Model Answer: Summer 2017

Subject: Irrigation Engineering | **Sub. Code: 17502**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1		**Attempt any TEN of the following:**		**20**
	a)	**Define dependable yield from a catchment.**		
	Ans.	**Dependable yield:** It is the quantity of water available for a given number of years per rainfall cycle.	***2***	**2**
	b)	**Enlist four purposes of galleries in gravity dam.**		
	Ans.	1) For inspection of dam from inside. 2) To drain off seepage water through the body of dam. 3) It provides access to spillway gate. 4) It helps in locating pumps, observation devices. 5) It provides access for grouting.	***1 mark each (any two)***	**2**
	c)	**State situations in which Bandhara Irrigation is preferred.**		
	Ans.	1) The river or stream on which bandhara is going to be constructed should be perennial. 2) The site should be within 5 km of the area to be irrigated. 3) Good foundation should be available for construction of bandhara. 4) Site should be such that it should provide irrigation on both banks through canals from both sides. 5) Site should be just on upstream side of steep bed slope.	***1 mark each (any two)***	**2**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	d) Ans.	**State Inglis formula for MFD.** Inglis formula to calculate MFD is: $$Q = \frac{123\,A}{\sqrt{A+10.24}}$$ **(Note:** value of constant 125 and 120 should also be considered**)**	*2*	*2*
	e) Ans.	**State the use of Area-capacity curve.** The area capacity curve is useful in: 1) Deciding capacity of reservoir. 2) Water spread of reservoir. 3) Elevation of water at any point can be calculated. 4) Determining control levels of dam.	*1 mark each (Any two)*	2
	f) Ans.	**Define balancing depth in canals.** The depth of particular cross section in which the amount of cutting and filling is equal is known as balancing depth.	*2*	*2*
	g) Ans.	**List eight components of diversion headworks.** 1)Weir (barrage) 2)Under sluice 3.)Fish ladder 4)Divide wall 5) Canal head regulator 6)Slit excluder 7) Guide bank 8) Marginal bunds	*2*	*2*
	h) Ans.	**Differentiate between Crop period and Base period.** **Crop Period**: Crop period is that period in number of days that crop takes from instant of its sowing to that of its harvest. **Base Period**: Base period in days from first watering before sowing to the last watering before harvesting.	*2*	*2*
	i) Ans.	**Classify dams on the basis of methods of construction with examples.** 1)Earthen Dam 2) Rockfill Dam 3) Gravity Dam 4)Steel Dam 5)Timber Dam 6) Arch Dam	*2*	2
	j) Ans.	**State the importance of fish ladder.** 1) It is passage provided adjacent to divide wall for the movement of fish from upstream to downstream and vice versa. 2) It allows free access to fish so that they can travel from colder water to hot water	*1 mark each*	2

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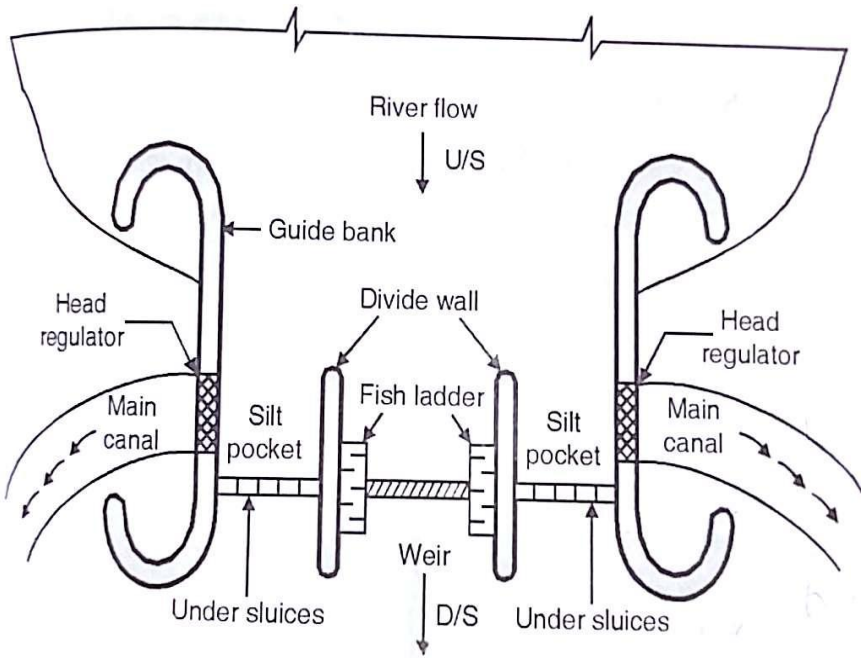
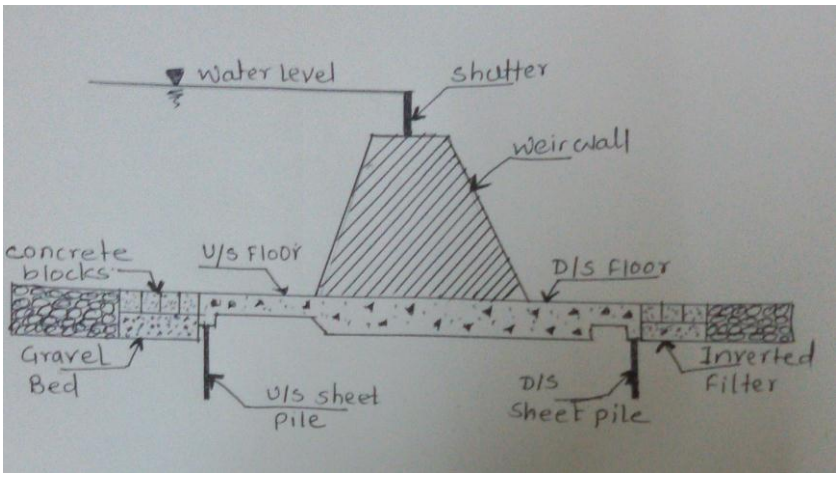
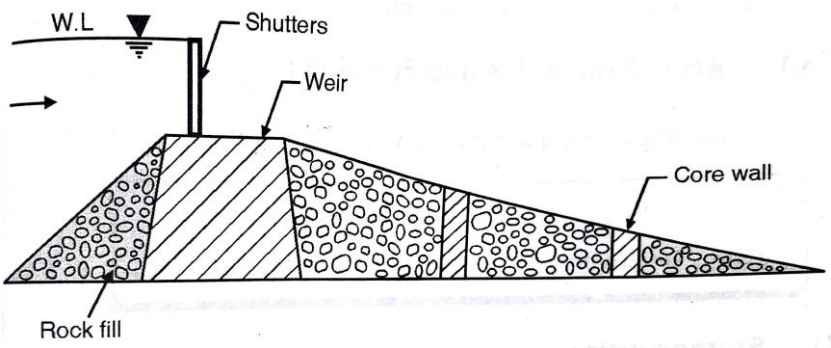
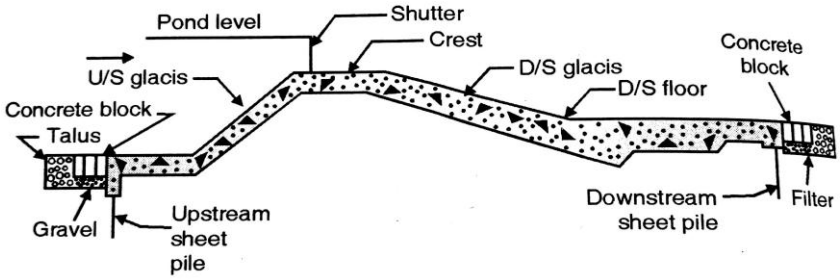
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**k) Ans.**	**Define assessment of irrigation water. State the methods.** **Definition:** Charges levied for construction, operation and maintenance of irrigation facilities based on water supplied is called as assessment of irrigation water. **Methods of assessment:** 1) Volumetric assessment 2) Assessment on area basis 3) Assessment on seasonal basis 4) Composite rate 5) Permanent assessment	*1* *½ mark each (any two)*	**2**
	l) Ans.	**State two advantages of lift irrigation over surface irrigation.** 1) Farmers can irrigate their field as per requirement and they have control on supply 2) Optimum use of water is possible 3) Lift irrigation reduces chances of water logging 4) It can be implemented at any desired place	*1 mark each (any two)*	**2**
	m) Ans.	**Spillway is safety valve for dams. Justify.** 1) Spillway is an arrangement provided at the crest of dam to expel the excess water rises above the full reservoir level. 2) This is necessary otherwise water will go on rising even above HFL and will start flowing from top of dam which may affect stability of dam. 3) Therefore it is very essential to provide spillway to dispose surplus water on downstream side.	*1 mark each (any two)*	**2**
	n) Ans.	**Enlist four materials used in canal lining.** 1) Cement / lime concrete lining 2) Cement mortar lining 3) Stone masonry lining 4) Brick lining 5) Shotcrete lining 6) Asphaltic lining 7) Precast concrete block lining 8) Sodium carbonate lining	*½ mark each (any four)*	**2**
Q.2		**Attempt any <u>FOUR</u> of the following:**		**16**
	a) Ans.	**Establish relation between Duty and Delta.** Let, D – Duty in hectares / cumec Δ - Delta for crop in meter B – Base period of crops in days If 1 cumec flowing for base period (B) and irrigates field of (D) hectares then total volume is given by, $= 1 \times (24 \times 60 \times 60) B\ m^3$ $= 8.64 \times 10^4 \times B$ cubic m	*2*	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**a)**	Volume calculated from delta Δ cm of depth required in base period = Δ x 10^4 and for D hectares the volume = 10^4 x Δ x D cubic m Equating above equations, 1 x (24 x 60 x 60) B = 10^4 x Δ x D Therefore, $\Delta = 8.64\frac{B}{D}$	***2***	**4**
	b)	**Define emergency spillway. Compare emergency spillway with main spillway on four distinct parameters.**		
	Ans:	**Defination:** When abnormal high intensity flood occurs the weaker portion gets washed and flood water flows through that portion which acts as additional spillway and thus avoids possibility of failure of the dam is called emergency spillway.	***1***	
		Sr. No. / **Emergency Spillway** / **Main Spillway** 1 / It is usually provided with earthen dam / It is provided with any type of dam 2 / Used in case of emergency / Used in general operating conditions 3 / It is constructed with weaker materials which gets washed away in case of high intensity flood / It is majorly constructed with RCC 4 / It is provided above the FRL of dam at HFL level / It is provided at FRL of dam	***3***	
	c)	**Write advantages and limitations of (two each)** **1) Ridge Canal** **2) Contour Canal**		
	Ans.	**Ridge Canal -** <u>Advantages:</u> a) It can irrigate on both sides b) Economical c) No cross drainage is required	***½ mark each (any two)***	
		<u>Limitations:</u> a) Velocity of water needs to be controlled b) Scouring of bed due to higher velocities	***½ mark each (any two)***	

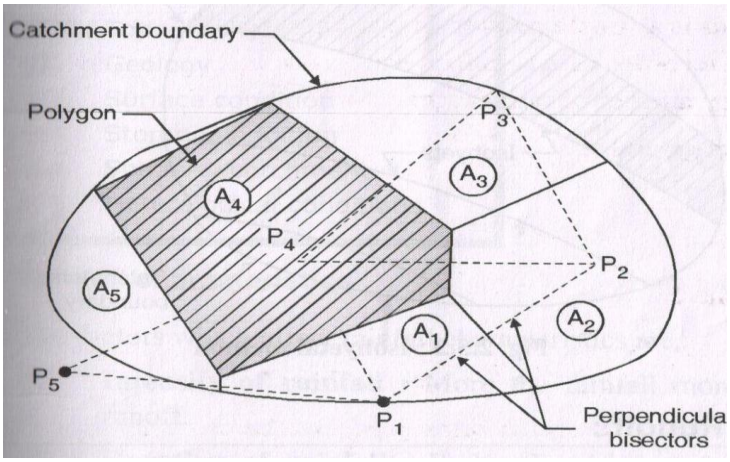
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**c)**	**Contour Canal-** **Advantages:** a) Suitable in hilly areas b) In contour canals longitudinal slope is given to enable water to flow by gravity **Limitations:** a) Large number of cross drainage works b) Can irrigate only one side	***1*** ***1***	**4**
	d)	**Estimate MFD from 500 km^2 catchment area in Maharashtra state. (Assume C = 14.5, use Dicken's and Inglis formulae).**		
	Ans.	**(i) By Dicken's formula:** $Q = C \times A^{3/4}$ $\therefore Q = 14.5 \times 500^{3/4}$ $\therefore Q =$ 1533.19 m^3/sec	***2***	**4**
		(ii) By Inglis formula: $Q = \frac{123xA}{\sqrt{A+10.24}} \therefore Q = \frac{123x500}{\sqrt{500+10.24}} \therefore Q =$ 2722.63 m^3/sec	***2***	
	e)	**Draw the layout diagram of diversion headworks. Write the purposes of any four components.**		
	Ans.		**2**	**4**
		Components: 1) Under Sluice: It controls entry of silt into canal. 2) Divide Wall: It separates under sluices from weir. 3) Fish ladder: It allows free movement of fish from upstream side to downstream side and vice versa. 4) Silt exclusion devices: It prevents entry of silt particles into canal.	***½ marks each (any four)***	

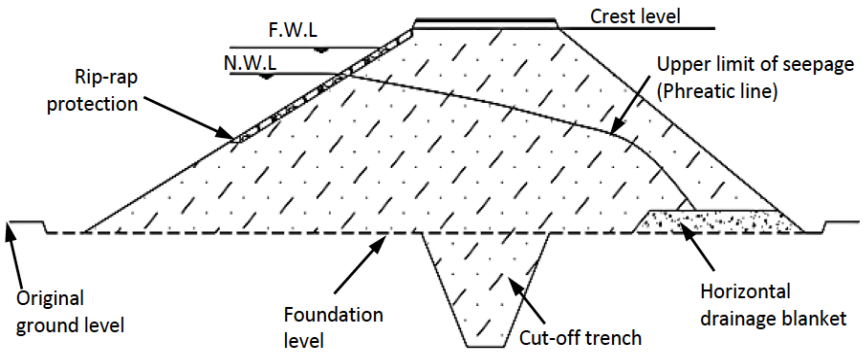
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**e)**	5) Silt ejectors: It is a structure constructed across canal to eject silt accumulated in canal section. 6) Guide bank: It protects regulator from river attack. 7) Marginal embankment: It protects land and property which is likely to be submerged.		
	f)	**Define waterlogging. State four causes of waterlogging with remedial measures.**		
	Ans.	**Waterlogging:** The condition of soil when it becomes completely saturated with water and becomes unfit for the growth of plants is called waterlogging.	**1**	
		Causes: 1) Heavy rainfall 2) Floods 3) Poor water management 4) Seepage from canals	***1½***	**4**
		Remedial measures: 1) Lining of canal 2) By providing intercepting drains 3) By providing proper drainage system 4) Awareness	***1½***	
Q.3		**Attempt any <u>FOUR</u> of the following :**		**16**
	a)	**State the advantages and disadvantages of percolation tank(Four each).**		
	Ans.	<u>Advantages of percolation tank-</u> 1. The total cost of project is low 2. The construction of bunds is simple and hence there is no need for skilled labours machines etc. 3. The site which are unsuitable for other type of irrigation may suitable for this type of scheme and thus better utilization of natural resources can be made. 4. The irrigation benefits of the percolation tanks are indirect as no irrigation outlet is provided for carrying out direct irrigation. 5. The water which goes underground passes through unknown seams and is spread over the unknown area and partially tapped by wells at isolated places	**½ Mark each (any four)**	**4**

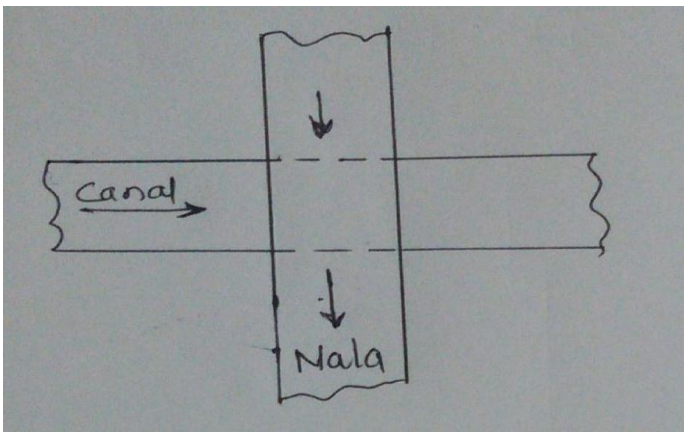
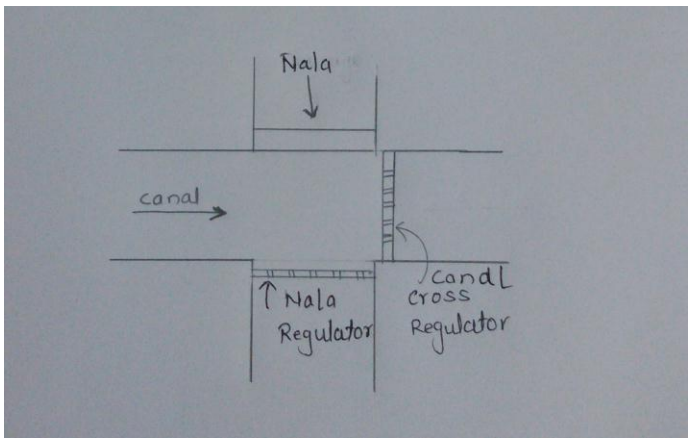
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**a)**	Dis-advantages of percolation tank- 1. The area commanded by percolation tank is uncertain. The reason for this is that the exact passage of water through the subsoil is not easy and economical to locate. 2. The efficiency is very low 3. The dam may slip and fail due to seepage forces. For carrying out reliable investigation, no of trial pits are required in entire command area as well as geological investigations are also required to be carried out which increases the cost.	**½ Mark each (any four)**	
	b) **Ans**	**Draw neat labeled sketches of – i. Vertical Drop weir** **ii. Sloping weir. State two purposes of each one** **Vertical Drop weir-** 1. To drop down the shutters during floods so as to reduce by increasing waterway opening 2. Due to raised masonry crest, the ponding water will be maximize.	**½ mark each**	
		 **Sketch of vertical drop weir**	**1**	**4**
		Sloping weir- 1. To dissipate the energy of the flowing water due to formation of hydraulic jump	**1**	
		 **Rock fill weir with sloping apron**	**1**	

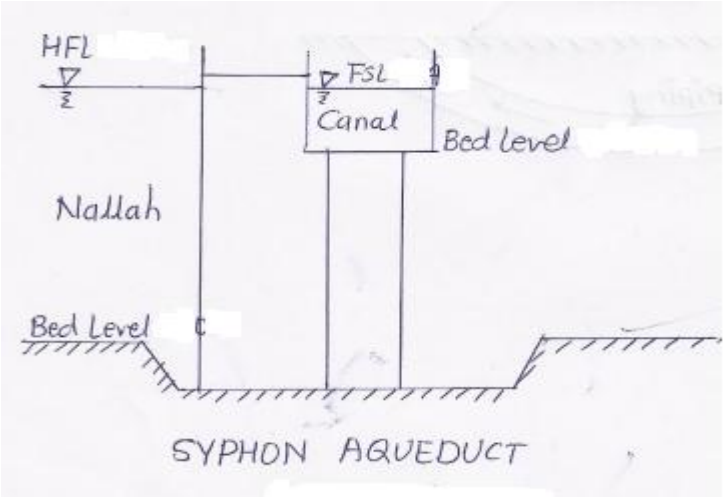
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	b)	**or**  **Concrete weir with sloping downstream glacis**		
	c)	**The base period , intensity of irrigation and duty of water for various crops under the canal system are given below. Determine design discharge at the head of main canal , if canal losses are 20% and CCA is 40000 hectares.** **Crop / Base Period / Duty at the field (ha/cumec) / Intensity of irrigation** **Wheat (Rabi) / 120 / 1500 / 20%** **Sugarcane (annual) / 360 / 1400 / 20%** **Cotton (kharif) / 120 / 1200 / 10%** **Rice (kharif) / 120 / 800 / 15%** **Vegetables (HW) / 120 / 1000 / 15%**		
	Ans	Crop / Base Period / Duty at the field (ha/cumec) / Intensity of irrigation / Area Wheat (Rabi) / 120 / 1500 / 20% / 0.2 x 40000 = 8000 Sugarcane (annual) / 360 / 1400 / 20% / 0.2 x 40000 = 8000 Cotton (kharif) / 120 / 1200 / 10% / 0.1 x 40000 = 4000 Rice (kharif) / 120 / 800 / 15% / 0.15 x 40000 = 6000 Vegetables (HW) / 120 / 1000 / 15% / 0.15 x 40000 = 6000	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**c)**	1. **Wheat-** Dischrage = Area / Duty = 8000/1500 =5.33 2. **Sugar cane-** Dischrage = Area / Duty = 8000/1400 =5.71 3. **Cotton-** Dischrage = Area / Duty = 4000/1200 =3.33 4. **Rice-** Dischrage = Area / Duty =6000/800 = 7.5 5. **Vegetables-** Dischrage = Area / Duty =6000/1000 = 6.00 Discharge in kharif season = 5.71 + 3.33+7.5 = 16.54 Discharge in Rabi season = 5.33 +5.71 = 11.04 Discharge in Hot weather season= 5.71+ 6.00 = 11.71 Discharge of canal in kharif is maximum Design discharge considering 20% losses =16.54/0.80 = 20.675 cumec	**1** **1** **1**	**4**
	d) **Ans.**	**Define lining of canals. State its eight advantages .** Lining of canal means providing impervious thin layer of 2.5 to 15 cm thickness to protect the bed and sides of canal. **Advantages :** 1. It reduces the loss of water due to seepage and hence the duty is enhanced. 2. It controls the water logging. 3. It provides smooth surface and hence the velocity of flow can be increased. 4. Due to the increased velocity the discharge capacity of canal is also increased. 5. Due to the increased velocity the evaporation also is reduced. 6. It eliminates the effect of scouring in the canal bed. 7. The increased velocity eliminates the possibility of silting in the canal bed. 8. It controls the growth of weeds along the canal sides and bed. 9. It provides the stable section of the canal. 10. It prevents the sub soil salt to come in contact with the canal water. 11. It reduces the maintenance cost of canal	**1** **3 (any eight advantages)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**(e)**	**Define computation of rainfall. Describe Thiessan's Polygon method with suitable sketch.**		
	Ans.	The computation of rainfall is done by following methods- **1.** Arithmetic mean method It includes averaging of all amount that has been recorded at the various stations in the area is added and then divided by number of rain gauges $P = (P_1 + P_2 + P_3 + P_4 \ldots\ldots P_n) / N$ **2.** Theissons polygon method **3.** Isohyetal method In this method, rainfall values recorded at various rain gauge station are collected and from that isohytel map is prepared and the area between successive is measured with the help of planimeter. $P_{avg} = [A_1 (P_1 + P_2) /2] + [A_2 (P_2 + P_3) /2] + \ldots\ldots P_n) / A_1 + A_2 + A_3 + \ldots\ldots$	**1**	**4**
		Theissons polygon method- **1.** In this method adjacent stations are joined by straight lines and thus dividing entire area into series of triangles and then perpendicular bisectors are erected on each of these lines and thus forms series of polygons each polygon contain one rain gauge station **2.** It is assumed that the entire area within any polygon is nearer to the rain gauge station which is included in polygon than to any other rainfall station. **3.** Then find the area of polygon as shown in figure **4.** If P is the mean rainfall on the basin, A is the area of basin then, Average annual rainfall = $(A_1 P_1 + A_2 P_2 + A_3 P_3 + \ldots\ldots A_n P_n)/ A$ Average annual rainfall = $(\sum AP) / \sum A$	**2**	
		Diagram –  	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**(f)** **Ans.**	**Describe significance of phreatic line in earthen dam with neat sketch.** **Significance of phreatic line in earthen dam-** 1. It gives us a divide line between dry and submerged soil. The soil above the seepage line will be taken as dry and the soil below the seepage line shall be taken as submerged for computations of shear strength. 2. It represents the top streamline and hence helps us in drawing the flow net. 3. The seepage line determination helps us to ensure that it does not cut the downstream face of the dam. This is extremely necessary for preventing softening or sloughing of the dam. **Diagram of phreatic line in earthen dam –**  	**2** **2**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		**Attempt any <u>FOUR</u> of the following:**		**16**
	a)	**Suggest suitable type of cross drainage works with neat labeled sketches (any two).** **i.Nallah bed level is well above canal FSL** **ii. Nallah and canal bed levels are almost equal with heavy flood discharge in Nallah** **iii. Canal Bed Level = 435.0 m** **Nallah bed level = 433.0 m** **Nallah HFL = 436.0**		
	Ans.	**i.Nallah bed level is well above canal FSL**  **Super passage** **ii. Nallah and canal bed levels are almost equal with heavy flood discharge in Nallah**  **Level Crossing**	**2 mark each (Any Two)**	**4**

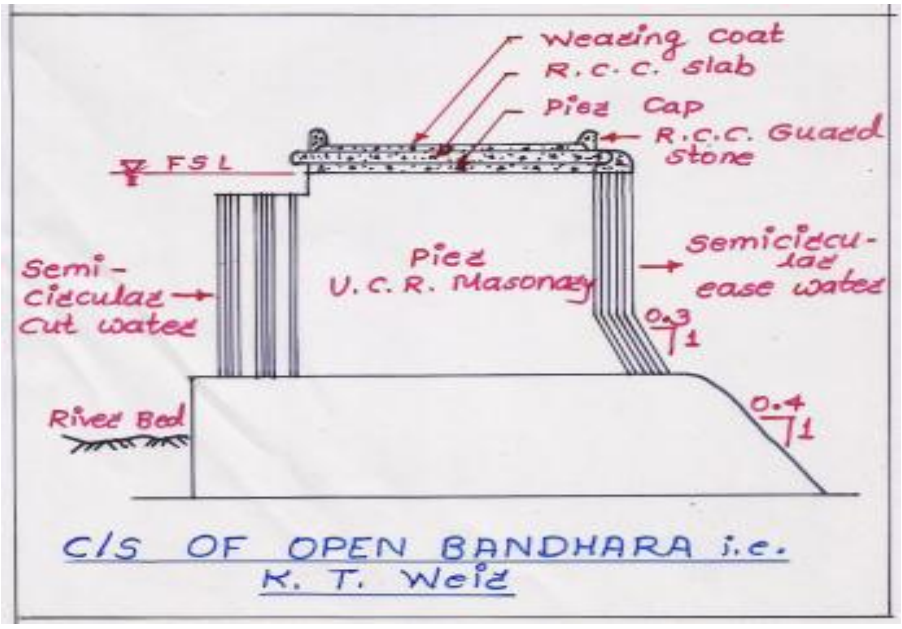
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	(a)	**iii.Canal Bed Level = 435.0 m** **Nallah bed level = 433.0 m** **Nallah HFL = 436.0**  		
	(b) Ans.	**Duty varies at varies points of measurement from head of water course to head of canal. Explain.** 1.In canal irrigation system, the water flows from head of water course to head of canal. 2. During the passage of water from these irrigation channels, water is lost due to evaporation and percolation . 3. Duty of water for crop , is the number of hectares of land which the water can irrigate. Therefore, If the water requirement of crop is more , less number of hectares of land it will irrigate 4. If water consumed is more , duty will be less. It becomes clear that duty of water at the head of the water course wiil be less than the duty of water on the field . because when water flows from the head of water course and reaches the field , some water is lost as transit losses.	**4**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	(c) Ans.	**State four important differences between diversion head works and storage head works .**	1 Mark each	4

Sr. No	Diversion head works	Storage head works .
1	Weir or barrage is constructed across a perennial river to raise water level and to divert the water to canal, is known as diversion head work.	Dam is constructed across a river valley to form storage reservoir, known as storage head works.
2	Water is supplied to the canal from this reservoir through canal regulator.	Flow of water in the canal is controlled by canal head regulator.
3	These serves for- 1. To rise the water level at head of the canal. 2. To control the entry of silt into the canal and to control the deposition of silt at the head of the canal.	These serves for multipurpose function like hydro-electric power generation, flood control, fishery.
4	It is constructed to divert the required supply into the canal from river.	It is constructed for controlling flood water

	d) Ans.	**Describe Kolhapur type Bandhara with neat labeled section with reference to its location , functions and working.**	1	

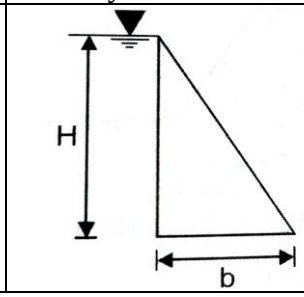
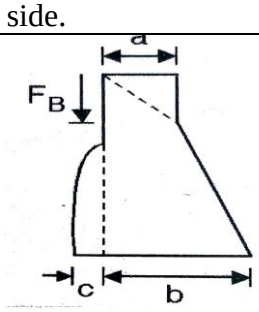
Kolhapur type Bandhara -



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**d)**	**Location –** This type of bandhara is commonly constructed in Kolhapur district	**1**	**4**
		Function – To raise the water level on upstream side so that it can be diverted in the canals on one side or both sides of banks.	**1**	
		Working - It is fully open weir. It consists of number of piers & has side grooves for fixing wooden needles. The needles are put across the piers for the required height to form continuous weir. The height can be changed by removing needles or putting additional needles. Needles are removed during floods to avoid rise of water on u/s.	**1**	
	(e)	**Determine LSL,FRL, MRL and TBL from the following data Given below.** **Effective storage required for crops- 5200 Ha.m** **Tank Losses – 15% of effective storage** **Carry over allowance = 10% of effective storage** **Dead storage = 10% of gross storage** **Contour R.L.** 51 54 57 ……. 110 113 116 **Storage Mm^3** 3.0 5.5 7.5 ……. 50.00 70.00 90.00		
	Ans.	Gross storage = 5200 +[(15/100) x 5200]+ [(10/100) x 5200] = 6500 Ham = 65 Mm^3		
		110 113 50.00 70.00		
		FRL = 110 + [(113-110)(65-50)] / (70-50) **= 112.25 m**	**1**	
		Dead storage = 10% of gross storage = 10/100 X 65 = 6.5 Mm^3		
		54 57 5.4 7.5		**4**
		DSL = 54 + [(57-54)(6.5-5.4)] / (7.5-5.4) = **55.57 m**	**1**	
		HFL = FRL + Flood Lift		
		HFL = 112.25 + 2 = 114.25 m	**1**	
		TBL = HFL + FB		
		TBL = 114.25 + 3 = 117.25 m	**1**	
		(Note -The assumed values of free board and flood lift may vary.)		

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.4</td><td>f)

Ans.</td><td>Differentiate between theoretical and practical profile of gravity dam.

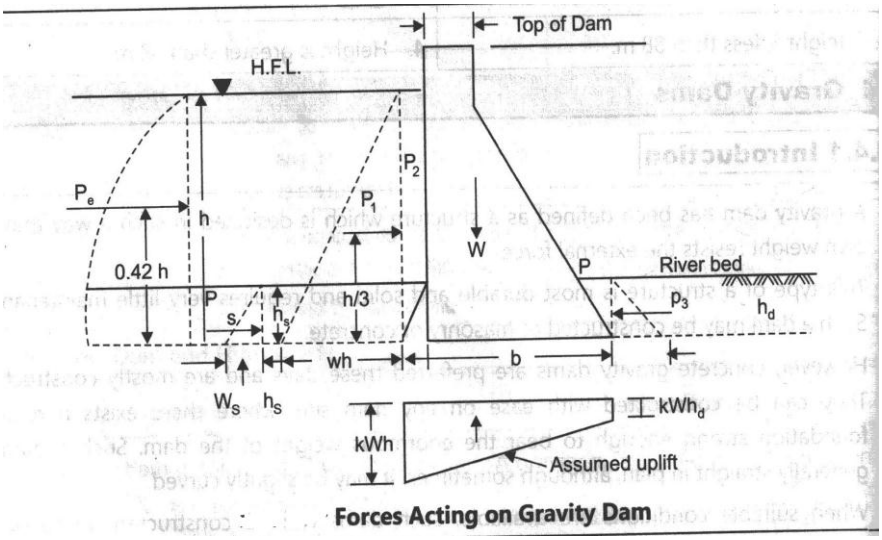
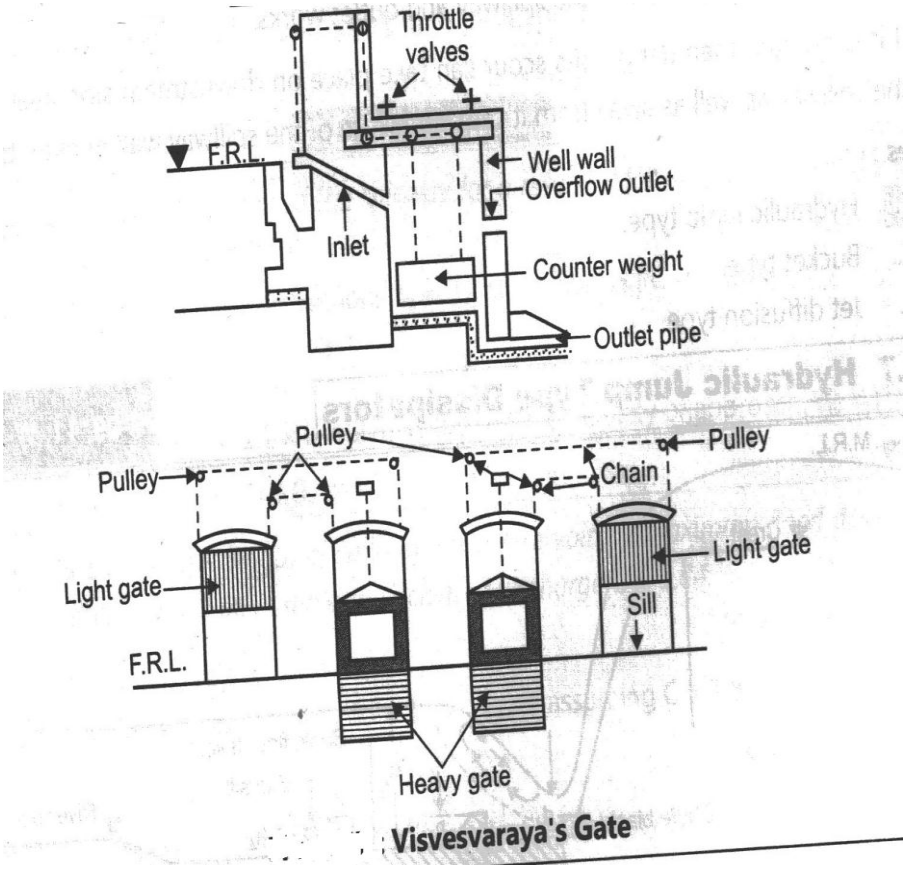
<table>
<tr><th>Sr. no.</th><th>Elementary profile</th><th>Practical profile</th></tr>
<tr><td>1</td><td>Provision of free board is not provided.</td><td>Provision of free board is provided.</td></tr>
<tr><td>2</td><td>Road way at top is not possible.</td><td>Road way at top is possible.</td></tr>
<tr><td>3</td><td>For reservoir empty condition it will provide maximum possible stability.</td><td>For reservoir empty condition tension is developed at toe and hence some masonry is provided on u/s side.</td></tr>
<tr><td>4</td><td> 
</td><td> 
</td></tr>
</table></td><td>1 mark each</td><td>4</td></tr>
<tr><td>Q.5</td><td></td><td>Attempt any <u>Four</u> of the following:</td><td></td><td>16</td></tr>
<tr><td></td><td>a)

Ans.</td><td>Enlist the forces acting on gravity dams. Describe with neat labelled diagram any two of them.
Following are the forces acting on gravity Dam:
1. Water pressure on upstream side
2. Water pressure on downstream side
3. Weight of the dam
4. Upstream silt pressure
5. Seismic forces
6. Uplift forces
7. Ice pressure
8. Wind pressure

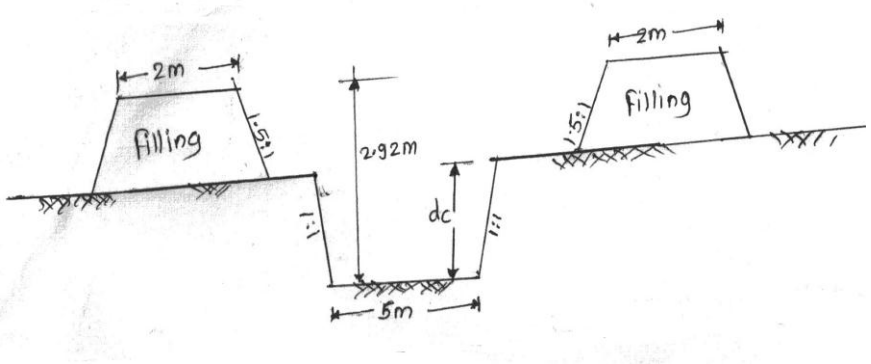
1. Water pressure on upstream side: Water pressure is the major external force acting on the dam. This is overturning force.

$P_1 = \frac{Wh^2}{2}$ acting at h/3 from the base.
Where, W = specific weight of water
H = height of water
P_2 = weight of wedge water on upstream slpoe acting downwards through C.G. This is retaining force.</td><td>1</td><td></td></tr>
</table>

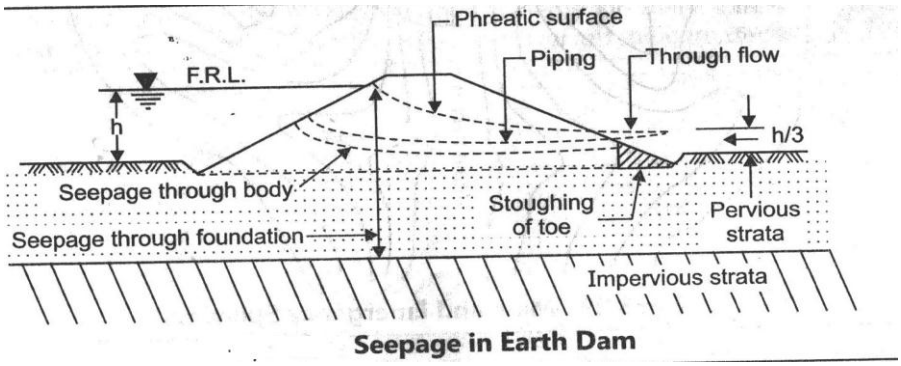
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**a)**	**2. Water pressure on downstream side**: Weight of water on downstream wedge acting at C. G. downwards. This is retaining force. $P_3 = \frac{Wh_d^2}{2}$ Where, H_d = depth of water on downstream side. **3. Weight of dam:** It is stabilizing force. W = Area of cross-section x Unit weight of dam material acting at C. G. of the dam section downward. **4. Upstream silt pressure:** $P_{silt} = \frac{W_b h_s^2}{2} \times \frac{1-\sin\phi}{1+\sin\phi}$ acting horizontally at $h_s/3$ from the base. Where, W_b = weight of submerged silt. Φ = Angle of internal friction of the silt. H_s = Depth of silt **5. Seismic forces :** These forces are considered only in such area of country which comes under seismic zones where possibility of earthquake is more and these are taken as, $P_e = 500h^2$ Approximately acting at 0.42h from the base, horizontally downstream direction. It is overturning force. **6. Uplift force:** It is the pressure due to the seepage of water through the foundation. It acts upwards on the foundation of the dam and reduces the effective weight. $U = Kw_b \left(\frac{h + h_d}{2}\right)$ Where, K = Permeability of the foundation = 0 for hard impervious rock. = 0.2 to 0.6 for other rocks. **7. Ice Pressure:** In extreme cold climate, the top surface of the reservoir freezes into ice. Due to variation in temperature, such ice expands during the day time and exerts pressure on the dam. This force acts along the length of the dam at the reservoir level. The magnitude of this force Varies from 25 to 150 t/m^2. **8. Wind pressure**: The wind acting on all exposed faces of the dam exerts pressure in the wind direction. This pressure depends on the speed of wind.	**1 Mark for each force (Any Two)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**a)**	**Diagram of forces acting on dam –**  **Forces Acting on Gravity Dam**	**1**	
	b) **Ans:**	**Draw a neat labelled diagram of visvesvaraya gates. Describe their working.**  **Visvesvaraya's Gate** (**NOTE: Any one diagram from the above should be considered)**	**2**	

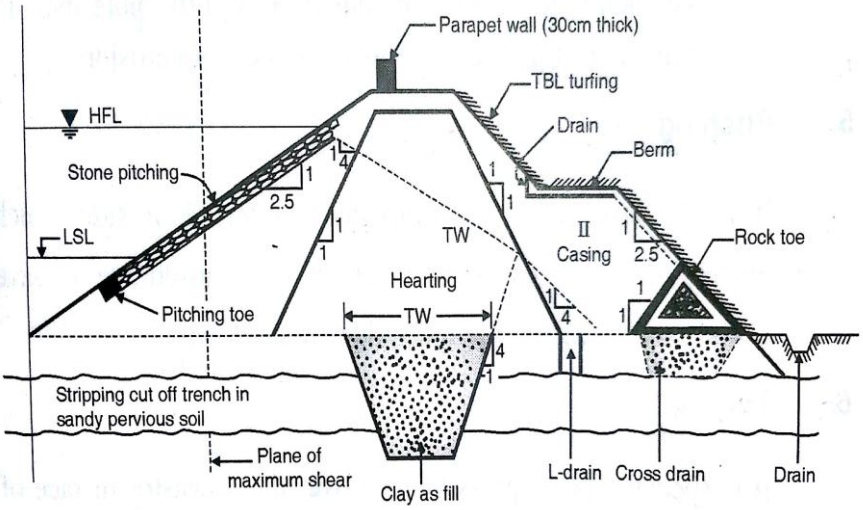
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**b)**	• This gate is fixed roller automatic gate. • There are 11 sets each having 8 gates. Out of 8 gates, 4 are heavy and 4 light, 2 heavy and 2 light gates on each side of the counterweight well. They are connected to each other by means of systems of pulleys and chains. • Water enters into the well through inlet pipe when it rises above FRL which reduces the weight of counterweight and the heavy gates slide downwards. The light gates which are connected to heavy gates slide downwards. • The light gates which are connected to heavy gates get pulled up creating the opening to pass the flood. When water level in the reservoir goes below FRL no water enters the well. The water in the well is drained out. • The counterweight now sinks down pulling 4 heavy gates up in a closed position. • 4 light gates which are connected to heavy gates will come down and close the openings. Thus, the opening and closing operation of the gate is automatic. • When the difference in upstream and downstream water level is more, the flowing water from the spillway has a very high kinetic energy due to high velocity of flow. This energy can cause dangerous scour of the channel bed, hence it is necessary to construct a structure known as energy dissipater to reduce or dissipate the kinetic energy of flow, before it enters in the tail channel. • It is located near the toe of the spillway and outlet works. • If it is omitted then dangerous scour can take place on downstream side near the toe of the spillway as well as away from it causing failure of the spillway wall or even the dam.	**2**	**4**
	c) **Ans:**	**Life of dam can be increased reducing sedimentation in reservoir. Justify with measures to reduce sedimentation.** **Life of dam can be increased reducing sedimentation in reservoir :** Run-off from catchment brings silt with it. The lighter silt remains in suspension and heavier silt gets deposited on bed and sides of reservoir which is called sedimentation. Finer particles of silt prevent leakage and reduce seepage through reservoir bed. As time passes on more and more silt is deposited which reduces capacity of the reservoir when it rises up to lowest silt level. A dead storage is kept roughly about 10% of the gross storage to low this silting-up to the reservoir. Hence, if sedimentation is not reduced, the dam storage capacity will get reduced and life of dam get reduced.	**2**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	c)	**Measures to reduce sedimentation:** **1. Pre-constructing measures:** i. Selection of dam site: Silting can be reduced by choosing the reservoir site in such a way as to exclude the run off from easily erodible catchment. As silting reduces it increases capacity of reservoir. ii. Construction of the dam in stages: The dam should be built lower, and raised subsequently when some of its capacity gets silted up. Therefore the life of a reservoir can be prolonged by constructing the dam in stages. iii. Construction of check dams: The sediment inflow can be controlled by constructing smaller check dams across the river contributing major sediment load and trap large amount of coarser sediments. iv. Vegetation screens: Vegetation's trap large amount of sediments which reduces entry of silt in reservoir and helps to increase life of dam. v. Construction of under sluices in the dam: The dam is provided with openings that is under sluices in its base, so as to remove the more silted water on the downstream side. **2. Post-constructing measures** i. Removal of post flood water: The sediment content increases just after the floods; therefore attempts are generally made not to collect this water, which reduces sediment load on reservoir. ii. Mechanical stirring of the sediment: The deposited silt is scoured and disturbed by mechanical mean, so as to keep it in a moving state, thus helps in pushing it towards the sluices. iii. Erosion control and soil conservation: this includes all those general methods which are adopted to reduce erosion of soil. Because when the soil erosion is reduced, automatically, the sedimentation problem is reduced	**1 Mark each (Any two)**	**4**
	d)	**Calculate the economical depth of cutting for the canal section. The bed width of the canal is 5m. and top width of banks are 2m each. Side slope in cutting is 1:1 and in banking is 1.5:1 (H:V). height of banks from bed is 2.92m throughout.**		
	Ans:			

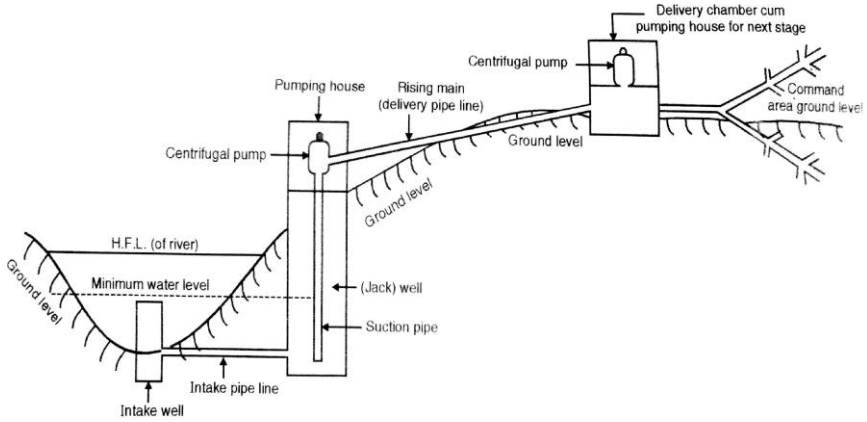
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**d)**	Let, dc= economical depth of cutting h is hight of bank above GL, = $(2.92 - dc)$ Area of cutting = (b + nd) d = (5 + 1 x dc) dc = (5 + dc) dc	**1**	**4**
		Area of filling = 2 (Area of one bank) = 2 [(b + nd) d] = 2 [(b + 1.5h) h] = 2 { [2 (2 + 1.5 (2.92- dc)] (2.92 - dc)} = 2 { (2 + 4.38 - 1.5dc) (2.92 - dc)} = 2 { 5.84 + 12.79 - 4.38dc - 2dc - 4.38dc + $1.5dc^2$ } = 37.26 - 21.52dc + $3dc^2$	**1**	
		Now, for economical depth , Area of cutting = 2 x Area of each bank $5dc + dc^2 = 37.26 - 21.52dc + 3dc^2$ $0 = 37.26 - 26.52dc + 2dc^2$ $2dc^2 - 26.52dc + 37.26 = 0$ $dc = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $= \frac{-26.52 \pm \sqrt{26.52^2 - 4x2x37.26}}{2x2}$ dc = 1.597m	**1** **1**	
	e) **Ans:**	**State the causes of failures of earth dams. Describe seepage failures with diagrams.** **Causes of failure**: 1. Hydraulic failures: • By overtopping • Erosion of upstream slope • Cracking due to frost action • Erosion of downstream slope • Erosion of the downstream toe 2. Seepage failure: • Piping through the body of the dam • Piping through foundation 3. Structural failure: • Upstream and downstream slopes slide • Faulty construction and improper maintenance	**2**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**e)**	**Seepage failure**: more than 33% of the earth dam failures are due to seepage. Seepage always occurs in earth dams. It does not harm its stability if it is within the design limits. But the excessive seepage will lead to failure of the dam. • Piping through the body of the dam: It is due to the transport of soil particles with seepage flow. It results in gradual formation of drain from upstream to downstream through which water flows and thus the dam fails. • Piping through foundation: when highly permeable strata of gravel, sand or cavities are present in the foundation of dam, it permits heavy seepage of water through it causing erosion of soil which will result in the formation of piping. Hence, the dam will sink down causing its failure. Careful investigation of foundation soil and proper design will help in avoiding such failures.	**1**	**4**
		 **Seepage in Earth Dam**	**1**	
	f) **Ans:**	**Compare drip irrigation system with sprinkler irrigation on four Distinct parameters.**	**1 mark each (any four)**	**4**

Sr.No.	Drip irrigation	Sprinkler irrigation
1.	Initial investment is more.	Initial investment is less as.
2.	Dripping valves are present in drip system	Spray guns and nozzles are used in sprinkler system.
3.	Only the root area is wetted by drip irrigation	Sprinkler wets an area of a circle, which covers a number of plants. more area is wetted by this system
4.	Drip irrigation prevents the spreading of diseases	sprinkler system does not prevent the spreading of diseases
5.	Run off and evaporation is less in sprinkler method.	Run off and evaporation is higher in sprinkler method.
6.	The effectiveness and efficiency is higher in drip irrigation	the effectiveness and efficiency is lesser in sprinkler irrigation

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6		**Attempt any Four of the following:**		**16**
	a)	**Draw a typical cross section of zoned earth dam, showing all components. Write the purposes of any four components.**		
	Ans.		**2**	
		1. **Hearting**: It forms the central impervious section constructed with clyee soil, silty clay, loam etc.It is compacted at OMC. It provides water tightness to the dam and adequate shear resistance against slipping. It controls the seepage flow through the body of the dam. 2. **Casing**: It forms outer portion of the dam. It is constructed with murum soft rock or sand and gravel etc. It is compacted at its OMC. Casing provides a cover to the hearting protecting it from cracking. It develpoes shear resistance against slip and provides stability to the dam. It also helps in drainage. 3. **Cut-off trench**: It is excavated below ground level under the hearting zone and filled with clayee soil and well compacted. The function of cut-off is to prevent or reduce seepage flow through the pervious foundation. It prevents piping of dam through foundation. 4. **Rock toe**: It is constructed from rock pieces or boulders larger than 20cm size. It helps to prevent sloughing of the toe due to the seepage flow and increases the stability of dam. 5. **Pitching**: Pitching 30cm to 45cm thickness is provided by laying stones of 30cm size and 40kg to 50kg weight on a dressed upstream slope. It prevents the erosion of material on the upstream face caused due to wave action and protects the slope from sudden drawdown. 6. **Turfing**: it is planting of special type of grass called harali on the downstream face of the dam. It protects the downstream slope from eroding action of rain water. 7. **Berms**: these are offsets provided on downstream at 8 to 10 m vertical intervals for 3 to 5m width. These are provided to collect the rain water and dispose it off safely,to provide roadway for vehicles, to reduce the velocity of rain water falling on slope, to provide minimum cover of 2m above the	**½ Mark Each (any four)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6		Seepage line.		
	a)	8. **Drains**: A network of drains is provided with longitudinal drains, cross drains and toe drains on downstream side of the embankment. **L- drain**: It is filter laid along the downstream toe of hearting to collect the seepage through the embankment and divert it into cross drains. **Cross drains**: Cross drains are laid at 45^0, 60^0, or 90^0 angle to the axis of dam. It is filled with sand, gravel and rock. The object of cross drain is to collect the seepage from the L-drain and downstream casing and lead it to the toe drain. **Toe drain**: It is an open continuous drain. It collects the discharge of seepage from cross-drains and discharges it into the river or nalla. 9. **Transition filter**: It is graded filter placed in between clayee core and sandy shells. It helps in draining of hearting and helps reduce the pore pressure.		
	b)	**Design a most economical canal section to carry discharge of 4 m^3/s with bed slope 1in 2000, lined with concrete (N= 0.015) and having side slpoe 1:1.**		
	Ans	**Given:** $Q = 4\ m^3/s$ s = 1 in 2000 N = 0.015 N = 1:1 **Solution:** For most economical channel, Half of the top width = length of sloping side $R = \frac{d}{2}$ $\frac{b + 2nd}{2} = d\sqrt{n^2 + 1}$ $\frac{b + 2\times(1)\times d}{2} = d\sqrt{(1)^2 + 1}$ $b + 2d = 2d\sqrt{2}$ $b = 0.828d$ $Area = (b + nd)d$ $= (0.828d + 1\times d)d$ $A = 1.828\ d^2$ *By* mannings formula, $Q = \frac{1}{N}.A.(R)^{\frac{2}{3}}.(S)^{\frac{1}{2}}$	**1** **1**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**b)**	$Q = \frac{1}{N}.A.(R)^{\frac{2}{3}}.(S)^{\frac{1}{2}}$ $4 = \frac{1}{0.015} \times 1.828\, d^2 \times (0.5d)^{\frac{2}{3}} \left(\frac{1}{2000}\right)^{\frac{1}{2}}$ $2.33011 = (d)^{\frac{8}{3}}$ $d = 1.373$ m $b = 0.828 \times d$ $b = 1.137m$	**1** **1**	
	c) **Ans.**	**Draw a layout of lift irrigation scheme. Show all components. State purposes of any two.**  **Layout of Lift Irrigation scheme** 1) **Intake well:** A channel is constructed for diverting the flow of water to inlet chamber. 2) **Inlet chamber:** It avoids silts and debris to enter into jack well. 3) **Jack well:** It is provided to facilitate location of an engine house above high flood level and allows pumping during floods. 4) **Inlet pipe:** To convey water from inlet chamber to jack well and inlet pipe is provided with proper gradient. 5)**Engine House**: It is small storage room which accommodates the engine and pumps to be installed. 6) **Rising main:** It is a delivery pipe which transmits water from well to delivery chamber. 7) **Delivery chamber:** The water from rising main is collected in delivery chamber and then it is allowed to flow in field ditches. 8) **Water distribution system:** It is the system which distribute water from delivery chamber to field channel.	**2** **1 marks Each (any two)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**d)**	**Describe maintenance works for canals with respect to four parameters.**		
	Ans:	**Maintenance work of canal:** **1. Removal of silt:** The silt should be removed properly during closure period either manually or with machines, and if it is more than canal should be closed and then silt should be removed. silt can be removed by increasing velocity of canal water by addition of more water in it. It also removed by providing silt ejector in canal. **2. Weed growth:** weed affects efficiency of canal and hence weeds and plants should be removed from canal from their roots. **3. Strengthening of canal bank:** The banks should be strengthened properly. If any holes made by insects are found, it should be properly closed. Leakage if any found should be properly treated, if scouring of banks noticed proper measures should be adopted. **4. Maintenance of service road:** Canal roads are inspected after Heavy rains and necessary repair. Work should be started if found any deterioration. **5. Overflow of canal banks:** After rainy season proper attention is given towards canal banks as banks may get deteriorated due to heavy rains or flood and then apply necessary treatment.	**1 Mark Each (any four)**	**4**
	e)	**Suggest four suitable measures with justification to control cracking in gravity dams.**		
	Ans:	**Measures to control cracking in gravity dam:** 1. Using minimum amount of cement in a given mix of specified strength. The quantity of cement can be decreased by better grading the aggregate. 2. When concrete is poured, it is poured up to a certain height in the first attempt. This height is called ' Lift '. Generally 1.5m lift is used in modern dams. If lift is reduced, more horizontal joints will get developed and also sufficient cooling time between two successive pours shall be obtained thus reducing cracking. 3. By providing suitably spaced contraction joints, in addition to the normal construction joints. 4. Special low heat cements may be used. 5. The materials which go into the concrete ,may be cooled before mixing. 6. Further cooling is accomplished by circulating cold water through pipes embedded in concrete. This is quite an expensive measure and is adopted only for large gravity dams.	**1 Mark Each (any four)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**f)**	**Define Runoff. State six factors affecting runoff mentioning their effects on run off.**		
	Ans:	**Runoff:** The amount of water which flows over the surface of earth after all losses have taken place is called as runoff. **Factors affecting runoff:** **1)Rainfall characteristics :** a. More the rainfall, runoff will be more. b. More the intensity of rainfall, More will be the runoff. **2) Topography:** a. It depends upon smoothness and roughness of the surface b. Steep slopes – Heavy runoff will reach the valley quickly, reducing losses gives more runoff. c. catchment is mountainous, more will be runoff d. catchment is in windward direction, more will be runoff **3) shape and size of catchment –** a. Catchment area – Larger the area, more runoff b. Fan shaped catchment gives greater runoff **4) Characteristics of catchment :** a. Rocky strata – heavy runoff b. Compactive strata - heavy runoff c. Sandy strata – reduced runoff d. if more area of catchment is cultivated ,surface runoff will be less. e. Presence of vegetation covers reduces the runoff during smaller storm. **5) Meterological characteristics :-** a. Low temperature – greater runoff b. High temperature– less runoff **6) Geological characteristics :-** a. pervious soil – reduces runoff b. porous and fissure rock – very low surface runoff	**1** **½ Mark Each (any six)**	**4**