1. Attempt any two parts of the following: \((2 \times 10 = 20)\)

(a) A horizontal impervious floor of length 20 m is provided with a cutoff of 4 m depth at its downstream end as shown in figure 1.

Determine analytically the uplift pressure at point E and D and also the exit gradient, if the head causing seepage is 2 m. Use Khosla's theory.
2. Attempt any four parts of the following: \((4 \times 5 = 20)\)

(a) What are different types of cross drainage works that are necessary on a canal alignment? Explain why such works are not met within a ridge canal system.

(b) Find out the regime scour depth and regime scour velocity for a vertical drop weir having maximum flood discharge as 3000 cumecs. Take Lacey's silt factor as 1.0

(c) Why the silt control is essential at headworks? Explain with neat sketches the functions and working of silt excluder and silt ejector.

(d) Which type of cross-drainage work you suggest for the data given below:

<table>
<thead>
<tr>
<th>Drain</th>
<th>Canal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge (m³/s)</td>
<td>200</td>
</tr>
<tr>
<td>Bed level (m)</td>
<td>25</td>
</tr>
<tr>
<td>F.S.L. (m)</td>
<td>31.5</td>
</tr>
<tr>
<td>H.F.L. (m)</td>
<td>28</td>
</tr>
</tbody>
</table>

5. Attempt any four parts of the following: \((4 \times 5 = 20)\)

(a) Explain the various relative positions of T.W.C. and T.H.C. with neat sketches. Suggest various protection works for the condition, when T.H.C. lies below T.W.C.

(b) Enlist various types of spillways. Explain the working of a side channel spillway with neat sketch.

(c) Give the classification of hydel plants based on the hydraulic characteristics. Explain Run-off river plants with neat sketch.

(d) Write a short note on "Hydropower potential of India".
(e) Design a contraction transition, for the data given below by Mitra’s method.

\[ \text{Total length of contraction transition} = 22.5 \, \text{m} \]
\[ \text{Original canal width} = 30 \, \text{m} \]
\[ \text{Flumed canal width} = 15 \, \text{m} \]

(f) Differentiate between critical and safe exit gradient. Find out the critical exit gradient for river sand with specific gravity \( G \) = 1.0 and porosity \( n \) = 0.4

3. Attempt any two parts of the following : (2×10=20)

(a) Calculate the seepage through an earthen dam resting on an impervious foundation. The relevant data is given below:

\[ \text{Height of the dam} = 60 \, \text{m} \]
\[ \text{Upstream slope} = 2.75 \, (H) : 1(V) \]
\[ \text{Downstream slope} = 2.50 \, (H) : 1(V) \]
\[ \text{Free board} = 2.5 \, \text{m} \]
\[ \text{Crest width} = 8 \, \text{m} \]
\[ \text{Length of drainage blanket} = 120 \, \text{m} \]

The coefficient of permeability of the embankment material in x and y direction are given as \( 8 \times 10^{-7} \, \text{m/sec.} \) and \( 2 \times 10^{-7} \, \text{m/sec.} \) respectively.

(b) A reservoir has a capacity of 10.5 Mm\(^3\) and is fed by a catchment of area 265 km\(^2\). The mean annual runoff at the site is 405 mm. The annual sediment yield and the specific weight of the sediment deposits are estimated to be \( 1.1 \times 10^6 \, \text{kg/km}^2 \) and \( 12.15 \times 10^3 \, \text{N/m}^3 \) respectively. Calculate the time it will take for the reservoir to fill up to leave a residual capacity of 2.5 Mm\(^3\) of water storage. The trap efficiency \( Y(9^\circ) \) may be taken as

\[ Y = 100 \left[ 1 - \frac{1}{(100X + 1)} \right]^{3/2} \]

where \( X = \) capacity-inflow ratio.

(c) Write short notes on any two of the following:

(i) Classification of dams and their selection criterion.

(ii) Hydrologic reservoir routing methods

(iii) Seepage failure of earth dams.

4. Attempt any two parts of the following : (2×10=20)

(a) Enlist the various forces acting on a gravity dam. Explain the effect of uplift and earthquake force on the stability of the dam with neat sketches.
(b) (i) Draw a neat layout of diversion head-works and indicate the various components of the system.

(ii) The data given below refers to a canal fall. Calculate the crest level.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full supply level</td>
<td>115 m</td>
</tr>
<tr>
<td>Bed level of canal</td>
<td>112 m</td>
</tr>
<tr>
<td>Bed width of canal</td>
<td>15 m</td>
</tr>
<tr>
<td>Full supply discharge</td>
<td>40 cumecs</td>
</tr>
<tr>
<td>Side slope of canal</td>
<td>2(h) : 1(V)</td>
</tr>
<tr>
<td>Length of crest of the fall</td>
<td>10 m</td>
</tr>
</tbody>
</table>

(Crest section is rectangular)

Coefficient of discharge over crest = 1.72 m^{1/2}/sec.

(c) Write short notes on any two of the following:

(i) Comparative merits and demerits of Notch falls and Sarda type falls.

(ii) Causes and ill effects of piping in a hydraulic structure.

(iii) Fundamental difference between Bligh's Creep theory and Khosla's theory.

(e) A runoff-river plant has an installed capacity of $15 \times 10^3$ kW and operates at 30% load factor when it serves as a peak load station. What should be the minimum discharge in the stream so that it may serve as a peak load station? The plant efficiency may be taken as 82% when working under a head of 30 m.

(f) At an energy dissipater structure below a low spillway, the discharge is 19 cumecs and the energy loss is 1 m at hydraulic jump forming therein. Determine the flow depths at both ends of the jump.