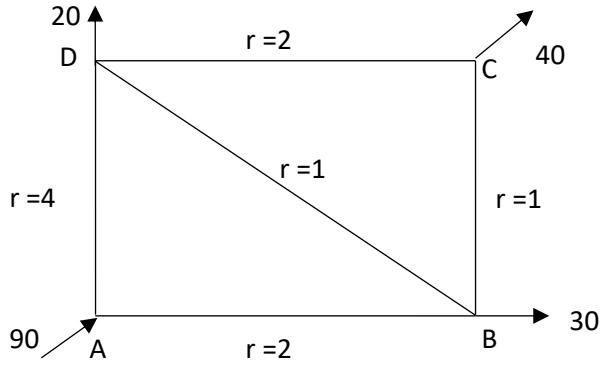
Course: Elements of Hydraulic Engineering **Semester:** IV
Program: B.Tech Civil Engineering **Time :** 03 hrs
Course Code: MECH2065 **Max. Marks:** 100

Instructions: Draw neat sketches using pencil wherever required to support your answer(s).

SECTION A
(5Qx4M=20Marks)

S. No.	List of questions	Marks	CO
Q 1	**Define the following terms based on your understanding:** a) Prandtl's mixing length b) Kinematic similarity c) Hydraulic jump d) Gradually varied flow	**4 x 1**	**CO1**
Q 2	**Distinguish between the following**: a) Uniform and non-uniform flow b) Impulse and reaction turbines	**2 + 2**	**CO2**
Q 3	**State 'True' or 'False' for the following statements:** a) In Rayleigh's method of dimensional analysis, the dependent variable is written as the function of exponential terms of independent variables. b) The specific speed of a tangential flow turbine is generally much less than that of an axial flow turbine. c) A loss of head at a sudden contraction in a pipe is smaller than that at a sudden expansion. d) The shear stress distribution from the center line of the pipe up to the pipe surface decreases linearly.	**4 x 1**	**CO1**
Q 4	**Fill in the blanks:** a) The minimum value of friction factor that can occur in laminar flow through a circular pipe is _____. b) The vertical difference between total energy line and hydraulic grade line is equal to the _____. c) The hydrodynamic boundary layer thickness is defined as the distance from the surface where the _____. d) The dimension of specific speed of a hydraulic turbine is _____.	**4 x 1**	**CO1**
Q 5	Estimate the specific energy of flowing water through a rectangular channel of width 5 m when the discharge is 10 m^3/s and depth of water is 3 m.	**4**	**CO2**

SECTION B **(4Qx10M= 40 Marks)**			
Q 6	Calculate the power required to overcome the viscous resistance to the flow of glycerine through a horizontal pipe of diameter 100 mm at the rate of 10 litres/s. The dynamic viscosity of glycerine is 8 poise, and the kinematic viscosity is 6 stokes.	**10**	**CO2**
Q 7	The depth of flow of water at a certain section of a rectangular channel 3 m wide is 0.45 m. The discharge through the channel is 3.1 m^3/s. Determine whether a hydraulic jump will occur, and if so, compute its height and loss of energy.	**10**	**CO3**
Q 8	A Pelton wheel turbine develops 8000 kW under a net head of 130 m at a speed of 200 rpm. Assuming the coefficient of velocity for the nozzle 0.98, hydraulic efficiency 87%, speed ratio 0.46, mechanical efficiency 75%, and jet diameter to wheel diameter ratio 1:9, determine: i) The discharge required. ii) Diameter of the wheel. iii) Diameter of jet and number of jets required. iv) Specific speed of the turbine.	**3+2+3+ 2**	**CO3**
Q 9	Derive all the necessary conditions for the most economical trapezoidal section in open channel flow. OR (a) Discuss the classification of open channel bottom slopes and draw their surface profiles. (b) Explain Boussinesq's theory to estimate shear stresses in turbulent flow highlighting its limitations.	**10** **5 + 5**	**CO2**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	(a) Derive an expression for the variation of depth along the length of the bed of the channel for gradually varied flow in an open channel, stating all the assumptions made. (b) Draw the specific energy curve and explain the importance of its different components. (c) Consider flow in a long and very wide rectangular open channel. The width of the channel can be considered as infinity compared to the depth of flow. Uniform flow depth is 1.0 m. The bed slope of the channel is 0.0001. The Manning's roughness coefficient is 0.02. Determine the critical depth corresponding to the flow rate resulting from the above conditions.	**8 + 6 + 6**	**CO3**

Q 11	Design the discharge in each pipe of the network shown below using Hardy Cross method. The pipe network consists of 5 pipes. The head loss h_f in a pipe is given by $h_f = rQ^2$. The values of r for various pipes and the inflow or outflows at nodes are shown in the figure.  OR a) Design the most economical trapezoidal canal section for carrying discharge of 45 m^3/s and side slope of 1.5:1 at a velocity of 0.9 m/s. Assume Manning's coefficient as 0.022. b) The pressure difference Δp in a pipe of diameter D and length l due to turbulent flow depends on the velocity V, viscosity μ, density ρ, and roughness k. Apply Buckingham's π theorem to obtain an expression for Δp.	**20** **10 + 10**	**CO4**