MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)

(ISO/IEC-270001 – 2005 certified)

SUMMER -13 EXAMINATION

Subject code: 12136 **Model Answer (Revised copy)** Page No:01/17 Nos

Important Instructions to examiners:

1) The answer should be examined by keywords 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 error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure 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 the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.

Q1.A)a)Define Irrigation and state its advantages.	4
Irrigation may be defined as the process of artificially supplying water to soil for raising crops. Advantages of Irrigation: i)Increase in food production ii) Cultivation of cash crops. ii)Protection from famine iv)Increase in prosperity of people *(Or any other such four advantages related to irrigation)*	2 ½ ½ ½ ½
Q1.A) b) What is Duty and delta ? State relationship between them.	4
i) Duty- It is the area in hectares irrigated by one cubic meter per Second of water flowing continuously for the base period for a particular crop. ii) Delta-It is the total depth of water in centimeter required by crop to come to maturity Relationship between Duty and Delta-	1 1

$D = \frac{8.64\ B}{\Delta}$ Where , D=Duty in Ha/cumec, Δ =Delta in meter B=Base period in days.	2
Q1.A)c)Define i)Rainfall ii)Rain gauge iii)Runoff iv)Precipitation	4
i)Rainfall:- It is depth in mm or cm of water(liquid Precipitation) that would stand on the surface of the earth provided it were not to be lost by any other manner like evaporation or absorption in to the soil etc. ii) Rain gauge:- It is the instrument which measures rainfall. iii)Run off:- It is that part of rainfall, which is not lost ,into the atmosphere or in the soil. OR It is the portion of precipitation that ultimately reaches the stream channel over the land surface and beneath the surface of the earth. iv)Precipitation:- It is the fall of moisture from the atmosphere on to the earth surface in any form. Precipitation may be two forms a)liquid Precipitation b)frozen Precipitation.	1 1 1 1
Q1.A)d)Classify canals according to alignment and position in the canal network.	4
Classification of canals :- i)According to alignment- a)Contour canal b)Watershed or Ridge canal c)Side-slope canal ii)According to their position- a) Main Canal b)Branch canal c)Major distributary d)Minor distributary or minors e)Water course	 2 2
Q1.B)a)State the period of cultivation and two examples each of kharif and rabbi crops.	6
(*Note-The period of cultivation is not mentioned in curriculum .It may be consider similar to base period or crop period. If student writes Definition and duration of base period / crop period for particular crop as mentioned above give marks as mentioned below)* Base Period:- It is period in days from the first watering of a crop at the time of sowing to the last watering before harvesting and represents the period in which water is provided for irrigation. Season | common crops | period From to | base period (days) Kharif | Jowar,Rice,Tur, Ground nut,Maize. | 15th June-14th Oct | 123 Rabi | wheat,Gram, Mustard Dhana | 15th Oct-14th Feb | 122	2 2 2
Q1.B)b)A proposed tank has 970km^2 of good catchment area .Assuming that dependable rainfall is 80% of average annual rainfall of 120 cm, calculate the yield in ha-m using Inglis's formula.	6

Given- C.A.=970km^2

Dependable rainfall(P) = 80%x120=96cm — 1

By Inglis's formula for Runoff (for non-ghat area) — 2

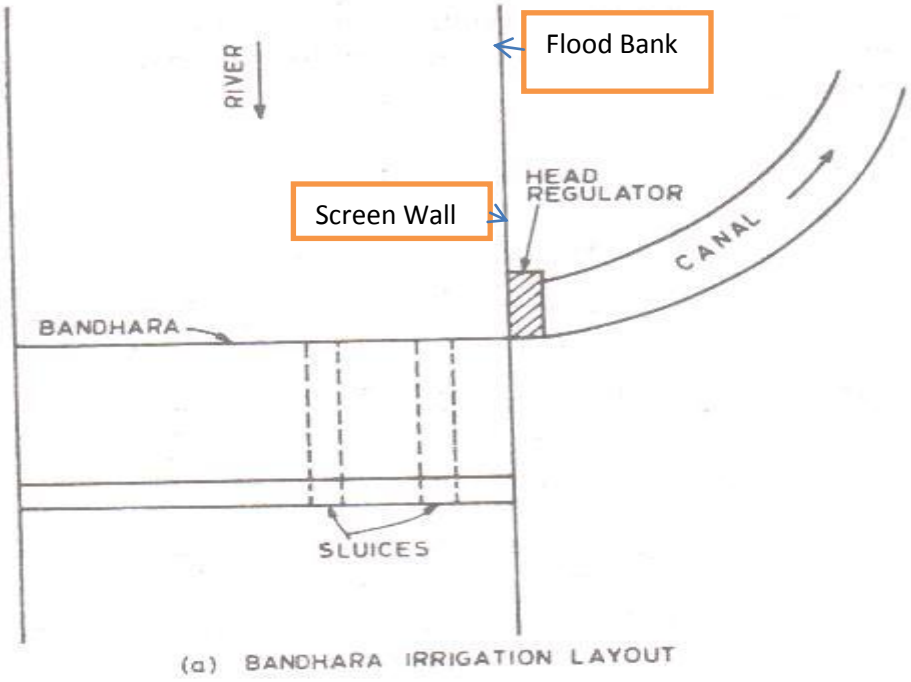
$$R = \frac{(P-17.8)\ x\ P}{254}$$

$$R = \frac{(96-17.8)\ x\ 96}{254} = 29.55cm$$

Yield= C.A x Runoff — 1

= 970x29.55 =28663.5 ha-m (Ans) — 2

Q2.a) Draw a layout at Bandhara Irrigation with component parts and write functions of component parts. — 8



(a) BANDHARA IRRIGATION LAYOUT — 4

Component parts and their functions-

i)Bandhara-To obstruct the flow of water and store the water. It is a weir. — 1

ii)Screen wall-It is constructed at right angle to the bandhara on upstream side at the main canal side. It is used to avoid the flood water not to outflank the bandhara. — 1

iii)Flood bank-To confine the upstream water within the bandhara and river. — 1

iv)Offtaking Canal-To take the water from the upstream side of the bandhara and supply to the agriculture land. — 1

v)Head Regulators-To control the flow of water through the canal.

vi) sluices -These are provided to drain out the sludge or silt accumulated at the bottom of the

bandhara. *(Note-Consider credit for the function of any four component as above)*	
Q2.b) Enlist the eight component parts of earthen dam and write there functions.	8
The various component parts of earthen dam and their functions are as given below i)Hearting (core)-It is the center impervious section .It provides water tightness to the dam and control the seepage flow through the body of the dam . ii)Casing-It is the outer portion of the dam. It provides cover the hearting and gives stability to the dam. iii)Cut off trench-It is excavated under the hearting zone and it prevents or reduces seepage flow .It also prevents piping of dam through foundation of dam. iv)Rock toe- It is provided to prevent the toe of dam from sloughing due to seepage flow and it increases the stability of dam v)Pitching-It is provide to avoid the erosion of dam material on the upstream side due to wave action of water .It also protects the upstream slope from sudden draw down vi)Turfing-It is provided to prevent the downstream slope from erosion action due flow of rain water. vii)Berms-It is provided on the downstream side . It collect the rain water and dispose it off safely. viii)Drains-The network of drains such as L-drain , cross drain and toe drain are provided to collect the seepage flow of water through the body of dam. (*Note-If only list of component parts is written give ¼ mark for each part)*	1 1 1 1 1 1 1 1
Q2.c) Design the section of a canal having design discharge 4 cumecs, bed slope 1 in 2500 and the canal is lined with concrete N=0.0012 and side slope is 1:1.	8
Given-Discharge Q=4.0 cumecs Coefficient of rugosity (N)=0.012 Side slope=1:1 (n=1) Bed slope(i)=1 in 2500 For most economical section $b+2nd=2d\sqrt{(n^2+1)}$ $b+2x1d=2d\sqrt{(1^2+1)}$ $b+2d=2.83d$	2

b=0.83d

Area=(b+nd)xd 2

(0.83d+1d)d.

$=1.83d^2$

Discharge (Q)=AxV $1.83d^2 \times \frac{1}{N} \times m^{2/3} \times s^{1/2}$

put m=d/2 2

$$4= \frac{1.83\ d2\left(1\ x\ m\ \frac{2}{3}\right)x\ s1/2}{N}$$

$$2.186 = d^2x\left(\frac{1}{0.012}\ X\left(\frac{d}{2}\right)2/3\ X\frac{1}{\sqrt{2500}}\ \right)$$

$$2.186 = \left(\frac{1}{0.012}\ x\ \frac{1}{2\left(\frac{2}{3}\right)}\ x\frac{1}{50}\ \right)d^{\ 8/3}$$

$d^{\ 8/3} = 2.082$

$d = 2.082^{\ 3/8}$

2

d = 1.317m

b = 0.83x1.317

b = 1.09m

Q3)a) Explain modified Penman method to compute evapotranspiration values. 4

Penman develop a theoretical formula for potential evapotranspiration which in its modified form is as follows: 2

$$E_{\ tp} = WR_n + (1-W).f(U)(e_s-e_a)$$

Where, $E_{\ tp=}$ potential evapotranspiration for reference crop in mm/day

W= Weightage factor=Δ/(Δ+r) 2 For Notation

Δ= slope of saturation vapour pressure vs temp.curve in mbar/^{0}C at daily mean temp.

r = psychometric constant.

$R_{n=}$net radiation in mm of evaporable water per day.

f(U)=a function of wind energy.

$e_{s=}$Saturation vapour pressure in mbar at mean day temp.

e_a=actual mean vapour pressure of the air in m bar.

Q3)b)Calculate the net volume of water in ha-m required for irrigation crops as follows: Name of crop — Area in ha — Average duty in ha/cumec Rice — 750 — 600 Jowar — 1200 — 2500 Assume base period of 120 days.	4
Given:- B=120 days $\Delta(\text{rice}) = \frac{8.64\,B}{D} = \frac{8.64\,x\,120}{600}$ =1.728 m. Δ(rice) in ha-m= Δ x area= 1.728 x750=**1296 ha-m** $\Delta(\text{jowar}) = \frac{8.64\,B}{D} = \frac{8.64\,x\,120}{2500}$ = 0.414m. Δ(jowar) in ha-m=Δ x area =0.414x 1200=**497 ha-m.** Net Quantity of water required=1296+497=**1793 ha-m (Ans)**	1 1 1/2 1 1 1/2 1
Q3) c) State the factors affecting silting in a reservoir	4
Factor affecting silting in a reservoir are as follows: i) Catchment area:- if catchment area is more ,silting will be more. If catchment area is less, silting will be less. — 1 ii) Shape of catchment:- if catchment area is fan shaped, silting will be more. If catchment area is fern shaped, silting will be less. — 1 iii) Slope of country: - if slope is steep, more particle will be erodes because of high velocity of runoff & will be deposited in reservoir basin and vice versa. — 1 iv) Climatic condition: - dry & rainy climate helps in production of more silt material. — 1 v) Nature of surface soil: - if soil is weathered or loose it can be easily flow with runoff and deposited in reservoir. (Note:- *Consider credit for the factors of any four as above)*	
Q3)d) Differentiate earthen and gravity dam with respect to foundation, seepage construction and maintenance.	4

Particulars	Earthen Dam	Gravity Dam	
Foundation	It can be located on any type of foundation	It should be located on hard strata only.	1
Seepage	Seepage losses are more	Seepage losses are less	1
Construction	Earthen dam can be constructed with locally available soil, stone,silt,clay and skilled labours are not required	Gravity dam can be constructed with stone, brick& concrete requires skilled labours.	1
Maintenance	Maintenance cost is more	Maintenance cost is less.	1

Q3) e) Explain the longitudinal joints used in gravity dam with sketch. 4

Longitudinal joints:- 2

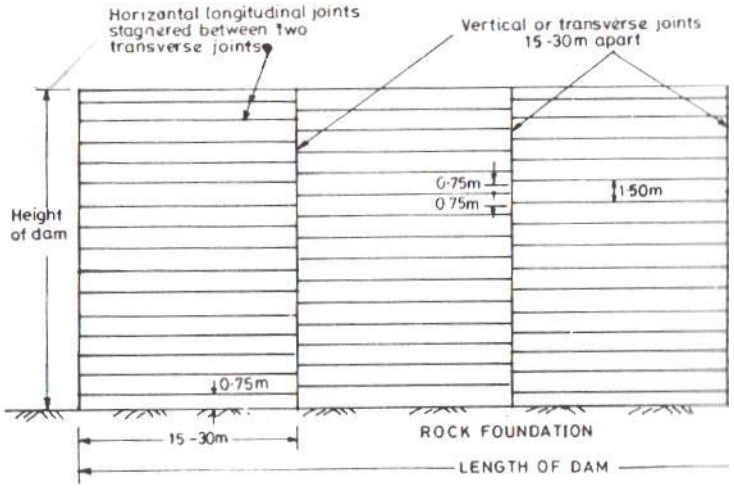
i) Longitudinal joints are provided parallel to the axis of the dam.

ii) These joints are extended vertically from foundation to the top of dam.

iii) The longitudinal joints runs between two adjacent transverse joints and and are not continuous all along the length of dam.

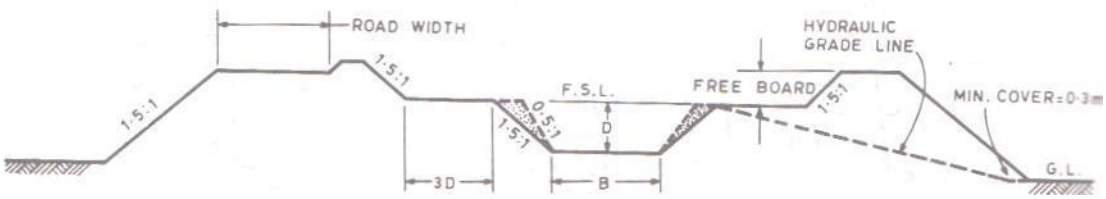
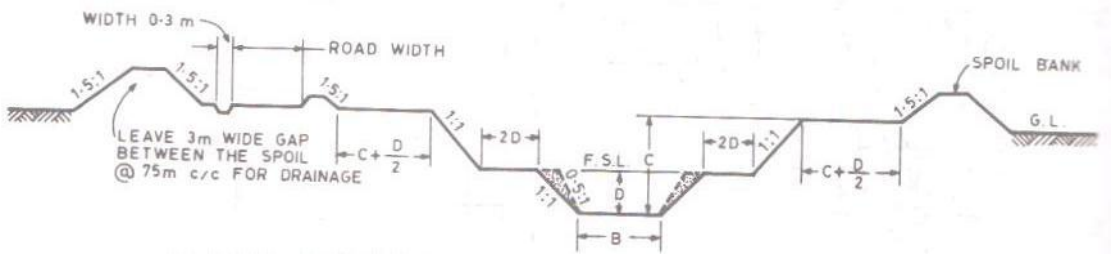
iv) A spacing is 15 to 30m is generally adopted which may varies according to foundation condition. .

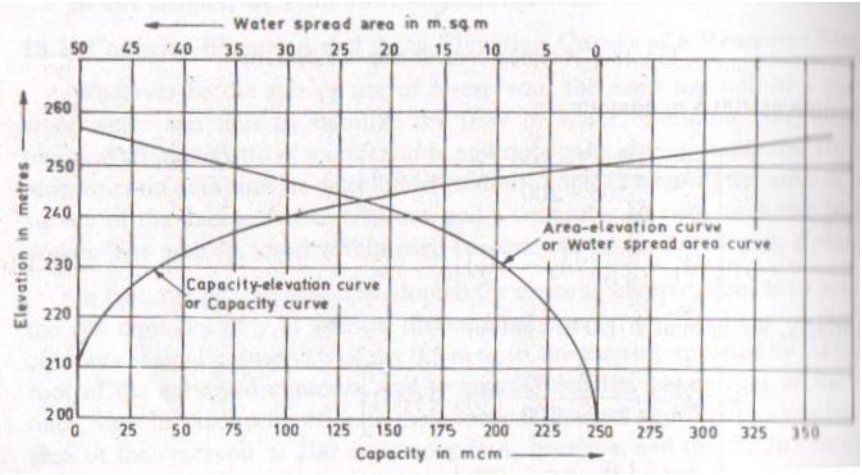
v) Keyways are provided in vertical longitudinal joints to transfer shear stresses from one block to other.



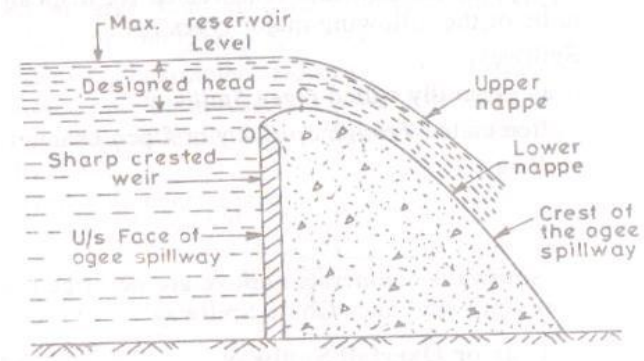
2 For fig .

Fig:- Longitudinal joints in dam.

Q4)A)a)Draw a cross section of canal in cutting and in embankment	4
 Fig. c/s of canal in Embankment	2
 Fig :- c/s of canal in cutting *(Note:-fig with appropriate labeling give full marks)*	2
Q4)A)b)State the two advantages of canal lining and two properties of good lining material.	4
Advantages of canal lining are as follows. i) It reduces seepage losses. 1 ii) It reduces water logging problem. 1 iii) It increases velocity of water and save water. iv) It avoids growth of weeds along the banks of canal. v) It reduces silting. vi) It reduces maintenance cost. vii) It increases hydraulic efficiency. Properties of good lining material i) It should be impervious and water tight. ii) It should be durable. 1 iii) It should have good strength. 1 iv) It should be cheap.	

v) It should not be easily erodible. vi) It should be easily repairable. vii) It should easy in construction. *(Note-Give 1 mark to each from any two Advantages and properties given as above)*	
Q4)A)c)State the situation where following structure are used. i)canal falls ii)canal escapes	4
i) Canal falls:-It is structure provided across a channel to permit lowering down of its water level and dissipate the surplus energy possessed by the falling water which may otherwise scour the bed and banks of the channel. It is used where ground slope is steeper than bed gradients.	2
ii) Canal escapes:-It is structure provided for the disposal of surplus water from the channel. if surplus water is allowed from canal then, there is chances of flowing water over the banks of canal and possibility of damages to the banks of canal in that situation canal escapes are provided at the in head reaches. Excess water goes to the waste canal and then natural drains. *(Note:-any other appropriate answer give full marks)*	2
Q4)A)d)Draw the area capacity curve and state its significance.	4
 Fig:- Area Capacity curve	2
Significance of area capacity curve: i)Area capacity curve include area curve and capacity curve ii)Area curve shows area in hector of water spread plotted on x axis, gives area under submergence	2

and useful in determining control levels of reservoir. iii)Capacity curve, on y axis gives information in deciding capacity of reservoir.	
Q4)B)a)Fix the control levels LWL and FTL from the given data: Effective storage for crops =3200ha-m Tank losses=20% of effective storage Carry over allowance=105 of effective storage Dead storage=105 of gross storage Contour RL 250 253 256 278 281 284 Storage (mm^3) 3.3 4.1 5.25 42.65 47.3 55.12	6
Gross storage =Dead storage+ Live Storage Live Storage = effective storage for crops+ Tank losses (20%)+ Carry over allowance(10%) =3200+640+320 =4160 ha-m = 41.60 Mm^3 But Gross storage = (10/100)x gross storage+39.0 0.9 Gross storage=41.60 Gross storage=46.22 Mm^3 From above table Interpolating value of 46.22 Mm^3 $= \frac{278+(281-278)\ x\ (46.22-42.65)}{(47.3-42.65)}$ =280.30m F.T.L=280.30m (Ans) Dead Storage=(10/100)gross storage=(10/100)x46.22 =4.62 Mm^3 R.L.corrsponding to 4.62 Mm^3 capacity $= \frac{253+(256-253)\ x\ (4.62-4.1)}{(5.25-4.1)}$ L.W.L. = 254.35m (Ans)	1 1 2 2
Q4)B)b)State the importance of spillway in earthen dam and explain construction and working of	6

ogee spillway with sketch.	
Importance of spillway in earthen dam are as follows (Any two of the following) i) It expell the excess water rises above the full reservoir level safely. ii) If spillway is not provided, water will go on rising above a embankment of earthen dam and causes erosion of all earthen material to move downstream side. iii) It provides stability to earthen dam.  Fig. c/s of ogee spillway Construction and Working: i) Ogee spillway has 'S' type profile. It is widely used for gravity, arch and buttress dam also several earthen dams constructed with ogee spillway. ii) In ogee spillway, water falling over the crest is guided smoothly over the crest of the spillway and made it to glide over the downstream face of spillway.	1 1 2 For Fig 2
Q5)a)Draw a layout of diversion of headwork and show its components .State the function of fish ladder.	8
Diagram on next page	4 fig. + 2 Labels

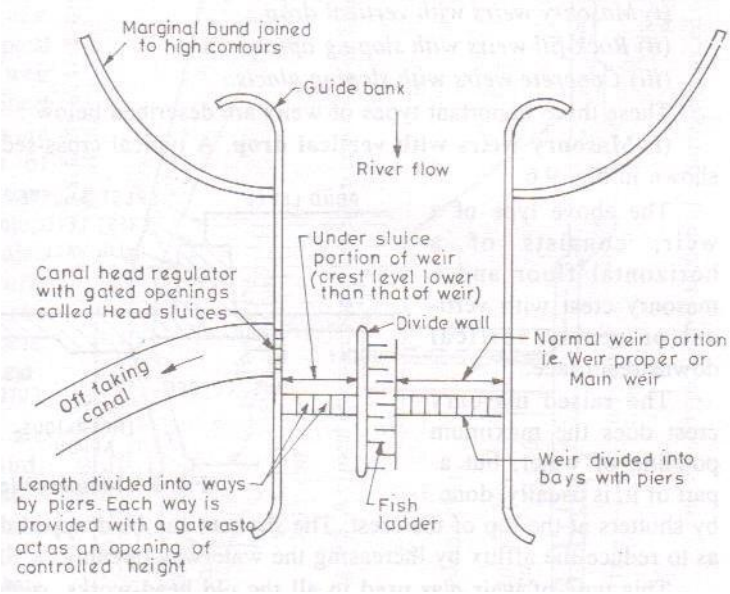


Fig:- Layout of Diversion Head Works

Function of fish ladder: To provide convenient passage for the easy movement of fishes from downstream to upstream side in summer season.It also divide the flow.

(Note-Neat layout-4 marks, labelling-2marks, functions of fish ladder-2 marks)

2

Q5)b) Explain the types of failure in earthen dam and its remedial measures. 8

Types of failure of earthen dam & its remedial measures.

The various causes leading to the failure of earthen dam can be grouped into the following three classes

1) Hydraulic failure.
2) Seepage failure.
3) Structural failure.

1) **Hydraulic failure**:- above 40% of earthen dams failure have been attributed to these cause. The failure under category occurs due to following reason (remedial measure). 3

Type of Failure	Remedial measures
a) By over topping	Sufficient free board should be provided.
Erosion of upstream face	Upstream stone pitching or rip-rap should be provided
Cracking due to frost action	Additional free board allowance up to say 1.5m be provided for dams in areas of low temperature
Erosion of downstream face by gully	these can be avoided by proper

formation	maintenance, filling the cuts from time to time especially during rainy season by growing the slopes and by providing proper berm of suitable heights
Erosion of the d/s toe	The erosion of the toe can be avoided by providing a downstream slope pitching or a riprap up to a height slightly above the normal tail water depth

2) **Seepage failure**: The failure under this category may occur due to the following reason. About 1/3 rd. of the earth dams have failed because of these reason. 3

Type of Failure	Remedial measures
a)Piping through foundation	This can be avoided by properly compa the foundation strata & proper selectio site.
b) piping through the dam body	This can be avoided by properly compa the soil of dam embankment.
c) sloughing of d/s toe	This process of failure due to sloughing when the d/s toe becomes saturated & g eroded hence it should be avoided by p rock toe of d/s.

3) **Structural failure**: About 25% of the dam failures have been attributed to structural failure are generally caused by shear failure causing slides. The failure under this category may occur due to the following reason. 2

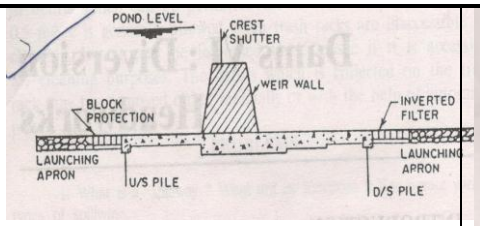
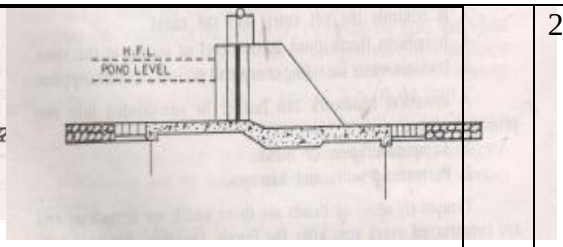
a) Foundation slides.

b) Slides in embankments.

(Note-In each category of failure for every type of failure and its Remedial measures 1 mark is given as mentioned above)

Q5)c)Differentiate between weir and barrage with respect to crest level ,afflux ,slitting. Food clearance and draw sketch of weir and barrage. 8

Particulars	Weir	Barrages

Diagram			2
Definitions	If the major part of the entire ponding of water is achieved by a raised crest and a small part by the shutters then this barrier is knows as weir	If most of the ponding is done by gates and smaller part is by the raised crest then this barrier is knows as barrage	2 1
Crest level	Crest level is high	Small crest level embankment is provided or barrage may be provided without embankment	1 1 1
Afflux	Afflux is more	Afflux is less	1
Silting	Large silting may occurs	Very less silting occurs	
Flood clearance	Flood clearance is less	Flood clearance is more	

Q6)a)Explain the river gauging method of estimation of MFD. Calculate MFD for a catchment area of 1600km^2 by Ingli's formula. 4

River Gauging- River or stream Gauging means actual measurement of the discharge of the river ,it is one of the method of calculating MFD .The area cross section of flow is measured by surveying the cross section of the stream at gauging stations . The water elevation is read on the gauges .The gauge is read three times a day during the rainy season and every two hours during floods at other times it is read once a day. At the same time , velocity is observed by single float ,double float, velocity rod or current meters. The discharge is calculated by using following formula 2

Q =A x V Where, Q=Discharge(m^3/s)

A=Area at the cross section of flow(m^2)

V=Mean Velocity(m/s) 1

MFD for a catchment area of 1600km^2 by Ingli's formula

$$Q=\frac{123A}{\sqrt{(A+10.24)}}$$

$$Q=\frac{123x1600}{\sqrt{(1600+10.24)}}$$ 1

Q=4904.33 m^3/sec

Q6)b)List the factors affecting runoff and explain any one. 4

The various factor affecting the runoff can be divided in two groups: i) Characteristics of precipitation ii) Characteristics of drainage basin. i) Characteristics of precipitation-This consist of following factors- a)Type of precipitation b)Rain intensity c)Duration of rainfall d)Soil moisture deficiency. e)Direction of the prevailing storm f)other climatic condition. ii) Characteristics of drainage basin.-This consist of a)size of basin b)Shape of basin-Fan Shape or fern shaped c)Elevation of water shade d)The type of arrangement of stream channels e) other factors as the type of the soil , vegetation cover the slow and orientation of the catchment etc. **Explanation of any one factor in brief** *(Note-In characteristics 1 and 2 any 3 are expected in each type and out of minimum 6 any one should explain)*	$1\frac{1}{2}$ $1\frac{1}{2}$ 1
Q6)c)What are the various types of engineering surveys carried out for an irrigation project.	4

Following surveys and investigation are necessary for irrigation project- 1)Engineering Surveys 2)Geological investigations 3)Hydrological investigations	1
1)Engineering Surveys-In Engineering Surveys the area under the dam site is surveyed in detail and contour plan is prepared . From the contour plan following physical characteristics are found out. i) Area elevation curve ii) Storage elevation curve	1
2)Geological investigations-It is requires to obtain information about i) Water tightness of reservoir ii) Suitability of foundation for the dam iii)Ground water condition in region iv) Geological structural features.	1
3)Hydrological investigations- It can be done under two heads i) Study of runoff pattern at the proposed dam site to find storage capacity. ii)Determination of the hydrographs to determine the spillway capacity and design.	1
Q6)d)State the function of galleries in gravity dam.	4
Function of foundation gallery and inspection gallery are as follows:	1
1)Foundation Gallery- It is provided near the rock foundation serves to drain of the water which percolate through the foundation .	1
2)Inspection Gallery-The function of Inspection Gallery are i) They intercept and drain of the water seeping through dam body ii) They provide access to dam interior for observing and controlling the behavior of the dam. iii) They provide enough space for carrying pips during artificial cooling of concrete. iv)They provide access for grouting the contracting joints v) They provide space for drilling and grouting the foundation *(Note-For Inspection Gallery out of 5 any 4 are expected)*	2
Q6) e)State the use of i)Canal head regulator ii) Silt Excluders.	4

i)	Canal head regulator:A canal head regulator is provided to the head of the off taking canal and it is used for. 1) Regulating the supply of water entering the canal. 2) Controlling the entry of silt in the canal . 3) Canal head regulator prevents the river floods from entering the canal.	2
ii)	Silt excluder: Silt excluders are those works which are constructed on the bed of the river, upstream of the head regulator. Use: By use of silt excluder the silt is removed from the water before it enter in the canal & the clearer water enters the head regulator.	2