Bengal Engineering and Science University, Shibpur
B.E. (Civil) 8th Semester Final Examination, 2013
Sub: Advanced Hydraulic Structures (CE-804/9)

Time: Three Hours Full Marks: 70

Answer Q. 8 and any four from the rest. Figures in the margin indicate full marks.
If any required data is unavailable, assume suitably.

---

1. a) Determine the horizontal and vertical forces due to water pressure on the inclined upstream face (slope 1V:0.12H) of a 30m high ogee spillway, when the head over the spillway is 5m. Take the velocity of approach as 3m/s. (6)

   b) The non-overflow section of a gravity dam is having a height of 50m, top width of 6m and base width of 45m. The headwater depth is 47m and the tailwater depth is 5m. Determine the reduction in the total uplift force and moment (w.r.t toe), if a drainage gallery is provided near the base at a distance of 5m from the u/s face. (10)

2. A 85m high gravity dam is having a top width of 8m, u/s face vertical up to a depth of 65m from top and then sloping @ 1(V):0.1(H), d/s face vertical upto a depth of 20m from top and then sloping @ 1(V):0.8(V). The headwater depth at FRL is 80m and tailwater depth is 5m. Determine the Shear Friction Factor (SFF) for load combination B. Take $\mu = 0.7$, $\gamma_c = 24$ kN/m^3, $\gamma_w = 9.807$ kN/m^3 and $q = 1400$ kN/m^2. (16)

3. For the gravity dam mentioned in question 2 above, determine the earthquake force and moment at a section 65m from the top. Use seismic coefficient method and take $\alpha_0 = 0.08$. [Not to consider the hydrodynamic effect.] (16)

4. a) Draw a neat sketch of the wave pressure diagram on the upstream face of a gravity dam, and calculate the force due to wave pressure on a 70m high gravity dam having a fetch of 80m, for a wind speed of 75 km/h. (6)

   b) A 100m high gravity dam is having top width of 8m, u/s face vertical, d/s face vertical upto a height of 20m from the top and then sloping @ 1(V) :0.8(H). Using response spectrum method, calculate the earthquake force and moment at the base. Take $F_0 = 0.40$, $\gamma_c = 24$ kN/m^3, $E_c = 2.1 \times 10^7$ kN/m^2 and (Sa/g) = 0.198 + (T - 0.26). (10)

5. A homogeneous earthen dam is having F.R.L. at 107.00m and M.W.L at 110.00m. The upstream face is covered with dumped riprap (correction factor 0.5) and the upstream slope is 0.3. Following data were collected to compute the freeboard.

Quantity	Normal Freeboard	Minimum Freeboard
Effective fetch	4.2 km	4.65 km
Wind velocity over land	110 km/h	55 km/h
Average depth of reservoir	52.0 m	55.0 m

Ratio of wind velocity over land to wind velocity over water

Effective fetch (km)	1	2	4	6	8	10 and above
Ratio	1.1	1.16	1.24	1.27	1.3	1.31

Take R/Ho as 1.2 and calculate the top level of the dam. Suitably assume any other data needed. (16)

6. A high overflow ogee spillway having the following characteristics: i) height of the spillway = 60m, ii) design head at FRL = 4m, iii) u/s face vertical, iv) d/s slope 1(H): 1(V), v) number of spillway bays = 8, vi) width of spillway bay = 15m, vii) Kp = 0.02, viii) Ka = 0.2. Determine a) design discharge capacity, b) equation of the u/s and d/s profile of the spillway crest, c) sequent depth at the toe of the spillway and d) energy lost in the hydraulic jump. Neglect approach velocity. (16)

7. a) A 25m high homogeneous earth dam with top width of 5m, retains 20m height of water. The slopes of the upstream and downstream faces are 1(V):1.8(H) each. Determine the phreatic line with appropriate entry and exit correction. Take $\Delta a/(a + \Delta a) = 0.36$. Also, find the seepage loss through the body of the dam. Assume the coefficient of permeability of the dam material as 5×10^{-4} cm/s. (8)

   b) If a horizontal blanket of length 20m is provided at the d/s end, determine the modified phreatic line with appropriate correction and resulting change in the seepage discharge. (8)

8. Draw a labeled layout plan of a diversion headwork. (6)