_____

WINTER–19 EXAMINATION
MODEL ANSWER

22501

Subject Name: WATER RESOURCES ENGINEERING   **Subject Code**:

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 etc 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 candidate and 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 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.

| Q. No.	Sub Q. N.	Answers	Marking Scheme	Total Marks
Q.1	a)	**Attempt any Five of the following:** **Define** i) **Irrigation** ii) **Runoff**		10
	Ans	i) **Irrigation:** Irrigation may be defined as the process of artificially supplying water to soil for full-fledged nourishment of the crops. OR It is the science of artificial application of water to the land in accordance with crop requirements throughout the crop period. ii) **Runoff:** The amount of water which flows over the surface of the earth after considering all losses is called as runoff. Runoff is expressed as in 'm' OR 'cm' or mm.	1 M for each definition	

Q.1	b)	**Enlist the Classification of Irrigation on the basis of purposes.**		

	Ans	A. **Single Purpose Irrigation Project:** A project planned for one or single purpose is called as single purpose project e.g. Koyana project for hydropower, Gangapur project for irrigation etc.
		
		B. **Multipurpose Irrigation Project:** A project planned for more than one purpose is called as multipurpose project. e.g. Bhakra Nangal project for irrigation & hydropower generation, Jayakwadi project for irrigation & hydropower generation etc.
		
		OR
		
		A. **Surface Irrigation:** a) **Flow Irrigation** : i) Perennial Irrigation ii) Flood irrigation
		                               b) **Lift irrigation**:
		B. **Sub-surface Irrigation: a) Natural Irrigation**
		                                b) Artificial Irrigation
		
		(Note: Marks should be given to any type of classification)
			2M for any classification	

Q.1	c)	**Define:** i) **C.C.A** ii) **G.C.A** i) **Culturable Command Area (C.C.A.):** It is the net area which can be irrigated by a canal system . It includes all land on which cultivation is possible , though all area may not be under cultivation. ii) **Gross command area (G.C.A.):** It is the total area lying between drainage boundaries which can be irrigated by a canal system. It includes barren land, village , roads and area of habitation. **G.C.A = C.C.A + Unculturable area**	**1 M for each definition**	
	Ans			
Q.1	d)	**Define Spillway and Enlist types of spillway**	**1 M for definition** **&** **1 Marks for types**	

	Ans	**Spillway:** It is the overflow portion of every dam , over which the surplus water flows from the upstream side of reservoir to the downstream side of reservoir. It is the safety valve of a dam. OR
		It is an arrangement provided at the crest of dam to expel the excess water rises above the full reservoir level.
		Types of spillway :
		 1. Main / Service spillway
		   i) Free fall or straight drop spillway.
		   ii) Ogee or overflow spillway
		   iii) Siphon spillway
		   iv) Side channel spillway
		   v) Trough / Chute spillway
		   vi) Shaft spillway
		   vii) Conduit or Tunnel spillway
		 2. Subsidiary or Emergency Spillway		

Q.1	e)	**Enlist the types of gates provided to reservoir.**		
	Ans	A. Non-automatic Gates: i) Radial ot Taintor gate ii) Vertical gate: 1) Sliding gate 2) Fixed gate 3) Stony gate iii) Rolling gate B. Automatic Gate: i) Reynolds Gate ii) Vishveshrayya gate	**1 M each for any 4 types**	
Q.1	f)	**Enlist the factors affecting on silting of reservoir.**		
	Ans	a) Catchment area b) Shape of catchment c) Slope of country d) Nature of surface soil e) Climatic conditions f) Rainfall characteristics g) Vegetation cover h) Construction of check dam	$\frac{1}{2}$ **M each for any 4 factors**	
Q. 1	g)	**State ill effects of excess Irrigation**		
	Ans	a) **Water logging:** Water logging renders the soil infertile and useless for cultivation. b) **Salt efflorescence due to water logging** Salt efflorescence due to water logging damages the soil. c) **Breeding of mosquitoes** Breeding of mosquitoes takes place due to over irrigation. d) **Damp climate** The climate becomes cold and damp due to over irrigation of an area. This dampness in climate causes diseases such as malaria , dengue etc e) **Excessive humidity** Excess and intense irrigation may result in increasing the humidity of the area. f) **Ecological imbalance:** g) **Water flooding in the crop root zone:** Water flooding in the crop root zone causes wilting of plants.	$\frac{1}{2}$ **M each For any 4 effects**	
Q.2		**Attempt any THREE of the following**		12
	a) Ans	**Describe in brief working of Symons rain gauge with neat labelled sketch.** The most common type of non- recording rain gauges used in our country is the 'Symon's raingauge'. **Working**: A Symons Rain gauge consists of a cylindrical vessel of 127 mm internal diameter with an enlarged base of 210 mm diameter. Inside the cylinder, a rain collecting bottle, made up of glass is placed. Over the top of this bottle, a glass funnel is inserted. The top section of the funnel is provided with a circular brass ring of exactly 127 mm diameter. With each raingauge, a cylindrical graduated measuring glass is also provided. Each graduation of this glass reads 0.2 mm. The reading should be read correctly upto 0.1 mm. The raingauge is set upon a concrete block. The rim of the funnel should remain at least 305 mm above the	**2 M for working** **And**	

ground. The bottle collects the rain falling over the rim which is then measured by the measuring glass in 'mm' and 'tenth of mm'

Concrete block 600 × 600 × 600
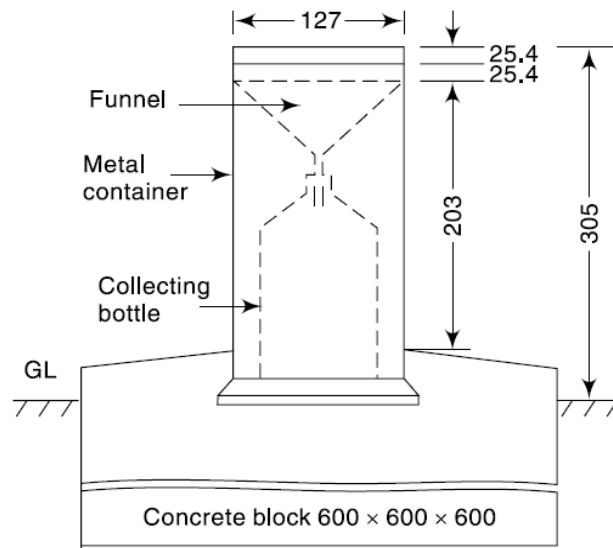
			2 M for sketch with labelling

| **b)** | **Compute the average rainfall over the catchment by Thiessen's polygon method and arithmetic mean method** | | | | |

Raingauge station	A	B	C	D
Area of thiessens polygon (sq.km)	45	38	30	40
Precipitation in mm	30.8	34.6	32.6	24.6

Ans

A) Calculate Average annual rainfall

Rain gauge Station	Area of Thiessen's polygon (A)	Precipitation in mm (P)	A× P
A	45	30.8	1386
B	38	34.6	1314.8
C	30	32.6	978
D	40	24.6	984
No of Stations (N) = 4	∑A = 153	∑ P = 122.6	∑AP = 4662.8

i) Theissons polygon method-

$$P_{avg} = \frac{\Sigma A.P}{\Sigma A} = \frac{4662.8}{153} = \textbf{30.476 mm}$$

ii) Arithmetic mean method-

$$P_{avg} = \frac{\Sigma P}{N} = \frac{122.6}{4} = \textbf{30.65 mm}$$

			2 M each for both methods

c)	**Explain the factors affecting Duty**		
Ans	1) **Type of Crop:** Different crops require different amount of water, and hence the duties for them are different. **Duty will be less for a crop requiring more water and vice-versa** 2) **Climate and Season:** In hot season, the atmospheric temperature of the area becomes high, the evaporation loss is more hence duty gets reduced as crop requires more water. 3) **Rainfall:** More the rainfall less will be the requirement of irrigation water, and hence more will be the duty. 4) **Type of Soil:** If soil is permeable, water lost due to percolation will be more, hence duty will be less and vice-versa. 5) **Method of Irrigation:** If method of irrigation is not proper i.e. in case of free flooding, wastage of water will be more and hence less duty. 6) **Canal condition:** Canal should be kept in proper condition by proper maintenance and lining, which will reduce the seepage, leakage and thus increase the duty. 7) **Mode of Assessment:** The tendency of using more water can be checked by adopting volumetric assessment which gives more duty than area wise assessment. 8) **Method of tilling (cultivation):** If proper method of tilling is adopted there will be less wastage of water, thus duty is more.	**1 M each for Any 4 factors**	
d)	**Explain in brief Engineering surveys carried out for reservoir planning.**		
Ans	In Engineering survey, various type of surveys such as plane table survey, traverse survey, aerial and photographic surveys etc. are carried out . **Purpose or Aim of engineering survey**: To prepare Contour map and Topographical map of the site. The contour interval may be taken as 1 to 3 m for fairly plain area, and 5 to 10 m for hilly area. For Dam site careful triangulation survey is required where contour interval is less than 1 m. Horizontal scale may be 1 in 500 to 1 in 1000. **Necessary information from contour plan:** From the contour map of reservoir area, the water spread of the reservoir at any	**2 M for purpose or aim**	

		elevation may be directly determined by measuring the area with help of planimeter. Following information can be obtained from contour map. 　1. Water spread area from Area-elevation curve 　2. Arrangement of lines of communication. 　3. Capacity of reservoir from storage elevation curve. 　4. Site for waste weir and outlets. 　5. Suitable dam site. From the contour map, the storage capacity of the reservoir should be fixed by assuming the height of the dam. Then the valuable land and properties which may get submerged in the reservoir can be found out.	2 M for informatio n (Any 2 points)	
Q. 3		**Attempt any THREE of the following**		12
	a) **Ans**	**State the reasons for which elementary profile of dam is not possible to construct in practice.** **Reasons:** 　a) For constructing a road at the top of dam, provision of top width is must but the shape of elementary profile is right angle triangle. 　b) Free board is essential to be kept to avoid spillage of water over the body of dam but in elementary profile, there is no provision for free board. 　c) In elementary profile, only pressure due to water and self-weight is considered but the other forces such as seismic pressure , silt pressure ice pressure , uplift pressure wind pressure , tail water pressure are neglected. 　d) In elementary profile, the provision of drainage galleries is not considered.	1 M each for 4 reasons	
	b)	**Draw a labelled sketch of Earthen dam** 	2 M for sketch & 2M for labelling	
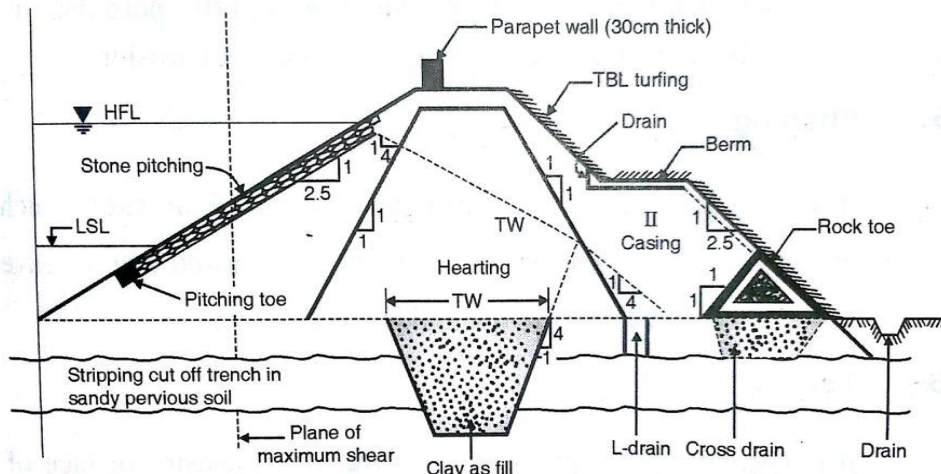
c)	**Differentiate between earthen dam and gravity dam with respect to seepage , foundation , construction and maintenance**	
Ans		**1 M for each parameter**

Parameters	Earthen dam	Gravity dam
Seepage	More seepage	Less seepage
Foundation	Suitable almost on any foundation	Suitable only when foundation is of solid rock having no fissures , cracks , cavities etc.
Construction	Construction materials are stone, earth containing silt, clay and sand.	Construction materials are stone , brick .Concrete etc
Maintenance	More costly	Less costly

d)	**Explain the requirement of site for percolation tank**		
Ans	1) The bed of tank should be pervious so that the water will percolate and then join the ground water table. 2) There should be sufficient number of wells and bore wells existing in the command area. 3) The nalla or stream should have sufficient discharge in monsoon. 4) The flanks on the both sides of the nalla should rise with steep slope. 5) Construction material , labour, machinery should be available near the site. 6) A good agricultural land should be available near each well for irrigating the crops.	**1 M each for any 4 points**	
Q. 4	**Attempt any THREE of the following**		**12**
a) **Ans**	**State the necessity and advantages of Drip irrigation scheme.** **Necessity**: 1) Drip irrigation is application of water, at a very slow rate, to the root zone of a plant. 2) This method is very useful in arid regions where water is scarce. 3) It enables application of fertilizers along with irrigation water. 4) It ensures optimal growth, better fruiting and growth of crops with optimum quantity of water 5) It is applicable to a variety of row crops – from widely spaced fruit crops to closely spaced vegetable crops **Advantages:** (i) It eliminates evaporation losses. (ii) It requires less water to mature a crop. (iii) Frequent ploughing is not required. (iv) It is best method of irrigation with ground water in arid zones. (v) It is very useful in reclaiming and developing desert area.	**1 M each for any 2 necessities** **½ M each for any 4 advantages**	

b)	**Discuss the different activities undertaken under Jalyukt Shivar Abhiyan**			
Ans	Jalyukt Shivar Abhiyan was launched by Maharashtra Government in 2015 in a bid to make Maharashtra draught free by 2019. The main aim of the project is to provide relief to farmers of draught affected areas of Maharashtra. It includes checking the problems and implementing new water conservation and irrigation techniques. **Activities undertaken under Jalyukt Shivar Abhiyan include:** 1. Deepening and widening of streams. 2. Construction of earthen and cement stop dams 3. Work on nullahs 4. Digging of Farm Ponds	**2 M for descriptions** **1 M each for any 2 activities**	
c)	**Enlist types of weir and explain any one in detail.**			

Ans	**Types of weirs are**
	    a) **Based on materials of construction**
	      1) Masonry weir
	      2) Rock-fill weir
	      3) Concrete weir
	    b) **Based on use and function**
	      1) Storage weir
	      2) Pick-up weir
	      3) Diversion weir
	      4) Waste weir
	    c) **Based on design**
	      1) Gravity weir
	      2) Non gravity weir
	
	1. **Masonry Weir**
	    i. It consists of a vertical drop wall or crest wall with or without crest gates and an impervious floor
	    ii. Cut off piles are provided at the upstream and downstream ends of the impervious floor
	    iii. Aprons are also provided at both upstream and downstream side to prevent scouring
	    iv. The raised masonry crest does the most ponding and a small part is done by the crest shutter
	    v. These weirs are suitable on any foundation
	2. **Rock fill weir**
	    i. This weir consists of a body wall and dry stones are laid on the upstream and downstream side
	    ii. It requires large quantity of stones
	    iii. These weirs are unsuitable for soft foundation where difference between weir crest and downstream river bed does not exceed 3m
	    iv. An example of this type of weir is Okhala weir on Yamuna river near Delhi
		2 M each for any 2 types of weirs
		
		2 M for explanation	

3. **Concrete Weir**
   i. This is comparatively new type of weir
   ii. When water passes over it, hydraulic jump is formed on the downstream glacis to dissipate energy of flowing water
   iii. They are exclusively used nowadays, especially on permeable foundations

4. **Pick-up Weir**
   i. It is a solid weir with crest gates constructed in concrete or stone masonry
   ii. It is constructed some distance downstream of dam to form a large reservoir to raise the water level upto FSL of canal
   iii. Pick-up weirs are constructed under following situations:
      a) Command area is not near the reservoir
      b) Canal has to run idle
      c) The terrain is geographically difficult so that canal alignment is very costly or impossible
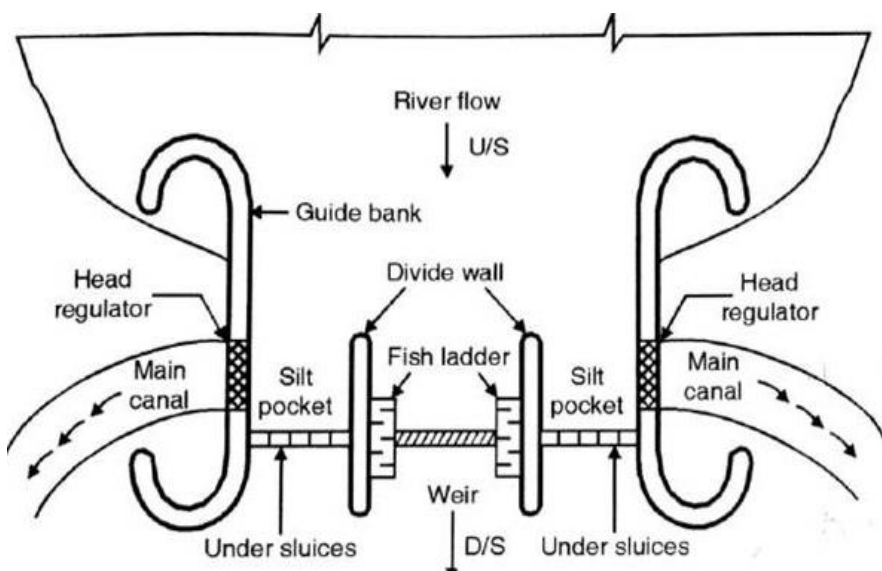
d) **Differentiate between weir and barrage**	
Ans	

S. No.	Weir	Barrage
1	Initial cost of weir is low	Initial cost of barrage is high.
2	Area of submergence is more due to large afflux.	Area of submergence less due to less afflux
3	Due to crest there is problem of silting	There is good control over silt entry into canal.
4	The raising and lowering of shutter is not convenient it requires more time and labour as it is done manually.	The raising and lowering of gate is convenient as it can be operated mechanically
5	The control over flood is not possible.	There is good control over flood situation.
6	It is difficult to inspect and repair.	These provide better facilities for inspection and repair of various structures
7	Roadway is not possible across river	Road way can be provided across the river
8	Storage of water is done by crest and very little by or nil portion of water is by gate	In barrage most of water storage is done by shutter and very less or nil portion of water is by crest

1M each for

any 4 points

	e)	**Draw a layout of diversion headwork**		
	Ans		2 M for correct sketch and 2 M for correct labelling	
Q.5		**Attempt any TWO of the following**		12
	a) (i)	**Calculate the MFD from catchment area 950 km². Use Dicken's formula (Assume C=24)**		
	Ans	**Given:** $\qquad$ A = 950 km² $\qquad$ C = 24 **Solution:** $\qquad$ Q = C x A$^{(3/4)}$ $\qquad\quad$ = 24 x 950$^{(3/4)}$ $\qquad\quad$ = 4106.80 m³/sec $\quad$ **Answer: MFD = 4106.80 m³/sec**	1M each for correct formula, substitution and answer	
	a) (ii)	**Explain any three factors affecting runoff.** $\quad$ **1. Rainfall characteristics:** $\qquad$ a. More the rainfall, runoff will be more. $\qquad$ b. More the intensity of rainfall more will be the runoff. $\quad$ **2. Topography:** $\qquad$ a. It depends upon smoothness and roughness of the surface $\qquad$ b. Steep slopes – Heavy runoff will reach the valley quickly, reducing losses giving more runoff.	1M each for any 3 factors	

		c. If catchment is mountainous, runoff will be more
		d. If catchment is in windward direction, runoff will be more
		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. Compacted strata - heavy runoff
		   c. Sandy strata – reduced runoff
		   d. Cultivated area - less runoff
		   e. Presence of vegetation covers reduces the runoff during smaller storm.
		5. Meteorological characteristics :
		   a. Low temperature – greater runoff
		   b. High temperature– less runoff
		6. Geological characteristics :
		   a. Pervious soil – less runoff
		   b. Porous and fissure rock – very low surface runoff		

b)
 	
Ans
	Derive 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,
	    Volume = 1 x (24 x 60 x 60) B m3
	          = 8.64×10^4 x B cubic m
	
	 Volume calculated from delta Δ cm of depth required in base period
	    Volume = $\Delta \times 10^4$ and for D hectares
	    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,
	      $\therefore D = \dfrac{8.64\,B}{\Delta}$
		2 M
		
		2 M
		
		2 M	

c)	**Fix the full reservoir level (FRL) and Top of Dam level (TDL) from the following data:**

i) Dead storage level = 112 m
ii) Crop water requirement = 8500 m^3
iii) Tank losses = 1500 m^3
iv) Free board = 1.5 m
v) Flood lift = 1.6 m

Control R. L. (m)	112	114	116	118	120	122
Capacity (m^3)	1000	2900	5000	6000	9000	12000

Ans

Effective live storage = 8500 m^3

Tank losses = 1500 m^3

Total live storage = Effective live storage + Tank losses
= 8500 +1500
= 10000 m^3

Dead storage = 1000 m^3 (corresponding to RL 112)   **1M**

Gross storage = 10000 m^3 + 1000 m^3

= 11000 m^3 **1M**

$$FRL = 120 + \frac{(122 - 120)\,(11000 - 9000)}{(12000 - 9000)}$$

= 120 + 1.33
FRL= 121.33 m   **1 M**

HFL = FRL + flood lift
= 121.33 + 1.6

HFL = 122.93 m   **2 M**

TDL = HFL + free board
= 122.93 + 1.5

TDL = 124.43   **1M**

Q.6		Attempt any TWO of the following		12
	a)	Draw layout of lift irrigation scheme and explain in brief component parts of the sam		
			2 M for sketch with labeling	
		Components Parts 1) **Intake well** - A channel is constructed to divert the flow of water into inlet chamber 2) **Inlet chamber** - It avoids the entry of silt and debris into Jack well 3) **Jack well** - It is provided to facilitate the location of an engine house above high flood level and allows pumping during floods 4) **Inlet pipe** - It is used to convey water from inlet chamber to Jack well. It is provided with a proper gradient 5) **Engine house** - It is a small storage room to accommodate the engines and the pumps to be installed 6) **Rising main** - It is a pipe used for carrying water from well to delivery chamber 7) **Delivery chamber** - The water from rising main is collected here and then it is allowed to flow in field ditches 8) **Water distribution system** - A system which distributes water from delivery chamber to field channels	**4 M for any 4 components**	
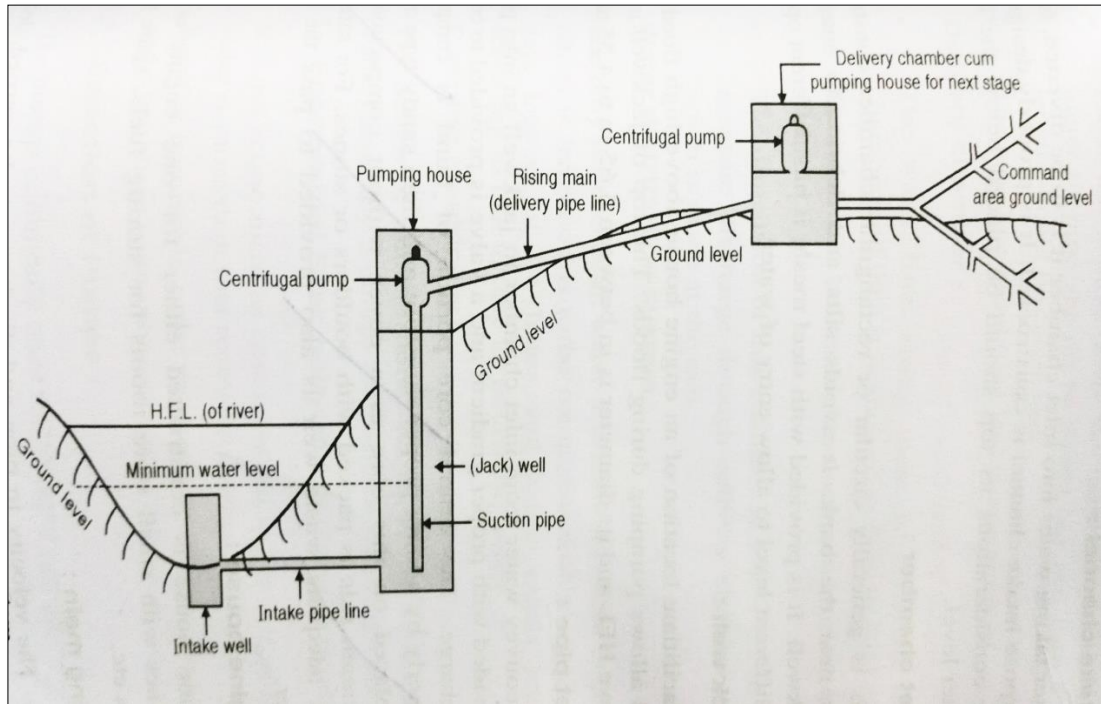
|			
b)	**Design economical trapezoidal section of canal to carry 30m³/sec of water with bed slope 1 m. per km and side slope 3H:2V. Take N=0.012.**		

Ans	**Given:**
	Q = 30 m³/sec S = 1/1000 n = H/V = 3/2 = 1.5 N = 0.012
	
	    For most economical channel,
	        1. R = d/2
	        2. $b + 2nd = 2d\sqrt{(1 + n^2)}$
	    Substituting the value of n in the second condition
	        $b + 2 \times 1.5\ d = 2d\sqrt{(1 + 1.5^2)}$
	          b + 3d = 3.605d
	            b = 0.605d
		1M	

	Area = bd + nd²
	        = 0.605 d² + 1.5d²
	    Area = 2.105d²
		1M	

	Velocity (v) = 1/N x R²/³ x S¹/²
	            = (1/0.012) x (d/2)²/³ x (1/1000)¹/²
	    Velocity (v) = 1.66d²/³
		1M	

	Substituting the values of Q, A and v in the equation for discharge
	    Q = A x v
	    30 = 2.105d² x 1.66d²/³
	    30 = 3.49 d⁸/³
	    30 / 3.49 = d⁸/³
	    8.596 = d⁸/³
	    Hence
	                          d = 2.24 m
		1M	

	b = 0.605 d
	        = 0.605 x 2.24
	                      b = 1.35 m
		1M	

		1M	

c)	Draw a neat labeled sketch of the following:		

c) Draw a neat labeled sketch of the following:
i) Aqueduct   ii) Super passage   iii)Level crossing

Ans
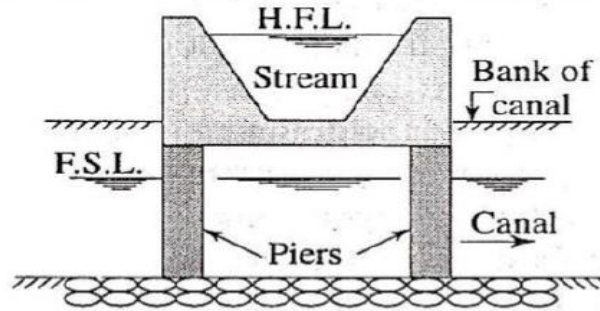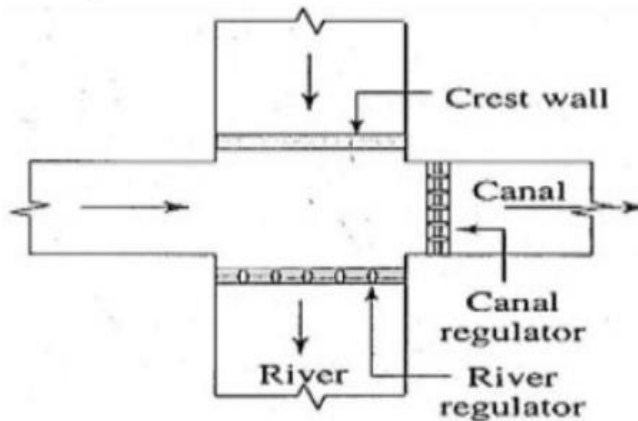
i) Aqueduct

Typical cross-section of an aqueduct.
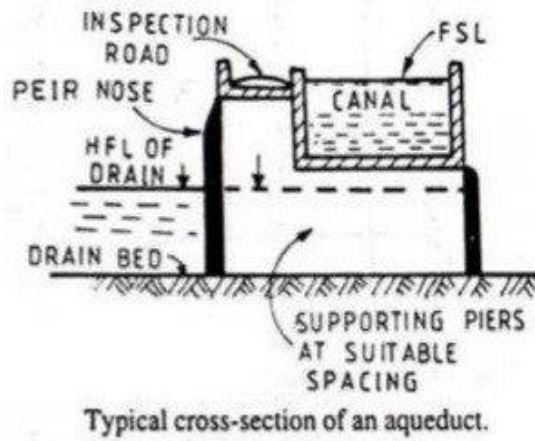
2 M

ii) Super passage

Fig: Super Passage

2 M

Iii) Level Crossing

2 M