## HYDRAULICS STRUCTURES
## (CIVL 4144)

**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)   In a diversion headwork project, the canal head regulator is usually aligned
         (a) parallel to barrage axis
         (b) perpendicular to the divide wall
         (c) parallel to the divide wall
         (d) 45° to the divide wall.

   (ii)  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.

   (iii) 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.

   (iv)  The back water effect of a weir is best called
         (a) retrogression               (b) afflux
         (c) back water curve            (d) ponding.

   (v)   Value of Khosla's critical exit gradient for usually met alluvial sandy soils of our country is about
         (a) 0        (b) 1        (c) $\infty$        (d) 1/4 to 1/6.

   (vi)  The minimum thickness (t) of the downstream floor, as required in the design of weirs, can be expressed by:
         (a) $h/(G+1)$                    (b) $h/(G-1)$
         (c) $h-t/(G-1)$                  (d) $1.33h/(G-1)$.

   (vii)  The major resisting force in a gravity dam is
          (a) water pressure              (b) wave pressure
          (c) self-weight of dam          (d) uplift pressur.

   (viii) 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.

   (ix)   A fish ladder is provided in a canal project
          (a) to catch the fish for commercial development
          (b) to enable the fish to move freely in river
          (c) to serve the same purpose as a canal ladder
          (d) both (b) & (c).

   (x)    The highest stone masonry gravity dam of India as well as of the world is
          (a) Ramganga dam                (b) Nagarjuna Sagar dam
          (c) Hirakud dam                 (d) Mettur dam.

### Group – B

2. (a) What are the functions of a canal head regulator. Draw a neat typical section through a canal head regulator indicating its various components.

   (b) What is meant by "afflux" and "pond level"?

                                                              **8 + 4 = 12**

3. (a) Differentiate between a weir & a barrage with the help of neat sketches.

   (b) Draw and explain various types of diversion weirs.

                                                              **4 + 8 = 12**

### Group – C

4. (a) What are the causes of failures of hydraulic structures on permeable foundations and what remedies are suggested to prevent them?

   (b) Explain Lane's weighted creep theory.

                                                              **8 + 4 = 12**

5. An impervious floor of a weir on permeable soil is 16 m long and has sheet piles at both the ends. The upstream pile is 4 m deep and the downstream pile is 5 m deep. The weir creates a net head of 2.5 m.

Neglecting the weight of the concrete floor and the uplift pressure of water. The weight of concrete may be taken as 24 kN/m³ and the uplift pressure of water 10 kN/m². The earthquake force may be taken as 0.12 g for Khosla's theory horizontal forces and 0.07 g 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.

6. Define dam. ... aterial used for dam co... ) hydraulic design. De... s of dam constructio...

**4 + 6 = 12**
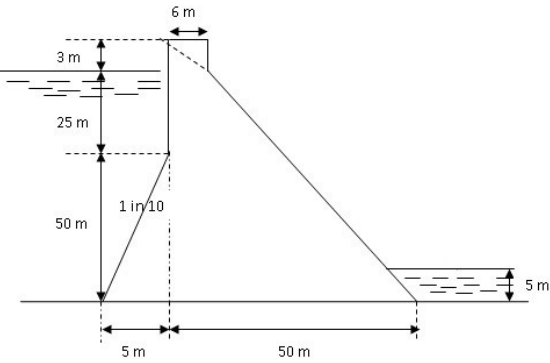


7. (a) An earthen ... wing data.
Level of top ...
Level of dee...
HFL of rese...
Width of top of dam = 10 m
Upstream slope = 3:1
Downstream slope = 2.5:1
Determine the phreatic line for this dam section and also the discharge through the dam.

**6 + 6 = 12**

   (b) Describe briefly the causes of failure of earthen dam with neat sketches.

**8 + 4 = 12**

## Group – E

8. (a) Define gravity dam. Draw typical cross-section of a concrete gravity dam.

   (b) Explain briefly with diagram the different forces acting on a gravity dam indicating the respective formulae (where applicable).

**(2 + 2) + 8 = 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.