HYDRAULIC STRUCTURES
(CIVL 4241)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The rate of seepage through an earth dam obtained from a flow net is given by (with usual notation)
(a) q = Kh (Nd×Nf) (b) q = Kh (Nd / Nf)
(c) q = kh √(Nf/ Nd) (d) q = kh (Nf/ Nd).

(ii) Khosla's safe exit gradient for design of weirs will be the lowest for the soil type
(a) fine sand (b) coarse sand (c) shingle (d) gravels.

(iii) For the stability of a structure against seepage pressure according to Khosla's creep theory, the critical gradient is
(a) Zero (b) 0.25 (c) 0.50 (d) 1.0.

(iv) Which of the following spillway is least suitable for an earthen dam?
(a) Ogee Spillway (b) Chute Spillway
(c) Shaft Spillway (d) Side channel Spillway.

(v) The maximum permissible eccentricity for no tension at the base of a gravity dam is
(a) B/2 (b) B/3 (c) B/4 (d) B/6.

(vi) Silt excluders are constructed
(a) on river bed downstream of head regulator
(b) on river bed upstream of the head regulator
(c) on canal bed downstream of canal head regulator
(d) on canal bed upstream of canal head regulator.

(vii) Uplift pressure is considered in the analysis of gravity dam
(a) only when there is drainage gallery in the dam
(b) only when there is tail water
(c) only when the reservoir is empty
(d) in all situation with water in the reservoir.

(viii) A non-cohesive soil has a porosity of 30% and the relative density of soil particles is 2.7. The value of critical exit gradient
(a) 0.81 (b) 1.00 (c) 1.19 (d) 1.89.

(ix) The factor that does not try to destabilise a masonry gravity dam is
(a) water seeping below the foundation of the dam
(b) generation of waves by high winds
(c) deposition of silt in dead storage zone of reservoir
(d) water standing against the downstream face of the dam.

(x) The blanket in earth dam is provided
(a) at the ground level on u/s side
(b) at the ground level on the d/s side
(c) at the ground level of the D/s side of the dam
(d) on the D/s slope.

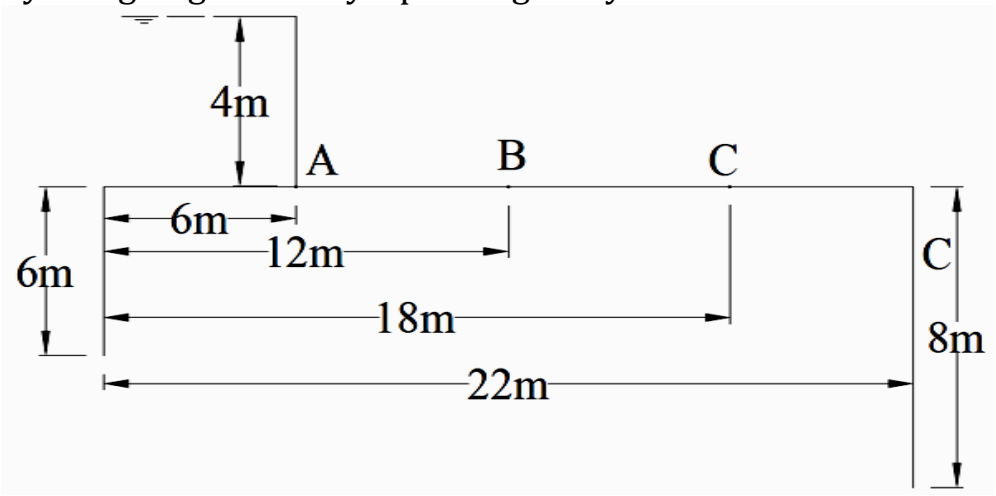
Group - B

2. Draw a neat layout of Diversion head-works and indicate the various components of the system. Briefly indicate the function of each component. [(CO1)(Understand/LOCQ)] **12**

3. Draw and explain various types of diversion weirs. [(CO1)(Understand/LOCQ)] **12**

Group - C

4. Figure shows the section of a hydraulic structure founded on sand. Calculate the average hydraulic gradient. Also find the uplift pressure and thickness of floor at points A, B and C by using Bligh's theory. Specific gravity of concrete is 2.24.



[(CO4)(Analyze/IOCQ)] **12**

5. (a) What are the causes of failures of hydraulic structures on permeable foundations and what remedies are suggested to prevent them? [(CO4)(Understand/LOCQ]

(b) A flow net for seepage flow through soil below a hydraulic structure gives Nf = 3; Nd = 30 and total head causing the flow = 10 m. What is the quantity of flow per metre run occurring under the structure? Take k = 10-6 m/s.

[(CO4)(Understand/LOCQ]

9 + 3 = 12

Group – D

6. Write short notes on:
   (i) Buttress dam
   (ii) Earthen dam
   (iii) Selection of site for dam construction. [(CO2)(Understand/LOCQ)]

(4 + 4 + 4) = 12

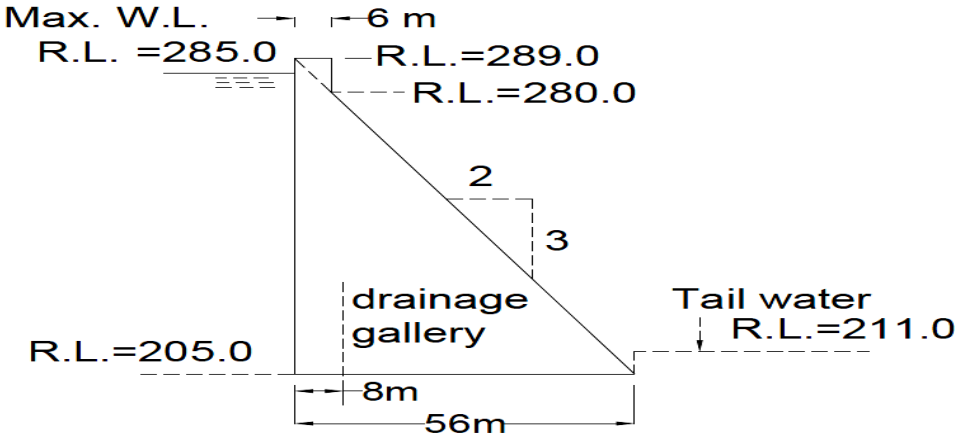
7. Explain the different seepage control method in earthen dam.

[(CO4)(Remember/LOCQ)]

12

Group - E

8. Figure shows the section of a gravity dam (non-overflow portion) built of concrete. Calculate (neglecting earthquake effects) vertical forces, horizontal forces and moments about toe.

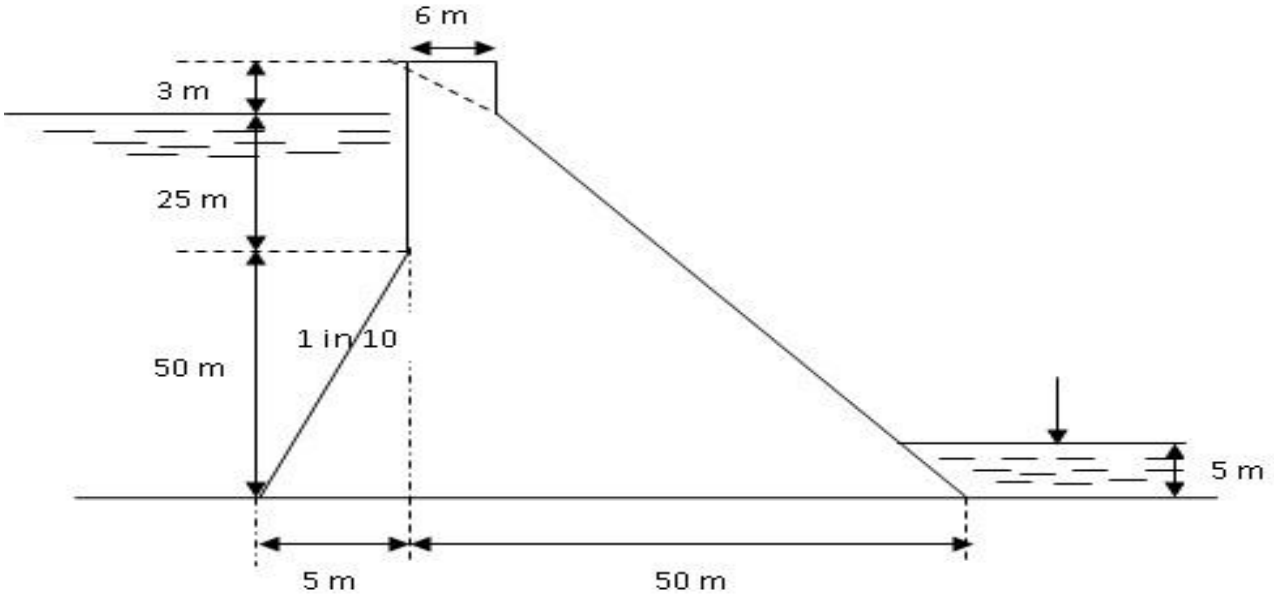


[(CO6)(Apply/IOCQ)]

12

9. The cross-section of a gravity dam is shown in figure. Examine the stability of this section at base when the reservoir is empty. Determine the principle stress at heel and toe, the shear stress at heel and toe for the following conditions:
   (i) For reservoir empty and vertical earthquake forces acting downward
   (ii) For reservoir empty and vertical earthquake forces acting upward

   Assume, the unit weight of concrete 24 KN/m3 and unit weight of water 10 kN/m3. The earthquake forces may be taken as 0.2g for horizontal forces and 0.07g for vertical forces. The uplift may be taken as equal to hydrostatic pressure at either ends and is considered to act over 50% of the area of section.



[(CO6)(Apply/IOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	62.5	37.5	0

Course Outcome (CO):

After the completion of the course students will be able to

1. Integrate hydraulics and water resources background by involving the students in water structures design applications.
2. Develop understanding of the basic principles and concepts of analysis and design of hydraulic structures.
3. Develop insight into the basic physical principles that govern the control of flows in hydraulic system.
4. Explain analytical and mathematical skills needed to describe and predict flow conditions in hydraulic structures.
5. Develop ability in students to effectively apply various principles and skills to the analysis and design of structures in hydraulic system.
6. Understand the fundamental concept, design and maintenance of hydraulic structures such as dams, diversion headworks etc.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.