Total number of printed pages:2 **Programme:PG/Semester:II/Code:MCE2108**

2025

Hydraulic Structures

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a)	What are the differences between a dam, a weir and a barrage? Classify dams according to (i) purpose or use, (ii) materials used for construction, and (iii) hydraulic design.	4+6
	b)	Draw a typical section of a radial gated overflow block of a gravity dam by showing (i) a drainage gallery, (ii) spillway with a ski-jump arrangement, and (iii) MWL, FRL, MDDL, live storage and dead storage of the impoundment.	6
	c)	List the criteria for selection of a suitable site of a dam on a river.	4
2.	a)	What are the types of forces that act on a gravity dam? Show with the help of sketches and conventional symbols the methods of estimating the uplift pressure on a gravity dam (i) without and (ii) with a drainage gallery.	2+2+3 = 8
	b)	Describe the middle-third rule for investigating the stability of a gravity dam against tension.	4
	c)	Investigate the stability against overturning of a concrete gravity dam having a simplified shape of a right-angled triangle with its upstream face vertical. The features of this dam are as below: Height of the dam = 130 m Slope of d/s face = 0.75 H : 1 V Height of water retained = 130 m Free-board = 0 Height of tail water = 0 Unit weight of concrete = 24 KN/m^3 Allowable coefficient of friction = 0.75 The earthquake forces may be taken as equivalent to 0.1 g for horizontal forces and 0.05 g for vertical forces. Neglect wave force. Assume any missing data.	8
3.	a)	Briefly describe with sketches, wherever applicable, the mechanisms under (i) hydraulic, (ii) seepage and (iii) structural failures of earthen dams.	3×4 = 12
	b)	If 4×10^{-6} m s^{-1} is the coefficient of permeability of the isotropic soil of an embankment of height 21.5 m and free board 1.5 m having a horizontal filter on the downstream end, estimate the discharge per unit width due to seepage through the body of the dam having a flow net with ten potential drops and five flow channels.	4

	c)	Draw a typical section of a homogeneous earthen dam with a downstream horizontal filter showing the phreatic surface of a flow net produced by Casagrande's graphical solution.	4
4.	a)	Under what conditions are (a) a chute spillway, (b) a morning glory spillway and (c) a piano-key spillway considered in planning a dam? Provide sketches.	6
	b)	Show that the total design head (including velocity head) on the crest of a spillway comprising six spans, each of 10 m width, would be 15 m if the pier contraction and the abutment contraction coefficients are 0.01 and 0.1 respectively, the coefficient of discharge is 2.2, and the discharge over the spillway is 7000 Cumec.	4
	c)	Under what condition is a hydraulic jump formed? If water emerges from an ogee spillway with 13.72 m s^{-1} velocity with 0.3 m depth at its toe, then show that the tail water depth required to form a hydraulic jump at the toe would be 3.24 m.	4
	d)	Show only with sketches the types of energy dissipation arrangements (together with the respective names) that may be constructed for the following three settings of the sequent depth curve (y_2-curve) and the tail water curve (TWC) on the downstream of a dam spillway: (i) the y_2-curve and the TWC coinciding at all spills, (ii) the TWC lying below the y_2-curve at all spills, and (iii) the y_2-curve lying below the TWC at all spills.	6
5.	a)	List the factors influencing the selection of a suitable type of a cross-drainage work. Name and provide sketches of different cross-drainage works under three distinct categories for disposing drainage water intercepting a canal.	2+6=8
	b)	State the purpose of providing (i) canal falls, (ii) canal head regulators, (iii) cross regulators, (iv) canal escapes, (v) silt excluders and (vi) silt ejectors.	6×2=12
6.	a)	Show that the critical velocity of an alluvial channel having 1.5 m depth of flow when computed using Kennedy's theory would be 0.784 ms^{-1} for a critical velocity ratio 1.1 and the Manning's roughness coefficient 0.018.	4
	b)	Define critical exit gradient as per Khosla's theory of seepage. Calculate the exit gradient in the case of a weir founded on a permeable stratum when the difference in elevations of the upstream pond level and the top of the downstream apron is 5 m, the depth of downstream cut-off is 4 m and the length of the floor of the weir is 10.0 m.	2+4=6
	c)	Write the formula for estimating hydroelectric power by naming the symbols and the units used. Draw an indicative arrangement for generating hydropower from the flow a river having a U-bend around a high hill. Name three major types of turbines that were discussed in your class.	4+4+2=10
7.	a)	Draw a typical layout of a diversion head works showing all components. Name the three types of weirs used in diversion head works.	6+4=10
	b)	Name any five types of canals falls and show indicative sketches of each type.	5×2 = 10
8.	a)	What are the objectives of river training works? Classify river training works according to purpose?	4+4=8
	b)	What are the functions of Guide bunds and Spurs?	6
	c)	Draw sketches of a normal, a repelling and an attracting type of spurs showing the pattern of flow impacted by such structures.	6