

**Bengal Engineering and Science University, Shibpur**

Civil Engineering Department

Water Resources Engineering

M.E. 1<sup>st</sup> Semester Examination, 2012-13

**Elements of Design of Hydraulic Structures (CE-911)**

Full Marks : 70

Time : 3 Hrs.

***Candidates are allowed to use text books, class notes during the examination***

Answer any four questions. All questions carry equal marks. Two marks are reserved for neatness.

1. A gravity dam 100 m high with its upstream face vertical, free board 5 m, top width 8m, base width 80m has its downstream face vertical upto a depth of 10m from top and then battered. Find the reduction in uplift pressure per unit length of the dam if a drainage gallery is provided at a distance of 7m from the heel. Find also the silt force on the dam if it is deposited upto a height of 30m from bed. Determine the factor of safety for sliding, overturning and shear friction factor considering water force only without considering uplift. Assume specific gravity of concrete as 2.4, specific wt. of water as  $10 \text{ kN/m}^3$  and shear strength of concrete as  $0.14 \text{ kN/m}^2$ .

2. Design a concrete gravity to retain water upto a height of upto height of 60m with a material of specific gravity 2.4 and permissible compressive stress of  $3 \text{ N/mm}^2$ . Provide a free board of 3m and a top width of 7m.

3. For the dam described is problem 1 find inertia forces by seismic co-efficient method and response spectra method if it is located in seismic zone IV. Also find the moment of this inertia forces at base level.

4.(a) Find the hydrodynamic force exerted on the dam by seismic effect for the dam described in question 1 if it is located in seismic zone V.

(b) For the dam described in problem 1, find the principal stresses developed at the head and toe if tail water depth is 3m, considering water pressure only.

5. A homogeneous earth dam 25m high has its crest width 6m, upstream slope 4:1 and downstream slope 3:1. Check the stability of the (i) upstream portion and (ii) downstream portion of the dam against horizontal shear assuming the depths of seepage line below the crest of dam at the top shoulder of the upstream and downstream slopes respectively as 4m and 5m. The properties of soil are as following :

(i)	Saturated unit wt.	:	$21.6 \text{ kN/m}^3$
(ii)	Submerged unit wt.	:	$11.6 \text{ kN/m}^3$
(iii)	Unit wt. of moist soil	:	$20 \text{ kN/m}^3$
(iv)	Angle of internal friction	:	$28^\circ$
(V)	Cohesion of Soil	:	$40 \text{ kN/m}^2$

In the upstream and downstream portion the area below the seepage line may be taken as 95% and 90% of the total wedge area.

6.(a) Find the seepage loss per unit length of the dam described in question 5 per day if the co-efficient of permeability of the dam material is  $5 \times 10^{-5} \text{ m/s}$ .

(b) Find the number of secondary girders to be provided in a vertical gate of a spillway 4m wide and 6m deep to retain 6m depth of water the permissible bending moment on these girders in 120 kNm. Also find the location of these girders.