M.E. (Water Resources & Hydraulic Engineering) Examination, 2025

(1st Semester)

HYDRAULIC STRUCTURE AND HYDEL POWER ENGINEERING

(Program Elective 2)

Time: Three Hours | Full Marks: 100

Answer any ***four*** questions.

1. (a) A culvert is to be designed to pass water under a roadway into a recreational lake, where the design elevation of the lake surface is 10 m and the bottom elevation of the lake is 9.5 m. the culvert is to be 350 mm diameter made of corrugated metal pipe, with 75 mm by 25 mm corrugated section, 8 m long and have a horizontal slope. Calculate the culvert performance from the no-flow condition up to a headwater elevation of 12 m. If the culvert is required to pass @ 0.30 m^3/s, under design condition, what is the minimum safe elevation of the roadway? If the lake elevation drops to 9.75 m, determine the percentage change in the culvert capacity.
   (b) Deduce an expression of flow through a culvert with a submerged entrance when the normal depth of flow in the culvert is larger than the culvert height with sketch.
   20 + 5 = 25

2. (a) The maximum design over a spillway is 300 m^3/sec, and the spillway and stilling basin are 10 m wide. The reservoir behind the spillway has a water-surface elevation of 50.00 m, and the river water surface elevation downstream of the stilling basin is 20.00 m. Assuming a 15% 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.

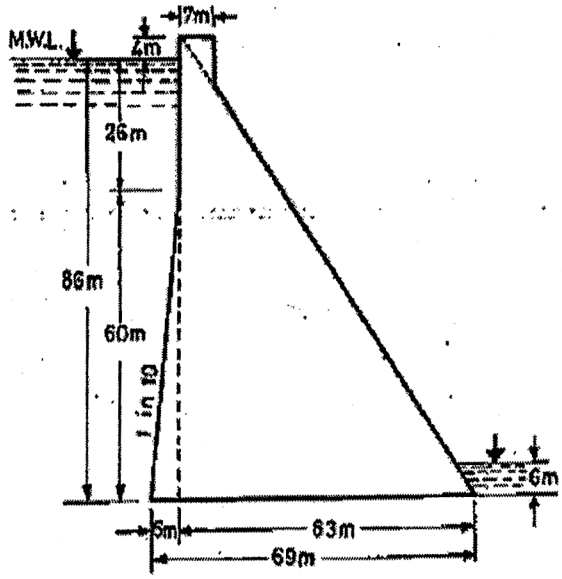
   (b) Derive the expression for calculating actual discharge in the case of a sluice gate.
   18+7=25

3. (a) Water flows under a vertical gate into a 3 m wide rectangular channel, where the flow rate and depth of flow are 4 m^3/s and 1.1 m. Estimate the minimum gate opening to prevent the formation of a hydraulic jump. What energy loss (in kW) can be expected in a hydraulic jump? Assume any data if required.

   (b) A sharp-crested rectangular weir is to be installed to measure flow rates that are expected to be on the order of 1 to 3 m^3/s. The depth of the channel is such that the maximum depth of water that can be accommodated at the weir is 3 m, and the width of the channel is 5 m. Determine the height of the suppressed weir that can be used to measure the flow rate. Assume Cd = 0.62
   (c) A broad-crested rectangular weir of length 1.5 m, width 1.5 m, and height 45 cm is constructed to measure the flow rate in a canal. For what range of the flow rate would the weir length be adequate? Assume Cd = 0.92
   12+6+7=25

4. a) Define the gravity dam and different forces acting on 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. 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



7+18=25

5. a) Why do fluctuations occur from day-to-day or hour-to-hour in supply and demand of turbines? How do you cater for the same?

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

   c) Differentiate between mini, and small hydro power plants.

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

   e) What do you understand by high head diversion plant? Draw a neat sketch of such a plant. Give examples of such plant in and outside India?

   f) What do you understand by the term "Stoarge 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

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

   b) What is the economical diameter of a penstock? How can you determine it analytically?

   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	20	4	17	17	14	14	15	12	12	6	17

5+5+9+6 = 25

7. a) A run-off stream station with an installed capacity of 15000 kW operates at 15% load factor when it serves as apeak load station. What should be the lowest discharge in the stream so that the station may serve as base load station. It is given that the plant efficiency is 75% when working under a head of 20 m. Also calculate the maximum load factor of the plant when the discharge in the stream rises to 20 cumec.

   b) A hydroelectric station is to be supplied with 10.5 m^3/s of water through a penstock which has a friction factor of 0.016. The maximum normal head on the penstock is 50 kg/cm^2 and a waterhammer overpressure of 20% over the normal pressure is anticipated. The safe stress in the steel used is presumed to be 3000 kg/cm^2. The ready penstocks at the site are likely to cost Rs 16,00,000/- per tonne including erection charges. The life of the project is 50 years and the rate of interest is 5.2%. It is proposed to sell the energy at the rate of Rs 3/- per kWh. What should be the optimum diameter of the penstock, given that the OMR costs are 5%? Assume the turbine efficiency to be 90% and the annual load factor as 0.345.

   c) What are the difficulties in tidal power generation?

   d) Explain with sketches the single Ebb Cycle System for tidal power generation. What are the limitations of this method?

6+9+3+7 = 25

8. a) Explain the importance of hydraulic structures in water resources engineering

   b) Estimate the length of the concrete apron (S0=0.001) for type I stilling basin downstream from overflow spillway. The spillway crest is 16 m long and consider a discharge of 56.64 m^3/s. Manning's roughness factor n= 0.025. Should Type I basin be used for this simulation based upon the information available?

   c) What is spillways? Briefly discuss the function of spillways.

   d) Which type of stilling basin includes Chute block and a solid end sill? What is the purpose of such intervention?

4+13+4+4=25