Ref. No. Ex/CE/5/T/502/2025

BACHELOR OF ENGINEERING IN CIVIL ENGINEERING EXAMINATION 2025

(Fifth Year; Evening, First Semester)

HYDRAULIC STRUCTURES

Time: Three Hours **Full Marks 100**

Question		Attempt any FOUR QUESTIONS	Marks
		Assume suitable values for the parameters if not supplied.	
1	(a)	Write and explain the 'Laplacian equation' regarding two-dimensional seepage. What are the assumptions for developing the 'Laplacian equation' regarding seepage flow?	2+5= **7**
	(b)	Define 'Isotropic Soil'. Write down the steps and derive the equation for determination of seepage discharge through 'Isotropic Soil'; also write down the equation for the same through 'Non-Isotropic Soil'.	1+6+1= **8**
	(c)	What is 'Phreatic Line'? Determine (graphically) the phreatic line for the earth dam (details given below) with a horizontal filter of length equal to 25m, provided inward from the downstream toe of the dam, also determine the discharge passing through the dam. The earth dam made of homogeneous material has the following details: Coefficient of permeability of dam material = $5x10^{-4}$ cm/sec; Level of top of dam = 200.0 m; Level of deepest river bed = 178.0 m; H.F. L. of reservoir = 197.5 m; Width of the top of dam = 4.5 m; U/s Slope = 3(H):1(V); D/s Slope = 2(H):1(V)	2+8= **10**
2		Design and draw (on a graph sheet) an Ogee spillway for low tail water curve, to be constructed on the good condition rock, using the following design data: Height of the spillway crest from reservoir bed = 100m; No. of spans = 5; Length of each clear span = 12.5m; Thickness of each pier = 3m; D/s slope = 1 (V): 0.8 (H) Design discharge = 8500 Cumecs; Assume K_p = 0.01, K_a = 0.1, and D/S profile $x^{1.85} = 2(H_d)^{0.85}y$	18+7= **25**
3	(a)	Write the expression of 'Froude Number'. Derive the expression for critical depth of flow. What are the advantages of 'hydraulic jump'?	1+2+2=**5**
	(b)	What are the assumptions made in the momentum formula for 'Hydraulic Jump'? Discuss the effect of inclined bed, on the depth estimating equation of 'Hydraulic Jump', derived for horizontal bed. What would be the type of hydraulic jump in case of critical flow?	3+3+1=**7**
	(c)	Derive the expression of 'Initial Depth' in 'Hydraulic Jump', using momentum formula for horizontal bed.	**13**
4	(a)	Define 'Freeboard' for Hydraulic Structures. Also define 'Fetch' and 'Effective Fetch'. How do you estimate 'Effective Fetch'? Explain Briefly.	2+3+5= **10**
	(b)	Compute 'Freeboard and the top elevation of the dam for the following details: Full reservoir level = 335.00m; Maximum water level = 337.20m Effective fetch: For normal freeboard = 3.66km & minimum freeboard = 4.00km Wind velocity over land for normal freeboard = 160km/hr Average depth of reservoir: For normal freeboard = 29.0m & minimum freeboard = 31.2m. Embankment slope = 2.25(H):1(V) along with the following coefficients: • The upstream face surface roughness = 0.75 • The ratio of wind velocity over water surface to the wind velocity over land surface for effective fetch 2 and 4 as 1.16 and 1.24 respectively • Variation of the Relative Run-up (R/H_0) against Embankment Slope is as follows:	**15**

Embankment slope	0.1	0.2	0.3	0.4	0.5	0.6
Relative Run-up, R/H_0	0.368	0.752	1.200	1.600	1.968	2.272

5	(a)	What is 'Canal Fall' structure? What is the necessity of the same?	2+3=**5**
	(b)	Design and provide a neat sketch of a siphon type well drop canal fall structure for the following design data: Fall = 4.0m; General ground level = +160.36m RL; Full supply depth = 75cm; Bed level at u/s = +159.83m RL; Discharge = 1.2 Cumecs; Bed width = 2.4m; Assume Darcy's Coefficient of friction 0.012 and Length of the pipe 12m.	15+5=**20**
6	(a)	Design an aqueduct flumed section for a cross drainage work for the following given data: **Canal Data**: Discharge = 30.0 Cumecs; Bed width = 20.0 m; Depth of Water = 1.5 m; Full Supply Level (FSL) = 251.50 m RL **Drainage Data**: High Flood Discharge = 250.0 Cumecs; High Flood Level = 252.5 m RL; High Flood Depth = 2.5 m; General Ground Level = 250.0 m	**18**
	(b)	Draw (on a graph sheet) the flumed section in plan and show the profile of Total Energy Level (TEL), Water Surface and Bed Level in elevation.	**7**