SAMSKRUTI COLLEGE OF ENGINEERING & TECHNOLOGY
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Subject Name: IRRIGATION AND HYDRAULIC STRUCTURES

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Year and Sem Department: IV / I

Unit-I:
STORAGE WORKS-RESERVOIRS

Important points / Definitions

- **Hydrology:**The branch of science concerned with the properties of the earth's water, and especially its movement in relation to land

- **Define Hydrologic cycle:** Describes the constant movement of water above, on, and below the earth's surface. Processes such as precipitation, evaporation, condensation, infiltration, and runoff comprise the cycle.

- **What is Abrasion:** Removal of stream-bank soil as a result of sediment-laden water, ice, or debris rubbing against the bank.

- **What is Absolute Humidity:** The actual weight of water vapor contained in a unit volume of the atmosphere, usually expressed in grams of water per kilogram of air

- **Precipitation mean:** Precipitation is rain, snow, sleet, or hail — any kind of weather condition where something's falling from the sky. Precipitation has to do with things falling down, and not just from the sky. It's also what happens in chemical reactions when a solid settles to the bottom of a solution.

- **System Absorption Loss:** The loss of water by Infiltration or Seepage into the soil during the process of priming, i.e., during the initial irrigation of a field; generally expressed as flow volume per unit of time

- **Acclimatization:** The physiological adjustment or adaptation by an organism to new physical and/or environmental conditions. With respect to water, it is frequently used in reference to the ability of a species to tolerate changes in water temperature, degradation of water quality, or increased levels of salinity

- **Acid Rain:** Rainfall with a pH of less than 7.0. One of the principle sources is the combining of rain (H_2O) and sulfur dioxide (SO_2), nitrous oxides (NO_x), and carbon dioxide (CO_2) emissions which are byproducts of the combustion of fossil fuels. These oxides react with the water to form sulfuric (H_2SO_4), nitric (HNO_3), and carbonic acids (H_2CO_3). Long-term deposition of these acids is linked to adverse effects on aquatic organisms and plant life in areas with poor neutralizing (buffering) capacity. Also see Acid Deposition

- **Acre:** A measure of area equal to 43,560 square feet (4,046.87 square meters). One square mile equals 640 acres, and is also referred to as a Section

- **Adiabatic:** Applies to a thermodynamic process during which no heat is added to or withdrawn from the body or system concerned. In the atmosphere, adiabatic changes of temperature occur only in consequence of compression or expansion accompanying an increase or decrease of atmospheric pressure. Thus, a descending body of air undergoes compression and adiabatic cooling.

- **Adiabatic Process:** A change involving no gain or loss of heat.

- **Aggressive Water:** Water which is soft and acidic and can corrode plumbing, piping, and appliances

- **Tributary:** A tributary is generally regarded as a surface water drainage system which is interconnected with a river system. Under Colorado law, all surface and groundwater, the withdrawal of which would affect the rate or direction of flow of a surface stream within 100 years, is considered to be tributary to a natural stream

- **Define Stream:** A general term for a body of flowing water; natural water course containing water at least part of the year

- **Infiltration:** The downward entry of water through the soil surface

Short Questions

1	Give the classification of reservoirs.	**May-2017**
2	Discuss the steps involved in selecting a site for reservoir construction.	**May-2017**
3	Write brief notes on reservoir yield.	**Dec-2016**
4	Explain various levels of a reservoir with neat sketch.	**Dec-2016**
5	Write short notes on mass curve and demand curve.	**May-2015**
6	Explain how reservoir capacity can be determined using a mass curve.	**May-2015**
7	What is meant by reservoir sedimentation?	**Dec-2016**

8	List out the factors affecting sedimentation.	**Dec-2016**
9	List out the control measures for sedimentation	**May-2014**
10	What do you understand by the term life of reservoir?	**May-2014**

Long Questions:

1	Explain the following terms, (i) Catchment area (ii) Normal pool level (iii) Maximum pool level (iv) Minimum pool level.	May-2014
2	Explain the different types of storages in a reservoir with the help of neat sketch.	**May-2014**
3	Explain the mass curve method that can be used for determining: (a) Reservoir capacity for fulfilling given demand (b) Demand rate from a reservoir of a given capacity.	**Dec-2014**
4	Describe the procedure for estimating the reservoir capacity using mass inflow and demand curves.	**Dec-2014**
5	How the capacity of reservoir fixed is based on a specific yield? Also explain how safe yield of a reservoir is obtained for a given capacity?	**May-2015**
6	What is meant by reservoir sedimentation and life of a reservoir?	**May-2015**
7	Give the classification of reservoirs.	**Dec-2015**
8	Write short notes on gravity dam and buttress dam..	**Dec-2015**
9	Discuss the steps involved in selecting a site for reservoir construction.	**May-2016**
10	Explain the procedure to determine reservoir capacity using a mass curve.	**Dec-2016**

Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)

1. The storage capacity of a reservoir may be divided into three zones. The lowest zone is _____.
2. Surcharge storage of a reservoir is above_____.
3. For wave action in dams, the maximum height of freeboard is generally taken to be equal to_____.
4. Trap efficiency of a reservoir is a function of_____.
5. The major resisting force in a gravity dam is _____ .

6. When the reservoir is full, the maximum compressive force in a gravity dam is produced at _____ .

7. The maximum permissible eccentricity for no tension at the base of a gravity dam is _____ .

8. The ratio of total capacity and dead storage is kept _____ .

9. When the upstream face of a gravity dam is vertical, then the intensity of water pressure at the water surface and at the base respectively will be_____ and _____ .

10. Seepage through embankments in an earthen dam is controlled by_____ .

Unit-II:
GRAVITY DAMS

Important points / Definitions

- **Flood control in emergencies:** It is advisable to prepare an emergency release schedule that uses information on reservoir data immediately available to the operator. Such schedule should be available with the operator to enable him to comply with necessary precautions under extreme flood conditions.
- **Control of reservoir design flood**: According to this principle, releases from flood control reservoirs operated on this concept are made on the same hypothesis as adopted for controlling the reservoir design flood, that is the full storage capacity would be utilized only when the flood develops into the reservoir design flood. However, as the design flood is usually an extreme event, regulation of minor and major floods, which occur more often, is less satisfactory when this method is applied.
- **Flood control**: Operation of flood control reservoirs is primarily governed by the available flood storage capacity of damage centers to be protected, flood characteristics, ability and accuracy of flood/ storm forecast and size of the uncontrolled drainage area. A regulation plan to cover all the complicated situations may be difficult to evolve, but generally it should be possible according to one of the following principles
- **Draining and Flushing:** The method involves relatively slow release of all stored water in a reservoir through gates or valves located near bottom of the dam and the maintenance thereafter of open outlets for a shorter or longer period during which normal stream flow cuts into or directed against the sediment deposits. Therefore, this method may be adopted in flood control reservoirs.
- **Excavation:** The method involves draining most of or all the water in the basin and removing the sediment by hand or power operated shovel, dragline scraper or other mechanical means. The excavation of silt and clay which constitute most of the material in larger reservoirs is more difficult than the excavation of sand and gravel. Fine-textured

sediment cannot be excavated easily from larger reservoirs unless it is relatively fluid or relatively compact.

- **Dead Loads:** Unless testing indicates otherwise, the unit weight of concrete can be assumed to be 150 lb/ft3 . In the determination of the dead load, relatively small voids, such as galleries, normally are not deducted unless the engineer judges that the voids constitute a significant portion of the dam's volume. The dead loads considered should include weights of concrete and superimposed backfill, and appurtenances such as gates and bridges.
- **Hydro Static Loads:** Although the weight of water varies slightly with temperature, the weight of fresh water should be taken at 62.4 lb/ft3 . A linear distribution of the static water pressure acting normal to the surface of the dam should be applied.
- **Nappe Forces:** The forces acting on an overflow dam or spillway section are complicated by steady state hydrodynamic effects. Hydrodynamic forces result from water changing speed and direction as it flows over a spillway. At small discharges, nappe forces may be neglected in stability analysis; however, when the discharge over an overflow spillway approaches the design discharge, nappe forces can become significant and should be taken into account in the analysis of dam stability.
- **Rock Foundations:** In the case of gravity Dams on rock foundations, a failure plane shall be assumed between the dam and the foundation. In addition, the potential for failure planes in the rock below the dam must be considered.
- **Grouting:** Grouting alone should not be considered sufficient justification to assume an uplift reduction. A grout curtain may retard foundation flows initially, but the degree of uplift relief may be lessened as the age of the dam increases due to deterioration of the curtain. A drainage system should be utilized downstream of grout curtains and, a monitoring system should be employed to determine actual uplift pressures and to detect any reduction in drain efficiency due to clogging of the drains.
- **Earthquake:** Uplift pressures should be assumed to be those existing under normal conditions during earthquake loading. However, when performing post earthquake stability analysis, the effects of silt liquefaction, apron cracking, or potential offsets must be considered.
- **Soil Foundations:** Uplift pressures acting upon the base of a gravity structure constructed on a pervious soil foundation are related to seepage through permeable materials
- **Creep Theory:** The word "Creep" in this usage refers to a simplified method which can be used to estimate uplift pressure under a structure. Under creep theory, the uplift pressure is assumed to be the sum of two components; the seepage potential and the position potential

Short Questions

1	Explain the forces acting on a gravity dam.	**May-2017**
2	Draw an elementary profile of a gravity dam.	**May-2017**
3	Draw the practical profile of a gravity dam.	**Dec-2016**
4	Write the effects of earthquake forces on a gravity dam..	**Dec-2016**
5	Explain the failure of a gravity dam due to overturning.	**May-2015**
6	Explain the failure of a gravity dam due to sliding.	**May-2015**
7	Explain the failure of a gravity dam due to crushing.	**Dec-2017**
8	Derive the limiting height of a gravity dam.	**Dec-2018**

9	What are the modifications given to an elementary profile to get practical profile?	**MAY-2016**
10	Explain the effect of wave pressure on gravity dam.	**DEC-2015**

Long Questions

1	Define the following parameters with respect to the gravity dam, (a) Dam base line (b) Structural height	**Dec -2014**
2	Write detailed notes on elementary and practical profiles of gravity dams.	**Dec-2014**
3	Enumerate various methods of stability analysis of gravity dam. Explain any two of them.	**May-2014**
4	A concrete gravity dam 20 m in height has top width 6 m and free board 2.5 m, upstream face is vertical, while downstream face has a slop of 0.6 H:1 V right from top to bottom. Check the stability of the dam. Take specific weight of concrete as 2.4 t/m^3 consider full uplift. There is no tail water. Assume any other data not given.	**May-2013**
5	What are the main points to be considered while selecting a site for a gravity dam construction?	**Dec-2015**
6	Derive limiting height of a gravity dam	**Dec-2015**
7	Write the effects of earthquake forces on a gravity dam.	**May-2015**
8	Explain the failure of a gravity dam due to crushing.	**May-2014**
9	What are the modifications given to an elementary profile to get practical profile?	**Dec-2013**
10	Explain the forces acting on a gravity dam.	**May-2016**

Fill in the blanks:

1. If the height of a dam is less than or equal to limiting height of elementary profile, the dam is called _____.
2. For a narrow V shaped valley with sound rock in abutment is the best choice.
   A) Gravity dam B) Spillway C) Cantilever dam D) Arch dam
3. The reservoir capacity for a given demand is obtained from
   A) Double mass curve B) Mass inflow curve C)Hydrograph D)None .
4. The following is not a component part of a diversion headwork
   A) Spillway B) Weir C)Fish ladder D)None
5. A dam which resist the external forces acting on it by its self-weight
   A) Weir B) Spillway C) Gravitydam D)None
6. The theory of infiltration capacity was given by
   (A) Merrill Bernard (B) W.W. Horner (C) Le-Roy K. Shermen (D) Robert E. Horten.
7. A recording type rain gauge (A) records the cumulative rain (B) produces a mass curve of rain fall (C) is sometimes called integrating rain gauge or continuous rain gauge (D) all 3.
8. Absolute humidity in air
   (A) decreases at higher altitudes (B) increases at higher altitudes (C) remains constant at all altitudes (D) none of these. 4.
9. If the potential infiltration of a water shed having a soil with fair pasture cover, is 10 cm and rainfall is 12 cm, the direct run off is
   (A) 2 cm (B) 5cm (C) 3cm (D) 8cm 5.

10. For the estimate of high floods in fan-shaped catchment, the formula used is
(A) Dicken's formula (B) Inglis formula (C) Ryve's formula (D) none of these. 6
11. . If the viscosity of ground water is 1.00, the Slitcher's constant is 400, the effective size of soil particles in acquifer is 0.5 mm and hydraulic gradient is 1 in 80, the velocity of flow is
(A) 0.50 m/day (B) 0.75 m/day (C) 1.00 m/day (D) 1.25 m/day.

Unit-III:
EARTH DAMS & SPILLWAYS

- **Water pressure:** Water pressure is the force exerted by the water stored in the reservoir on the upstream and the water depth at the tail of the dam
- **Hydrostatic pressure:** In practice dams are usually provided with cut-off walls or grout curtains to reduce seepage and drain to relieve pressure downstream from the cutoff. Actually cutoff and grout curtains may not be perfectly tight and hence fail to dissipate the head ($h_1 - h_2$)
- **Wight of Structure:** For a gravity dam the weight of the structure is the main stabilizing force, and hence the construction material should be as heavy as possible. Structure self weight is accounted for in terms of the resultant, W, which acts through the centroid (center of gravity) of the cress-sectional area. The weight of the structure per unit length is W = □c * A Where: □c is the unit weight of concrete A is the cross-sectional area of the structure
- **Earth and silt pressure:** The gradual accumulation of significant deposits of fine sediment, notably silt, against the face of the dam generates a resultant horizontal force, F_s. The magnitude of this force in additional to water load, F_{WH}, is a function of the sediment depth, h_s, the submerged unit weight, □ss, and the active pressure coefficient, K_a, and is determined according to Rankine"s formula.
- **Wind pressure:** When the dam is full, wind will act only on the downstream face, thus contributing to stability. When the dam is empty, wind can act on the upstream face, but the pressure is small compared to the hydraulic pressure of the water. Hence for gravity dams wind is not considered. For buttress dams, wind load on the exposed buttresses has to be considered
- **Wave pressure and wave height:** Wave exerts pressure on the upstream face. This pressure force, F_{wv} depends on fetch (extent of the water surface on which the water blows) and wind velocity. It is of relatively small magnitude and, by its nature, random and local in its influence. An empirical allowance for wave load may be made by adjusting the static reservoir level used in determining F_{WV}. According to Molitor the following formula could be used to determine the rise in water level
- **Earthquake forces:** Dynamic loads generated by seismic disturbances must be considered in the design of all major dams situated in recognized seismic "high risk" regions. The possibility of seismic activity should also be considered for dams located outside those regions, particularly where sites in close proximity to potentially active geological fault complexes
- **Free Overfall Spillway:** In this type of spillway, the water freely drops down from the crest, as for an arch dam (Figure 1). It can also be provided for a decked over flow dam with a vertical or adverse inclined downstream face
- **Saddle Spillway:** In some basins formed by a dam, there may be one or more natural depressions for providing spillway. They are sometimes preferred for locating main spillway or emergency or auxiliary spillways. A site which has a saddle is very desirable and economical, if the saddle is suitable for locating the spillway

- **Fuse plug:** It may be a simple earth bank, flash board or other device designed to fail when overtopped. Such plugs may be used where the sudden release of a considerable volume of water is both safe and not over destructive to the environment. "For example, the saddle spillway of Figure 9 may be constructed as an earthen embankment dam, with its crest at a slightly higher elevation than the High Flood Level (HFL) of the reservoir. In the occurrence of a flood greater than the design flood which may cause rise in the reservoir water would overtop the earthen embankment dam and cause its collapse and allow the flood water to safely pass through the saddle spillway.
- **Sluice Spillway:** The use of large bottom openings as spillways is a relatively modern innovation following the greater reliance on the safety and operation of modern control gates under high pressure. A distinct advantage of this type of spillway is that provision can usually be made for its use for the passage of floods during construction. One disadvantage is that, once built, its capacity is definite whereas the forecasting of floods is still indefinite. A second disadvantage is that a single outlet may be blocked by flood debris, especially where in flow timber does not float. Figure 20 shows an example of a sluice spillway
- **Ogee crests with sloping up stream face:** In this case, the desired inclination of the upstream face is made tangential to the same elliptical profile as provided for a crest with a vertical face. The down stream face equation remains unchanged.
- **Selection of spillways:** The Bureau of Indian Standards code IS: 10137-1982 "Guidelines for selection of spillways and energy dissipators" provide guidelines in choosing the appropriate type of spillway for the specific purpose of the project.
- **Safety Considerations Consistent with Economy:** Spillway structures add substantially to the cost of a dam. In selecting a type of spillway for a dam, economy in cost should not be the only criterion. The cost of spillway must be weighed in the light of safety required below the dam.
- **Hydrological and Site Conditions:** The type of spillway to be chosen shall depend on: a) Inflow flood; b) Availability of tail channel, its capacity and flow hydraulics; c) Power house, tail race and other structures downstream; and d) Topography
- **Type of Dam:** This is one of the main factors in deciding the type of spillway. For earth and rockfill dams, chute and ogee spillways are commonly provided, whereas for an arch dam a free fall or morning glory or chute or tunnel spillway is more appropriate. Gravity dams are mostly provided with ogee spillways.
- **Purpose of Dam and Operating Conditions:** The purpose of the dam mainly determines whether the dam is to be provided with a gated spillway or a non-gated one. A diversion dam can have a fixed level crest, that is, non-gated crest.
- **Conditions Downstream of a Dam:** The rise in the downstream level in heavy floods and its consequences need careful consideration. Certain spillways alter greatly the shape of the hydrograph downstream of a dam. The discharges from a siphon spillway may have surges and break-ups as priming and depriming occurs.

Short Questions

1	What are the types of embankment dams?	**May-2017**
2	Explain various earth dams classified based on the materials used.	**May-2017**
3	Explain various types of earth dams classified based on methods of construction.	**Dec-2016**
4	Explain the hydraulic failures of earth dams.	**Dec-2016**

5	Explain seepage failures of earth dams.	**May-2015**
6	Explain the structural failures of earth dams.	**May-2015**
7	Give brief description of phreatic line of an earth dam.	**Dec-2017**
8	Write the criteria for safe design of earth dams.	**Dec-2018**
9	Write short notes on rolled type earth dams.	**MAY-2016**
10	Write short notes on zoned type earth dams.	**DEC-2015**

Long Questions

1	What is the purpose of providing a spill way to the dam structure?	**Dec-2016**
2	What are the essential requirements of a spillway?	**Dec-2016**
3	What are the factors affecting spillway capacity?	**May-2015**
4	What are the components of a spillway?	**May-2015**
5	Give the classification of spillway based on purpose.	**May-2015**
6	Give the classification of spillway based on control	**May-2015**
7	Give the classification of spillway based on pertinent feature.	**Dec-2017**
8	Explain free over fall spillway with neat sketch.	**Dec-2017**
9	Explain ogee-shaped spillway.	**Dec-2018**
10	Explain siphon spillway.	**MAY-2016**

Fill in the Blanks:

1. The earthen dam provided with a stone masonry or concrete spillway section is known as _____.
2. The straight length of water expense measured normal to the axis of the dam is knownas]
   A) Siltpressure B) Elementary profile C)Headway D)Fetch 3.
3. It is an embankment protected on all sides by stones or concrete blocks.
   A) Weir B) Spillway C) Groyne D) none 4.
4. The silt supporting power of a riveror channel mainly depends upon
   A) Silt pressure B) hydraulic slope C) headway D) Fetch .
5. Structure constructed to regulate the discharge, full supply level orvelocity in a canal is known as
   A) Regulation work B) Dam C) CD work D) none
6. . _____is an irrigation structure constructed across a canaltolower down its water level and destroy the surplus energy
7. Crossings' in a meandering river, are :
   (a) straight channel reaches, between two consecutive clockwise and anticlockwise loops ·
   (b) apex points of clockwise loops
   (c) apex points of anticlockwise loops
   (d) both (b) and (c).
8. A river reach downstream of a newly built dam, may behave as :
   (a) aggrading (b) degrading (c) virgin (d) all of them
9. An unconfined aquifer in ground water profile is also known, as :
10. (a) an artesian aquifer (b) a perched aquifer (c) a water table aquifer .(d) none of the a~ove.
11. The upper iiinit of Reynold's number, for the Darcy's law to remain valid for ground water flow, is :
    (a) 0 (b) 1 (c) 100 (d) oo.

Unit-IV:

DIVERSION HEADWORKS & WEIRS ON PERMEABLE FOUNDATIONS

- **Diversion Head Works:** The works, which are constructed at the head of the canal, in order to divert the river water towards the canal, so as to ensure a regulated continuous supply of silt-free water with a certain minimum head into the canal, are known as **diversion heads works**.
- **Weir:** If the major part or the entire ponding of water is achieved by a raised crest and a smaller part or nil part of it is achieved by the shutters, then this barrier is known as a **weir**.
- **Types of weirs:**
  - Masonry weirs with vertical drop
  - Rock-fill weirs with sloping aprons
  - Concrete weirs with sloping glacis
- **Barrage:** If most of the ponding is done by gates and a smaller or nil part of it is done by the raised crest, then the barrier is known as a **barrage** or a river regulator.
- **Timber Spur:** In this type, a box like compartment is prepared by driving timber piles at 15 cm to 30 cm centre to centre. The piles are secured by wooden bracings. The hollow space is filled up by boulders. This spur is permeable but stable. This is recommended for bi rivers with high velocity of flow. The length of the timber piles depend on bed condition.
- **Repelling Groyne:** A groyne which is aligned towards upstream at an angle of 60^o to 75^o with the river bank is known as repelling groyne
- **Deflecting Groyne:** The groyne which is constructed perpendicular to the river bank is known as deflecting groyne.
- **Pond Level:** The water level required in the under-sluice pocket upstream of the Canal Head Regulator, so as to feed the canal with its full supply, is known as Pond Level.
- **Silt Regulation works:** The entry of silt into a canal, which takes off from a head works, can be reduced by constructed certain special works, called silt control works.
- **Silt Ejectors:** the silted water has traveled a certain distance in the off-take canal These works are, therefore, constructed on the bed of the canal, and little distance downstream from the head regulator.
- **Silt Excluders:** Silt excluders are those works which are constructed on the bed of the river, upstream of the head regulator. The clearer water enters the head regulator and silted water enters the silt excluder. In this type of works, the silt is, therefore,, removed from the water before in enters the canal.
- **Shutters and Gates:** Functions of shutters and gates are:
  - They maintain pond level.
  - They raise water level during low flow.

Short Questions:

1	Give a brief note on diversion headwork.	**May-2015**
2	Distinguish between weir and a barrage.	**May-2015**
3	Give the classification of weirs.	**Dec-2017**
4	Draw a neat sketch of layout of a diversion headwork.	**May-2013**
5	Mention various components of a diversion headwork.	**Dec-2014**
6	Explain the functions of canal head regulator.	**Dec-2016**
7	Give the necessity of providing silt excluder.	**Dec-2016**
8	What is the purpose of providing a divide wall in a diversion headwork?	**May-2015**
9	Give the necessity of providing silt ejector inside a canal..	**May-2015**

10	What are guide banks and marginal banks?	**Dec-2014**

Long question

1	What is the difference between diversion head works and a storage head works (dam) ? What considerations will you	**May-2015**
2	Explain clearly the difference between barrage and weir.	**May-2015**
3	Write a short notes on the following, (a) Dropping shutters. (b) Stop logs Also draw the relevant sketches.	**Dec-2017**
4	Explain different causes of weirs or barrages on the regimes of river.	**May-2013**
5	Explain the functions of various components of a diversion work.	**Dec-2016**
6	Explain the functions of canal head regulator.	**Dec-2016**
7	Give the necessity of providing silt excluder.	**May-2015**
8	What is the purpose of providing a divide wall in a diversion headwork?	**May-2015**
9	Give the necessity of providing silt ejector inside a canal..	**Dec-2014**
10	What are guide banks and marginal banks?	**May-2014**

Fill in the Blanks:

1. If the duty for a crop with base period of 120 /days is 1500 ha/cumec, then its de! ta is ..... :
2. An isohyet is a line joining points of ..... .
3. The infiltration capacity of a soil ..... with time.
4. Canals taken d~rect!y __ ~rom t-~~ ri~ers with or witbout headregulatol"s- are called ·····.····.··.
5. When the canarwith bed level higher than the high flood level in drain cross each other, then the cross drainage structure is called ..... .
6. The suction pressure on the ogee spillway is caused, when the head on spillway is ..... , ... the design head. ·
7. An example of vertical lift gate is ..... .
8. Cross drainage works are not needed when canal is aligned as ..... .
9. Movement of water under or around an impervious structure is called ..... .
10. The type of dam preferred for a narrow gorge with strong abutments is

UNIT-V
CANAL FALLS & CROSS DRAINAGE WORKS

- **Definition:** A cross drainage work is a structure carrying the discharge from a natural stream across a canal intercepting the stream.
- **Aqueduct:** When the HFL of the drain is sufficiently below the bottom of the canal such that the drainage water flows freely under gravity, the structure is known as Aqueduct.
- **Super passage:** The hydraulic structure in which the drainage is passing over the irrigation canal is known as super passage.
- **Canal Syphon**: If two canals cross each other and one of the canals is siphoned under the other, then the hydraulic structure at crossing is called “canal siphon”
- **lower Jhelum canal:** The lower Jhelum canal is siphoned under the Rasul-Qadirabad (Punjab, Pakistan) link canal and the crossing structure is called “L.J.C siphon”
- **What is cross drainage works:** Cross drainage works is a structure constructed when there is a crossing of canal and natural drain, to prevent the drain water from mixing into canal water. This type of structure is costlier one and needs to be avoided as much as possible

- **Siphon Aqueduct:** In case of the siphon Aqueduct, the HFL of the drain is much higher above the canal bed, and water runs under siphonic action through the Aqueduct barrels
- **Super passage:** The hydraulic structure in which the drainage is passing over the irrigation canal is known assuper passage. This structure is suitable when the bed level of drainage is above the flood surface level of the canal. The water of the canal passes clearly below the drainage
- **Canal Syphon:** If two canals cross each other and one of the canals is siphoned under the other, then the hydraulic structure at crossing is called "canal siphon". For example, lower Jhelum canal is siphoned under the Rasul-Qadirabad (Punjab, Pakistan) link canal and the crossing structure is called "L.J.C siphon"
- **Types of Falls**: Various types of falls have been designed and_ tried since the inception of the idea of 'falls construction' came into being. The important types of such falls, which were used in olden days and those which are being used in modern days, are described below:
- **Trapezoidal Notch Falls:**. The trapez9_idal n9tch fall was designed by Ried in 1894. It consists of a number of trapezoidal notches constructed in a high crested wall across the channel with a smooth entra:nce and a flat.circular Hp projecting downstream from each notch to spread out the falling jet
- **Montague Type Falls**: The energy dissipation on a straight glacis remain incomplete due to vertical component of velocity remaining unaffected. An improvement in energy dissipation may be brought about in this type of fall by replacing the straight glacis by a parabolic glacis', commonly known as 'Montague Profile'.
- **Length of the Crest**:. Since fluming is not permissible in this type of falls, the length of the crest is kept eqr-tal to the.bed width of the canal. Sometimes, for future eX:p11-nsion, the crest length may be kept equal to (bed w}dth +depth)

Short questions

1	What are the different types of cross drainage works necessary on canal alignment?	**Dec-2013**
2	What do you understand by the term level crossing?	**May-2013**
3	Explain the necessity of cross drainage structure.	**May-2014**
4	Explain various types of cross drainage works.	**May-2015**
5	What is a cross drainage work?	**Dec-2014**
6	How would you select suitable type of cross drainage work?	**Dec-2015**
7	Explain super passage in detail with neat sketch.	**Dec-2017**
8	What is an aqueduct? Explain with neat sketch.	**Dec-2016**
9	Write short notes on siphon aqueduct.	**May-2016**
10	Write short notes on canal siphon.	**May-2017**

Long questions:

1	Explain the procedure for the design of trapezoidal notch fall.	**Dec-2013**
	Describe the procedure for the design of a straight glacis fall when it is,	**May-2013**

2	(i) Unflumed and non-metered (ii) Flumed and metered.	
3	Data refer to fall site, full supply discharge us/ds =50 cumecs, bed width u/s/d/s = 28 m, full supply level u/s/d/s = 150/148.50, bed level u/s/d/s = 148/146.5. What type of fall would you recommend for this canal. Design cistern of fall.	**May-2014**
4	What are the functions of distributor head regulator and cross-regulator?	**May-2015**
5	Define outlet. What are the essential requirements of a good outlet?	**Dec-2014**
6	How would you select suitable type of cross drainage work?	**Dec-2015**
7	Explain super passage in detail with neat sketch.	**Dec-2017**
8	What is an aqueduct? Explain with neat sketch.	**Dec-2016**
9	Write short notes on siphon aqueduct.	**May-2016**
10	Write short notes on canal siphon.	**May-2017**

Fill in the Blanks:

1. Where water must be raised by pumps or other means to irrigate crops is called ..... irrigation.
2. Soil in which the groundwater table rises so high as to affect the productivity of the soil due to air circulation to the plant root zone is called .....
3. An irrigation outlet whose discharge is independent of water levels in the distributary and the water course and whichensures constant supply within certain working limits is called a .....
4. The scour depth for a channel in fine silt is ..... than in coarse silt.
5. Excess flood over a concrete dam is released through the .....
6. The loss of water from plant surfaces and utilised in its growth is known as…..
7. A canal is 80 km long and has an average surface width of 15 m. If the average evaporation measured in a standard U.S. Weather Bureau Class, a pan is 0.5 cm/day, the volume of water evaporation in the m:onth of September is ..... . cubic metres.
8. If the wind velocity at a height of 2 m above ground is 5.0 km per hour, its value at a height of 10 m above ground can be expected to be about ..... km per hour.
9. liuLtriangular-channel the top widthana depth of-flow were 2;0 m and !l9m respectively. Velocity measurements on the centre line at 18 cm and 72 cm below the free water surface indicated velocities of 0.6 mis and 0.4 mis respectively. The ~ischarge in the channelis ..... cumec. .
10. During a flood in a wide rectangular channel it is found that at a section the depth of flow increases by 50 per cent and at this depth the water surface slope . is half its original value in a given interval of time. This marks an approximate change in the discharges of ..... per cent.