M.E. (Water Resources & Hydraulic Engineering) Examination, 2024

(1st Semester)

HYDRAULIC STRUCTURE AND HYDEL POWER ENGINEERING

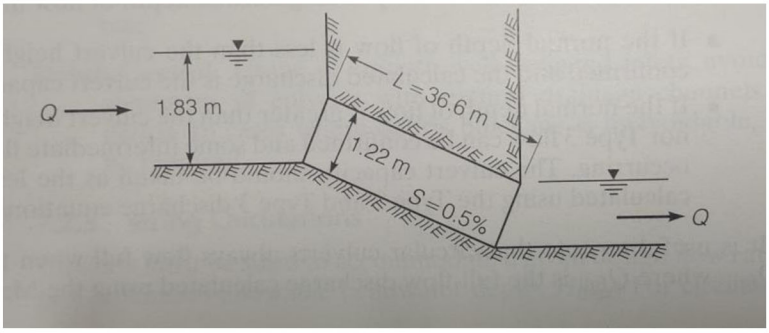
(Paper - III)

Time : Three Hours Full Marks: 100

Answer any ***four*** questions.

1. (a) Write down all governing equations of flow through culvert for free entrance conditions being dependent on the flow regime.

   (b) What is the capacity of a 1.22 m by 1.22 m concrete box culvert (n=0.013) with a rounded entrance ($k_e = 0.05$, $C_d = 0.95$) is the culvert slope is 0.5%, the length is 36.6 m, and the maximum allowable headwater level is 1.83 m above the culvert invert? Consider the following cases: (a) free outlet conditions and (b) for the culvert to pass the flow rate that exists in case (a)?



5+20=25

2. (a) A rectangular, full width, sharp crested weir is 2 m long and 0.6 m high. Estimate the discharge when the depth of flow upstream of the weir is 0.9 m. If the same discharge was to pass over an alternative contracted weir of 1.5 m length and 0.6 m height at the same location, what would be the change in the upstream water level? Assume any value

   (b) A rectangular channel of 3.0 m width had a broad crested weir of height 1.0 m and the crest width of 2.0 m built at a section. The weir spans the full canal width. If the water surface elevation above the crest is 0.6 m, estimate the discharge passing over the weir. If the same discharge passes over another, similar weir, but with a crest width of 3.0 m, what would be the water surface elevation upstream of this second weir? 12+13=25

3. (a) A vertical gate is installed at the end of a canal i.e. 7 m wide. The depth of flow is 3.5 m. If the gate has a width 3 m, estimate the flow rate through the gate when the gate is raised 0.5 m. Neglect the effect of the downstream water depth.

   (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 140 m at 20 m intervals, and the respective contour areas are found to be 5 ha, 20.5 ha and 42.6 ha respectively. Determine the general equation for the area-elevation curve and capacity-elevation curve. Also find out the future capacity of reservoir at 180 m RL.

(c)A rectangular full width, sharp crested weir is to be used in a field scale to control and measure water flow rate, which is expected to vary between 50 and 72 m^3/hr. Estimate the width of the weir if the level change between these flow rates is 35 mm.

8+10+7=25

4. a) Discuss the relative merits and demerits of hydro-power as compared to other power sources.

b) 'The hydro-potential of India needs new revised estimates.' Why?

c) Differentiate between minimum, small and mean potential powers.

d) Why is it necessary to predict the future load demand?

e) What do you understand by diversion canal plant? What are the parts and arrangements of such plants? Draw a neat sketch of such a plant.

f) What do you understand by the term "Pondage Factor"?

g) How are the load factor, capacity factor and diversity factor interrelated? What is the significance of the utilization factor?

5+3+2+2+6+2+5 = 25

5. a) Explain the double basin system method for tidal power generation. What are the limitations of this method?

b) How can you select the location of the tidal power plant? What are the components of tidal power plants?

c) Typical weekly and daily releases of water from an upstream reservoir on a river are given below. Estimate the pondage capacity to operate a run-of-river plant at a downstream location so that a steady uniform power output is available from the plant.

Weekly Release Pattern

Day	*Average daily release rate, m^3/s*
Sunday	20
Monday	37
Tuesday	50
Wednesday	60
Thursday	50
Friday	40
Saturday	30

Daily Release Pattern

Time	*Volume released, %*
12 MN – 6 AM	5
6 AM – 12 Noon	35

12 Noon – 6 PM	50
6 PM – 12 MN	10

d) Following values of flow which were observed in a river. Each flow value that occurred for the given number of days is mentioned against it. If the available head is 14 m, plot the corresponding flow duration curve and power duration curve by the total period method.

Discharge (cumec)	200	460	210	250	385	305	335	416	230	370	460	410	355	295	450	395	320	280
No. of days	5	18	8	13	20	11	9	21	4	17	18	14	14	15	12	12	6	17

5+5+9+6 = 25

6. (a) Determine the phreatic line when the dam section is homogeneous and provided with horizontal filter

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

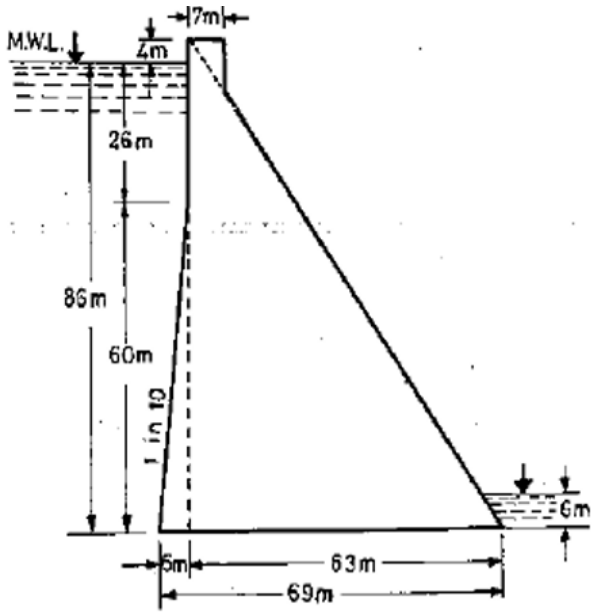
Coefficient of permeability of dam material: 5×10^{-4} cm/sec
Level of top of dam: 200.0 m
Level of deepest riverbed: 178.0 m
H.F.L of reservoir: 197.5 m
Width of the top of dam: 4.5 m
Upstream Slope: 3:1
Downstream slope: 2:1

Determine the phreatic lines for this dam section and discharge passing through the dam.

5+20=25

7. (a) Briefly describe the different failure mode of Gravity DAM with diagram

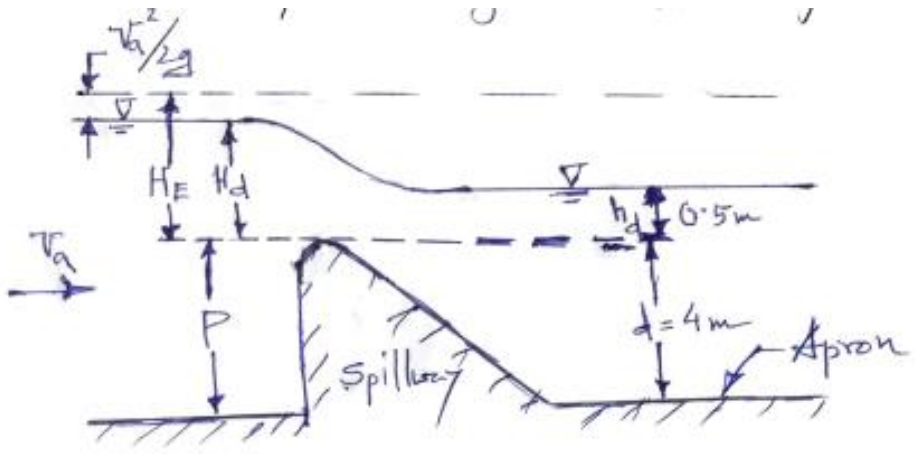
(b) Below figure shows the section of gravity damn built of concrete examine the stability of the section at the base considering reservoir is empty. The earthquake force may be taken as equivalent to 0.1 g for horizontal force and 0.05 g what vertical forces. the uplift may be taken as equal to the 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

8. (a) What is spillway?

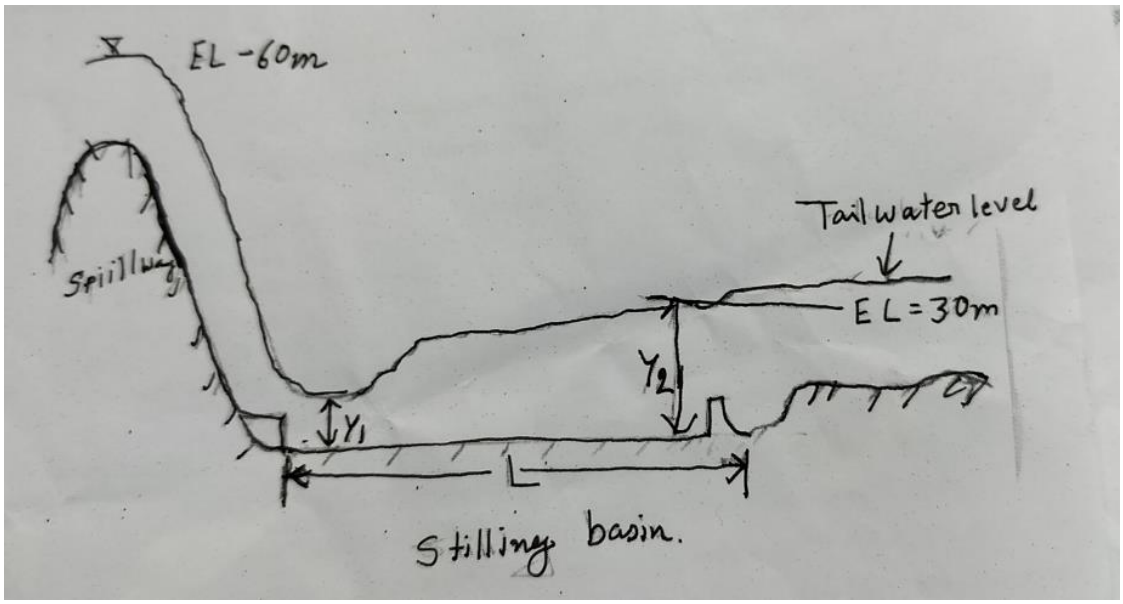
   (b) An ogee spillway, shown in the figure, Where the headwater is 1 m, above the crest and the tailwater is 0.5 m above the crest. The height of the crest relative to the bottom of the upstream reservoir is 3.5 m, the height of the crest relative to the bottom of the downstream apron is 4 m. The effective height of the spillway crest is 3 m and design head is 1 m. Estimate the spillway discharge under the given conditions.



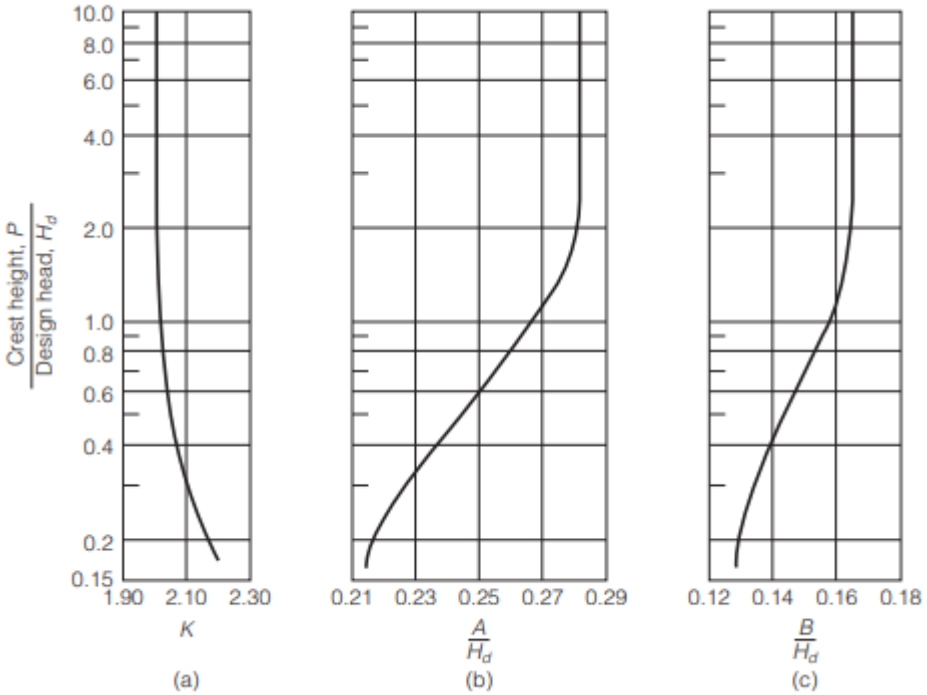
9. (a) What are the functions of spillway?

   (b) What is stilling basin? Discuss the standard stilling basin design criteria as per U.S. Bureau of Reclamation in connection with type-I stilling basin and type II stilling basin.

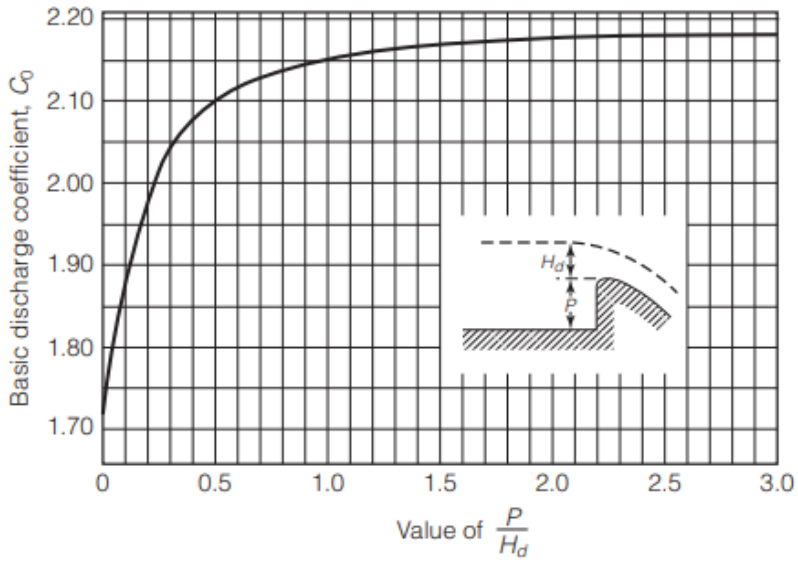
(c) The maximum design discharge over a spillway is 280 m^3/s, and the spillway and stilling basin are 12 m wide. The reservoir behind the spillway has a water-surface elevation of 60 m and the river water surface elevation downstream of the stilling basin is 30 m. Assuming a 10% loss of hydraulic head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



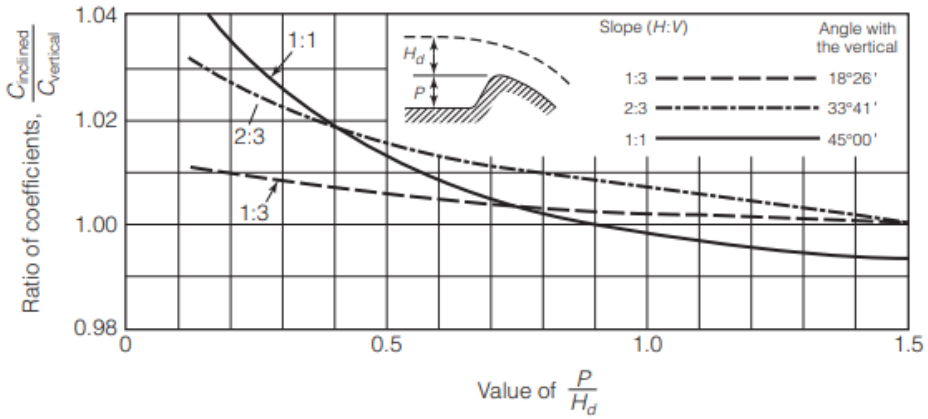
2+5+18=25



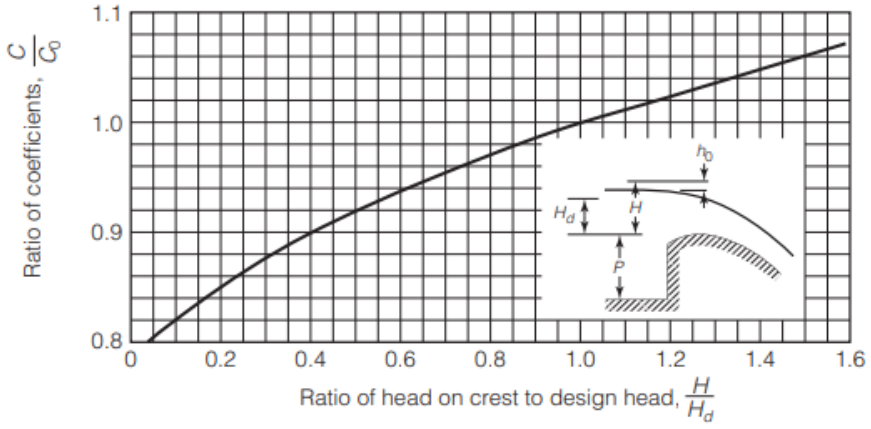
Coordinate coefficients for spillway crests.



(a) Basic discharge coefficient

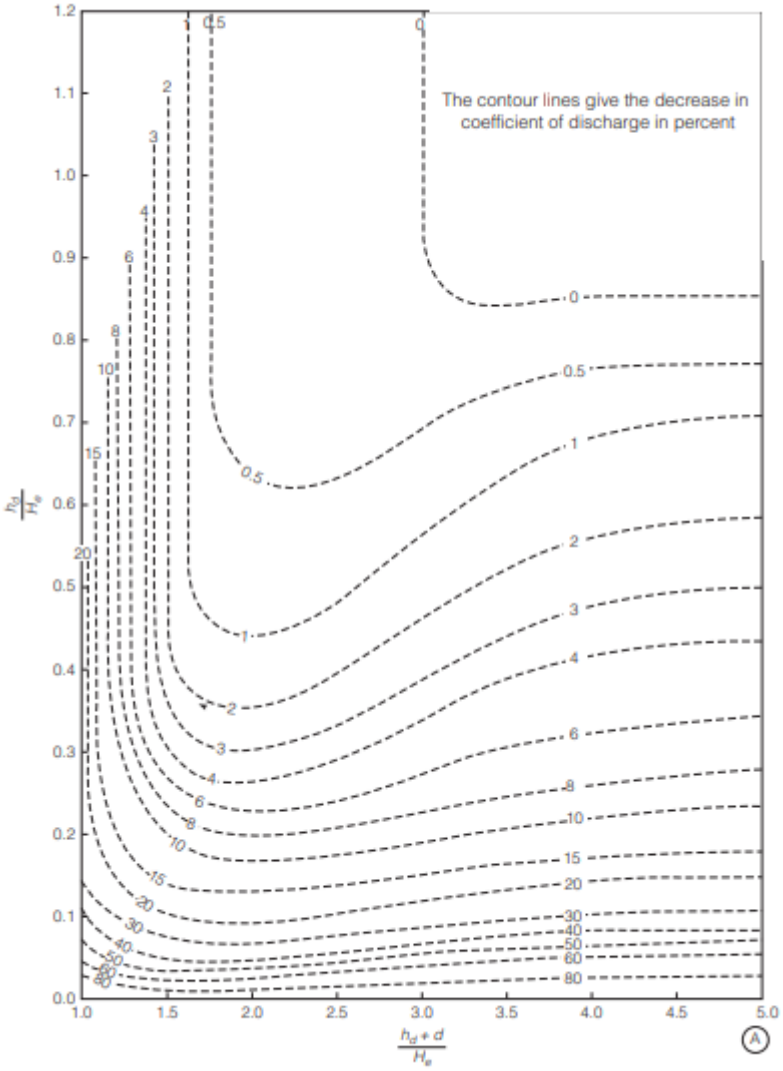


(b) Correction factor for sloping upstream face



(c) Correction factor for other than design head

Discharge coefficient for overflow spillways



Discharge-coefficient reduction percentages for submerged flow Source: U.S. Army Corps of Engineers (1990b)