Total number of printed pages: **Programme:PG/Semester:II/Code:PCEW2124**

2023

Hydraulic Structures

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1.	a)	What do you mean by aggrading, degrading, meandering, braided and deltaic rivers? Provide sketches of each type.	5×2 = 10
	b)	At least two types of river training works are clearly visible on the following Google Earth imagery of the Gaurang River near the Gaurang Park Bridge in Kokrajhar. Name these types and describe their functions. Under which of the high, low and mean river training would you categorize these works and why? 	4+2 = 6
	c)	Draw sketches of a normal, a repelling and an attracting groyne protruding from a river bank showing the pattern of flow impacted by such structures.	4
2.	a)	What are the different types of dams and their classifications?	4
	b)	What are the factors based on which you would decide an appropriate type of a dam at a location?	4
	c)	Draw a typical section of a gated Over Flow (OF) block of a gravity dam showing (i) inspection and drainage galleries, (ii) a spillway with a roller bucket arrangement, and (iii) MWL, FRL, MDDL, live storage and dead storage of the impoundment. You may show a radial gate for the OF block.	4+2+2 = 8
	d)	What is a rule curve for operating a reservoir of a water resource project? Draw a typical Reservoir Area-Capacity curve.	2+2 = 4

<table>
<tr><td>3.</td><td>a)</td><td>What are the forces acting on a gravity dam? Draw two sketches of a Non-Over Flow (NOF) section of a gravity dam showing the uplift pressure diagram together with the values of pressure at different locations for calculating upthrust in the cases (i) with no drainage gallery and (ii) with drainage gallery.</td><td>2+(2×4) = 10</td></tr>
<tr><td></td><td>b)</td><td>Answer the following Multiple-Choice Questions (MCQs) by choosing the correct or the most appropriate option:
<table>
<tr><td>(i)</td><td colspan="2">The uplift pressure of a dam can be controlled by
(α) Constructing cut-off under upstream face
(β) Constructing drainage channels between the dam & its foundation
(γ) Pressure grouting the foundation
The correct answer is</td></tr>
<tr><td></td><td>[A] (α), (β) and (γ)</td><td>[B] Both (α) and (β)</td></tr>
<tr><td></td><td>[C] Both (α) and (γ)</td><td>[D] Only (α)</td></tr>
<tr><td>(ii)</td><td colspan="2">Horizontal acceleration due to earthquake results in</td></tr>
<tr><td></td><td>[A] hydrodynamic pressure</td><td>[B] Inertia force into the body of the dam</td></tr>
<tr><td></td><td>[C] Both [A] and [B]</td><td>[D] None of these</td></tr>
<tr><td>(iii)</td><td colspan="2">Vertical acceleration due to earthquake results in</td></tr>
<tr><td></td><td>[A] increase in the effective weight of the dam</td><td>[B] decrease in the effective weight of the dam</td></tr>
<tr><td></td><td>[C] Both [A] and [B]</td><td>[D] None of these</td></tr>
<tr><td>(iv)</td><td colspan="2">Total force exerted on a gravity dam by the pressure of a wave of height h_w acts above the still water level at a height of</td></tr>
<tr><td></td><td>[A] $(3/8)\times h_w$</td><td>[B] $(5/8)\times h_w$</td></tr>
<tr><td></td><td>[C] $(2/3)\times h_w$</td><td>[D] $(5/3)\times h_w$</td></tr>
</table></td><td>4×1 = 4</td></tr>
<tr><td></td><td>c)</td><td>Starting with the expression for finding the vertical direct stress distribution at the base of a dam, show with the help of a sketch that "the resultant must lie within the middle third" for safety against compression of a gravity dam.</td><td>6</td></tr>
<tr><td>4.</td><td>a)</td><td>Briefly describe any three mechanisms of failure under each of the three causes, namely (i) hydraulic, (ii) seepage and (iii) structural, failures of earthen dams. Provide sketches wherever appropriate in order to shorten the text of the descriptions.</td><td>3×4 = 12</td></tr>
<tr><td></td><td>b)</td><td>Derive an expression for estimating discharge per unit width through an embankment of isotropic soil due to seepage under a hydraulic head H by considering a flow net</td><td>6</td></tr>
</table>

<table>
<tr><td></td><td>c)</td><td>Answer the following Multiple-Choice Questions (MCQs) by choosing the correct or the most appropriate option:
<table>
<tr><td>(i)</td><td colspan="2">The focus of base parabola for an earthen dam of base width B having a horizontal drainage filter of width b is located from the toe of the dam at a distance</td></tr>
<tr><td></td><td>[A] $B/2$</td><td>[B] $b/2$</td></tr>
<tr><td></td><td>[C] B-b</td><td>[D] b</td></tr>
<tr><td>(ii)</td><td colspan="2">Seepage through embankment is controlled by</td></tr>
<tr><td></td><td>[A] Drain trench</td><td>[B] Chimney drain</td></tr>
<tr><td></td><td>[C] Impervious cut-off</td><td>[D] Relief well</td></tr>
</table></td><td>1×2 = 2</td></tr>
<tr><td>5.</td><td>a)</td><td>When is a hydraulic jump formed? If water emerges from an ogee spillway with 13.72 m/sec velocity 0.3 m depth at its toe, then show that the tail water depth required to form a hydraulic jump at the toe would be 3.24 m.</td><td>2+4 = 6</td></tr>
<tr><td></td><td>b)</td><td>Briefly describe with suitable sketches the different types of energy dissipation arrangements that may be constructed for the following four settings of the sequent depth curve (y_2-curve) and the tail water curve (TWC) on the downstream of a dam spillway:
(i) the y_2-curve and the TWC coinciding at all spills,
(ii) the TWC lying below the y_2-curve at all spills, and
(iii) the y_2-curve lying below the TWC at all spills.</td><td>6</td></tr>
<tr><td></td><td>c)</td><td>Under what conditions (a) a chute spillway, (b) a morning glory spillway and (c) a pian-key spillway may be appropriate? Provide indicative sketches.</td><td>6</td></tr>
<tr><td></td><td>d)</td><td>How can cavitation occur in a spillway?</td><td>2</td></tr>
<tr><td>6.</td><td>a)</td><td>How is Khosla's theory different from Bligh's theory of seepage? Draw a sketch of Khosla's flow net. Define the terms: exit gradient, critical exit gradient and safe exit gradient as per Khosla's theory of seepage.</td><td>3+3+6 = 12</td></tr>
<tr><td></td><td>b)</td><td>Calculate the exit gradient in the case of a weir founded on a permeable stratum when the difference in elevations of the upstream pond level and the top of the downstream apron is 5 m, the depth of downstream cut-off is 4 m and the length of the floor of the weir is 10.0 m.</td><td>4</td></tr>
<tr><td></td><td>c)</td><td>Draw a typical section of a concrete weir on a pervious stratum by showing level difference between upstream and downstream floor levels, upstream pond level, and upstream, intermediate and downstream cut-off lines.</td><td>4</td></tr>
<tr><td>7.</td><td>a)</td><td>What are the three methods of aligning irrigation canals? Which of these (i) save the cost of cross-drainage works, (iii) irrigates only one side of the canal, and (iii) ensures gravity irrigation on both sides of the canal? List the components of a distribution system for canal irrigation.</td><td>3+3+2 = 8</td></tr>
<tr><td></td><td>b)</td><td>State the purpose of providing (i) canal falls, (ii) canal head regulators, (iii) cross regulators, (iv) canal escapes, (v) silt excluders and (vi) silt ejectors.</td><td>6×2 = 12</td></tr>
</table>

<table>
<tr><td>8</td><td>a)</td><td>Answer the following Multiple-Choice Questions (MCQs) by choosing the correct or the most appropriate option:
<table><tr><td>i)</td><td colspan="2">If the base period of the crop is 120 days and the duty is 1500 ha/m^3/sec, and the, then delta (cm) for the crop is</td></tr><tr><td></td><td>[A] 184</td><td>[B] 139</td></tr><tr><td></td><td>[C] 86</td><td>[D] 69</td></tr><tr><td>ii)</td><td colspan="2">The bed level of a canal is +100.0 m and the FSL is +104.5 m. The appropriate type of cross-drainage work for crossing a natural drain with bed level at +102.0 m and HFL at +106.0 m is</td></tr><tr><td></td><td>[A] canal syphon</td><td>[B] aqueduct</td></tr><tr><td></td><td>[C] super-passage</td><td>[D] level crossing</td></tr></table></td><td>2×1 = 2</td></tr>
<tr><td></td><td>b)</td><td>Draw a typical layout of a diversion head works showing all components. Name the three classes of weirs used in diversion head works.</td><td>6</td></tr>
<tr><td></td><td>c)</td><td>Name any six types of canals falls and show indicative sketches of each type.</td><td>6×2 = 12</td></tr>
</table>