M.E. WATER RESOURCES AND HYDRAULIC ENGG. (Six-Semester)
FIRST YEAR SECOND SEMESTER EXAM 2024

HYDRAULIC STRUCTURE AND HYDEL POWER ENGINEERING

(Paper - III)

Time: Three Hours Full Marks: 100

Answer any ***four*** questions.

1. a) Define Hydraulic Structure.

   b) A contour survey of a reservoir site has been carried out by using a total station and the area is calculated based on different contour values, which vary from 100 m to 150 m at 25 m intervals, and the respective contour areas are found to be 6 ha, 22.5 ha and 46.6 ha respectively. Determine the general equation for area-elevation curve.
   If the capacity of a reservoir up to 100 m elevation is found to be 12.8 ha-m, determine the general equation for the capacity-elevation curve. Also estimate the reservoir capacity at RL 160 m.

   c) A reservoir has a plan area of 0.130 km^2. The discharge from the reservoir passes over a rectangular broad-crested weir, having the following dimensions: width of the weir- 4.5 m, crest height- 2.0 m, length of the weir- 3.5 m. If there is no inflow into the reservoir, estimate the discharge over the weir consider the reservoir level is 1 m above the weir crest. Also estimate the time taken for the reservoir level to fall from 1 m to 0.5 m above the weir crest. Assume c_d=0.9

   d) Differentiate between sharp crested and broad crested weir

2+10+10+3=25

2. a) Deduce the expression of normal and critical depths for analyzing of culvert flows and also highlight explicit equation to find out the exact solution for critical depth.

   b) An existing drainage channel has trapezoidal cross section with a bottom width of 3.5 m, side slope of 2:1 (H:V), a longitudinal slope of 0.5% and a Manning's n of 0.025. A roadway is to be constructed across the channel and a culvert structure is to be used to pass a design flow rate of 3m3/s under the roadway. The culvert barrel is to be approximately horizontal, 10 m long and under design conditions, ponding to a depth of 3 m will be allowed at the entrance to the culvert structure. Design the culvert

10+15=25

3. a) Deduce an expression of flow over a sharp-crested weir in an open channel for rectangular section considering the flow across a horizontal partial width.

   b) Deduce an expression of flow under a sluice gate having low tail water in an open channel with diagram.

   c) A contracted sharp crested rectangular weir is to be used to measure the flow rate in an open channel 5 m wide, 2 m depth. It is desired that the depth of water over the crest of weir not less than 0.5 m when the flow rate is 1 m^3/s and the water level at least 30 cm below the top of the channel. What should be the crest length of the weir 'b' and how far below the top of the channel should the crest get located (Take Cd=0.62)

8+9+8=25

4. a) Name the three most important sources according to the criteria of mass generation power.
   b) Why is the running cost of hydro power installation very low compared to thermal and nuclear stations?
   c) What are the three emerging basic principles of hydro power?
   d) What do you mean by average potential power and gross river potential?
   e) Why is in some cases the peak demand found higher in winter than in the summer?
   f) Define demand factor and plant factor.
   g) What do you mean by surplus power?
   h) What is manifold? In hydro power plants, where is it used?
   i) How is multi-layer construction made for banded penstock?

3+3+3+3+3+3+2+3+2 = 25

5. a) Classify different types of hydro power plants based on their operation and location.
   b) What is the reason for the non-availability of run-of-river plants in India?
   c) Name different parts of a valley dam plant.
   d) Which hydro power plant is more suitable on rivers of meandering reaches?
   e) Which type of hydro power plants were installed for the following project?
   Hirakund dam, Maithon dam, Beas Sutlej Link Project and Koyna Project
   f) Define the dead storage capacity of a reservoir.
   g) State the purpose of anchor blocks.
   h) Why is the ebb cycle system more advantageous than the tide cycle system?
   i) How many full tidal cycles are usually observed in 365 days?

4+3+4+2+2+2+3+3+2 = 25

6.a) What are the functions of a spillway?

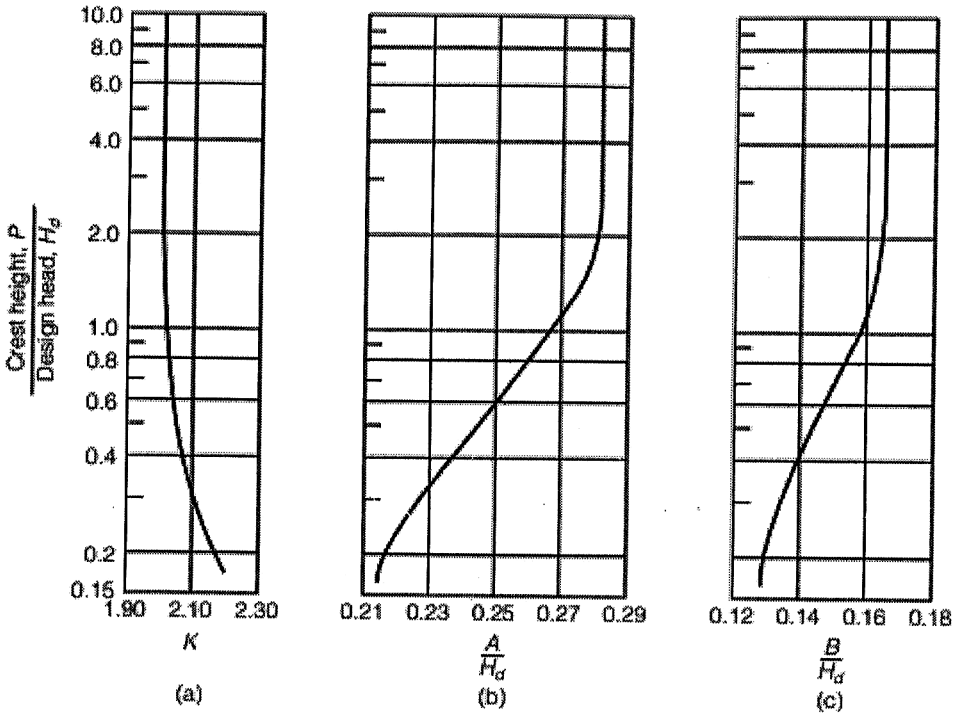
b) Design a 40 m long overflow spillway that will discharge a design flow rate of 1600 m^3/s at a maximum allowable pool elevation of 200 m. The bottom elevation behind the spillway is 170 m, the upstream face of the spillway is vertical and the spillway chute is to have a slope of 1:1.5 (H: V).

5+20=25

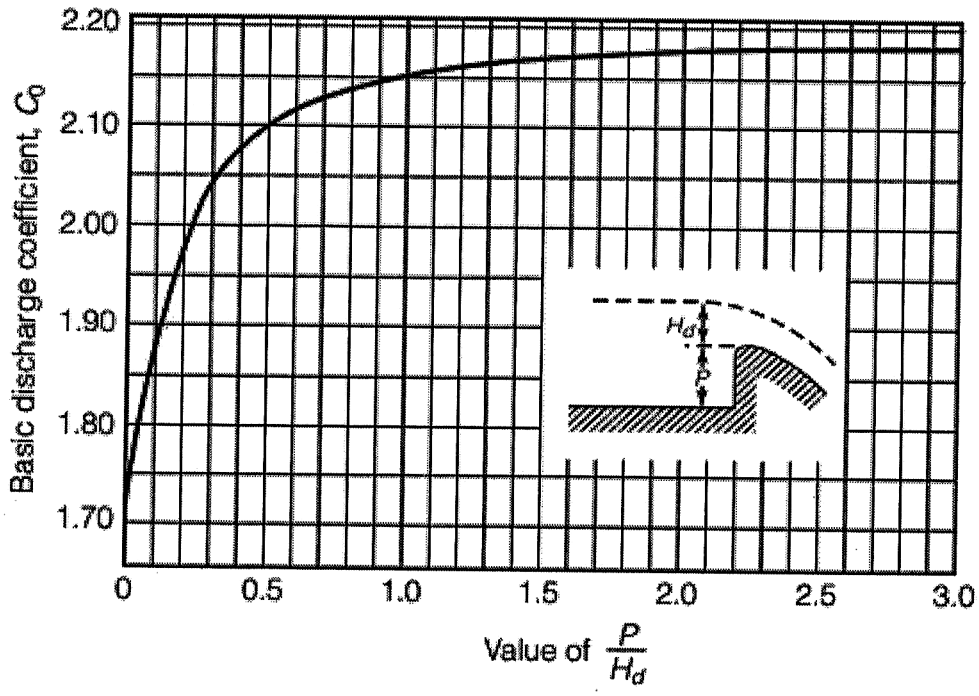
7.a) What is stilling basin and why is stilling basin used?

b) The maximum design discharge over a spillway is 280 m^3/s and the spillway and stilling basin are 12 m wide. The reservoir behind the spillway has a water surface elevation of 60 m and the river water surface elevation downstream of the stilling basin is 30m. Assuming a 10% loss of hydraulic head in the flow down the spillway, find the elevation of the floor of the stilling basin so that the hydraulic jump focuses in the basin. Design the stilling basin.

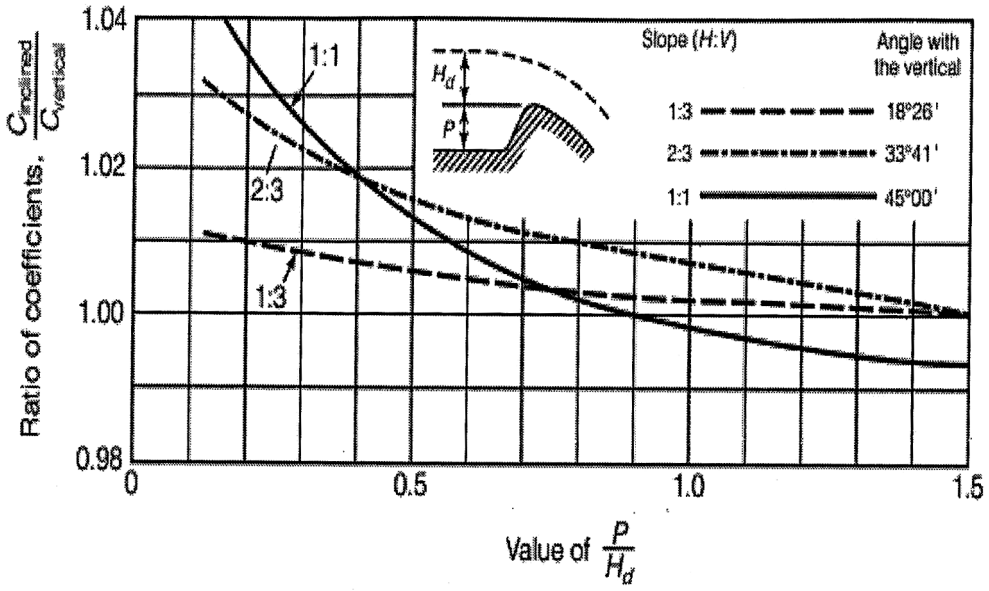
5+20=25



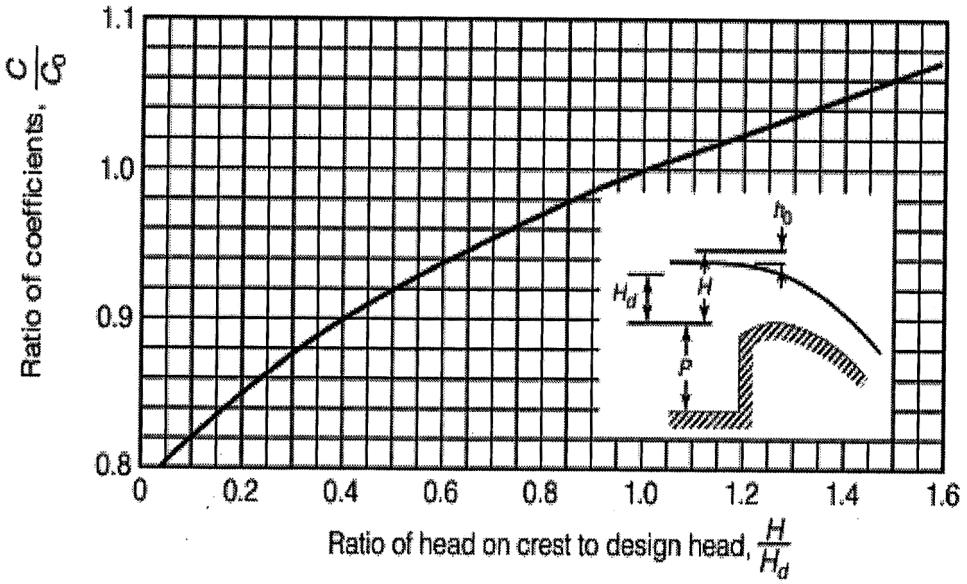
Coordinate coefficients for spillway crests.



(a) Basic discharge coefficient



(b) Correction factor for sloping upstream face



(c) Correction factor for other than design head

Discharge coefficient for overflow spillways

8. a) Briefly describe the different components of an earthen dam with a neat sketch.

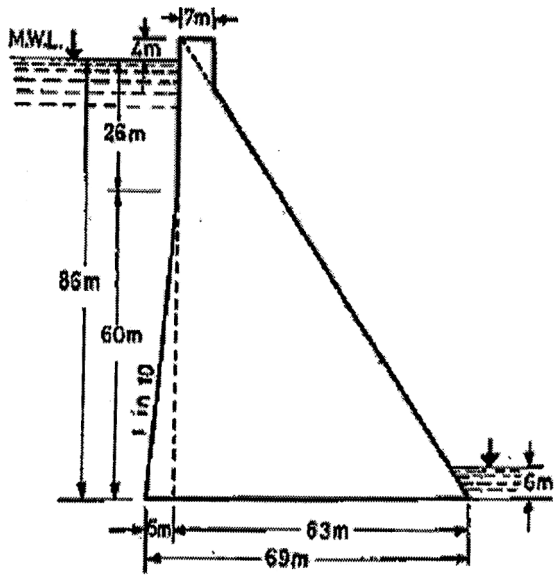
b) An earth dam made of a homogeneous material has the following data

Coefficient of permeability of dam material: 5×10^{-4} cm/sec
Level of top of dam: 200.0 m
Level of deepest riverbed: 178.0 m
H.F.L of reservoir: 197.5 m
Width of the top of dam: 4.5 m
Upstream Slope: 3:1
Downstream slope: 2:1
Determine the phreatic lines for this dam section and discharge passing through the dam.

5+20=25

9. a) Explain the concept of a gravity dam, detailing the forces that act upon it and provide an annotated diagram illustrating these forces

b) Below figure shows the section of gravity damn built of concrete examine the stability of the section at the base considering reservoir is empty. The earthquake force may be taken as equivalent to 0.1 g for horizontal force and 0.05 g what vertical forces. the uplift may be taken as equal to the hydrostatic pressure at the either ends and is constructed to act over 60% of the area of the section. A tail water depth of 6 m is assumed to be present when reservoir is full and there is no tailwater when the reservoir is empty. Also indicate the values of various kind of stresses that are developed at heel and toe. Assume unit weight of concrete as 24 kN/m^3 and unit weigh of water =10 kN/m^3 .



5+20=25