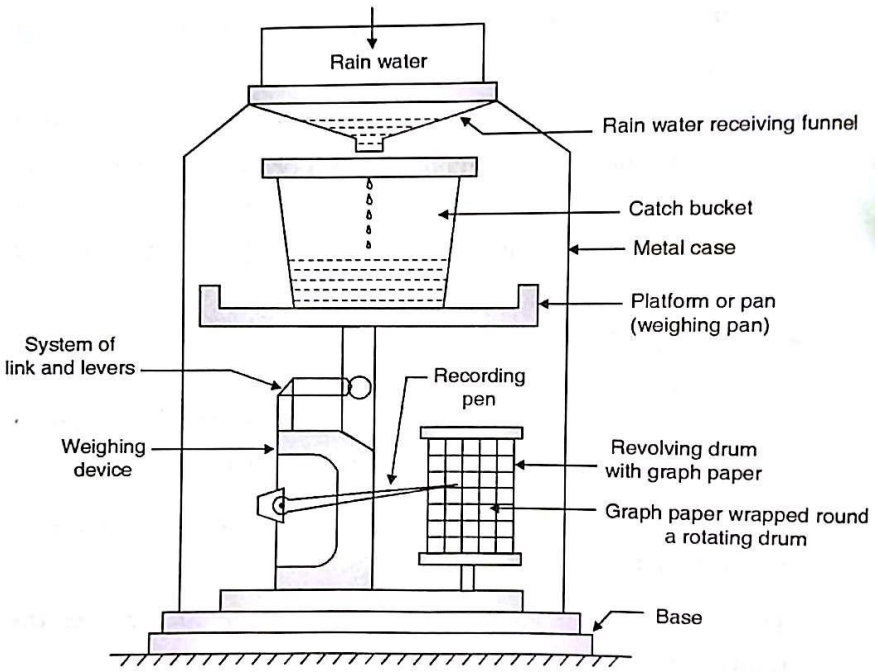
Model Answer : Winter 2016

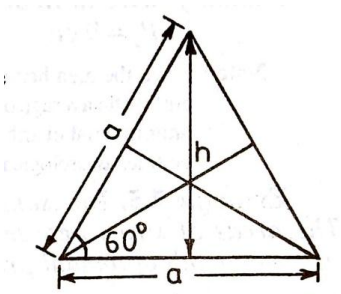
Subject : Irrigation Engineering | **Subject Code : 17502**

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	**A)**	**Attempt any THREE**		**(12)**
	a)	**Define runoff? State the various factors affecting runoff.**		
	Ans.	**Runoff:** The amount of water which flows over the surface of earth after all losses have taken place is called as runoff.	**1 mark**	
		Factors affecting runoff: 1) Intensity of rainfall 2) Duration of rainfall 3) Distribution of rainfall 4) Topography 5) Geology 6) Surface condition 7) Storage condition 8) Shape of catchment 9) Meterological conditions	**1 mark each (any three)**	**4 marks**
	b)	**What is raingauge? Explain any one recording type raingauge with a neat sketch.**		
	Ans.	**Raingauge:** The instrument which measures rainfall is called raingauge.	**1 mark**	
		Types of raingauges: 1) Weighing bucket gauge 2) Tipping bucket gauge 3) Syphon gauge (Float type rain gauge)		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**A)**	**Weighing type rain gauge:**		
	b)	- The rain water passes through a funnel into a bucket called as catch bucket which is placed on weighing platform. - When weight of bucket is increased due to rain water the weighing platform moves. Movement of weighing platform is transmitted to Links and levers to a pen arm. This pen traces the collected amount of rainfall on a graduated graph paper wrapped around drum. -Thus increasing weight of the bucket helps in recording the rainfall with time by moving a pen on a revolving drum.	**1 mark**	**4 marks**
			**2 marks**	
		Fig. Weighing type rain gauge		
		(Note: Explanation for any type mentioned above should be considered)		
	c)	**Compute the MFD of a stream over a catchment area of 150 km^2 using:** **(i) Dicken's formula (C=27)** **(ii) Inglis formula**		
	Ans:	**(i) By Dicken's formula:** $Q = C \times A^{3/4}$ $\therefore Q = 27 \times 150^{3/4}$ $\therefore Q = 1157.26$ m^3/sec	**2 marks**	**4 marks**
		(ii) By Inglis formula: $Q = \frac{123xA}{\sqrt{A+10.24}}$ $\therefore Q = \frac{123x150}{\sqrt{150+10.24}}$ $\therefore Q =$ 1457.50 m^3/sec	**2 marks**	

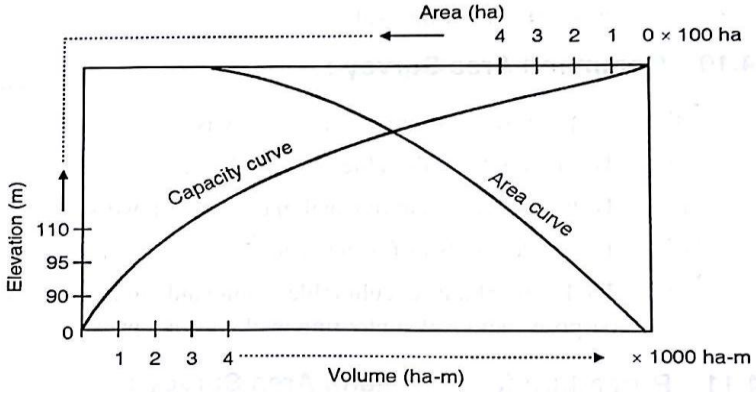
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**d) Ans:**	**Define Duty. State the factors on which duty depends.** **Duty:** Duty is the area in hectares irrigated by one cubic per meter per second of water flowing continuously for the base period for a particular crop. **Factors affecting duty:** 1) Type of crop 5) Methods of irrigation 2) Season 6) Method of tilling 3) Rainfall 7) Canal Condition 4) Soil type 8) Mode of assessment	**1 mark** **1 mark each (any three)**	**4 marks**
	B)	**Attempt any ONE:**		**(6)**
	a) Ans:	**An area contains three raingauge stations which are equidistant from each other at a distance of 5 km. The rainfall measured at each station is 4.8 cm, 3.2 cm and 8 cm. Calculate the mean precipitation for the area by using Thiessen's method.** Three raingauge stations are equidistant from each other which form an equilateral triangle by joining all of them. In equilateral triangle, the three raingauge stations will be fed equally, i.e. equal to 1/3 x area of triangle $= \frac{1}{3} x \left(\frac{1}{2} a x \frac{\sqrt{3}}{2} a\right) = \frac{1}{3} x \frac{\sqrt{3}}{4} a^2 = \frac{a^2}{4\sqrt{3}}$  $\frac{h}{a/2} = \tan 60° = \sqrt{3}\ ;\ h = \frac{\sqrt{3}}{2} a$ Area $A_1 = \frac{a^2}{4\sqrt{3}} = \frac{5^2}{4\sqrt{3}} = 3.61\ km^2$ Similarly, $A_2 = 3.61\ km^2$ and $A_3 = 3.61\ km^2$ Using, $P = \frac{P_1A_1 + P_2A_2 + P_3A_3}{A1 + A2 + A\ 3}$	**1 mark** **2 marks** **1 mark**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1		$\therefore P = \frac{4.8\,x\,3.61+3.2\,x\,3.61+8\,x\,3.61}{3.61+3.61+3.61} = 5.33$ cm Hence, the mean precipitation for the area = 5.33 cm	**2 marks**	**6 marks**
	b)	**The capacity-elevation curve of a proposed irrigation reservoir having 20 km^2 of catchment, is represented by the following data:**		

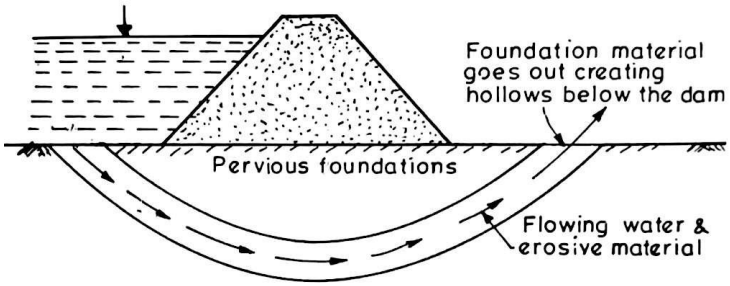
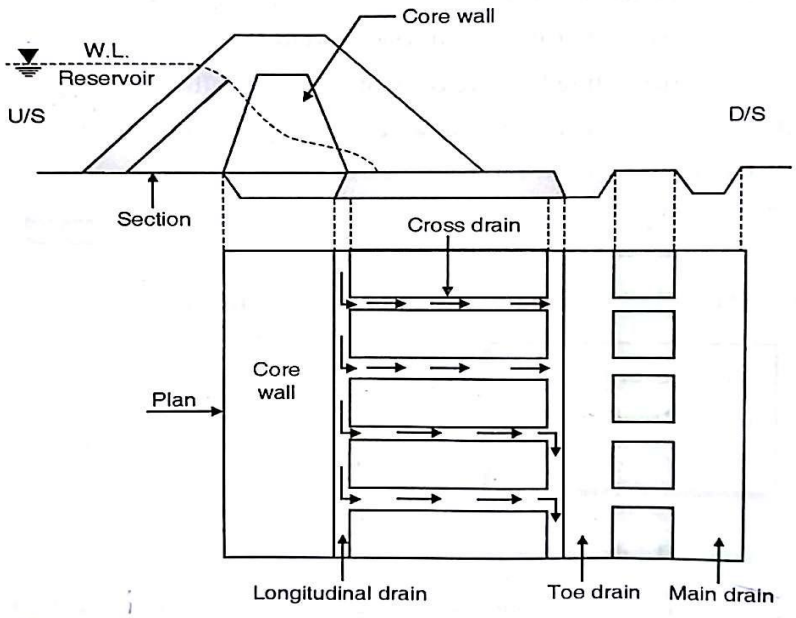
Elevation in m	**600**	**602**	**604**	**606**
Capacity in ha.m	**24.20**	**26.20**	**30.30**	**36.80**

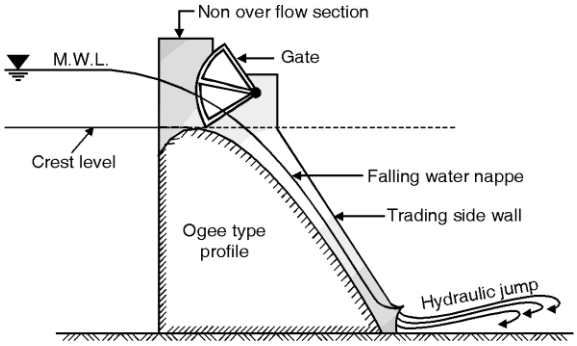
The rate of silting for the catchment has been assessed to be 300m^3/km^2/year. Assuming the life of the reservoir to be 50 years, compute the dead storage and LSL, if the main canal is 6 km long with a bed slope of 1 in 1000 and the canal bed level at the tail end is at RL 594.500 m. The FSD of the canal at the head is 80 cm. The crop water requirement is assessed as 250 ha.m.

	Ans.	**1) Calculation for DSL:** The dead storage is first of all computed as maximum of the following three values: A) DSL=10% x net water demand or crop water requirement=25 ha.m B) DSL = FSL of canal at head works = 594.5 + (6 x 1000) x $\frac{1}{1000}$ + 0.8 = 601.4 m Dead storage capacity at RL 601.4 m is interpolated = 24.2 + $\frac{(26.2-24.2)ha.m}{(602-600)RL}$ x (601.4 - 600) RL = 25.6 ha.m C) Dead Storage = Catchment area x rate of silting x life of reservoir = 20 km^2 x 300 m^3/km^2/year x 50 years = 300000 m^3 $\therefore$ Dead Storage = 30 ha.m Hence choose Dead storage at **30 ha.m** **2) Calculation for LSL:** The LSL (x) corresponds to 30 ha.m capacity, which is computed by interpolation as: 30 = 26.2 ha.m + $\frac{(30.3-26.2)ha.m}{(604-602)RL}$ x (x - 602) RL $\therefore$ 3.8 = $\frac{4.1}{2}$ (x - 602) $\therefore$ (x - 602) = $\frac{3.8\,x\,2}{4.1}$ $\therefore$ x = RL 603.85 m Hence LSL is fixed at RL **603.85 m**	**1 mark** **1 mark** **1 mark** **2 marks** **1 mark**	**6 marks**

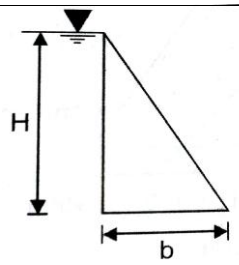
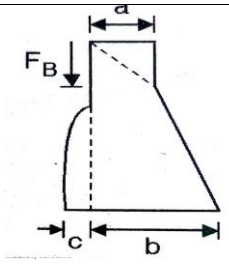
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2.		**Attempt any FOUR:**		**(16)**
	a)	**Draw a neat sketch of Area-Capacity elevation curve. Describe how to interpret various parameters from this curve.**		
	Ans:	 Fig. Area-Capacity elevation curve	**1 mark**	
		1) Area capacity curve is a curve in which two curves are plotted in one graph having area in hectares of water spread and reservoir capacity plotted at x and y axis resp. 2) The area curve gives information about area under submergence and useful in determining control level of dam. 3) The capacity curve provides the information about capacity of reservoir which is useful in deciding capacity of reservoir. 4) From the contour map of reservoir area, the water spread of the reservoir at any elevation is directly determined by measuring area at that contour with the help of planimeter. 5) The capacity may be determined by taking contour areas at equal intervals and summing up these areas by following methods: a) Trapezoidal formula b) Prismoidal formula	**3 marks**	**4 marks**
	b)	**What do you understand by the term 'silting of reservoir'? Explain the measures to be taken to minimize the silting of reservoir.**		
	Ans.	**Silting of reservoir:** 1) The nature of the soil of the catchment area is an important factor. If the soil is soft, there is always a possibility of sheet erosion. 2) The streams collecting water of the catchment area containing hard soil carry lesser silt. Steep slopes give rise to high velocities and erode the surface soil. 3) Similarly higher intensity of rainfall causes greater runoff and more erosion. 4) If the catchment area has sufficient vegetation cover, higher velocities are checked and erosion is reduced. 5) The rivers or streams passing through low vegetation area carry more silt load with it causing quick silting of reservoir.	**2 marks**	

<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.2</td><td></td><td>Methods for minimizing silting:
1) Proper selection of reservoir site
2) Control of sediment inflow
3) Proper designing and reservoir planning
4) Control of sediment deposit
5) Removal of sediment deposit</td><td>1 mark each (any two)</td><td>4 marks</td></tr>
<tr><td></td><td>c) Ans.</td><td>Differentiate between Earthen and Gravity dam
<table>
<tr><th>Criteria</th><th>Earthen dam</th><th>Gravity dam</th></tr>
<tr><td>Foundation</td><td>They can be founded on any soil</td><td>They cannot be founded on any soil without proper foundation</td></tr>
<tr><td>Seepage</td><td>There is more seepage through the body of the dam and it’s foundation compared to gravity dam</td><td>Comparatively there is less seepage in case of gravity dam</td></tr>
<tr><td>Construction</td><td>1.For its construction skilled labours are not required
2.Construction cost of earthen dam is less
3.For earth dams the diversion of flow during construction is costly</td><td>1.For its construction skilled labours are required
2.Construction cost of gravity dam is more
3. the diversion of flow during construction of gravity dam is costly</td></tr>
<tr><td>Maintenance</td><td>Maintenance cost of earthen dam is more</td><td>Maintenance cost of gravity dam is less</td></tr>
</table></td><td>1 mark each</td><td>4 marks</td></tr>
<tr><td></td><td>d) Ans.</td><td>Enlist the types of failure of earthen dams and explain any one with a neat sketch.
Types of failures of earthen dams:
1) Seepage Failures
a) Piping through foundations
b) Piping through the dam body
c) Sloughing of D/S Toe
2) Hydraulic Failures
a) By overtopping
b) Erosion of upstream face
c) Cracking due to frost action
d) Erosion of downstream face by gully formation
e) Erosion of D/S toe
3) Structural Failures
a) Foundation slide
b) Slide in Embankments</td><td>2 marks</td><td></td></tr>
</table>

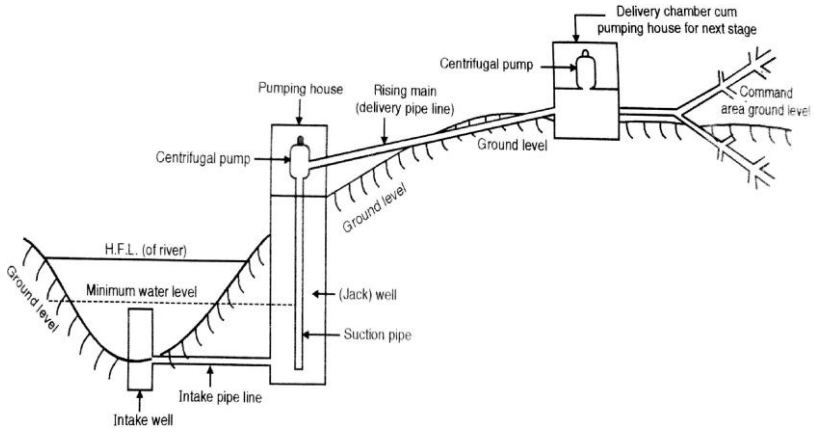
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**Piping through foundations:**  1) Sometimes, when highly permeable strata are present in foundation of the dam, water may start seeping at a huge rate through them. 2) This concentrated flow at a high gradient, may erode the soil. This leads to increased flow of water and soil, ultimately resulting in rush of water and soil, thereby creating hollows below the foundation. 3) The dam may sink down into the hollow so formed, causing its failure. **(Note : Any one of above type of failure explained should be considered)**	**1 mark** **1 mark**	**4 marks**
	e) **Ans.**	**Draw a neat and labelled sketch of drainage arrangements in an earthen dam.**  	**3 marks for sketch** **1 mark for label**	**4 marks**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	**f) Ans.**	**List various types of spillways and explain anyone with a sketch.** **Types of Spillway:** 1) Ogee spillway 2) Service spillway 3) Emergency spillway 4) Bar spillway **OGEE spillway** 1) The shape of spillway is ogee or S shaped. The main difference between free over fall spillway and ogee spillway is that in case of free over fall spillway water flowing over the crest of spillway drops vertically as free set where in ogee shaped spillway water is guided smoothly over the crest and is made to guide over the downstream face of the spillway.  Fig. Ogee-spillway 2) It is ideal spillway as water flowing over the crest of spillway always remains in contact with the surface spillway. **(Note: Explanation for any one of above mentioned should be considered)**	**2 marks** **1 mark** **1 mark**	**4 marks**

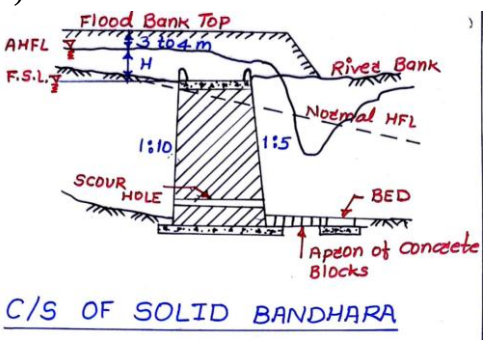
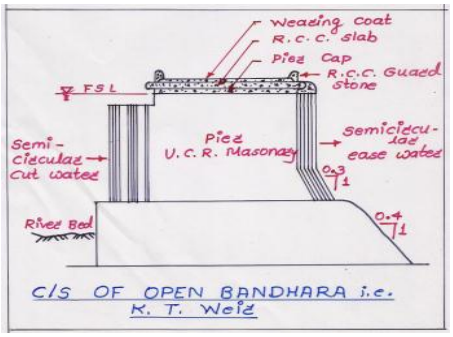
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3		**Attempt any FOUR.**		**(16)**
	a)	**Differentiate high dam with a low dam? Explain with a neat sketch.**		
	Ans.	See table below	**1 mark each (any four)**	**4 marks**

High Dam	**Low Dam**
1) A gravity dam is said to be high when it's height in meters is more than the expression – $H = \frac{\lambda}{w(1+s)}$ Where, H = Height of dam in meters λ = Safe allowable compressive stress for dam masonry in tonnes /m^2 w = Specific weight of water in tonnes/m^3 s = Specific Gravity of dam material	1) A gravity dam is said to be low when it's height in meters is less than the expression – $H = \frac{\lambda}{w(1+s)}$ Where, H = Height of dam in meters λ = Safe allowable compressive stress for dam masonry in tonnes /m^2 w = Specific weight of water in tonnes/m^3 s = Specific Gravity of dam material
2) In general, if λ = 300 tonnes /m^2, w = 1 tonnes/m^3, s = 2.4 H = 88 m. If eight of dam is more than 88 m, it is called hig dam.	2) If height of dam is less than 88 m, it is called low dam.
3) The resultant may go outside the middle third point.	3) The resultant passes through the lower middle third point.
4) Maximum compressive stresses may exceed the permissible limit.	4) Maximum compressive stresses does not exceed the permissible limit.
5) Upstream face of dam given a slope for lower portion of dam height to maintain resultant in middle third portion.	5) Upstream face of dam is vertical.
	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3	**b)**	**What are the salient features of radial gate? State where it is suitable?**		
	Ans.	**Salient features of radial gate :** 1) The gate in cross – section is seen as a sector of a circle. 2) A radial gate has a curved water supporting face made of steel. 3) It is properly braced by a steel framework which is pivoted on horizontal shafts. 4) The gate can rotate about fixed horizontal axis. 5) Hoisting cables are attached to the gate and lead to winches on hoisting platform. 6) The gate is pulled up by using cables and water is released through the gate.	**3 marks (any three)**	
		Suitability of radial gate : It is used for big spans varying from 4 m to 15 m height 3 m to 10 m	**1mark**	**4 marks**
	c)	**State the function of an energy dissipater? Where it is located? What will happen if it is omitted?**		
	Ans.	**Function of an energy dissipater:** When water flows from crest and if the difference in upstream and downstream water level is more. This causes very high velocity. This high velocity has a very high kinetic energy which can scour the bed. Hence, energy dissipaters help in reducing this kinetic energy of flow.	**2 marks**	
		Location of an energy dissipater: It is located near toe of spillway.	**1 mark**	**4 marks**
		If energy dissipater will not be provided, it can cause dangerous scour of the channel bed causing failure of spillway.	**1 mark**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3	**d)** **Ans.**	**Draw a layout of lift irrigation scheme and enlist the various valves provided in lift irrigation scheme.** **Layout of lift irrigation scheme :**  **Valves provided in lift irrigation scheme :** 1) Sluice Valve 2) Foot Valve 3) Air Valve 4) Non-return valve	**2 marks for sketch and 1 mark for label** **1 mark**	**4 marks**
	e) **Ans.**	**What are the advantages and disadvantages of Bandhara Irrigation?** **Advantages of Bandhara Irrigation :** 1) The system of irrigation is economical 2) The irrigated area is compact and hence irrigation is intensive, length of canal is less, transit losses are also less, all these factors lead to high duty of water. 3) The water of small catchments which would otherwise have gone waste is fully utilized **Disadvantages of Bandhara Irrigation :** 1) As irrigable area is fixed if more water is available for irrigation it cannot be used. 2) There might be uncertainty of supply of water in case of non-Perennial River. 3) If number of bandhara are constructed on a stream downstream people may be adversely affected.	**1 mark each (any two)** **1 mark each (any two)**	**4 marks**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**A)**	**Attempt any THREE.**		**(12)**
	a) Ans.	**Compare solid and open Bandhara.**	**1 mark each**	**4 marks**

Solid Bandhara	Open Bandhara
1) It is solid weir.	1) It is fully open weir.
2) It's height varies from 2.5 to 3 m without shutters and 1.5 to 2.5 m with shutters.	2) The height of weir can be changed by removing or putting additional needles.
3) There is no control on flood water during floods.	3) There is control on flood water during floods.
4)  C/S OF SOLID BANDHARA	4)  C/S OF OPEN BANDHARA i.e. R. T. Weir

(Note - Simple line sketch should be considered)

	b) Ans.	**What is need of drip irrigation? What are the components of drip irrigation?** **Need of drip irrigation :** 1) It saves the water and fertilizer by allowing water to drip slowly to the root of the plants. 2) In water scarcity zones, this system is much useful. 3) There is no wastage of water in this system. 4) It is most suitable for row crops.	**1 mark each (any two)**	**4 marks**
		Components of drip irrigation: 1) Pump unit 2) Control head 3) Main, sub main lines and laterals 4) Drippers or emitters	**1 mark each (any two)**	

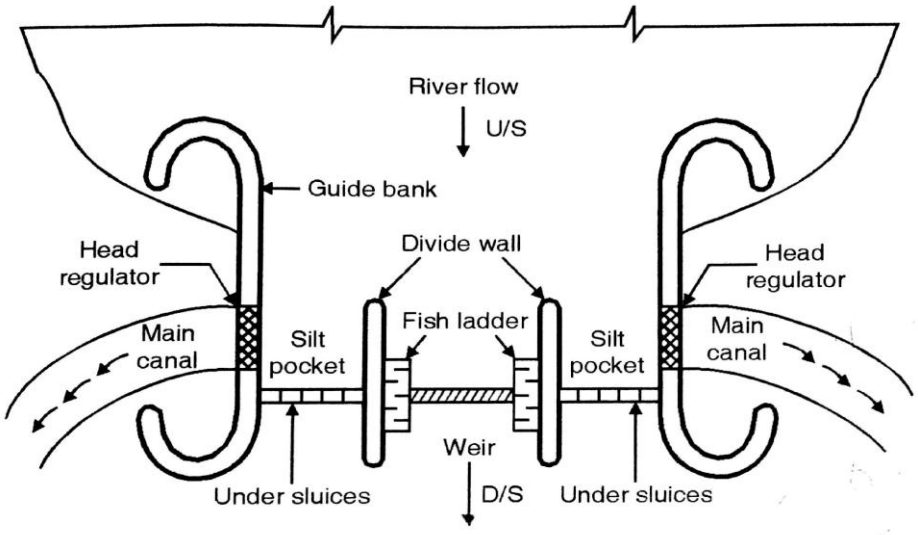
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**c) Ans.**	**Differentiate between weir and barrage.**	**1 mark each (any four)**	**4 marks**

Sr. No.	Weir	Barrage
01	Initial cost is low	Initial cost of barrage is high.
02	Area of submergence is more	Area of submergence is less
03	The raising and lowering of shutter is not convenient	The raising and lowering of shutter is convenient
04	The control over flood is not possible	There is good control over flood
05	It is difficult to inspect and repair	These provides better facilities for inspection and repair
06	Roadway is not possible across river	Roadway can be provided across the river
07	Storage of water is done by crest and very little by gate	In barrage most of water storage is done by shutter and very less by crest

d) Ans.

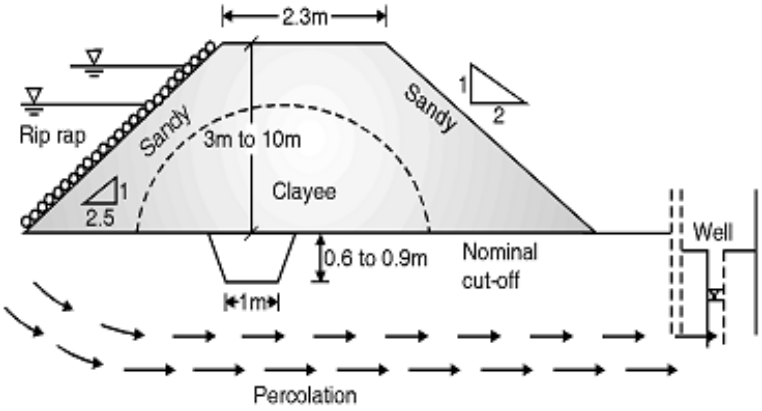
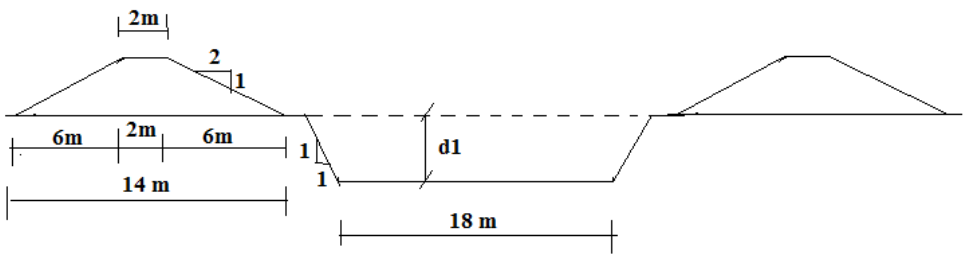
Draw the layout of diversion head work and give function of each component.

Layout of diversion head work :



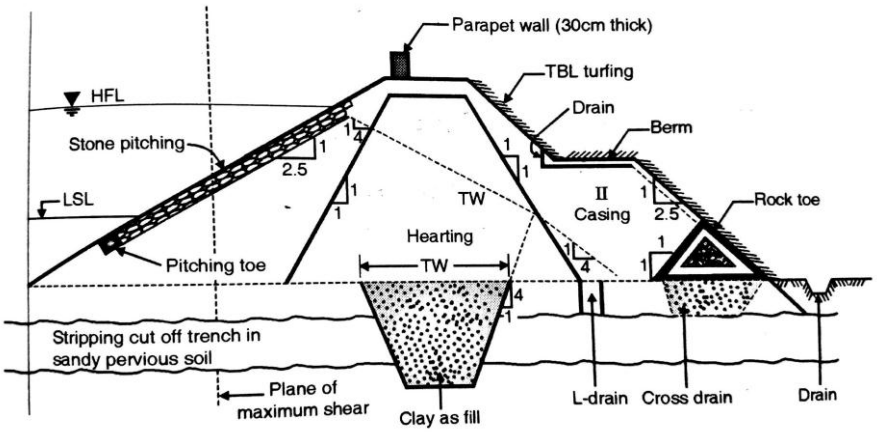
2 marks for sketch and labelling

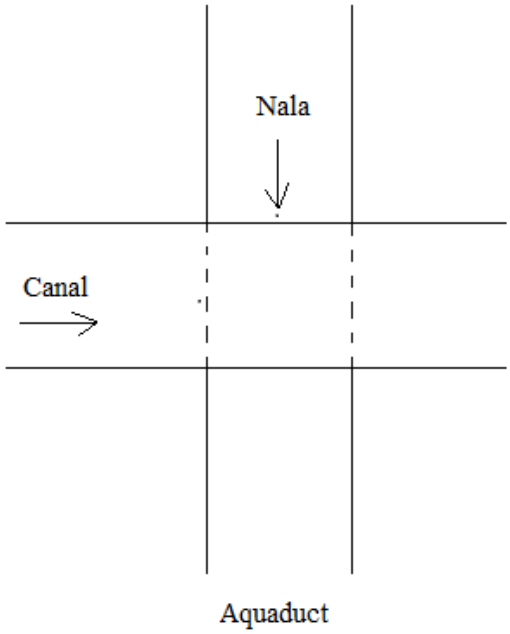
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		**Function of component of diversion head work:** **i) <u>Head regulator:</u>** 1) It regulate the supply of water entering in canal. 2) It controls the entry of silt into canal 3) It prevents the river flood entering the canal **ii)<u>Divide wall:</u>** 1) To separate flow from the scouring weir which is at lower leve than proper weir 2) To separate the silting packet from scouring sluices 3) To prevent formation of cross currents to avoid domain effects 4) To cut off the main portion of the river and provide a comparatively quite packet in front of the canal head regulator resulting in deposition of silt in the pocket and enter clear water in canal **iii) <u>Fish ladder:</u>** 1) To help the survival of the fishes 2) To provide free movement of fishes **iv) <u>Scouring Sluice:</u>** Deposited silt and soil are scoured through the scouring sluice **v) Stilling Pond:** 1) To reduce velocity of water. 2) To settle down the silt & allow clear water to the canal.	**1 mark each (any two)**	**4 marks**
	B)	**Attempt any ONE.**		**(6)**
	a)	**Explain percolation tank with a neat and labeled sketch and state the criteria's considered for the selection of site for the construction of percolation tank?**		
	Ans.	**Percolation Tanks :-** For percolation tank, the bed should be pervious. They are constructed at suitable site by providing earthen bunds. The water from it percolates through the tank bed & joins the ground water table. It raises the water level of the following existing wells. The water is then pumped for irrigation. Thus it is an indirect system of irrigation.	**2 marks**	

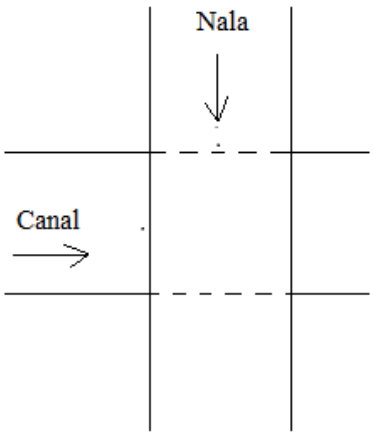
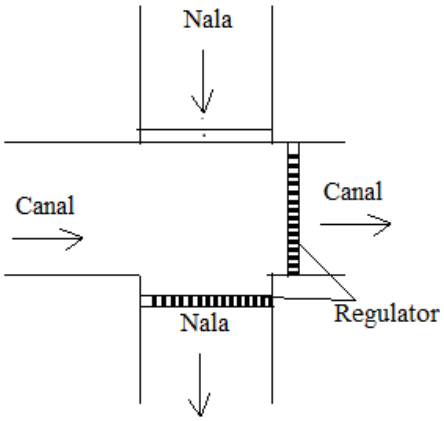
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		 **Percolation Tank**	**2 marks for sketch and labell-ing**	
		Criteria's to be considered for the selection of site for the construction of percolation tank : 1) The percolation tanks are constructed where soil is porous and it is not possible to construct the big retaining structures. 2) In percolation tank water percolate through soil pores and joins the ground water which increases water level in wells on downstream side. 3) Thus percolation tanks are suitable where there are more number of wells and bore wells. 4) Useful in areas where other water retaining structures cannot be constructed. 5) The bed of tank should be pervious so that water will percolate and join ground water. 6) The site at which bunds are constructed should have sufficient discharge. 7) The side of stream should be steep	**1 mark each (any two)**	**6 marks**
	b) **Ans.**	**Calculate the balancing depth for a channel section having a bed width equal to 18 m and side slopes of 1:1 in cutting and 2:1 in filling. The bank embankments are kept 3.0 m higher than the ground level and crest width of banks is kept as 2.0 m.** 	**1 mark**	

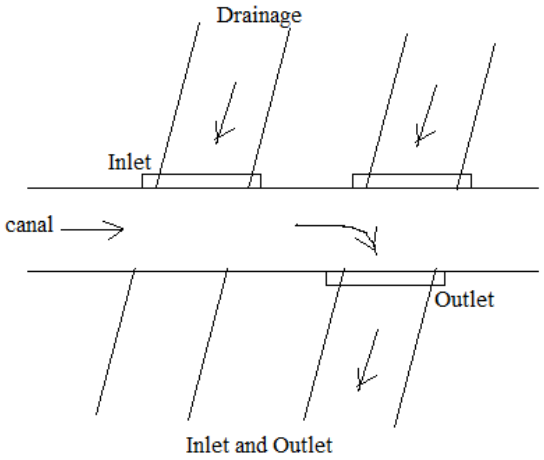
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		Area of cutting = $(18 + d_1)\, d_1$	**1 mark**	**6 marks**
		Area of filling = $2\left[\frac{(2+14)}{2} X 3\right] = 48$	**1 mark**	
		Equating cutting and filling $(18 + d_1)d_1 = 48$ $18d_1 + d_1^{\,2} = 48$ $d_1^{\,2} + 18d_1 - 48 = 0$	**1 mark**	
		$d_1 = \frac{-18 \pm \sqrt{324 + 192}}{2} = \frac{-18 \pm 22.7}{2}$	**1 mark**	
		$d_1 = \frac{-18 + 22.7}{2} = \frac{4.7}{2} = 2.35m$ Hence, balancing depth = 2.35 m	**1 mark**	
Q.5		**Attempt any TWO.**		**(16)**
	a)	**The gross command area of the distributary is 3000 hectares of which 1800 hectares is covered by forests & 400 hectares by pasture land. Intensities of sugarcane and wheat crops are 20% and 40% respectively. The duties of the crops at the head of the distributary are 730 ha/cumec and 1800 ha/cumec respectively, find:** **i) The discharge required at the head of the distributary.** **ii) The design discharge at the head of water course assuming time factor equal to 0.8 and 15% transmission losses.**		
	Ans.	**Given:** Gross command area = 3000 hectares Area covered by forest = 1800 hectares Area covered by pasture land = 400 hectares Intensities of sugarcane = 20% Intensities of wheat crops = 40% Duty of sugarcane = 730 ha/cumec Duty of wheat crops = 1800 ha/cumec		
		Solution: Available land for irrigation= = GCA - Area covered by forest - Area covered by pasture land = 3000 -1800- 400 **= 800 hectare**	**1 mark**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		Area under sugarcane = $\frac{20}{100} \times 800 = 160$ hectares	**1 mark**	
		Area under wheat crop = $\frac{40}{100} \times 800 = 320$ hectares	**1 mark**	
		Discharge = $\frac{\text{Area}}{\text{Duty}}$		
		Discharge required for sugarcane = $\frac{160}{730} = 0.21917$ cumec	**1 mark**	
		Discharge required for wheat crop = $\frac{320}{1800} = 0.1778$ cumec	**1 mark**	
		Since the seasons are overlap, the discharge required at the head of canal = discharge required for sugarcane + discharge required for wheat		
		= 0.21917 + 0.1778 = 0.39697 cumec	**1 mark**	
		Considering 15% transmission losses and 0.8 time factor,		
		Design discharge = $\frac{0.39697}{0.85 \times 0.8}$	**2 marks**	**8 marks**
		= **0.58377 cumec**		
	b)	**Draw a neat and labeled diagram of cross-section of an earthen dam. Describe the methods of construction of earthen dam.**		
	Ans.	**<u>Methods Of construction of earthen Dam</u>:**		
		There are two methods of constructing earthen dams:		
		1) Hydraulic fill method:		
		a) In this method, the dam body is constructed by excavating and transporting soils by using water pipes called flumes, which are laid along the outer edge of the embankment. The soil materials are mixed with the water and pumped into these flumes. The slush is discharged through the outlets in the flumes at suitable intervals along their length.	**2 mark**	

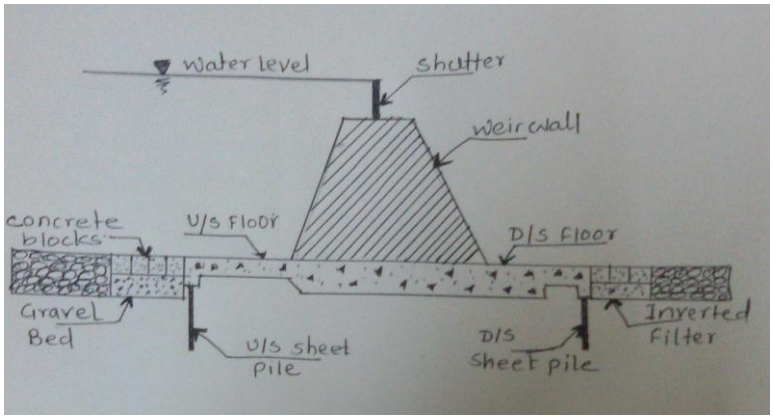
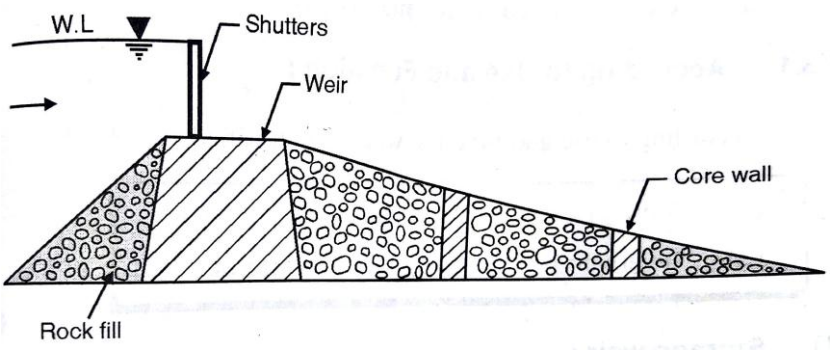
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		b) The slush flowing towards the center of the bank, tens to settle down. The coarse particle gets deposited soon after discharge near the outer edge. While the fines gets carried and settle at the center, forming a zoned embankment having impervious central core. Because of slow drainage from core this method is susceptible to settlement over long period. Therefore this method is seldom adopted these days. **2) Rolled fill method**: a) The embankment is constructed by placing suitable soil materials in thin layer and compacting them with rollers. The soil is brought to the site from burrow pits and spread by bulldozers in layers. b) These rollers are compacted by rollers of designed weights. Ordinary road rollers can be used for low embankments. The moisture content of the soil fill must be properly controlled. Compaction of gravel can be done by vibrating equipment. This method is used for construction of dam. **<u>Diagram of cross section of earthen dam:</u>**  	**2 marks** **4 marks for sketch and labell-ing**	**8 marks**

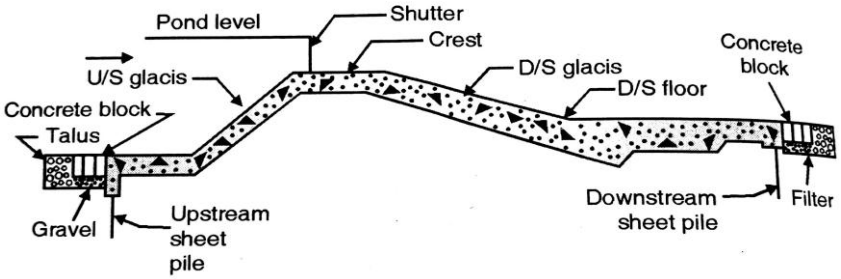
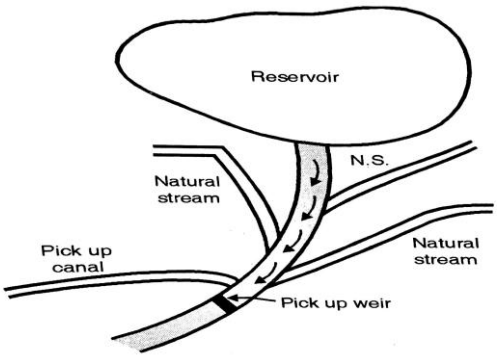
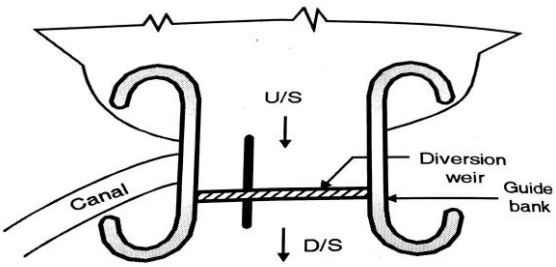
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**c)** **Ans.**	**What is necessity of C.D. works? What are the different types of C.D. works? Explain one with neat sketch.** **Necessity of C. D. work:** i. Irrigation structures constructed for carrying the canal water safely over or under the drainage water are called cross drainage work. ii. When a canal is taken off from the reservoir, it meets various natural drainages before reaching the watershed line. In this range cross drainage works are required to be constructed. **Different types of C.D. works:** i. Aqueduct ii. Super passage iii. Level crossing iv. Inlet and outlet **i) Aqueduct:** a) The irrigation structure constructed for passing the canal water safely over the drainage water is called an aqueduct. b) Aqueducts are constructed where the discharge of drain is more in comparison to canal discharge and when canal bed level is sufficiently above HFL in the drain.  Aquaduct	**2 marks** **2 marks**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		**ii) Super passage:** a) When the drainage water at a point of crossing is taken over the canal, the structure is called super passage. b) Super passages are constructed when the discharge is small in comparison with the canal discharge and when sufficient clearance is available between the FSL of canal and drain bed  Super passage **iii) Level crossing:** a) When the canal bed level and drain bed level practically the same, drain water is taken into the canal and it is allowed to intermingle with the canal water. Such type of cross-drainage work is known as level crossing. b) It is constructed where RL of canal bed and RL of natural drain are practically the same. Also when the discharge of drain and that of the canal is approximately of the same magnitude, duration of the flood in drain is short and no other structure is economically feasible.  Level Crossing	**2 marks for explan-ation and 2 marks for sketch (any one)**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		**iv) Inlet and outlet:** a) Inlet admits water of stream into the canal and it flows mixed with canal water and then excess discharge is allow to pass through outlet. b) The capacity of inlet and outlet must be same and sides and beds of canal must be protected by stone pitching.  		**8 marks**
Q.6		**Attempt any FOUR.**		**(16)**
	a)	**Enlist the components parts of the barrage and state their functions.**		
	Ans.	**Following are the components parts of barrage:** **i.** Body of barrage **ii.** Upstream apron **iii.** Upstream curtain wall **iv.** Downstream apron **v.** Downstream curtain wall **vi.** Crest **vii.** Gate / Shutter **i. Body of barrage :** ➢ To raise the water level on upstream side. **ii. Upstream Apron :** ➢ To protect main body of barrage during floods. **iii. Upstream curtain wall :** ➢ To reduce uplift pressure. **iv. Downstream Apron :** ➢ To protect downstream bed of river.	**2 marks (any four)**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**v. Downstream curtain wall :** ➢ To protect downstream and floor from uplift pressure. **vi. Crest wall:** ➢ To raise water level and divert the water into the canal. **vii. Gate / Shutter :** ➢ During the floods, the gates are raised to clear off the high flood level, enabling the high flood to pass downstream with maximum afflux. ➢ When the flood reduces, the gates are lowered and the flow is obstructed, thus raising the water level to the upstream of the barrage.	**1 mark each (any two)**	**4 marks**
	b) **Ans.**	**List the various types of weirs and explain anyone with a neat sketch.** **Weirs are mainly classified as follows** 1) Gravity weir. Depending on material and design features, gravity weirs are subdivided into following types- (i) Vertical drop weir. (ii) Sloping weir a. Rock fill weirs. b. Concrete weirs. (2) Non gravity weir. **OR** **Weirs are also classified as follows :** (1) According to use and function. (1) Storage weir. (2) Pick up weir. (3) Diversion weir. (4) Waste weir. (2) According to control of surface flow. (3) According to the design of floors. (4) According to constructional material.	**2 marks**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6		**i) Vertical Drop weir:**  ➢ This type of weir consists of horizontal floor and masonry crest with vertical or nearby vertical downstream face and the shutters are provided at the crest. ➢ Most of the storage is done by raised crest and some storages by shutters provided over the crest. **ii) Rock fill weir** ➢ It is also called as dry stone slope weir. It is suitable for fine sandy foundation stone are mainly used for construction of such type of weir and hence requires large quantities of stone  **Rock fill weir** **iii) concrete weir:** ➢ These are suitable for permeable foundations. In such weirs sheet piles are provided on both upstream and downstream floors in order to destroy the energy of water.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6				
		iv) storage weir : ➢ It is high weir constructed for storing water. It is also called as diversion weir. In such weirs shutters may or may not be provided. **v) pick up weir;** ➢ These are constructed when command area is far away from reservoir either due to rolling topography or because the land is not cultivable and if there is broken or rolling topography on one or both banks of parent river in which construction of canal may be costly. 	**2 marks for explanation and sketch (any one)**	
		vi) diversion weir: ➢ A weir which is constructed for diverting the river water into the canal is called as diversion weir. Generally it is constructed at 90^0 to the flow of river.  **Diversion weir**		**4 marks**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**c)** **Ans:**	**Classify canals according to alignment and its position in the canal network.** **A) Classification based on alignment:** 1) Contour Canal 2) Ridge Canal 3) Side Slope Canal **B) Classification based on position:** 1) Main Canal 2) Branch Canal 3) Major Distributary 4) Minor distributary 5) Water Course 6) Head Work	**2 Marks (any two)** **2 Marks (any two)**	**4 Marks**
	d) **Ans:**	**State the objectives of canal lining.** **Purposes of lining :** 1. To reduce the seepage losses in canal. 2. To prevent scouring of bed sides. 3. To improve the discharge of canal by increasing the velocity of flowing water. 4. To prevent water logging. 5. To increase the capacity of canal. 6. To increase the command area. 7. To control the growth of weeds. 8. To protect the canal from the damage by flood.	**4 Marks (any four)**	**4 Marks**
	e) **Ans:**	**State the precautions to prevent a land from getting waterlogged.** **Following are the precautions to prevent a land from getting waterlogged:** i) Reducing the intensity of irrigation ii) Providing intercepting drains iii) Lining of canals iv) Providing intercepting drains v) Improving natural drainage of the area vi) Providing intercepting drains vii) Provision of an efficient drainage system viii) Improving natural drainage of the area	**1 mark each (any four)**	**4 Marks**