HYDRAULIC STRUCTURES
(CIVL 4241)

Time Allotted: 2½ hrs **Full Marks: 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The most suitable location of canal headwork is
(a) Rock stage of the river (b) Trough stage of the river
(c) Boulder stage of the river (d) Delta stage of the river.

(ii) Which of the following structures is constructed to separate under sluices from the main weir?
(a) Fish ladder (b) Divide wall (c) Head regulator (d) Marginal bund.

(iii) The minimum clear length of the crest of >3m drop in a straight glacis fall is
(a) 65% (b) 85% (c) 30% (d) 15%.

(iv) The small openings made in the huge body of a concrete gravity dam such as sluices and inspection galleries can be assumed to be causing only local effects without any appreciable effect on the distribution of stresses as per the principle of_____
(a) Laplace (b) St. Venant (c) Reynold (d) St. Francis

(v) For smooth entry of canal water, the angle between canal head regulator and weir/barrage is kept between
(a) 90° to 150° (b) 110° to 130°
(c) 90° to 110° (d) 15° to 30°

(vi) Which failure occurs when the minimum stress exceeds the allowable compressive stress of the dam material?
(a) Overturning (b) Sliding
(c) By development of tension (d) Crushing

(vii) Presence of tail-water in a gravity dam
(a) increases the principal stress and decreases the shear stress
(b) increases both the principal stress and the shear stress
(c) decreases the principal stress and increases the shear stress
(d) decreases both the principal stress and the shear stress.

(viii) Which failure occurs when the net horizontal force above any plane in the dam or at the base of the dam exceeds the frictional resistance developed at that level?
(a) Overturning (b) Crushing
(c) Sliding (d) By development of tension.

(ix) Tension cracks in the dam may sometimes lead to the failure of the structure by
(a) Sliding of dam at cracked section (b) Overturning about the toe
(c) Crushing of concrete from the toe (d) Both overturning and crushing.

(x) The factor of safety against overturning in case of gravity dam generally varies between
(a) 0.5 to 1.5 (b) 1.5 to 2.5 (c) 1 to 2 (d) 2 to 3.

Fill in the blanks with the correct word

(xi) The hydraulic structures constructed across a river and supplies water to the off-taking canal is called _____.

(xii) The most preferred soil material for the central core material of zoned embankment type dam is _____.

(xiii) The blanket in earth dam is provided at _____.

(xiv) _____ is the arrangement made near top of dam for passage of excess water from the reservoir.

(xv) Gravity dam is most suitable when the foundation is _____.

Group - B

2. (a) Short note on Modes of Failure of diversion weirs. *[(CO3)(Remember/LOCQ)]*
(b) Draw a typical layout of diversion head-works, indicating the various components of the system. *[(CO1)(Understand/LOCQ)]*

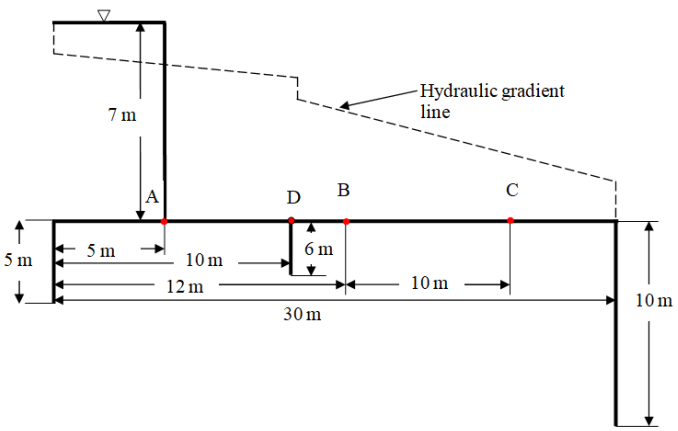
8 + 4 = 12

3. (a) Short note on: Vertical drop weirs; Rockfill weirs. *[(CO1)(Remember/LOCQ)]*
(b) Write in detail about river training works and fish ladder. *[(CO3)(Remember/LOCQ)]*

6 + 6 = 12

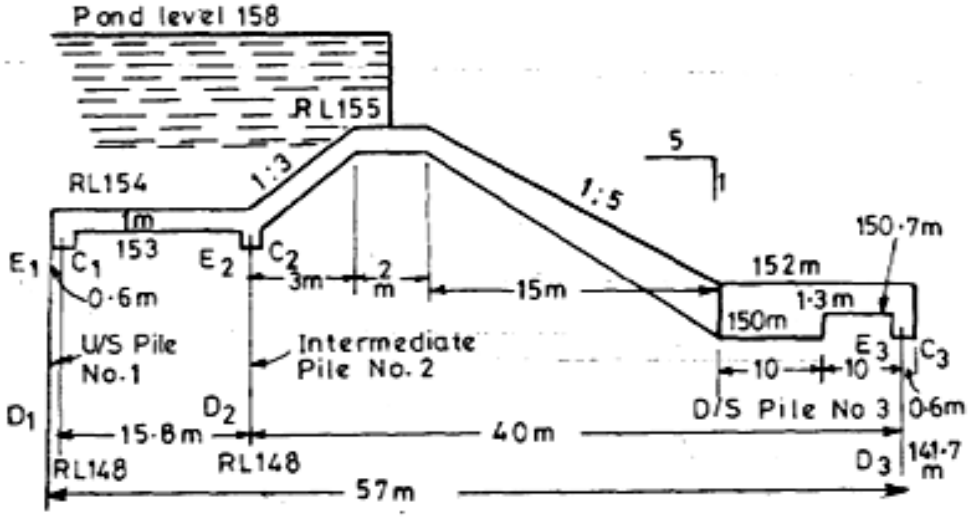
Group - C

4. The accompanying figure shows the section of a weir on permeable foundation. Calculate the average hydraulic gradient according to Bligh's creep theory, Lane's weighted creep theory. Also find the uplift pressure at points A, B, C and D as shown in figure and the floor thickness requires at these points. Locate the point where the required floor thickness is same from both the theories. *[(CO5)(Analyse/HOCQ)]*



(6 + 6) = 12

5. (a) Determine the percentage pressure at various key points of the accompanying figure applying Khosla's theory. *[(CO4)(Apply/IOCQ)]*



(b) Explain briefly Khosla's exit gradient concept. *[(CO2)(Remember/LOCQ)]*

8 + 4 = 12

Group - D

6. (a) How dams are classified based on the structural behaviour? Discuss them briefly. *[(CO1)(Remember/LOCQ)]*

(b) Short note on site selection of dam. *[(CO1)(Remember/LOCQ)]*

7 + 5 = 12

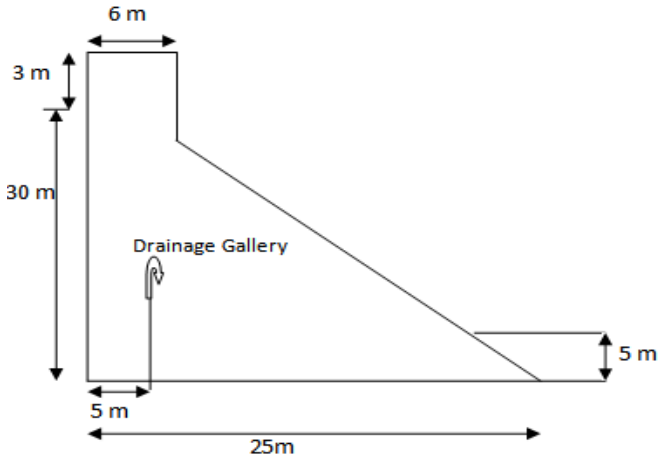
7. (a) An earthen dam made of homogenous material has the following data.
Level of top of dam = 250 m
Level of deepest riverbed = 200 m
HFL of reservoir = 210 m
Width of top of dam = 10 m
Upstream slope = 4:1
Downstream slope = 3:1
Determine the phreatic line for this dam section and also the discharge through the dam. *[(CO4)(Analyse/HOCQ)]*

(b) Short note on Zoned and Diaphragm type of earthen dam. *[(CO2)(Remember/LOCQ)]*

7 + 5 = 12

Group - E

8. (a) Determine the uplift force at the base of the dam as shown in the attached figure for following cases:
(i) No drains
(ii) With drains a distance of 5 m from upstream
(iii) Tension crack up to 2 m from upstream end without drains

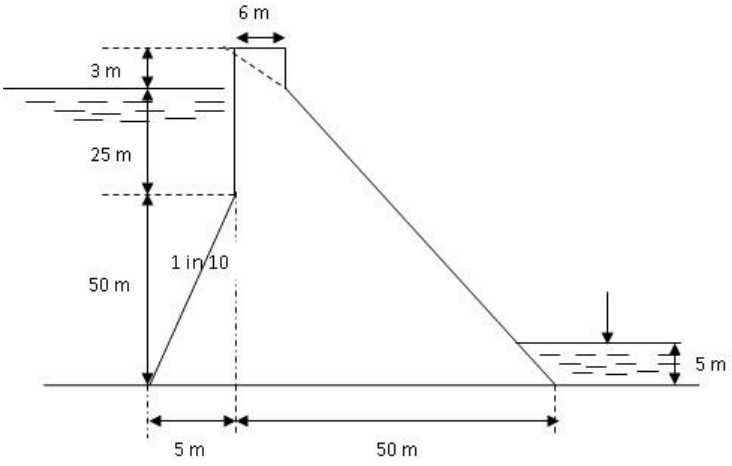


[(CO6)(Apply/IOCQ)]

(b) Discuss in details the various forces acting on a gravity dam. *[(CO2)(Remember/LOCQ)]*

7 + 5 = 12

9. The cross-section of a gravity dam is shown in the attached figure. Determine the maximum vertical stresses at heel and toe; the major principle stress at toe; the intensity of shear stress on a horizontal plane near the toe. Assume weight of concrete = 24 kN/m^3.



[(CO6)(Analyse/HOCQ)]

(6 + 6) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	52.08	15.62	32.3

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.*