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vii) Which one of the following spillways is least suited to earthen dam ?

- a) Ogee spillway b) Side channel spillway
- c) Chute spillway d) Shaft spillway.

viii) Hydraulic jump is widely used for dissipation of energy in

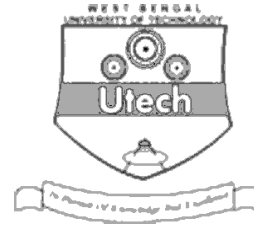
- a) Ogee spillway
- b) Trough spillway
- c) Side channel spillway
- d) All of these.

ix) The discharge passing over an ogee spillway, per unit length of its apex line, is proportional to

- a) H b) H^2
- c) $H^{1/2}$ d) $H^{3/2}$.

x) Which one of the following sets is used to control the seepage through the foundation of an earthen dam ?

- a) Chimney drain, upstream blanket and cut-off trench
- b) Cut-off sheet piles, upstream blanket and cut-off trench
- c) Upstream blanket, cut-off sheet piles and chimney drains
- d) Relief well, upstream blanket and chimney drain.



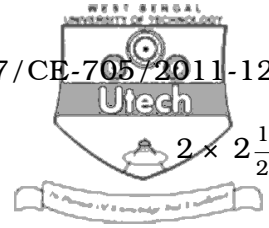
- xi) A coffer dam is
- a) a kind of gravity dam
 - b) an earthen dam of small height built to protect important areas
 - c) a temporary structure constructed to exclude water from the work area during construction
 - d) an embankment built along a river to regulate the river.
- xii) Canal drops are required to
- a) dissipate excess energy
 - b) dissipate inadequate land slope
 - c) dissipate excess land slope
 - d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Write down the possible causes of failure of an earthen dam.
3. Explain Khosla's theory and concept of flownet.
4. Explain the fundamental difference between Khosla's theory and Bligh's creep theory for seepage below a weir on permeable foundation.
5. What are the differences between siphon aqueduct and canal siphon ?
6. Discuss energy dissipation in hydraulic jump.



7. Explain any *two* of the following :

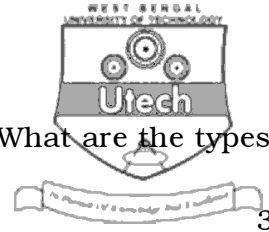
- a) Piping in earthen dams
- b) Grout curtain
- c) Relief wells
- d) Inverted filter.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Discuss Bligh's criteria for design of impervious floor of weir for sub-surface flow. 8
- b) An weir is constructed to withstand water 4.5 m deep. The floor length is 25 m with sheet piles 5 m and 8 m deep at either end. The weir is erected at a distance of 6 m on the upstream end of the floor. Find using Bligh's theory the uplift pressures at 6 m, 12 m and 18 m from the upstream end of the floor and find thickness of the floor at those points. 7



9. a) What is meant by canal regulation ? What are the types of canal regulation works ? 3

b) Distinguish between head regulator and cross regulators. Give the functions of head regulator and cross regulator. 12

10. a) When are canal falls necessary ? Give the considerations for location of canal falls. 6

b) Discuss any *two* of the following types of the canal falls : $2 \times 4 \frac{1}{2}$

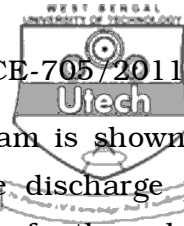
i) Ogee fall

ii) Stepped fall

iii) Sarda type fall

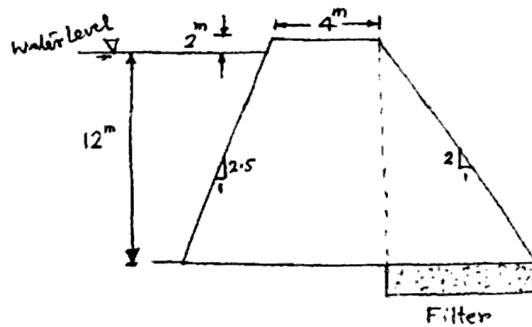
iv) Stepped glacis fall.

11. a) Write the conditions for drawing the flownet diagram and also derive the expression for seepage flow. 3 + 3

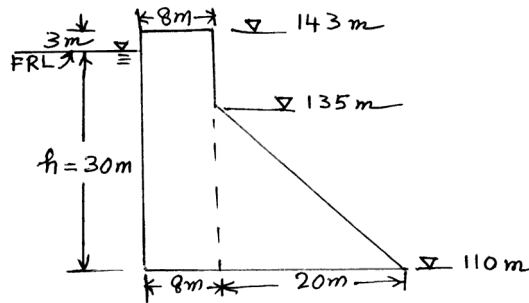


- b) A section of a homogeneous earthen dam is shown in following figure. Calculate the seepage discharge per metre length through the body of the dam.
 $K = 8 \times 10^{-5}$ m/sec.

9



12.



The following particulars refer to a concrete gravity dam resting over a rocky foundation as given in the above figure.

- RL of top of dam = 143.00 m
- Free board = 3 m
- Upstream face vertical
- Downstream face sloped at 0.8(H) : 1(V) from RL 135.00 m up to base.
- RL of base (foundation) 110.00 m
- Top width 8 m.



Determine the stability of the dam and the stress induced when the reservoir is full. Neglect all other forces except hydrostatic thrust, uplift and self weight. Take unit weight of concrete as 2300 kg/m^3 , unit weight of water as 1000 kg/m^3 , $\mu_{\text{safe}} = 0.7$, $f_{\text{permissible}} = 20 \text{ kg/cm}^2$ and bearing capacity $= 15 \text{ kg/cm}^2$.

13. a) With a sketch, explain what is a 'rock toe' in earthen dams.
- b) Explain briefly Khosla's exit gradient concept on the design of weirs on permeable foundation.
- c) With a sketch, explain what is a 'chimney drain' in earthen dams.
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