Total number of printed pages:3 **PG/2nd/PCEW2124**

2021

HYDRAULIC STRUCTURES

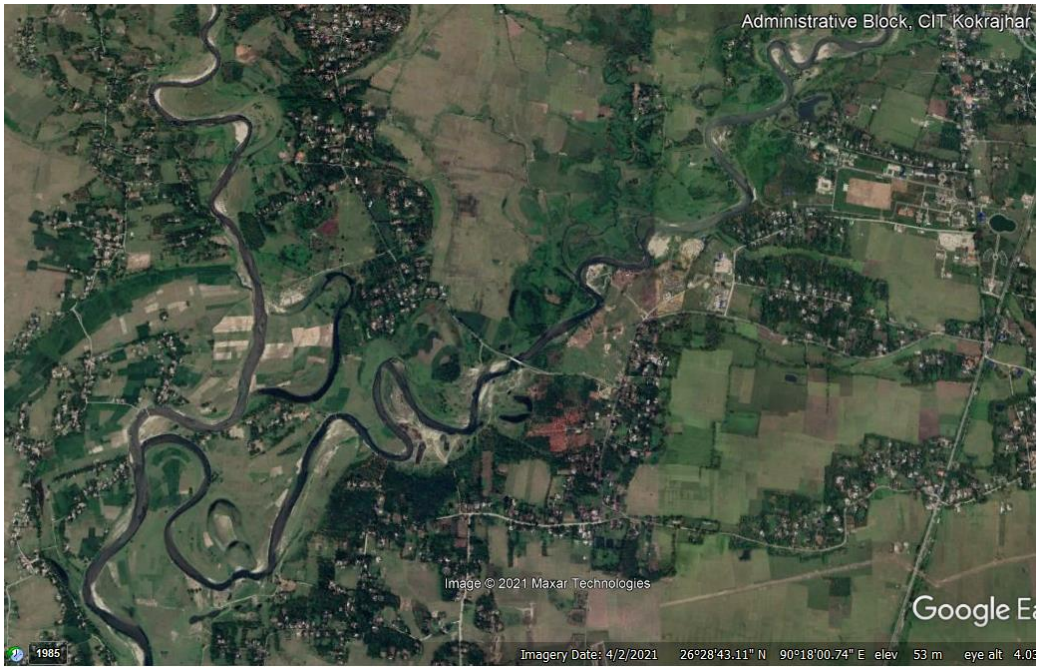
Full Marks: 60

Time: 2 hours

The figures in the margin indicate full marks for the questions.

Answer any five questions. Each question carries 12 marks.

1. (i) The following is the Google Earth imagery of the Gaurang River on the downstream of the location of your Institute. By looking at the imagery, comment on the river morphology as regards aggrading, degrading, stable, braided, or meandering type of the channel and formation of ox-bow or horse-shoe lakes in this stretch of the Gaurang River. [4]



(ii) What problems do you foresee in managing the flood plains of this river? What objectives are generally met by training a river? [4]

(iii) Classify different river training works. [4]

2. If you are assigned a consultancy job of preparing a pre-feasibility report of a hydroelectric power project requiring the construction of a dam for storing a river's flow at a site identified from study of GIS-derived contour maps, then, on visiting the site with your team comprising a geologist, a hydrologist and a surveyor, and on carrying out reconnaissance and preliminary studies of available data and information from secondary and/or tertiary sources, write

(ii) how would you select alternative locations of the dam for further study and final selection by optimization? [4]

(ii) what are factors based on which you would decide the appropriate type(s) of dam at the selected locations? [4]

(iii) what are the aspects for which you would collect and compile data for analysing and ensuring safety of the types of dams that you might consider? [4]

3. (i) Describe the design criteria for embankment dams. [4]

(ii) What are the mechanisms of failure of a weir or a barrage in the case of founding the structure in a pervious stratum? [4]

(iii) What are the major causes of failure of a gravity dam? [4]

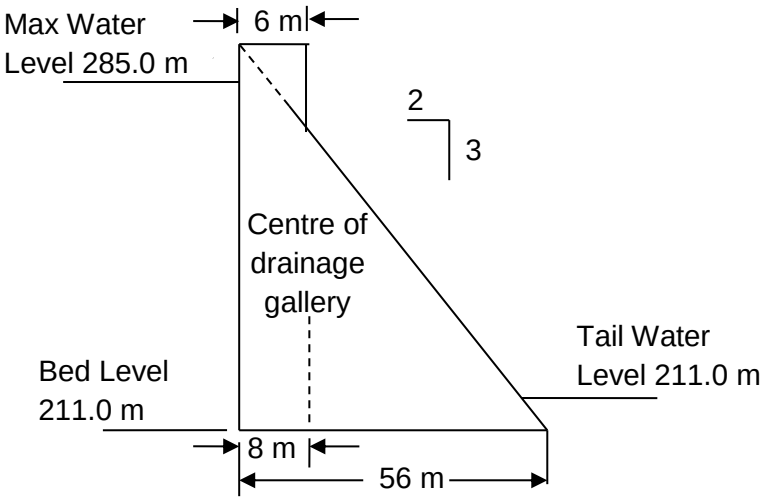
4. (i) Why canal falls are necessary in an irrigation project? What are the considerations made in deciding the locations of canal falls? [4]

(ii) Describe any one type of canal falls with a suitable sketch. [4]

(iii) Why are fish ladders provided in some dams? What could be the criteria for designing the fish ladder shown on the downstream side of a dam in the following photograph? [4]

5. (i) What are the design considerations for a spillway? On what basis is the profile of an ogee spillway determined? [4]

(ii) The non-overflow section of a concrete gravity dam shown in the accompanying figure, calculate, for unit length of the dam, i) the maximum vertical stresses at the heel and the toe, ii) the major principal stresses at the toe, and iii) the intensity of shear stress on a horizontal plane near the toe. Assume unit weight of concrete as 24 KN/m^3. [8]



6. A masonry dam 8 m high is trapezoidal in section with a top width of 1 m and bottom width of 6.5 m. The face exposed to water has a batter of 1:10. Calculate the (i) factor of safety against

overturning; (ii) factor of safety against sliding; (iii) shear friction factor. Unit weight of masonry is 23 KN/m^3. Permissible shear stress of joint = 1.4 N/mm^2. Assume coefficient of friction as 0.75. You may neglect wave forces and earthquake forces. [12]

7. Investigate the stability against overturning of a concrete gravity dam having the shape of a right-angled triangle with the upstream face vertical. Other features of the dam are as below:

Height of the dam = 130 m
Sloe of d/s face = 0.75 H : 1 V
Height of water retained = 130 m
Free-board = 0
Height of tail water = 0
Unit weight of concrete = 24 KN/m^3
Uplift intensity factor = 0.6
Allowable coefficient of friction = 0.75

The earthquake forces may be taken as equivalent to 0.1 g for horizontal forces and 0.05 g for vertical forces. Neglect wave forces and its pressure. Assume any data if required. [12]

8. (i) What is a flow net in the case of an embankment dam? Explain with the help of a sketch. Describe the graphical method of constructing a flow net. [6]

(ii) Calculate the exit gradient at the downstream of a weir having the elevations at the upstream pond level and the top of the downstream apron as 158.0 m and 152.0 m respectively. The downstream cut-off is 10.3 m deep and the floor is 57.0 m long. Comment on this exit gradient with reference to the safe exit gradient which varies from 0.17 for fine sand to 0.25 for shingle. [6]

9. A section of a homogenous earth dam is shown in the following figure. Calculate the seepage discharge per meter length through the body of this dam. The coefficient of permeability of the dam material may be taken as 8×10^{-5} m/sec. [12]