



KINGS



COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

SUB. NAME: CE 2253 APPLIED HYDRAULIC ENGINEERING

YEAR/SEM:II/IV

UNIT I

OPEN CHANNEL FLOW

1. Define open channel flow with examples.

Flow of liquid with a free surface (i.e., surface exposed to atmosphere) through any passage is known as open channel flow. The liquid flowing through any closed passage without touching the top can also be treated as open channels.

Examples:

1. Flow in natural waterfalls, river and streams
2. Flow in artificial or man-made channels such as irrigation channels and flumes.
3. Closed conduit or pipe carries liquid partially (sewers that carry domestic or industrial waste water).

Generally, liquid flowing in open channel is water.

2. Explain laminar and turbulent flow.

(a) Laminar flow:

If Reynolds number of flow is less than 500, it is called as Laminar flow. The value of Reynolds number is between 500 and 2000, the flow is transitional.

(b) Turbulent flow:

For values of Reynolds number greater than 2000, the flow is turbulent.

3. What are the various types of flow in open channels?

The flow in open channel is classified into the following types:

- (a) Steady and unsteady flow
- (b) Uniform and non- uniform flow
- (c) Laminar and turbulent flow
- (d) Subcritical, critical and supercritical flow.

4. Define the term uniform flow.

If the depth of flow, slope of the bed of channel and cross section remain constant with respect to distance is called uniform flow.

$$\left(\frac{\partial y}{\partial s}\right) = 0, \quad \left(\frac{\partial V}{\partial s}\right) = 0$$

5. Define non uniform flow.

Flow properties, such as depth of flow, velocity of flow are not constant with respect to distance is called non uniform flow.

$$\left(\frac{\partial y}{\partial s}\right) \neq 0, \quad \left(\frac{\partial V}{\partial s}\right) \neq 0$$

6. Distinguish between steady and unsteady flow.

In steady flow, various characteristics of flowing fluids such as velocity, pressure, density, temperature etc. at a point do not change with time. In other words, a steady flow may be defined as that in which the various characteristics are independent of time. Mathematically it can be expressed as

$$\left(\frac{\partial u}{\partial t}\right) = 0; \quad \left(\frac{\partial v}{\partial t}\right) = 0; \quad \left(\frac{\partial w}{\partial t}\right) = 0;$$
$$\left(\frac{\partial p}{\partial t}\right) = 0; \quad \left(\frac{\partial \rho}{\partial t}\right) = 0.$$

In unsteady flow, various characteristics of flowing fluids such as velocity, pressure, density, etc. at a point change with respect to time.

Mathematically,

$$\left(\frac{\partial v}{\partial t}\right) \neq 0; \text{ and or } \left(\frac{\partial p}{\partial t}\right) \neq 0 \quad \text{etc.}$$

Unsteadiness refers to the change of flow pattern with the passage of time at a position in the flow.

7. Explain the terms: (i) Gradually varied flow and (ii) Rapidly varied flow. [Anna Univ.Nov'07&Nov'08]

1. Gradually varied flow

If the depth of flow changes gradually over a long length of the channel, the flow is said to gradually varied flow (GVF).

2. Rapidly varied flow.

If the depth of flow changes rapidly over a small length of the channel, the flow is said to be rapidly varied flow.

8. Write down the formula for Froude number.

$$\text{Froude number, } F = \frac{V}{\sqrt{gD}} < 1$$

where

V = Average velocity of flow in m/s

g = Acceleration due to gravity = $9.81 m/s^2$

D = Hydraulic depth in m

$$= \frac{\text{Crosssection area of flow}}{\text{Top width}} = \frac{A}{T}$$

9. Define hydraulic mean depth.

$$D = \text{Hydraulic depth in } m \\ = \frac{\text{Crosssection area of flow}}{\text{Top width}} = \frac{A}{T}$$

10. Define specific energy. [Anna Univ. Nov'06 & Nov'08]

Specific energy of a flowing liquid is defined as energy per unit weight of a liquid with respect to the bottom of the channel. By a symbol E .

$$E = y + \frac{V^2}{2g}$$

where
 y = Depth of flow
 V = Velocity of flow

11. Define critical flow.

Depth of flow of water at which the specific energy, E is minimum is called as critical depth (y_c)

For rectangular channel, critical depth,

$$y_c = \left(\frac{q^2}{g} \right)^{\frac{1}{3}}$$

12. Define critical velocity.

Velocity of flow at the critical depth is called critical velocity V_c

$$V_c = \sqrt{g y_c}$$

where
 y_c = Critical depth
 g = Acceleration due to gravity in m/s^2

13. Distinguish between critical, sub critical and subcritical flows.

Critical flow:

Depth of flow of water at which the specific energy is minimum is called as critical flow. Otherwise, flow corresponding to critical depth is called as critical flow.

For a critical depth, Froude number,

$$F = \frac{V_c}{\sqrt{g D}} = 1$$

where, D = Hydraulic mean depth

$$= \frac{\text{Area of flow}}{\text{Top width}}$$

Sub critical flow:

When the depth of flow in a channel is greater than the critical depth y_c , the flow is called as sub critical flow. It is otherwise, called as streaming flow or tranquil flow.

For sub critical flow, Froude number, $F < 1$

Sub critical flow:

When the depth of flow in a channel is less than the critical flow, y_c , the flow is called as sub critical flow or torrential flow.

For supercritical flow, Froude number, $F > 1$

14. Differentiate prismatic and non-prismatic channels.

Prismatic channel

Geometric dimensions of the channel, such as cross section and bottom slope are constant throughout the length of the channel is called as a prismatic channel. Eg. Most of the artificial channels of circular, rectangular, trapezoidal and triangular cross section are called prismatic channels.

Non- prismatic channel

Geometric dimensions of the channel, such as cross section and bottom slope are constant for length of the channel is called as a non-prismatic channel. Eg. All natural channels such as river, are non-prismatic channels.

15. Explain specific force (F_c) [Anna Univ. Nov'08]

Specific force is the sum of the pressure force (F) and momentum force due to flow (M) per unit weight of the liquid at a section.

$$\text{Specific force, } F_s = \frac{(F + M)}{\gamma}$$

where

γ = Weight density of liquid

16. What is specific energy and what is condition for obtaining only one depth for a given specific energy? [Anna Univ. May'07]

Total energy of open channel flow, $E = Z + y + \frac{V^2}{2g}$

Considering the channel bed as datum line, $Z = 0$, then the energy equation is called as specific energy.

Specific energy, $E = y + \frac{V^2}{2g}$

From specific energy curve, corresponding to specific energy minimum (E_{min}), there is only one depth of flow which is called *critical depth*.

17. Differentiate closed flow closed conduit flow and open channel flow. [Anna Univ. May'07]

| S.No | Closed conduit flow | Open channel flow |
|------|---|---|
| 1. | Water does not have with free surface. | Water flows with a free surface. |
| 2. | Water does not contact with atmosphere pressure but it has only hydraulic pressure. | Water contents with atmospheric pressure. |
| 3. | Flow may be due to either by pump pressure or by gravity flow | Flow is obtained only by gravity. |

UNIT -II
UNIFORM FLOW

1. Define uniform flow. Give examples.

Uniform flow is a fluid flow in which the velocity of any given instant does not change both in magnitude and direction with respect to space. Mathematically,

$$\left(\frac{\partial v}{\partial s}\right)=0$$

Example:

- Open channel flow with constant depth of water
- Flow through uniform diameter pipes.

2. What are the instruments used for measuring velocity in open channels?
[May'06, May'07, May'08 & May'09]

Velocity of flow is measured by various instruments such as Pitot tube, Current meter, hot wire anemometer, floats and Laser Doppler velocimetry.

3. What is cup type current meter?

In this type, series of conical cups called revolving element are mounted on a spindle vertically at right angle to the direction of flow.

4. Give some applications of laser Doppler Anemometer.

1. It is used for the flow between blades of a turbine.
2. It is used for combustion and flame phenomena in gas turbines.

3. It is used in Jet propulsion systems.
 4. It is used for measuring the blood flows.
 5. In remote sensing of wind velocities.
- 5. Write down the Manning's formula for determining velocity of flow in an open channel.**

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

where 'n' is called Manning's Roughness Coefficient.
 V = mean velocity of flow in m/s
 n = a roughness coefficient or Manning's 'n'
 R = hydraulic radius of the channel in m
 S = Channel bed slope

- 6. List the factors affecting Manning's roughness coefficient. [Nov'08]**

The following factors affecting Manning's roughness coefficient are:

1. Surface roughness
 2. Vegetation growth
 3. Channel irregularities
 4. Sitting and scouring
 5. Stage (water surface elevation) and discharge
 6. Transport of suspended and bed material.
- 7. What are the condition for obtaining most economical circular channel section for maximum velocity and discharge?**
- a. Condition for maximum velocity of circular section
 - (i) Depth of flow is 0.81 times the diameter of the circular channel.
 - (ii) Hydraulic radius is equal to 0.3 times the diameter of channel.
 - (iii) Angle subtended by water surface from the centre,
 $2\theta = 257^{\circ}30'$

b. Condition for maximum discharge of circular section

(iv) Depth of flow is 0.91 times the diameter of the circular channel.

(v) Hydraulic radius is equal to 0.286 times the diameter of channel.

(vi) Angle subtended by water surface from the centre, $2\theta = 308^\circ$.

8. Show that maximization of discharge required minimization of the wetted perimeter of the channel for a given area of flow. [May'10]

For a given channel slope, roughness coefficient and area of flow, the maximum discharge of channel is obtained when the wetted perimeter is minimum.

$$\text{For wetted perimeter } (P) \text{ to be minimum, } \frac{dP}{dy} = 0$$

If second derivative of P is positive, the condition of minimum P is obtained.

9. Define non-erodible channels.

Channels which are constructed from materials, such as concrete, masonry and metal can withstand erosion under all including most extreme conditions are called as non-erodible sections.

10. What are the factors considered while designing non-erodible channels?

The following factors considered while designing the non-erodible channels are:

- (a) Manning's constant ' n ' value of the material
- (b) Channel slope
- (c) Free board

11. How Stickler equation can be used to calculate roughness coefficient?

Stickler formula is used to determine Manning's constant 'n' in non-erodible channels

$$n = 0.038d^{1/6}$$

Where, d= Particle size diameter in m.

UNIT-III

VARIED FLOE

1. Define varied flow. Explain its classification.

Flow properties, such as depth of flow area of cross section and velocity of flow vary with respect to distance is called Non-uniform flow.

It is, otherwise, called as varied flow. The varied flow is broadly classified into two types:

- 1) Rapidly varied flow (R.V.F)
- 2) Gradually varied flow (G.V.F)

2. Define gradually varied flow and rapidly varied flow in open channel.

[Nov'07, May'08&Nov'08]

If the depth of flow changes quickly over a small length of the channel, the flow is said to be gradually varied flow (GVF). Example: Back water in a dam. Depth of water increases rapidly over a short length of the channel is called rapidly varied flow.

Example: hydraulic jump.

3. State the assumptions made in the derivation of dynamic equation for gradually varied flow. [Nov'08]

The following assumptions are made for analyzing the gradually varied flow:

1. The flow is steady

2. The pressure distribution over the channel section is hydrostatic, i.e., streamlines are practically straight and parallel.
3. The head loss is same as for uniform flow.
4. The channel slope is small, so that the depth measured vertically is the same as depth measured normal to the channel bottom.
5. A channel is prismatic.
6. Kinetic energy correction factor is very close to unity.
7. Roughness coefficient is constant along the channel length.
8. The formulae, such as Chezy's formula, Manning's formula which are applicable, to the uniform flow are also applicable for the gradually varied flow for determining slope of energy line.

4. Distinguish between draw down and back water curves. [Nov'07, Nov'08&May'10]

When the depth of flow decreases along the flow direction

$$\frac{dy}{dx}$$

becomes negative and the surface profile is called a drawdown curve.

When the depth of flow (y) increases in the direction of flow, slope of water

surface

$$\left(\frac{dy}{dx}\right)$$

is positive (upward slope) and the water

surface is known as Backwater curve.

5. Write the expression to determine the length of the backwater curve. (Nov'09)

$$\text{Length of backwater curve, } L = \frac{E_2 - E_1}{S - S_c}$$

where

E_2 = Energy head at section 2-2

E_1 = Energy head at section 1-1

S_c = Slope of energy line

6. What is backwater curve in gradually varied flow profile and give practical example for getting this type of profile. (Nov'06)

When the depth of flow (y) increases in the direction of flow, slope of water surface $\left(\frac{dy}{dx}\right)$ is positive (upward slope) and the water surface is known as Backwater curve. Due to obstruction (dam), the water level raises and it has maximum depth of water near to the dam as shown in figure is an example for back water curve.

7. What is normal slope of an open channel?

If the flow in the channel is uniform, the channel is said to have a normal slope denoted by S_n .

8. What are the flow profiles possible in mild sloped channels?

1. Flow behind an overflow weir.
2. Flow Over a free overall
3. Flow downstream of a sluice gate.

9. Classify surface profiles in a channel. [May'08&Nov'06]

Based on channel slopes, channels can be classified into five types as stated earlier.

1. Mild slope (M)
2. Critical slope (C)
3. Steep slope (S)
4. Horizontal slope (H)
5. Adverse slope (A)

10. What are the methods used to determine the length of surface profile?

Length of surface profile determined with the help of any one of the following methods.

1. Graphical Integration method.
2. Direct step method.
3. Standard step method.

11. Define the Afflux.

[Nov'08]

Afflux is defined as the maximum increase in water level due to obstruction in the path of flow of water.

12. What is transition in open channel?

Transition means a change of channel cross section.

- (i) Provision of a hump or depression along depth and
- (ii) Contraction or expansion of channel width, in any combination.

13. Write down the applications of transition.

Transition in open channel flow is made to measure discharge of channel.

Generally, discharge, $Q = \text{Area } (A) \times \text{Velocity } (V)$. For discharge calculation, both cross section of flow and velocity are necessary. With the help of channel transition, discharge of water obtained from measured flow cross section dimensions and / specific energy equations.

14. What is hydraulic jump in horizontal bed channel? [Nov'06 & May'07]

The rise of water level which takes place due to the transformation of the shooting to the streaming flow is known as hydraulic jump.

15. Write the expression for hydraulic jump?

$$y_2 = \frac{y_1}{2} \left(\sqrt{1 + 8(F_1)^2} - 1 \right)$$

Depth of hydraulic jump = $y_1 - y_2$

where

y_1 = Depth of flow at section 1-1

y_2 = Depth of flow at section 2-2

F_1 = Froude number at section 1-1

16. Define loss of energy due to hydraulic jump.

$$h_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$$

where

y_1 = Depth of flow at section 1-1

y_2 = Depth of flow at section 2-2

17. State the uses of hydraulic jump. [Nov'06, Nov'07 & May'10]

The kinetic energy of flow after the hydraulic jump is greatly reduced, which may prevent erosion of the channel boundaries of downstream side.

18. Explain the classification of hydraulic jumps. [May'10]

Based on Froude number (F), hydraulic jump can be classified into 5 types.

- a. Undulation jump: The Froude number F ranges from 1 to 1.7 and the liquid surface does not rise sharply but having undulations of radically decreasing size.
- b. Weak jump: The Froude number F ranges from 1.7 to 2.5 and the liquid surface remains smooth.
- c. Oscillating jump: The Froude number F ranges from 2.5 to 4.5 and there is an oscillating jet which enters the jump bottom and oscillating to the surface.
- d. Steady jump: The Froude number F ranges from 4.5 to 9 and energy loss due to steady jump is between 45 and 70%.
- e. Strong jump: The Froude number greater than 9 and the downstream water surface is rough. Energy loss due to strong jump may be up to 85%.

19. Define surges.

When the flow properties, such as discharge or depth varies suddenly is called surge.

Example: sudden closure of gate.

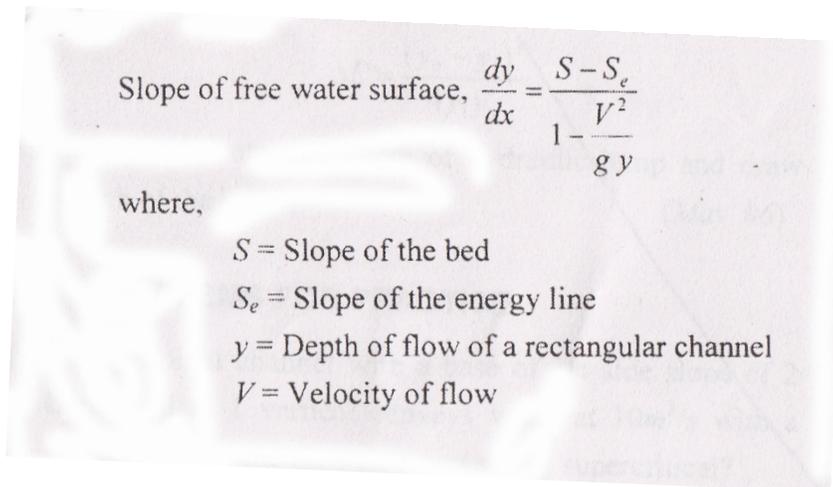
20. What are meant by positive and negative surges? [Nov'07]

1. Positive surge – a surge producing increase in depth
2. Negative surge – a surge producing decrease in depth.
- 3.

21. Define the term backwater curve.

The profile of the rising water on the upstream side of the dam is called backwater curve. The distance along the bed of the channel between sections where water is having maximum height is known as length of back water curve.

22. Write down the dynamic equation for gradually varied flow.



UNIT-IV

TURBINES

1. What do you mean by turbine?

The hydraulic machine which convert the hydraulic energy in to mechanical energy is called turbine

2. Define pump:

It is defined as the hydraulic machine which converts mechanical energy in to hydraulic energy

3. Explain net head

It is defined as the head available at the inlet of turbine .If H_f is the loss due to friction between water and penstock then net head

$$H=H_g-H_f$$

4. Define Hydraulic Efficiency:

It is defined as the ratio of power delivered to the runner to the power supplied at the inlet.

5. Define mechanical efficiency

It is defined as the ratio of power at the shaft of the turbine to the power delivered by the water to runner.

6. Define volumetric efficiency

It is defined as the ratio of volume of water actually striking the runner to the Volume of water supplied to the runner.

7. Define over all efficiency

It is defined as the ratio of shaft power by water power

8. Explain impulse turbine

If at the inlet of the turbine the energy available is only kinetic energy the turbine is known as impulse turbine.

9. Explain Reaction turbine

If at the inlet of the turbine the water possesses kinetic energy as well as pressure energy the turbine is known as reaction turbine.

10. Explain tangential flow turbine

If the water flows along the tangent of the runner, the turbine is known as the tangential flow turbine.

11. Explain radial flow turbine

If the water flows in the radial direction through the runner the turbine is called radial flow turbine.

12. Explain inward flow radial turbine

If the water flows from outwards to inwards radially the turbine is called inward radial flow turbine.

13. Explain outward flow radial turbine

If the water flows radially from inwards to outwards the turbine is known as outward radial flow turbine.

14. Define axial flow turbine

If the water flows through the runner along the direction parallel to the axis of rotation of the runner the turbine is called axial flow turbine.

15. What is Pelton wheel:

Pelton wheel or Pelton turbine is a tangential flow impulse turbine. The water strikes the bucket along the tangent of the runner. The energy available at the inlet of the Turbine is only kinetic energy. This turbine is used for high heads.

16. What is breaking jet?

When the nozzle is completely closed, the amount of water striking the runner reduces to zero but the runner due to inertia goes on revolving for a long time to stop the runner in a short time a small nozzle is provided which directs the jet of water on the back of vanes. This jet of water is called breaking jet.

17. What is jet ratio?

It is the ratio of pitch diameter (D) to the diameter of jet (d).

18. What is Draft tube?

A tube or pipe of gradually increasing area is used for discharging water from the exit of the turbine to the tail race is called draft tube.

19. Define Degree of Reaction (R)

It is defined as the ratio of change of pressure energy inside the runner to the change of total energy outside the runner.

20. What is radial discharge?

This means the angle made by absolute velocity with the tangent on the wheel is 90° and the component of whirl velocity is zero.

22. Define Francis turbine:

Inward flow reaction turbine having radial discharge at outlet is known as Francis Turbine

23. Define propeller turbine:

This is an example of axial flow reaction turbine. Here the vanes are fixed to the hub and are not adjustable.

24. Define Kaplan turbine:

This is an example of axial flow reaction turbine. Here the vanes are not fixed to the hub and are adjustable.

25. What are the uses of draft tube?

1. The net head on the turbine increases.
2. Due to increase in net head the power and efficiency of the turbine also increases.
3. The large amount of rejected kinetic energy is converted into useful pressure energy

26. What are types of draft tube?

1. Conical draft tube
2. Simple elbow tube
3. Moody spreading tube
3. Draft tube with circular inlet and rectangular outlet.

27. What are the types of characteristic curves?

1. Main characteristic curves
2. Operating characteristic curve
3. Muschel characteristic curves

28. What is specific speed of the turbine?

It is defined as the speed of a turbine which will develop unit power under unit head.

29. Define unit quantities;

Unit quantities are the quantities which are obtained when the head on the turbine are unity.

30. Explain about characteristic curves of a hydraulic turbine

Characteristic curves of a hydraulic turbine are the curves with the help of which the exact behavior and performance of the turbine under different working conditions can be known.

31. What are the main parts of pelton wheel turbine?

1. Nozzle and flow regulating arrangement
2. Runner with buckets
3. Casing
4. Breaking jet

32. What are the main mechanisms of Radial flow reaction turbine?

1. Casing
2. Guide mechanism
3. Runner

4. Draft tube

33. What are the classifications of hydraulic turbine according to the type of energy at inlet?

- (a) Impulse turbine and
- (b) Reaction turbine

34. What are the types of turbine according to direction of flow through runner?

- (a) Tangential flow turbine
- (b) Radial flow turbine
- (c) Axial flow turbine
- (d) Mixed flow turbine

35. What are the types of turbine according to the head at the inlet of the turbine?

- (a) High head turbine
- (b) Medium head turbine
- (c) low head turbine

Where on e section is taken

36. What do you know about Hub or Boss?

It is the core part of the axial flow turbine where the vanes are attached.

37. Under what head the propeller turbine take water?

About 100 m head the propeller turbine take water.

When the vanes are fixed to the hub and they are not adjustable the turbine is Called propeller turbine.

38. What are the uses of Kaplan turbine?

1. To produce more out put.
2. The efficiency of the turbine is more

UNIT-V

PUMPS

1. How are fluid machines classified?

Fluid machines are classified into 2 categories depending upon the direction of transfer of energy:

1. Turbines
2. Pumps or compressors.

2. What is centrifugal pump?

The hydraulic machines which convert mechanical energy in to pressure energy by means of centrifugal force is called centrifugal pump. It acts a reverse of inward radial flow turbine.

3. What are the main parts of centrifugal pump?

1. Suction pipe with foot valve and strainer
2. Impeller
3. Casing
4. Delivery pipe

4. Write down the use of centrifugal pump?

1. Used in deep sump and basement
2. The high discharge capacity
3. It is driven by electric motors

5. Define multistage pump:

If centrifugal pump consists of two or more impellers the pump is called Multistage pump. To produce a high head impellers are connected in series .To produce high discharge impellers are connected in parallel.

6. What is Net Positive Suction Head (NPSH)?

NPSH is defined as the total head required making liquid flow through suction pipe to pipe impeller.

7. Define slip of a reciprocating pump and negative slip:

Slip is defined as the difference between theoretical discharges and actual discharge.

If actual discharge is greater than theoretical discharge negative value is found this negative value is called negative slip.

8. What do you know coefficient of discharge?

It is defined as the ratio of actual discharge by theoretical discharge. It is denoted by C_d

9. What do you know Drop down curve?

The water surface has a convex profile upwards this curve is called drop down Curve.

10. What is separation of reciprocating pump?

If the pressure in the cylinder is below the vapour pressure, dissolved gases will be liberated from the liquid and cavitations will take place. The continuous flow of liquid will not exist which means separation of liquid takes place. The pressure at which separation takes place is called separation pressure and head corresponding to the separation pressure is called separation pressure head.

11. What is an indicator diagram?

Indicator diagram is the graph between the pressure head and distance traveled by the piston from inner dead center for one complete revolution.

12. What is Air vessel?

Air vessel is a closed chamber containing compressed air in the top portion and liquid at the bottom of the chamber. It is used to obtain a continuous supply of water at uniform rate to save a considerable amount of work and to run the pump at high speed without separation.

13. What is the purpose of an air vessel fitted in the pump?

1. To obtain a continuous supply of liquid at a uniform rate.
2. To save a considerable amount of work in overcoming the frictional resistance in the suction and delivery pipes, and
3. To run the pump at a high speed with out separation.

14. What is the work saved by fitting a air vessel in a single acting, double acting pump?

Work saved by fitting air vessels in a single acting pump is 84.87%,
In a double acting pump the work saved is 39.2%.

15. What is Discharge through a Reciprocating Pump in per sec?

For Single acting

$$\text{Discharge (Q)} = \frac{ALN}{60}$$

Where,

A=Area of the Cylinder

L=Length of Stroke in m.

N=Speed of Crank in RPM

For Double acting

$$Q = \frac{2ALN}{60}$$

16. What is the relation between Work done of a Pump and Area of Indicator Diagram?

Work done by the pump is Proportional to the area of the Indicator diagram.

16 MARKS

UNIT – I

1. Show that in rectangular channel maximum discharges occurs when the flow is critical for a given value of specific energy?
2. A trapezoidal channel has side slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 2000. The area of the section is 42 m². Find the dimensions of the section if it is to be most economical. Determine the discharge of the most economical section of $C = 60$.
3. Describe various types of flow in an open channel.
4. A rectangular channel with a base width of 0.60 m carries a discharge of 100 lps. The Chezy's C is 60. If the depth of flow is 0.25 m, determine the bed slope of the channel
5. In a flow through a rectangular channel for a certain discharge Froude number corresponding the two alternate depths are y_1 and y_2 . Show that $(F_2/F_1)^{(3/2)} = (2+F_2^2)/(2+F_1^2)$
6. A rectangular channel 1.5m wide and depth 2.25m, discharge is 10m³/sec. calculate the specific energy and depth alternate to the given depth.
7. A trapezoidal channel has a bottom width 6m and side slope of 2h to 1v if a depth of flow is 1.2m at a discharge of 10m³/sec. compute the specific energy and critical depth.
8. Define wide open channel and also what are the important assumptions in hydraulic parameters?
9. The rectangular channel carries a discharge of 30m³/sec. The bottom width of the channel is 6.0m and flow velocity is 1.75m/sec. Determine two alternate depths possible in the channel.
10. If y_1 and y_2 are alternate depths in a rectangular channel show that $Y_C^3 = (2y_1^2y_2^2) / (y_1 + y_2)$ And hence the specific energy $E = (y_1^2 + y_1y_2 + y_2^2) / (y_1 + y_2)$

11. For a constant specific energy of 3.0m, what maximum flow may occur in a rectangular channel of 4.5m bed width?
12. The specific energy for a 3m wide channel is 8N.m/N. What is the maximum possible discharge in the channel?
13. Show that the minimum specific energy in a rectangular channel is 1.5 times the critical depth.
14. Show that the relation between alternate depths y_1 and y_2 in a rectangular channel can be expressed by $2y_1^2 y_2^2 / (y_1 + y_2) = y_c^3$ where y_c is the critical depth of flow.
15. For a constant energy of 2.4N.m/N. Calculate the maximum discharge that may occur in a rectangular channel 4m wide.
16. For a purpose of discharge measurement the width of a rectangular channel is reduced gradually from 3m to 2m and floor is raised by 0.3m at a given section when the approaching depth of flow is 2m, what rate flow will be indicated by a drop of 0.15m in the water surface elevation at the contracted section?
17. The specific energy for a 5m wide rectangular channel is 4m, the discharge of water through the channel is 19cumecs. Determine the alternate depths of flow?

UNIT – II

1. Determine the dimensions of the most economical trapezoidal channel with Manning's $n = 0.02$, to carry a discharge of $14\text{m}^3/\text{sec}$ at a slope of 4 in 10,000.
2. Determine the longitudinal slope of a triangular channel carrying $1.2\text{m}^3/\text{sec}$ for a normal depth of flow 0.75m and a side slope 2 : 1. Take Chezy's $C = 45$.
3. A trapezoidal channel with side slope 1 to 1 has to be designed to convey $10\text{m}^3/\text{sec}$ at a velocity of a 2m/sec so that the amount of concrete lining for the bed and sides is the minimum. Calculate the area of lining required for one meter

length of channel

4. What diameter of a semicircular channel will have the same discharge as a rectangular channel of width 2.5m and depth 1.25m? Assume the bed slope and Manning's 'n' are the same for both the channels.
5. A canal is formed with side slopes 2:1 and a bottom width of 3.0m. The bed slope is 1 in 4500. Using Manning's formula and assuming Manning's 'n' as 0.025, calculate the depth of water for a discharge of 3.0m³/sec for a uniform flow.
6. For the purpose of discharge measurement width of a rectangular channel is reduced gradually from 4.0m to 2.0m and the flow is raised by 0.45m at a given section. When the approaching depth of flow is 2m, what rate of fall will be indicated by a drop of 0.3m in the water surface elevation at the contracted section?
7. Obtain an expression for the depth of flow in a circular channel which gives maximum velocity for a given longitudinal slope. The resistance to flow can be expressed by Manning's equation
8. In a rectangular channel 3.5m wide, flow depth of 2m, find how high can be raised without causing afflux. If the upstream depth of flow raised to 2.5m what should be the height of the hump? Flow in the channel is 26.67m³/sec.
9. Calculate the critical depth and corresponding specific energy for a discharge of 5.0m³/sec in the following channel.
 - i) Rectangular channel of bed width 2.0m
 - ii) Triangular channel of side slope 1h and .5v
 - iii) Circular channel of diameter 2.0m
10. Prove that for maximum discharge in circular channel the depth of flow is equal to 0.95 times diameter of the channel.
11. A trapezoidal channel having bottom width 6m and side slope 2h and 1v is laid in the bottom slope of 0.0016. If it carries a uniform flow of water at the rate of 10m³/sec, compute the normal depth and the mean velocity of flow. Take

manning's as 0.025.

12. Define uniform flow in open channel and write chezy's equation.
13. The trapezoidal channel of bottom width of 3m side slope 1.5h and 1v carries discharge of $10\text{m}^3/\text{sec}$ at a depth of 1.5m under uniform flow condition the longitudinal slope of channel is 0.001. compute manning's roughness coefficient of the channel
14. A circular pipe diameter 600mm carries discharge $0.2\text{m}^3/\text{sec}$ will flow half full. Determine the slope of pipe to be laid in the ground. Assume manning's $n=0.013$ for concrete pipe. Also determine the depth of flow if the pipe is laid in a slope of 0.01.
15. Derive chezy's formulae to determine the velocity of flow in open channel
16. Determine the discharge through a rectangular channel of width 2m having a bed slope of 1 in 2000. The depth of flow is 1.5m and the value of manning constant n is 0.012.
17. Determine the dimensions of most economical trapezoidal channel section with 1.5 side slope to carry 10 cumecs of water on a bed slope of 1 in 1600.
18. The rate of flow of water through a circular channel of diameter 0.6m is 0.15 cumecs. Determine the slope of bed of the channel for maximum velocity. Assume c as 60.
19. Show that for a trapezoidal channel of a given area of flow, the condition of maximum flow requires that hydraulic mean depth is equal to one half of the depth of flow.
20. The circular sewer 0.6m inner diameter has a slope of 1 in 400. Find the depth when the discharge is $0.283\text{m}^3/\text{sec}$. take $c=50$.
21. List the various characteristics of critical state of flow through channels.
22. A trapezoidal channel having a bottom width of 5.0 m and side slope 2 : 1 is laid with a bottom slope of $1/750$. If it carries a uniform flow of $8\text{ m}^3/\text{s}$ compute the normal depth. Assume

Manning's $n = 0.025$.

23. A canal is formed with side slopes 2: 1 and a bottom width of 3.0m. The bed slope is 1 in 4500. Using Manning's formula and assuming Manning's n as 0.025. Calculate the depth of water for a discharge of $3.0\text{m}^3/\text{sec}$ for a uniform flow.
24. Define specific energy of flow at a channel section. Draw the specific energy curve and explain.

UNIT III

1. Discuss briefly the types of hydraulic jump, its application
2. Explain the development of M, S and H profiles with neat sketches
3. Briefly explain the direct step method and standard step method to determine the gradually varied flow profiles.
4. Define gradually varied and rapidly varied flow in open channel?
5. Derive the relation between sequent depths in open channel?
6. Derive the dynamic equation of gradually varied flow.
7. Determine the slope of the free water surface in a rectangular channel of width 20m, having depth of flow 5m. the discharge through the channel is 52 cumecs. The bed slope of the channel is 1 in 4000. Assume Chezy's constant c as 60.
8. During an experiment conducted on a hydraulic jump, in a rectangular open channel 0.5m wide, the depth of water changes from 0.2m to 0.5m. determine the discharge in the channel and the loss of head due to the formation of hydraulic jump.
9. Show that the loss of energy in a hydraulic jump $\Delta E = \frac{(y_2 - y_1)^3}{4y_1y_2}$ where ' y_1 ' and ' y_2 ' are the conjugate depths.

10. Explain the direct step method for computing the length of the water surface profile.
11. State the application of hydraulic jump.
12. A partially open sluice gate discharges water at 10m/sec with 1m depth in a horizontal rectangular channel of width 5m. Can a hydraulic jump occur? If so find the sequent depth and energy loss.
13. Define uniform flow and draw the hydraulic gradient line, total energy line and water surface for uniform flow.
14. A concrete lined trapezoidal channel ($n=0.015$) is to have a side slope of 1 horizontal to 1 vertical. The bottom slope is to be 0.004. Find the bottom width of the channel necessary to carry 100m³/sec of discharge at a normal depth of 2.5m.
15. Define most economical section in open channel and obtain the relation for a trapezoidal channel.
16. A rectangular channel 10m wide carries a discharge of 30m³/s. it is laid at a slope of 0.0001. if at a section in this channel, the depth is 1.6m, how far upstream or downstream from the section will the depth be 2.0. take manning's n as 0.015.
17. Show that the head loss in a hydraulic jump formed in a rectangular channel may be expressed as $\Delta E = \frac{(V_1 - V_2)^2}{2g(V_1 + V_2)}$
18. A horizontal rectangular channel 4m wide carries a discharge of 16m³/sec. determine whether a jump may occur at an initial depth of 0.5m or not. If jump occurs determine the sequent depth to this initial depth.
19. A rectangular channel having bottom width 4.0m, manning's $n=0.025$, bottom slope 0.0005. The normal depth of flow in the channel is 2.0m. if the channel empties into a pool at the downstream and the pool elevation is 0.060m higher than the canal bed elevation at the downstream end, calculate the coordinates of the resulting gradually varied flow profile.

20. A sluice gate discharges $2.5\text{m}^3/\text{sec}$ into a wide horizontal rectangular channel. The depth at the vena contracts is 0.2m . the tail water depth is 2.0m assuming the channel to have a manning's $n=0.015$, determine the location of the hydraulic jump.
21. What are the assumptions made to derive the gradually varied flow from the basic energy equation and derive an expression for water surface slope?
22. How dynamic equation of gradually varied flow is simplified in wide rectangular channel?
23. How surface profiles of Gradually Varied Flow are classified and explain them with sketches
24. Derive the dynamic equation of gradually varied flow in an open channel and also state the methods of estimating the flow profile.
25. A river 100m wide and 3m depth has an average bed slope of 0.0005 . estimate the length of the gradually varied flow profile between 4.5m to 4m depth of flow. This back water profile produced by a low weir which raises the water surface just upstream of it by 1.5m from normal depth. Assume $n=0.035$
26. How to estimate the hydraulic jump and draw sketch of the jump
27. A rectangular channel of width 5m flows 1.5m in uniform flow bed slope of channel is 0.005 . The uniform flow is blocked be a weir and flow depth of 4m from bed of the channel. Determine the length of the back water profile between 4m to 2m . use direct step method and assume manning's n as 0.015

UNIT-IV

1. Explain the momentum principle with its application.
2. Explain the working of radial flow turbine with neat sketch.
3. Distinguish between impulse and reaction turbines.
4. Derive an expression for specific speed of a turbine.

5. Prove that the maximum efficiency is only 50%. When a liquid jet strikes a series of flat vanes mounted on the periphery of a wheel.

6. A reaction turbine works at 450 rpm under a head of 120m. The diameter at inlet is 120 cm and the flow area is 0.4m². The angles made by absolute and relative velocities at inlet are 20 and 60 respectively with the tangential velocity. Find i) discharge ii) power developed and iii) hydraulic efficiency. Assume velocity of whirl at outlet is zero.

7. What is the main advantage of fitting draft tube in Francis turbine?

8. The velocity of whirl at inlet to the runner of an inward flow reaction turbine is $3.15\sqrt{H}$ m/sec and the velocity of flow at inlet is $1.05\sqrt{H}$ m/s. The velocity of whirl at exit is $0.22\sqrt{H}$ m/s in the same direction as at inlet and the velocity of flow at exit is $0.83\sqrt{H}$ m/s, where H is head of water 30m. The inner diameter of the runner is 0.6 times the outer diameter. Assuming hydraulic efficiency of 80%. Compute angle of the runner vanes at inlet and exit.

9. An impulse wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 1.0m³/s under a head of 50m. The buckets deflect the jet through an angle of 165 degrees. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.99.

10. The external and internal diameters of an inward flow reaction turbine are 1.2m and 0.6 respectively. The head on the turbine is 22m and velocity of flow through the runner is constant and is equal to 2.5m/s. The guide blade angle is 10 degrees and the runner vanes are radial at inlet. The discharge is radial at outlet. Determine i) the speed of the turbine ii) the vane angle at outlet iii) hydraulic efficiency

11. What are the main components of Kaplan turbine? Explain with a neat sketch.

12. A Kaplan turbine is to be designed to develop 9000 kW. The net available head is 5.6m. the speed ratio is 2.09 and the flow ratio is 0.68. the overall efficiency is 86% and the diameter of the boss is one third the diameter of the runner. Determine the diameter of the runner, speed and specific speed of the turbine.
13. Classify hydraulic turbines.
14. A pelton wheel has to work under a head of 60m while running at 200 rpm. The turbine is to develop a power of 95.6475 kW. The velocity of buckets is 0.45 times of the velocity of jet. The overall efficiency is 0.80 and coefficient of velocity is 0.98. Design the pelton wheel.
15. A Kaplan turbine while working under a head of 35m develops power of 20,000kW. Assume flow ratio of 0.6, speed ratio of 2, the diameter of boss is 0.35times the diameter of the runner and overall efficiency is 85%. Find the diameter, speed and specific speed of the turbine
16. What are unit quantities? Define the unit quantities for a turbine. Why are they important?
17. Define the term ‘governing of a turbine’. Describe with a neat sketch the working of an oil pressure governor.
18. What are the functions of draft tubes? Sketch the different types of draft tubes and explain the merits and demerits.
19. An inward flow reaction turbine works under a head of 22.5 m. The external and internal diameter of the runner is 1.35 m and 1.0 m respectively. The angle of guide vane is 15° And the moving vane is radial at inlet. Radial velocity of flow through runner is constant and equal to 0.2 there is no velocity of whirl at outlet. Determine the speed of the runner and the angle of vanes at outlet.
20. Determine the speed of a pelton wheel, its diameter, number of jet required and the size of each jet if it develops 13,800 MHP under a head of 430m. Its specific speed is 42. Assume necessary suitable values.

UNIT-V

1. The centrifugal pump has the following characteristics. Outer diameter of impeller is 800mm: width of the impeller vane at outlet = 100mm: angle of the impeller vanes at outlet is 40 degree. The impeller runs at 550 rpm and delivers 0.98m³/sec under an effective head of 35m. A 500kW motor is used to drive the pump. Determine the manometric, mechanical and overall efficiencies of the pump. Assume water enters the impeller vanes radially at inlet.
2. Distinguish between single stage pump and multistage pump.
3. The diameters of an impeller of a centrifugal pump at inlet and outlet are 300mm and 600mm respectively. Determine the minimum starting speed of the pump if it work against head of 28m.
4. Explain the working principle of single acting reciprocating pump with neat sketch.
5. A single acting reciprocating pump running at 50rpm delivers 0.01m³/sec of water. The diameter of the plunger is 200 mm and the stroke length is 400mm. the delivery and suction head are 10m and 5m respectively. Determine the theoretical discharge, slip, percentage slip, coefficient of discharge and the power required to drive the pump.
6. Define manometric efficiency and net positive suction head (NPSH).
7. A centrifugal pump works against a net head of 20m at a speed of 1200rpm. The vane angle at outlet is 30deg the impeller diameter and width at outlet are 40cm and 6cm respectively. Find the discharge. Take manometric efficiency as 95%.
8. The inlet and outlet diameters of the impeller of a centrifugal pump are 25cm and 50 cm respectively. The velocity of flow at outlet of flow is 2.5m/s and the vanes are set back at an angle of 45deg at the outlet. Find the minimum starting speed if the manometric efficiency is 0.8.

9. Explain the working of single acting reciprocating pump with air vessel.
10. A single acting reciprocating pump running at 30rpm has a stroke length of 40cm and piston diameter of 20cm. the suction head is 3.0m and length and diameter of suction pipe are 6m and 10cm respectively. Take $f=0.02$ and $H_{atm}=10.3\text{m}$ of water. Find the absolute pressure head inside the cylinder at the beginning middle and end of suction stroke.
11. What is specific speed of a pump and what is its importance?
12. The cylinder bore diameter of a single acting reciprocating pump is 150mm. and its stroke length is 300 mm. the pump runs at 50 rpm and lifts water through a height of 25m. The delivery pipe is 22m long and 100mm in diameter. Find the theoretical discharge and the theoretical power required to run the pump. If the actual discharge is 4.2 litres/s, find the percentage slip.
13. A single acting reciprocating pump is installed 3.5 m above the water level in the pump. The suction pipe is 20cm in diameter and 10m in length. The piston is of 30cm diameter and has 50cm stroke. Determine the speed at which separation may take place. Take $H_{atm}=10.3\text{m}$ of water and $H_{sep}=2.5\text{m}$ of water absolute.
14. A single acting reciprocating pump having a plunger of 12cm diameter and a stroke of 25 cm draws a water from a sump 2m below its center and delivers to a tank 10m above its centre. The diameter of the pipe is 8cm and the suction pipe is 3m long and the delivery pipe is 12m long. An air vessel is fitted to the delivery pipe along very near to the pump axis. The separation pressure is 8 kN/m² below atmospheric pressure. The density of the liquid pumped is 1200 kg/m³ and the friction factor for the pipes is 0.01. Find the maximum speed of the pump to run without separation to occur. Also determine the power required to run the pump at this speed.
15. What is an air vessel? Describe the function of the air vessel for reciprocating pumps.

16. Describe the principle and working of a reciprocating pump with a neat sketch.
17. Explain the occurrence of negative slip.
18. Explain: Priming, specific speed of a centrifugal pump. (6)
19. What is the difference between single-stage and multistage centrifugal pumps?
20. Describe multistage pump with (1) impellers in parallel and (2) impellers in series
21. Explain various losses occurring in a centrifugal pump.
22. A centrifugal pump has an impeller of 0.50 m outer diameter. It runs at 750 rpm and discharges 140 lps against a head of 10 m. The water enters the impeller without whirl and shock. The inner diameter is 0.25 m. The vanes are set an angle of 45° at the outlet. The area of flow is constant from inlet to outlet of the impeller and equals to 0.06 m^2 .

Determine (1) Manometric efficiency of the pump (2) Vane angles at inlet.

23. Explain with sketch how multi cylinder pump supplies more uniform flow as compared to single cylinder pump without any air vessel.
24. Explain the principle of gear pump and rotating cylinder pump.
25. A single acting reciprocating pump discharges 5 l / sec with cylinder bore diameter 200 mm and its stroke length 300 mm . The pump runs at 350 rpm and lifts water through a height of 25 m . The delivery pipe is 30 m long and 100 mm in diameter. Find the theoretical discharge and theoretical power required to run the pipe and determine the percentage slip and also determine the delivery head due to acceleration at beginning, middle and end.