Name:

Enrolment No:

UPES

End Semester Examination, December 2024

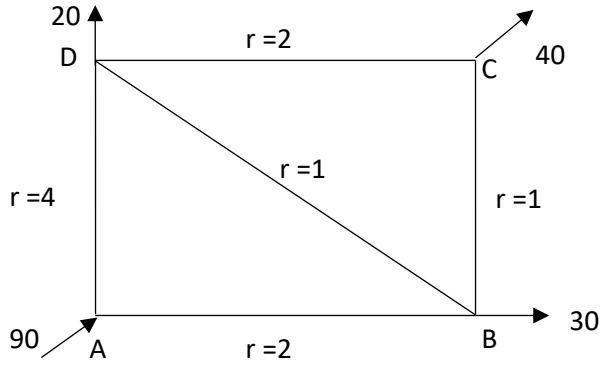
Course: Hydraulic Engineering
Program: B.Tech in Civil Engineering
Course Code: CIVL 3060

Semester: V
Time : 03 hrs
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	**Fill in the blanks:** 1. A 4 m wide rectangular channel carries 6 m^3/s of water. The Manning's 'n' of the open channel is 0.02. Considering g = 9.81 m/s^2, the critical velocity of flow (in m/s) in the channel, is _____. 2. The flow of water (mass density = 100 kg/m^3 and kinematic viscosity = $10^{-6} m^2/s$) in a commercial pipe, having equivalent roughness k as 0.12 mm, yields an average shear stress at the pipe boundary = 600 N/m^2. The value of k/δ′ (δ′ being the thickness of laminar sub-layer) for this pipe is _____.	**2 + 2**	**CO2**
Q 2	**Differentiate between the following**: a) Uniform and non-uniform flow b) Sub-critical and super-critical flow	**2 + 2**	**CO1**
Q 3	Recall the utility of gradually varied flow and rapidly varied flow in an open channel.	**4**	**CO1**
Q 4	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**
Q 5	Explain the concept of hydraulic jump using a neat sketch.	**4**	**CO2**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	Derive all the necessary conditions for the most economical trapezoidal section in open channel flow.	**10**	**CO3**
Q 7	Three pipes of lengths 800 m, 500 m and 400 m, and of diameters 500 mm, 400 mm, and 300 mm respectively are connected in series. These pipes are to be replaced by a single pipe of length 1700 m. Evaluate the diameter of the equivalent pipe.	**10**	**CO3**

Q 8	Draw the boundary layers in laminar, transition, and turbulent flow through a neat sketch, showcasing your understanding on the laminar boundary layer, turbulent boundary layer, laminar sub-layer and boundary layer thickness.	**10**	**CO2**
Q 9	Using Manning's method, estimate the bed slope of trapezoidal channel of bed width 4 m, depth of water 3 m, and side slope of 2 horizontal to 3 vertical, when the discharge through the channel is 20 m^3/s. Take Manning's N as 0.03. OR Determine the thickness of the boundary layer at the trailing edge of smooth plate of length 4 m and of 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/s.	**10** **10**	**CO3**
SECTION-C (2Qx20M=40 Marks)			
Q 10	(a) The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Analyze and express η in terms of dimensionless parameters. (b) The depth of flow of water, at a certain section of a rectangular channel 2 m wide, is 0.3 m. The discharge through the channel is 1.5 m^3/s. Determine whether a hydraulic jump will occur, and if so, estimate its height and loss of energy per kg of water.	**10 + 10**	**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 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 12 m. Design the rate of flow of	**20**	**CO4**

	water, if coefficients of friction are 0.005, 0.0052, and 0.0048 respectively, considering (i) minor losses also, and (ii) neglecting minor losses.		