CE 8302 FLUID MECHANICS

Two Marks Questions & Answers

UNIT I : FLUID PROPERTIES AND FLUID STATICS.

1. Define density or mass density.

Density of a fluid is defined as the ratio of the mass of a fluid to its volume.

Density, ρ = mass/volume (Kg/m^3)

ρ_{water} = 1000 Kg/m^3

2. Define specific weight or weight density.

Specific weight or weight density of a fluid is defined as the ratio between the weight of a fluid to its volume.

Specific weight, v = weight/volume
(N/m^3) v = ρg

v_{water} = 9810 N/m^3

3. Define specific volume.

Specific volume of a fluid is defined as the volume of fluid occupied by an unit wt or unit mass of a fluid.

Specific volume vs = volume/ wt = 1/ v = 1/ρg -----
for liquids Specific volume vs = volume/ mass =
1/ρ ----- for gases

4. Define dynamic viscosity.

Viscosity is defined as the property of fluid which offers resistance to the movement of one layer of fluid over another adjacent layer of the fluid.

$$\zeta = \mu \frac{du}{dy}$$

μ – dynamic viscosity or viscosity or coefficient of viscosity (N-s/m^2)

$$1\ N\text{-}s/m^2 = 1\ Pa\text{-}s = 10\ Poise$$

5. Define Kinematic viscosity.
   It is defined as the ratio between the dynamic viscosity and density of fluid.

$$\nu = \mu/\rho\ (m^2/s)$$

$$1\ m^2/s = 10000\ Stokes\ (or)\ 1\ stoke = 10^{-4}\ m^2/s$$

6. Types of fluids.

   Ideal fluid, Real fluid, Newtonian fluid, Non-Newtonian fluid, Ideal Plastic fluid.

7. Define Compressibility.
   It is defined as the ratio of volumetric strain to compressive stress.

$$\text{Compressibility}, \beta = (d\ Vol/ Vol) / dp\ (m^2/N)$$

8. Define Surface Tension.

   Surface tension is defined as the tensile force acting on the surface of the liquid in contact with a gas or on the surface between two immiscible liquids such that the contact surface behaves like a membrane under tension.

$$\text{Surface Tension}, \sigma = Force/Length\ (N/m)$$

$$\sigma_{water} = 0.0725\ N/m, \sigma_{Mercury} = 0.52\ N/m$$

9. Surface tension on liquid droplet, $\sigma = pd/4$ Surface tension on a hollow bubble, $\sigma = pd/8$
   Surface tension on a liquid jet, $\sigma = pd/2$ σ – surface tension (N/m)
   d – diameter (m)
   p – pressure inside (N/m^2)

   $p_{total} = p_{inside} + p_{atm}$ $p_{atm} = 101.325 \times 10^3\ N/m^2$

10. Define Capillarity.

    Capillarity is defined as a phenomenon of rise or fall of a liquid surface in a small tube relative to the adjacent general level of liquid when the tube is held vertically in the liquid. The rise of liquid surface is known as capillary rise while the fall of liquid surface is known as capillary depression.

Capillary Rise or fall, $h=(4\sigma\cos\theta) / \rho g d$

$\theta = 0$ for glass tube and water $\theta = 130^{\circ}$ for glass tube and mercury

11.Define Vapour Pressure.

When vaporization takes place, the molecules start accumulating over the free liquid surface exerting pressure on the liquid surface. This pressure is known as Vapour pressure of the liquid.

12. Define Control Volume.

A control volume may be defined as an identified volume fixed in space. The boundaries around the control volume are referred to as control surfaces. An open system is also referred to as a control volume.

UNIT-II
FLUID KINEMATICS AND DYNAMICS

1) Define forced vertex flow? Give example?

It is defined as that type of vertex flow in which some external torque is required to rotate the fluid mass.
Example.
1.A vertical cylinder containing liquid which is rotated about its central axis with a constant angular velocity.
2.Flow of liquid inside the impeller of a
centrifugal pump.

2) Define free vertex flow? Give examples?
When no external torque is required to rotate the fluid mass, that type of flow is called free vertex flow.
Example.
1.Flow of liquid through a hole provided at the bottom of a container.
2.A whirlpool in a river.

3) Write the equation of motion for vertex flow?

$$dp=\rho(v^2/r)dr-\rho g dz$$

4) Write the equation of forced vortex flow?

$$Z=(\omega^2 r^2)/2g$$

Where

Ω-Angular velocity.

5) Write the equation of closed cylindrical vessels?

$$Z=(\omega^2 r^2)/2g$$

Volume of air before rotation=Volume of closed vessel-Volume of liquid in vessel. Volume of air after rotation=Volume of parabolic formed.

6) What are the forces present in a fluid flow?
Fg-Gravity force
Fp-Pressure force Fv-Force due to viscosity Ft-force due to turbulence.
Fc-Force due to compressibility.

7) Give the Euler's equation of motion?

$(dp/\ )+gdz+vdv=0$

8) What are the assumptions made in deriving Bernoulli's equation?

1.The fluid is ideal
2.The flow is steady.
3.The flow is incompressible.
4.The flow is irrotational.

9) What is Bernoulli's equation for real fluid?

$(p1/\ g)+(v1^2/2g)+z1=(p2/\ g)+(v2^2/2g\ )+z2+hl$
where hl is the loss of energy

(p/ g)-Pressure energy.
(v2/2g)=Kinetic energy. z-Datum energy.

10. What arrangements should be adopted to find the velocity at any point in a pipe by a pitot tube? The arrangements to be adopted are (1)Pitot tube along with vertical piezometer tube.(2)Pitot

tube connected with piezometer.(3)Pitot tube and vertical piezometer connected with a differential U-tube manometer.

11. What are the types of fluid flows?

The fluid flow is classified as,

(1)Steady and unsteady flow.
(2)Uniform and non-uniform flow.
(3)Laminar and turbulent flow
(4)Compressible and incompressible flow. (5)Rotational and irrotational flow.
(6)One, two and three dimension flow.

12. Differentiate steady and unsteady flow?

Steady flow	unsteady flow.
1.Steady flow is defined as that type of flow in which the fluid characteristics like velocity, pressure etc at a point not change with time	Unsteady flow is that type of flow in which the velocity. pressure at a point do changes with time.
2. (dv/dt)(0,0,0)=0	(dv/dt)(0,0,0)=/0

13. Differentiate uniform and non-uniform flow?

Uniform flow	Non-uniform flow.
1.It is defined as that type of flow in which the velocity at any given time does not change with respect to space.	It is defined as that type of flow in which the velocity at any given time changes with respect to time.
2.(dv/dt)t=constant=0	(dv/dt)t=constant=/0

14. Differentiate laminar and turbulent flow?

Laminar flow.

1.Laminar flow is defined as that type of flow in which the fluid particle move along well defined path or streamline and all the streamline are straight and parallel.
2.Reynolds number<2000

Turbulent flow.

It is defined as that type of flow in which the fluid particle moves ina zig-zag way Reynolds number>4000.

15. Define compressible flow?

Compressible flow is that type of flow in which the density of the fluid changes from point to point.(eg)Flow of gasses through orifice nozzle and gas turbine.

16. Define incompressible flow?

Incompressible flow is that type of flow in which the density is constant for the fluid flow.(eg)Subsonic aerodynamics.

17. Define rotational flow?

Rotational flow is that type of flow in which in which the fluid particle flowing along streamlines, also rotate about their own axis.

18. Define irrotational flow?

It is that type of flow in which the fluid particle while flowing along streamlines; do not rotate about their own axis.

19. Define one dimensional flow?

One dimensional flow is that type of flow in which the flow parameter such as velocity is a function of time and one space co-ordinate only, say X. U=F(x),V=0,w=0.

20. Define two dimensional flow?

It is that type of flow in which the velocity is a function of time and two rectangular space say X and Y.

u=F1(X,Y),V=F2(X,Y) and w=0.

21. What is three dimensional flow?

A three dimensional flow is that type of flow in which the velocity is a function of time and three mutually perpendicular directions. U=F1(X,Y,X),v=F2(X,Y,Z),w=F3(X,Y,Z).

U,v,w are velocity components inX,Y,Z direction respect.

22. What is total acceleration of three dimensional fluid flow?

If a_x, a_y,a_z are the total acceleration in x,y,z directions.

Then $a_x=du/dt=u.(\partial u/\partial x)+v.(\partial u/\partial y)+w.(\partial u/\partial z)+\partial u/\partial t$.

$a_y=dv/dt=u.(\partial v/\partial x)+v.(\partial v/\partial y)+w.(\partial v/\partial z)+\partial v/\partial t$.

$a_z=dw/dt=u.(\partial w/\partial x)+v.(\partial w/\partial y)+w.(\partial w/\partial z)+\partial w/\partial t$

23. Define local acceleration?

It is defined as the rate of increase of velocity with respect to time at a given point in a flow field.

24. Define convective acceleration?

It is defined as the rate of change of velocity due to the change of position of fluid particle in a fluid flow.

25. Define velocity potential function?

It is defined as a scalar function of space and time such that its negative derivative with respect to any direction gives the fluid velocity in that direction. It is denoted by .

$U = -\partial\Phi/\partial x, v = -\partial\Phi/\partial y, w = -\partial\Phi/\partial z.$

U,v,w are the velocity in x,y,z direction.

26.Mention the properties of potential function?

1. If velocity potential exists, The flow should be irrotational.

2. If velocity potential satisfies the Laplace equation, It represents the possible steady incompressible irrotational flow.

27.Define stream function

It is defined as the scalar function of space and time, such that its partial derivative with respect to any direction gives the velocity component at right angles to that direction.

28.Mention the properties of stream function?

1. If stream function exists, it is a possible case of fluid flow which may be rotational.
2. If stream function satisfies Laplace equation, It is a possible case of an irrotational flow.

30.What is equipotential line?

A line along which the velocity potential is constant is called equipotential line. 31. Give the relation between stream function and velocity potential function?

$u = -\partial\Phi/\partial x$ and $v = -\partial\Phi/\partial y$

$u = -\partial\Psi/\partial y$ and $v = -\partial\Psi/\partial x$

$u = -\partial\Phi/\partial x = -\partial\Psi/\partial y$ and $v = -\partial\Phi/\partial y = -\partial\Psi/\partial x$

Hence $\partial\Phi/\partial x = \partial\Psi/\partial y$

$\partial\Phi/\partial y = -\partial\Psi/\partial x$

32. What is flow net?

A grid obtained by drawing a series of equipment lines and steam lines is called a flow net. The flow net is an important tool is analysis two dimensional. Irrotational flow problems.

33.What are the types of motion of fluid particle?

i. Linear translation or pure translation.
ii. Linear Deformation.
iii. Angular Deformation

iv. Rotation.

34.What is linear translation?

It is defined as the movement of a fluid element in such a way that it moves bodily from one position to represents in new position by a'b'&c'd' are parallel.

35. What is linear deformation?

It is defined as the deformation of a fluid element in linear direction when the element moves the axes of the element in the deformation position and un deformation position are parallel but their lengths changes.

36. Define angular deformation?

It is defined as the average change in the angle contained by two adjacent sides. Let s & s is the change in angle between two adjacent sides of a fluid element. The angular deformation=1/2*(S 1 +S 2).

37. Define rotation of fluid element?

It is defined as the movement of a fluid element in such a way that both of Rotate in same direction. It is equal to1/2(v/ x- u/ y) for a two-dimensional element x, y plane.

z=1/2(u/ x-u/ y)
x=1/2(w/ y-v/ z)
y=1/2(u/ z-w/ x)

38. Define vortex flow mention its types?

Vortex flow is defined as the flow of a fluid along a curved path or the flow of a rotating mass of fluid is known as vortex flow.
i. Forced vortex flow.
ii. Free vortex flow.

39. Define free vortex flow?

When no external torque is required to rotate the fluid mass that type of flow Is called free vortex flow.

40. Define forced vortex flow?

Forced vortex flow is defined as that type of vortex flow in which some external Torque is required to rotate the fluid mass. The fluid mass in the type of flow rotates at constant Angular velocity 'w'.The tangential velocity of any fluid particle is given by v=cosr.

41. Give the equation of motion for vortex flow?

Pressure acting PSA on the face AB. Pressure force (P+ p/ r r) SA on the face cd. Centrifugal force mv^2/r acting in the direction away.

From center O

Now the mass of the element= mass density*volume

$=\rho*\Delta A*\Delta r$

Centrifugal force$=\rho*\Delta A*\Delta r*v^2/r$

Equal the forces in the radial direction we get

$$(P+\partial p/\partial r\Delta r)\Delta A-p\Delta A=\rho\Delta A\Delta rv^2/r$$

$$\partial p/\partial r\Delta r\Delta A=\rho\Delta A\Delta rv^2/r$$

Cancelling $\Delta A.\Delta r$ on both sides we get

$$\partial p/\partial r=\rho v^2/r$$

UNIT III FLOW THROUGH PIPES

1. List the types of fluid flow.

Steady and unsteady flow

Uniform and non-uniform flow

Laminar and Turbulent flow

Compressible and incompressible flow

Rotational and ir-rotational flow

One, Two and Three dimensional flow

2. Define Steady and Unsteady flow.

Steady flow

Fluid flow is said to be steady if at any point in the flowing fluid various characteristics such as velocity, density, pressure, etc do not change with time.

$$\partial V/\partial t = 0 \quad \partial p/\partial t = 0 \quad \partial \rho/\partial t = 0$$

Unsteady flow

Fluid flow is said to be unsteady if at any point flowing fluid any one or all characteristics which describe the behaviour of the fluid in motion change with time.

$$\partial V/\partial t \neq 0 \quad \partial p/\partial t \neq 0 \quad \partial \rho/\partial t \neq 0$$

3. Define Uniform and Non-uniform flow.

Uniform flow

When the velocity of flow of fluid does not change both in direction and magnitude from point to point in the flowing fluid for any given instant of time, the flow is said to be uniform.

$$\partial V/\partial s = 0 \quad \partial p/\partial s = 0 \quad \partial \rho/\partial s = 0$$

Non-uniform flow

If the velocity of flow of fluid changes from point to point in the flowing fluid at any instant, the flow is said to be non-uniform flow.

$$\partial V/\partial s \neq 0 \quad \partial p/\partial s \neq 0 \quad \partial \rho/\partial s \neq 0$$

4. Compare Laminar and Turbulent flow.

Laminar and Turbulent flow

A flow is said to be laminar if Reynolds number is less than 2000 for pipe flow. Laminar flow is possible only at low velocities and high viscous fluids. In laminar type of flow, fluid particles move in laminas or layers gliding smoothly over the adjacent layer.

Turbulent flow

In Turbulent flow, the flow is possible at both velocities and low viscous fluid. The flow is said to be turbulent if Reynolds number is greater than 4000 for pipe flow. In Turbulent type of flow fluid, particles move in a zig – zag manner.

5. Define Compressible and incompressible flow

Compressible flow

The compressible flow is that type of flow in which the density of the fluid changes from point to point i.e. the density is not constant for the fluid. It is expressed in kg/sec.

$$\rho \neq \text{constant}$$

Incompressible flow

The incompressible flow is that type of flow in which the density is constant for the fluid flow.

Liquids are generally incompressible. It is expressed in m^3/s.

$$\rho = \text{constant}$$

6. Define Rotational and Ir-rotational flow.

Rotational flow

Rotational flow is that type of flow in which the fluid particles while flowing along stream lines and also rotate about their own axis.

Ir-rotational flow

If the fluid particles are flowing along stream lines and do not rotate about their own axis that type of flow is called as ir-rotational flow

7. Define One, Two and Three dimensional flow.

One dimensional flow

The flow parameter such as velocity is a function of time and one space co-ordinate only. $u = f(x), v = 0$

& $w = 0$.

Two dimensional flow

The velocity is a function of time and two rectangular space co-ordinates. $\mathbf{u = f_1(x,y)}$, $\mathbf{v = f_2(x,y)}$ **&** $\mathbf{w = 0}$.

Three dimensional flow

The velocity is a function of time and three mutually perpendicular directions.

$$u = f_1(x,y,z),\ v = f_2(x,y,z)\ \&\ w = f_3(x,y,z).$$

8. Write the Bernoulli's equation applied between two sections

$$p_1/\rho g + v^2_1/2g + Z_1 = p_2/\rho g + v^2_2/2g + Z_2$$

$p/\rho g$ = pressure head

$v^2/2g$ = kinetic head Z = datum head

9. State the assumptions used in deriving Bernoulli's equation

Flow is steady;

Flow is laminar;

Flow is irrotational;

Flow is incompressible;

Fluid is ideal.

10. Write the Bernoulli's equation applied between two sections with losses.

$$p_1/\rho g + v^2_1/2g + Z_1 = p_2/\rho g + v^2_2/2g + Z_2 + h_{loss}$$

11. List the instruments works on the basis of Bernoulli's equation.

Venturi meter

Orifice meter

Pitot tube.

12. Define Impulse Momentum Equation (or) Momentum Equation.

The total force acting on fluid is equal to rate of change of momentum. According to Newton's second law of motion,

$$F = ma$$
$$F\,dt = d(mv)$$

13.Mention the range of Reynold's number for laminar and turbulent flow in a pipe.

If the Reynolds number is less than 2000, the flow is laminar. But if the Reynold's number is greater than 4000, the flow is turbulent flow.

14. What does Haigen-Poiseulle equation refer to?

The equation refers to the value of loss of head in a pipe of length 'L' due to viscosity in a laminar flow.

15. What is Hagen poiseuille's formula?

$$(P_1-P_2) / \rho g = h_f = 32\ \mu \bar{U} L / \rho g D^2$$

The expression is known as Hagen poiseuille formula.

Where $P_1 - P_2 / \rho g$ = Loss of pressure head, $\bar{U}$= Average velocity,
μ = Coefficient of viscosity, D = Diameter of pipe,
L = Length of pipe

16. Write the expression for shear stress?

$$\text{Shear stress } \zeta = -(\partial p/\partial x)(r/2)$$
$$\zeta_{max} = -(\partial p/\partial x)(R/2)$$

17.Give the formula for velocity distribution: - The formula for velocity distribution is given as

$$u = -(¼\ \mu)(\partial p/\partial x)(R^2-r^2)$$

Where R = Radius of the pipe,

r = Radius of the fluid element

18. Give the equation for average velocity: -

The equation for average velocity is given as

$$\bar{U} = -\ (1/8\mu)\ (\partial p/\partial x)\ R^2$$

Where R = Radius of the pipe

19. Write the relation between Umax and Ū?

$$U_{max} / \bar{U} = \{ -\ (¼\ \mu)\ (\partial p/\partial x)\ R^2 \} / \{ -\ ⅛\mu\ (\partial p/\partial x)\ R^2 \}\ U_{max} / \bar{U} = 2$$

20. Give the expression for the coefficient of friction in viscous flow? Coefficient of friction between pipe and fluid in viscous flow

$$f = 16/\ Re$$

Where, f = Re = Reynolds number

21. What are the factors to be determined when viscous fluid flows through the circular pipe? The factors to be determined are:

i. Velocity distribution across the section.

ii. Ratio of maximum velocity to the average velocity.

iii. Shear stress distribution.

iv. Drop of pressure for a given length

22. State Darcy-Weisbach equation **OR** What is the expression for head loss due to friction?

$$h_f = 4flv^2 / 2gd$$

where, h_f = Head loss due to friction (m), L = Length of the pipe (m),

d = Diameter of the pipe (m), V = Velocity of flow (m/sec) f = Coefficient of friction

23. What are the factors influencing the frictional loss in pipe flow? Frictional resistance for the turbulent flow is,

i. Proportional to v^n where v varies from 1.5 to 2.0.

ii. Proportional to the density of fluid.

iii. Proportional to the area of surface in contact.
iv.Independent of pressure.

v.Depend on the nature of the surface in contact.

UNIT IV
BOUNDARY LAYER

1. Mention the range of Reynold’s number for laminar and turbulent flow in a pipe.

If the Reynolds number is less than 2000, the flow is laminar. But if the Reynold’s number is greater than 4000, the flow is turbulent flow.

2. What does Haigen-Poiseulle equation refer to?

The equation refers to the value of loss of head in a pipe of length ‘L’ due to viscosity in a laminar flow.

3. What is Hagen poiseuille’s formula?

$$(P_1-P_2) / \rho g = h_f = 32 \mu \bar{U} L / \rho g D^2$$

The expression is known as Hagen poiseuille formula.

Where $P_1-P_2 / \rho g$ = Loss of pressure head, $\bar{U}$= Average velocity, μ = Coefficient of viscosity, D = Diameter of pipe,

L = Length of pipe 4. Write the expression for shear stress?

$$\textbf{Shear stress } \zeta = -(\partial p/\partial x)(r/2)\ \zeta max = -(\partial p/\partial x)(R/2)$$

5. Give the formula for velocity distribution: - The formula for velocity distribution is given as

$$u = -(\tfrac{1}{4}\mu)(\partial p/\partial x)(R^2-r^2)$$

Where R = Radius of the pipe,

r = Radius of the fluid element 6. Give the equation for average velocity: -

The equation for average velocity is given as

$$\bar{U} = -(1/8\mu)(\partial p/\partial x) R^2$$

Where R = Radius of the pipe

7. Write the relation between Umax and Ū?

$$U_{max} / \bar{U} = \{ -(1/4\,\mu)(\partial p/\partial x) R^2 \} / \{ -1/8\mu\,(\partial p/\partial x) R^2 \} \quad U_{max} / \bar{U} = 2$$

8. Give the expression for the coefficient of friction in viscous flow? Coefficient of friction between pipe and fluid in viscous flow

$$f = 16/Re$$

Where, f = Re = Reynolds number

9. What are the factors to be determined when viscous fluid flows through the circular pipe? The factors to be determined are:

   i. Velocity distribution across the section.
   ii. Ratio of maximum velocity to the average velocity.
   iii. Shear stress distribution.
   iv. Drop of pressure for a given length

10. Define kinetic energy correction factor?

Kinetic energy factor is defined as the ratio of the kinetic energy of the flow per sec based on actual velocity across a section to the kinetic energy of the flow per sec based on average velocity across the same section. It is denoted by (α).

K. E factor (α) = K.E per sec based on actual velocity / K.E per sec based on Average velocity

11. Define momentum correction factor (β):

It is defined as the ratio of momentum of the flow per sec based on actual velocity to the momentum of the flow per sec based on average velocity across the section.

β= Momentum per sec based on actual velocity/Momentum Per sec based on average velocity

12.Define Boundary layer.

When a real fluid flow passed a solid boundary, fluid layer is adhered to the solid boundary.

Due to adhesion fluid undergoes retardation thereby developing a small region in the immediate vicinity of the boundary. This region is known as boundary layer.

13.What is mean by boundary layer growth?

At subsequent points downstream of the leading edge, the boundary layer region increases because the retarded fluid is further retarded. This is referred as growth of boundary layer.

14.Classification of boundary layer.

(i) Laminar boundary layer, (ii) Transition zone,

(iii) Turbulent boundary layer.

15.Define Laminar boundary layer.

Near the leading edge of the surface of the plate the thickness of boundary layer is small and flow is laminar. This layer of fluid is said to be laminar boundary layer.

The length of the plate from the leading edge, upto which laminar boundary layer exists is called as laminar zone. In this zone the velocity profile is parabolic.

16. Define transition zone.

After laminar zone, the laminar boundary layer becomes unstable and the fluid motion transformed to turbulent boundary layer. This short length over which the changes taking place is called as transition zone.

17.Define Turbulent boundary.

Further downstream of transition zone, the boundary layer is turbulent and continuous to grow in thickness. This layer of boundary is called turbulent boundary layer.

18.Define Laminar sub Layer

In the turbulent boundary layer zone, adjacent to the solid surface of the plate the velocity variation is influenced by viscous effects. Due to very small thickness, the velocity distribution is almost linear. This region is known as laminar sub layer.

19. Define Boundary layer Thickness.

It is defined as the distance from the solid boundary measured in y-direction to the point, where the velocity of fluid is approximately equal to 0.99 times the free stream velocity (U) of the fluid.

It is denoted by δ.

20. List the various types of boundary layer thickness.

Displacement thickness(δ*), Momentum thickness(θ), Energy thickness(δ**)

21. Define displacement thickness.

The displacement thickness (δ) is defined as the distance by which the boundary should be displaced to compensate for the reduction in flow rate on account of boundary layer formation.

$$\delta^* = \int [\, 1 - (u/U) \,]\, dy$$

22. Define momentum thickness.

The momentum thickness (θ) is defined as the distance by which the boundary should be displaced to compensate for the reduction in momentum of the flowing fluid on account of boundary layer formation.

$$\theta = \int [\, (u/U) - (u/U)^2 \,]\, dy$$

23.Define energy thickness

The energy thickness (δ**) is defined as the distance by which the boundary should be

displaced to compensate for the reduction in kinetic energy of the flowing fluid on account of boundary layer formation.

$$\delta^{**} = \int [\, (u/U) - (u/U)^3 \,]\, dy$$

24. What is meant by energy loss in a pipe?

When the fluid flows through a pipe, it looses some energy or head due to frictional resistance and other reasons. It is called energy loss. The losses are classified as; Major losses and Minor losses

25. Explain the major losses in a pipe.

The major energy losses in a pipe is mainly due to the frictional resistance caused by the shear force between the fluid particles and boundary walls of the pipe and also due to viscosity of the fluid.

26. Explain minor losses in a pipe.

The loss of energy or head due to change of velocity of the flowing fluid in magnitude or direction is called minor losses. It includes: sudden expansion of the pipe, sudden contraction of the pipe, bend in a pipe, pipe fittings and obstruction in the pipe, etc.

27. State Darcy-Weisbach equation **OR** What is the expression for head loss due to friction?

$$h_f = 4flv^2 / 2gd$$

where, h_f = Head loss due to friction (m), L = Length of the pipe (m),

d = Diameter of the pipe (m), V = Velocity of flow (m/sec) f = Coefficient of friction

28. What are the factors influencing the frictional loss in pipe flow? Frictional resistance for the turbulent flow is,

i. Proportional to v^n where v varies from 1.5 to 2.0.
ii. Proportional to the density of fluid.
iii. Proportional to the area of surface in contact.
iv. Independent of pressure.
v. Depend on the nature of the surface in contact.

29. Write the expression for loss of head due to sudden enlargement of the pipe.

$$h_{exp} = (V_1-V_2)^2 /2g$$

Where, h_{exp} = Loss of head due to sudden enlargement of pipe. V_1 = Velocity of flow at pipe 1; V_2 = Velocity of flow at pipe 2.

30. Write the expression for loss of head due to sudden contraction.

$$h_{con} = 0.5\, V^2 /2g$$

h_{con} = Loss of head due to sudden contraction. V = Velocity at outlet of pipe. 31. Write the expression for loss of head at the entrance of the pipe.

$$hi = 0.5V^2/2g$$

hi = Loss of head at entrance of pipe. V = Velocity of liquid at inlet of the pipe. 32. Write the expression for loss of head at exit of the pipe.

$$ho = V^2/2g$$

where, ho = Loss of head at exit of the pipe. V = Velocity of liquid at inlet and outlet of the pipe. 33. Give an expression for loss of head due to an obstruction in pipe

Loss of head due to an obstruction = $V^2 / 2g \, (A/ Cc (A-a) -1)^2$ Where, A = area of pipe, a = Max area of obstruction,

V = Velocity of liquid in pipe A-a = Area of flow of liquid at section 1-1 34. What is compound pipe or pipes in series?

When the pipes of different length and different diameters are connected end to end, then the pipes are called as compound pipes or pipes in series.

35. What is mean by parallel pipe and write the governing equations.

When the pipe divides into two or more branches and again join together downstream to form a single pipe then it is called as pipes in parallel. The governing equations are:

$$Q_1 = Q_2 + Q_3 \quad h_{f1} = h_{f2}$$

36. Define equivalent pipe and write the equation to obtain equivalent pipe diameter.

The single pipe replacing the compound pipe with same diameter without change in discharge and head loss is known as equivalent pipe.

$$L = L_1 + L_2 + L_3$$

$$(L/d^5) = (L_1/d_1^5) + (L_2/d_2^5) + (L_3/d_3^5)$$

37. What is meant by Moody's chart and what are the uses of Moody's chart?

The basic chart plotted against Darcy-Weisbach friction factor against Reynold's Number

(Re) for the variety of relative roughness and flow regimes. The relative roughness is the ratio of the mean height of roughness of the pipe and its diameter (ε/D).

Moody's diagram is accuratetoabout15%fordesign calculations and used for a large number of applications. It can be used for non-circular conduits and also for open channels.

38. Define the terms a) Hydraulic gradient line [HGL] b) Total Energy line [TEL]

Hydraulic gradient line: It is defined as the line which gives the sum of pressure head and datum head of a flowing fluid in a pipe with respect the reference line.

HGL = Sum of Pressure Head and Datum head

Total energy line: Total energy line is defined as the line which gives the sum of pressure head, datum head and kinetic head of a flowing fluid in a pipe with respect to some reference line.

TEL = Sum of Pressure Head, Datum head and Velocity head

UNIT V : DIMENSIONAL ANALYSIS AND MODEL STUDIES

1. Define dimensional analysis.

Dimensional analysis is a mathematical technique which makes use of the study of dimensions as an aid to solution of several engineering problems. It plays an important role in research work.

2. Write the uses of dimension analysis?

- It helps in testing the dimensional homogeneity of any equation of fluid motion.
- It helps in deriving equations expressed in terms of non-dimensional parameters.
- It helps in planning model tests and presenting experimental results in a systematic manner.

3. List the primary and derived quantities.

Primary or Fundamental quantities: The various physical quantities used to describe a given phenomenon can be described by a set of quantities which are independent of each other. These quantities are known as fundamental quantities or primary quantities. Mass (M), Length

(L), Time (T) and Temperature (θ) are the fundamental quantities.

Secondary or Derived quantities: All other quantities such as area, volume, velocity, acceleration, energy, power, etc are termed as derived quantities or secondary quantities because they can be expressed by primary quantities.

4. Write the dimensions for the followings.

Dynamic viscosity (μ) – $ML^{-1}T^{-2}$,

Mass density (ρ) – ML^{-3},

Force (F) - MLT^{-2},

Power (P) - $ML^{2}T^{-3}$

5. Define dimensional homogeneity.

An equation is said to be dimensionally homogeneous if the dimensions of the terms on its LHS are same as the dimensions of the terms on its RHS.

6. Mention the methods available for dimensional analysis. Rayleigh method,

Buckinghum π method

7. State Buckingham's π theorem.

It states that "if there are 'n' variables (both independent & dependent variables) in a physical phenomenon and if these variables contain 'm' functional dimensions and are related by a dimensionally homogeneous equation, then the variables are arranged into n-m dimensionless terms. Each term is called π term".

8. List the repeating variables used in Buckingham π theorem.

Geometrical Properties – l, d, H, h, etc, Flow Properties – v, a, g, ω, Q, etc,

Fluid Properties – ρ, μ, γ, etc.

9. Define model and prototype.

The small scale replica of an actual structure or the machine is known as its Model, while the actual structure or machine is called as its Prototype. Mostly models are much smaller than the corresponding prototype.

10. Write the advantages of model analysis.

- Model test are quite economical and convenient.

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Alterations can be continued until most suitable design is obtained.

- Modification of prototype based on the model results.
- The information about the performance of prototype can be obtained well in advance.

11.List the types of similarities or similitude used in model anlaysis.

Geometric similarities, Kinematic similarities, Dynamic similarities

12. Define geometric similarities

It exists between the model and prototype if the ratio of corresponding lengths, dimensions in the model and the prototype are equal. Such a ratio is known as "Scale Ratio".

13. Define kinematic similarities

It exists between the model and prototype if the paths of the homogeneous moving particles are geometrically similar and if the ratio of the flow properties is equal.

14. Define dynamic similarities

It exits between model and the prototype which are geometrically and kinematic similar and if the ratio of all forces acting on the model and prototype are equal.

15.Mention the various forces considered in fluid flow.

Inertia force,

Viscous force,

Gravity force,

Pressure force,

Surface Tension force,

Elasticity force

16.Define model law or similarity law.

The condition for existence of completely dynamic similarity between a model and its prototype are denoted by equation obtained from dimensionless numbers.

The laws on which the models are designed for dynamic similarity are called Model laws or Laws of Similarity.

17. List the various model laws applied in model analysis.

Reynold's Model Law,

Froude's Model Law,

Euler's Model Law,

Weber Model Law,

Mach Model Law

18. State Reynold's model law

For the flow, where in addition to inertia force the viscous force is the only other predominant force, the similarity of flow in the model and its prototype can be established, if the Renold's number is same for both the systems. This is known as Reynold's model law. $\mathbf{Re_{(p)} = Re_{(m)}}$

19. State Froude's model law

When the forces of gravity can be considered to be the only predominant force which controls the motion in addition to the force of inertia, the dynamic similarities of the flow in any two such systems can be established, if the Froude number for both the system is the same. This is known as Froude Model Law. $\mathbf{Fr_{(p)} = Fr_{(m)}}$

20. State Euler's model law

In a fluid system where supplied pressures are the controlling forces in addition to inertia forces and other forces are either entirely absent or in-significant the Euler's number for both the model and prototype which known as Euler Model Law.

21. State Weber's model law

When surface tension effect predominates in addition to inertia force then the dynamic similarity is obtained by equating the Weber's number for both model and its prototype, which is called as Weber Model Law.

22. State Mach's model law

If in any phenomenon only the forces resulting from elastic compression are significant in addition to inertia forces and all other forces may be neglected, then the dynamic similarity between model and its prototype may be achieved by equating the Mach's number for both the systems. This is known Mach Model Law.

23.Classify the hydraulic models.

The hydraulic models are classified as: Undistorted model & Distorted model

24.Define undistorted model

An undistorted model is that which is geometrically similar to its prototype, i.e. the scale ratio for corresponding linear dimensions of the model and its prototype are same.

25. Define distorted model

Distorted models are those in which one or more terms of the model are not identical with their counterparts in the prototype.

26. Define Scale effect

An effect in fluid flow that results from changing the scale, but not the shape, of a body around which the flow passes.

27.List the advantages of distorted model.

- The results in steeper water surface slopes and magnification of wave heights in model can be obtained by providing true vertical structure with accuracy.
- The model size can be reduced to lower down the cast.
- Sufficient tractate force can be developed to produce bed movement with a small model.

28.Write the dimensions for the followings.

Quantities	Symbol	Unit	Dimension
Area	A	m^2	L^2
Volume	V	m^3	L^3
Angle	A	Deg. Or Rad	$M^0L^0T^0$
Velocity	v	m/s	LT^{-1}
Angular Velocity	ω	Rad/s	T^{-1}
Speed	N	rpm	T^{-1}
Acceleration	a	m/s^2	LT^{-2}
Gravitational Acceleration	g	m/s^2	LT^{-2}
Discharge	Q	m^3/s	L^3T^{-1}
Discharge per meter run	q	m^2/s	L^2T^{-1}
Mass Density	ρ	Kg/m^3	ML^{-3}
Sp. Weight or Unit Weight		N/m^3	$ML^{-2}T^{-2}$
Dynamic Viscosity	μ	$N\text{-}s/m^2$	$ML^{-1}T^{-1}$
Kinematic viscosity		m^2/s	L^2T^{-1}
Force or Weight	F or W	N	MLT^{-2}
Pressure or Pressure intensity	p	N/m^2 or Pa	$ML^{-1}T^{-2}$
Modulus of Elasticity	E	N/m^2 or Pa	$ML^{-1}T^{-2}$
Bulk Modulus	K	N/m^2 or Pa	$ML^{-1}T^{-2}$
Workdone or Energy	W or E	N-m	ML^2T^{-2}
Torque	T	N-m	ML^2T^{-2}
Power	P	N-m/s or J/s or Watt	ML^2T^{-3}