QUESTION BANK

Name of the Department : Civil Engineering

Subject Code & Name : CE8302 & Fluid Mechanics

Year & Semester : II & III

UNIT I FLUID PROPERTIES AND FLUID STATICS

PART-A

1. Define fluid mechanics.
It is the branch of science, which deals with the behavior of the fluids (liquids or gases) at rest as well as in motion.

2. Define Mass Density.
Mass Density or Density is defined as ratio of mass of the fluid to its volume (V)
Density of water = 1 gm/cm3 or 1000 kg /m^3.

3. Define Specific Weight.
It is the ratio between weight of a fluid to its volume.
Unit: N / m^3

4. Define 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 fluid.

5. Define Specific Volume.
Volume per unit mass of a fluid is called specific volume
Unit: m^3 / kg.

6. Define Specific Gravity.
Specific gravity is the ratio of the weight density or density of a fluid to the weight density or density of standard fluid. It is also called as relative density.
Unit : Dimension less. Denoted as: ‘S’

8. State Newton’s Law of Viscosity.
It states that the shear stress on a fluid element layer is directly proportional to the rate of shear strain. The constant of proportionality is called the co-efficient of viscosity.

9. Name the Types of fluids.
1. Ideal fluid
2. Real fluid
3. Newtonian fluid
4. Non-Newtonian fluid.
5. Ideal plastic fluid

10. Define Kinematic Viscosity.
It is defined as the ratio between the dynamic viscosity and density of fluid.
Represented as γ.
Unit: m^2 / sec.

11. Define Compressibility.
Compressibility is the reciprocal of the bulk modulus of elasticity, K which is defined as the ratio of compressive stress to volumetric strain.

12. Define Surface Tension.
Surface tension is defined as the tensile force acting on the surface of a 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.
Unit: N / m.

13. Define Capillarity:
Capillary is defined as a phenomenon of rise of a liquid surface is a small tube relative to adjacent general level of liquid when the tube is held vertically in the liquid. The resistance of liquid surface is known as capillary rise while the fall of the liquid surface is known as capillary depression. It is expressed in terms of cm or mm of liquid.

14. Define Real fluid and Ideal fluid.
Real Fluid:
A fluid, which possesses viscosity, is known as real fluid. All fluids, in actual practice, are real fluids.
Ideal Fluid:
A fluid, which is incompressible and is having no viscosity, is known as an ideal fluid. Ideal fluid is only an imaginary fluid as all the fluids, which exist, have some viscosity.

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15. Define Newtonian fluid.
A real fluid in which shear stress is directly proportional to the rate of shear strain.
$\tau = \mu . du/dy$

16. Define ideal plastic fluid.
A fluid whose shear is more than yield value and its shear stress is directly proportional to shear strain is called as ideal plastic fluid.

17. What is an incompressible fluid?
A liquid is considered to be incompressible only when there is a change in volume of a liquid that occurs under smaller pressure variation.

18. Define specific gravity with respect to weight density?
It is the ratio of specific weight of fluid to specific weight of a standard fluid.
i.e., s = Specific weight of liquid (for liquids)
Specific weight of water
i.e., s = Specific weight of gas (for gasses)
Specific weight of air

19. Define dynamic viscosity?
The shear stress required to move one layer with unit velocity over another layer at unit distance. It is known as dynamic viscosity. It is denoted as μ.

20. What is cause for viscosity?
The causes for the viscosity are
(i) Inter molecular force of cohesion and
(ii) Moment of molecules being exchanged.

PART-B

1.Calculate the capillary effect in millimeters a glass tube of 4mm diameter, when immersed in (a) water (b) mercury. The temperature of the liquid is 200 C and the values of the surface tension of water and mercury at 200 C in contact with air are 0.073575 and 0.51 N/m respectively. The angle of contact for water is zero that for mercury 1300 . Take specific weight of water as 9790 N / m3

2. A cylinder of 0.6 m3 in volume contains air at 500C and 0.3 N/ mm2 absolute pressure. The air is compressed to 0.3 m3 . Find (i) pressure inside the cylinder assuming isothermal process (ii) pressure and temperature assuming adiabatic process. Take K = 1.4

3. If the velocity profile of a fluid over a plate is a parabolic with the vertex 202 cm from the plate, where the velocity is 120 cm/sec. Calculate the velocity gradients and shear stress at a distance of 0,10 and 20 cm from the plate, if the viscosity of the fluid is 8.5 poise.

4. A 15 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 15.10 cm. Both cylinders are 25 cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12.0 Nm is required to rotate the inner cylinder at 100 rpm determine the viscosity of the fluid.

5. The dynamic viscosity of oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 rpm. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.5 mm.

6. If the velocity distribution over a plate is given by 2 3 2 y− y =u in which U is the velocity in m/s at a distance y meter above the plate, determine the shear stress at y = 0 and y = 0.15 m. Take dynamic viscosity of fluid as 8.63 poise

7. The diameters of a small piston and a large piston of a hydraulic jack at3cm and 10 cm respectively. A force of 80 N is applied on the small piston Find the load lifted by the large piston when: a. The pistons are at the same level b. Small piston in 40 cm above the large piston.

8. A U - Tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and its open to atmosphere. The contact between water and mercury is in the left limb. Determine the pressure of water in the main line, if the difference in level of mercury in the limbs of U-tube is 10 cm and the free surface of mercury is in level with the centre of the pipe. If the pressure of water in pipe line is reduced to 9810 N/m2, Calculate the new difference in the level of mercury. Sketch the arrangement in both cases.

9. A vertical sluice gate is used to cover an opening in a dam. The opening is 2m wide and 1.2m high. On the upstream of the gate, the liquid of sp. Gr 1.45, lies upto a height of 1.5m above the top of the gate, whereas on the downstream side the water is available upto a height touching the top of the gate. Find the resultant force acting on the gate and position of centre of pressure. Find also the force acting horizontally at the top of the gate and posiotn of centre of pressure. Find also the force acting horizontally at the top of the gate which is capable of opening it. Assume the gate is hinged at the bottom.

10. Determine the total pressure on a circular plate of diameter 1.5 m which is placed vertically in water in such a way that the centre of the plate is 3 m below the free surface of water. Also find the position of centre of pressure. (ii) Determine the total pressure and centre of pressure on an isosceles triangular plate of base 4m and altitude 4 m when it is immersed vertically in an oil of sp.gr 0.9. The base of the plate is coincides with the free surface of oil.

UNIT II FLUID KINEMATICS AND FLUID DYNAMICS

PART-A

1. Define "Pascal's Law":

It stats that the pressure or intensity of pressure at a point in a static fluid is equal in all directions.

2. What is mean by Absolute pressure and Gauge pressure?

Absolute Pressure: It is defined as the pressure which is measured with the reference to absolute vacuum pressure.

Gauge Pressure: It is defined as the pressure which is measured with the help of a pressure measuring instrument, in which the atmospheric pressure is taken as datum. The atmospheric pressure on the scale is marked as zero.

3. Define Manometers.

Manometers are defined as the devices used for measuring the pressure at a point in a fluid by balancing measuring the column of fluid by the same or another column of fluid.

1. Simple M 2. Differential M

4. **Define local acceleration?**
   It is defined as the rateofincreaseofvelocitywith respect to time at a given point in a flow field.

5. **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.

6. Define META – CENTRE

It is defined as the point about which a body starts oscillating when the body is fitted by a small angle. The meta – centre may also be defined as the poit at which the line of action of the force of buoyancy wil meet the normal axis of the body when the body is given a small angular displacement.

7. Write a short notes on " Differential Manometers".

Differential manometers are the devices used for measuring the difference of pressures between two points in a pipe or in two different pipes/ a differential manometer consists of a U – tube containing a heavy liquid, whose two ends are connected to the points, whose difference of pressure is to be measured. Most commonly types of differential manometers are:

1. U – tube differential manometer.

2. Inverted U – tube differential manometers.

8. Define Centre of pressure.

Is defined as the point of application of the total pressure on the surface. The submerged surfaces may be:

1. Vertical plane surface
2. Horizontal plane surface
3. Inclined plane surface
4. Curved surface

9. Write down the types of fluid flow.

The fluid flow is classified as :

1. Steady and Unsteady flows.
2. Uniform and Non – uniform flows.
3. Laminar and turbulent flows.
4. Compressible and incompressible flows.
5. Rotational and irrotational flows
6. One, two and three dimensional flows.

10. Write a short notes on “Laminar flow”.

Laminar flow is defined as that type of flow in which the fluid particles move along well – defined paths or stream line and all the stream lines are straight and parallel. STUDENTSFOCUS.COM Thus the particles move in laminas or layers gliding over the adjacent layer. This type of flow is also called stream – line flow or viscous flow/

11. Define “ Turbulent flow”.

Turbulent flow is that type of flow in which the fluid particles move in a zig –zag way. Due to the movement of fluid particles in a zig – zag way.

12. What is mean by Rate flow or Discharge?

It is defined as the quantity of a fluid flowing per second through a section of a pipe or channel. For an incompressible fluid(or liquid) the rate of flow or discharge is expressed as volume of fluid flowing across the section per section. For compressible fluids, the rate of flow is usually expressed as the weight of fluid flowing across the section. The discharge (Q) = A X V Where, A = Cross – sectional area of pipe. V = Average velocity of fluid across the section.

13. What do you understand by Continuity Equation?

The equation based on the principle of conservation of mass is called continuity equation. Thus for a fluid flowing through the pipe at all the cross-section, the quantity of fluid per second is constant. $A_1V_1 = A_2V_2$

14. What is mean by Local acceleration?

Local acceleration is defined as the rate of increase of velocity with respect to time at a given point in a flow field. In equation is given by the expression $(\partial u / \partial t)$, $(\partial v / \partial t)$ or $(\partial w / \partial t)$ is known as local acceleration.

15. What is mean by Convective acceleration?

It is defined as the rate of change of velocity due to the change of position of fluid particles in a fluid flow. The expressions other than (Ə u / Ət) , (Əv / Ət) and (Əw / Ət) in the equation are known as convective acceleration.

16. 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 defined by Φ (Phi). Mathematically, the velocity, potential is defined as Φ = f (x,y,z) for steady flow such that. u = - (Ə Φ/Əx) v = - (Ə Φ/Əy) w = - (Ə Φ/Əz) where, u,v and w are the components of velocity in x.y and z directions respectively.

17. 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. It is denoted by ψ (Psi) and only for two dimensional flow. Mathematically. For steady flow is defined as ψ = f(x,y) such that , (Ə ψ / Əx) = v (Ə ψ / Əy) = - u.

18. What is mean by Flow net?

A grid obtained by drawing a series of equipotential lines and stream lines is called a flow net. The flow net is an important tool in analyzing the two – dimensional irrotational flow problems.

19. Write the properties of stream function.

The properties of stream function (ψ) are:

1. If stream function (ψ) exists, it is possible case of fluid flow which may be rotational or irrotational.

2. If stream function (ψ) satisfies the Laplace equation, it is a possible case of irrotational flow.

20. What are the types of Motion?

1. Linear Translation or Pure Translation.

2. Linear Deformation.

3. Angular deformation.

4. Rotation.

21. Define "Vortex flow".

Vortex flow is defined as the flow of a fluid along a curved path or the flow of a rotating mass of a fluid is known ' Vortex Flow'.

The vortex flow is of two types namely:

1. Forced vortex flow, and

2. Free vortex flow.

PART-B

1) Water flow through a pipe AB 1.2 diameter at 3m/s and then passes through a pipe BC 105m diameter. At C, the pipe branch CD is 0.8m in diameter and carries one third of flow in AB. The flow velocity in branch CE is 2.5 m/s. Find the volume rate in B.C, the velocity in CD and the diameter of

2) State Bernoulli"s theorem for steady flow of a incompressible third. Derive an expression for Bernoulli"s equation from first principle and state the assumption made for such a derivation

3) The stream function for a dimensional flow is given by Ψ =2xy. Calculate the resultant velocity at P(3,4). Also the velocity potential function ϕ.

4) A venture meter of inlet diameter 300mm and throat diameter 150mm is inserted in vertical pipe carrying in the upward direction. A different mercury manometer connected to the inlet and throat gives a reading of 200mm. Find the discharge if the coefficient of discharge of meter is 0.98

5) A ripple 200 m long slop down at 1 in 100 and taper from 600 mm diameter at the higher end to 300 mm diameter at the lower end, and carries 100 litres/ sec of oil having specified gravity 0.8. If the pressure gauge at the higher end reads 60 kN/m2, determine the velocities at the two ends and also the pressure at the lower end

6) Briefly describe about velocity potential function and stream function and its relations.

7) A horizontal venturi meter with inlet diameter 250 mm and throatdiameter 120mm is used to measure the flow of oil specific gravity 0.85. The discharge of oil through the venture meter is 80 lit/sec. Find the reading of oil – mercury differential manometer. Take Cd =0.97

8) If for a two – diamantine potential flow, the velocity potential is given by $\phi = x\,(2y - 1)$ determine the velocity at the point P(4,5). Determine also the value of stream function Ψ at the point P.

9) The velocity component for a two dimensional incompressible flow are given by u =3x – 2y and v = -3y – 2x. Show that the velocity potential exists. Determine the velocity potential function and stream function.

10) An oil of sp .Gr. 0.8 is flowing through a venturimeter having an inlet diameter 20 cm and throat diameter 10 cm. The oil mercury differential manometer shows a reading of 25 cm. Examine the discharge of oil through the horizontal venturimeter, Take CD = 0.98.

11) A pitot static tube is used to measure the velocity of water in a pipe. The stagnation pressure head is 6m and static pressure head is 5m. Calculate the velocity of flow assuming the coefficient of tube equal to 0.98. (ii) An orifice meter with orifice diameter 15cm is inserted in a pipe of 30 cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50 cm of mercury. Fine the rate of flow of oil of sp.gr 0.9 When the coefficient of discharge of the orifice meter = 0.64.

12) A 400 x 200 mm venturimeter is provided in a vertical pipe line carrying oil of relative density 0.9, the flow being upwards. The difference in elevation of the throat section and entrance section of the venturimeter is 30 cm. The differential U tube mercury manometer shows a gauge deflection of 250 mm. calculate the discharge of oil, if the coefficient of meter is 0.98.

13) A two dimensional flow is described by the velocity components, u = 5x3 and v = -15x2y. Determine the stream function, velocity and acceleration at point P (x= 1m ; y = 2m) (ii) A 40 cm diameter pipe, conveying water, branches into two pipes of diameters 30cm and 20cm respectively. If the average velocity in the 40 cm diameter pipe is 3m/s, find the discharge in this pipe. Also determine the velocity in 20 cm pipe if the average velocity in the 30 cm diameter pipe is 2m/s.

14) Derive continuity equation from principle of conservation of mass.

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES

PART-A

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) – $ML^{-1}T^{-2}$
Force (F) - MLT^{-2}
Mass density (ρ) – ML^{-3}
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.

i)Rayleigh method
ii)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.
- 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.

i. Geometric similarities
ii. Kinematic similarities
iii. 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 kinematically 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.

i. Inertia force
ii. Viscous force
iii. Gravity force
iv. Pressure force
v. Surface Tension force
vi. 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.

i. Reynold‟s Model Law
ii. Froude‟s Model Law
iii. Euler‟s Model Law
iv. Weber Model Law
v. 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. 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. 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.

PART-B

1) Explain Buckingham's theorem.

2) The resisting force (R) of a supersonic flight can be considered as dependent upon length of aircraft (l), velocity (V), air viscosity 'μ', air density 'ρ', and bulk modulus of air ' k'. Express the functional relationship between these variables and the resisting force.

3) A ship is 300 m long moves in sea water, whose density is 1030 kg/m3. A 1:100 model of this to be tested in a wind tunnel. The velocity of air in the wind tunnel around the model is 30 m/s and the resistance of the model is 60 N. Determine the velocity of ship in sea water and also the resistance of the ship in sea water. The density of air is given as 1.24 kg/m3. Take the Kinematic viscosity of sea water and air as 0.012 stokes and 0.018 stokes respectively.

4) A 7.2 m height and 15 m long spillway discharge 94 m3/s, under a head of 2.0m. If a 1:9 scale model of this spillway is to be constructed, determine model dimensions, head over spillway model and the model discharge. If model experience a force of 7500 N (764.53 Kgf), determine force on the prototype.

5) A quarter scale turbine model is tested under ahead of 12 m. The full scale turbine is to work under a head of 30 m and to run at 428 rpm. Find N for model. If model develops 100 kW and uses 1100 l/s at this speed, what power will be obtained from full scale turbine assuming its n is 3% better than that of model.

6) Using Buckingham's π theorem, show that the drag force FD = ρ L2V2φ (Re,M) which Re = ρ LV/μ; M = V/C; ρ = fluid mass density; L = chord length: V= velocity of aircraft; μ = fluid viscosity; C = sonic velocity = √K/ ρ where K = bulk modulus of elasticity.

7) The resistance ' R' experienced by apartially, submerged body depends upon the velocity 'V', length of the body 'l', viscosity of fluid 'μ', density of the fluid 'ρ', and gravitational acceleration 'g'; obtain expression for R.

8) Derive the relation using Buckingham's π theorem F = ρ U2D2f (μ/UD ρ), ND/U).

9) State the reasons for construction distorted model of rivers and discuss the various types of distortion in models. What are the merits and demerits of distorted models as compared to undistorted model?

10) In an aeroplane model of size 1/10 of its prototype the pressure drop is 7.5 kN/m3. The model is tested in water. Find the corresponding pressure drop in the prototype. Take density of air is 1.4 kg/ m3, density of water is 1000 kg/ m3, viscosity of air is 0.00018 poise and viscosity of water is 0.01 poise.

UNIT IV FLOW THROUGH PIPES

PART-A

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?
$(P1-P2)/\rho g = hf = 32\ \mu \bar{U} L / \rho g D$
The expression is known as Hagen poiseuille formula. Where $P1-P2 / \rho g$ = 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?
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
$u = - (¼\ \mu)\ (\partial p/\partial x)\ (R2-r2)$
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
$\bar{U} = - (1/8\mu)\ (\partial p/\partial x)\ R2$
Where R = Radius of the pipe

7. Write the relation between Umax and $\bar{U}$?
$Umax / \bar{U} = \{ - (¼\ \mu)\ (\partial p/\partial x)\ R2 \} / \{ - ⅛\mu(\partial p/\partial x)\ R2 \}$
$Umax / \bar{U} = 2$

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. What is meant by energy loss in a pipe?

When the fluid flows through a pipe, it losses 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

13. 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.

14. 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.

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

hf = 4flv2 / 2gd

where, hf = 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

16. What are the factors influencing the frictional loss in pipe flow?

Frictional resistance for the turbulent flow is,
a. Proportional to vn where v varies from 1.5 to 2.0.
b. Proportional to the density of fluid.

c. Proportional to the area of surface in contact.
d. Independent of pressure.
e. Depend on the nature of the surface in contact.

17. Write the expression for loss of head due to sudden enlargement of the pipe.
hexp = (V1-V2)2 /2g
Where, hexp = Loss of head due to sudden enlargement of pipe.
V1 = Velocity of flow at pipe 1;
V2 = Velocity of flow at pipe 2.

18. Write the expression for loss of head at the entrance of the pipe.
hi =0.5V2/2g
hi = Loss of head at entrance of pipe.
V = Velocity of liquid at inlet of the pipe.

19. Write the expression for loss of head at exit of the pipe.
ho = V2/2g
where, ho = Loss of head at exit of the pipe.
V = Velocity of liquid at inlet and outlet of the pipe.

20. Give an expression for loss of head due to an obstruction in pipe
Loss of head due to an obstruction
V2 / 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

21. 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.

22. 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:
Q1 = Q2 + Q3
hf1 = hf2

23. 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 = L1 + L2 + L3
(L/d^5) = (L1/d^5) + (L2/d^5) + (L3/d^5)

24.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 accurate to about 15% for design calculations and used for a large number of applications. It can be used for non-circular conduits and also for open channels.

25. 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

PART-B

1) Find the head lost due to friction in a pipe of diameter 300 mm and length 50 m, through which water is flowing at a velocity of 3 m/s using (i) Darcy formula, (ii) Chezy's formula for which C = 60.

2) An oil of sp.Gr 0.9 and viscosity 0.06 poise is flowing through a pipe of diameter 200 mm at the rate of 60 litres/sec./ find the head lost due to friction for a 500 m length of pipe. Find the power required to maintain this flow.

3) The rate of flow of water through a horizontal pipe is 0.25 m3 /s. The diameter of the pipe which is 200 mm is suddenly enlarged to 400 mm. The pressure intensity in the smaller is 11.772 N/cm2 . Determine: (i) loss of head due to sudden enlargement, (ii) pressure intensity in the large pipe, (iii) power lost due to enlargement.

4) A horizontal pipe line 40 m long is connected to a water tank at one end discharges freely into the atmosphere at the other end. For the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of the pipe. Considering all losses of head which occur, determine the rate of flow. Take f = 0.01 for both sections of the pipe.

5) A pipe line, 300 mm in diameter and 3200 m long is used to pump up 50 kg per second of oil whose density is 950 kg/m3 and whose kinematic viscosity is 2.1 stokes. The centre of the pipe line at the upper end is 40 m above than that at the lower end. The discharge at the upper end is atmospheric. Find the pressure at the lower end and draw the hydraulic gradient and the total energy line.

6) A siphon of diameter 200 mm connects two reservoirs having a difference in elevation of 15 m. The total length of the siphon is 600 mm and the summit is 4 m above the water level in the upper reservoir. If the separation takes place at 2.8 m of water absolute, find the maximum length of siphon from upper reservoir to the summit. Take f = 0.004 and atmospheric pressure = 10.3 m of water.

7) The difference in water surface levels in two tanks, which are connected by three pipes in series of lengths 300 m, 170 m and 210 m and of diameters 300 mm, 200 mm and 400 mm respectively, is 12m. Determine the rate of flow of water if co – efficient of friction are 0.005, 0.0052 and 0.0048 respectively, considering: (i) minor losses also (ii) neglecting minor losses.

8) A main pipe is divided into two parallel pipes which again forms one pipe. The length and diameter for the first parallel pipe are 2000 m and 1.0 m respectively, while the length and diameter of 2nd parallel pipe are 2000 m and 0.8 m. Find the rate of flow in each parallel pipe, if total flow in the main is 3 m^3 /s. The co efficient of friction for each parallel pipe is same and equal to 0.005.

9) A pipe of diameter 20 cm and length 2000 m is connects two reservoirs, having difference of water levels as 20 m. Determine the discharge through the pipe. If an additional pipe of diameter 20 cm and length 1200 m is attached to the last 1200 m length of the existing pipe, find the increase in the discharge. Take f = 0.015 and neglect minor losses.

10) A pipe line 60 cm diameter bifurcates at a Y- junction into two branches 40 cm and 30 cm in diameter. If the rate of flow in the main pipe is 1.5 m^3 /s and mean velocity of flow in 30 cm diameter pipe is 7.5 m/s, determine the rate of flow in the 40 cm diameter pipe.

11) A pipe line of length 2000 m is used for power transmission. If 110.3625 kW power is to be transmitted through the pipe in which water having a pressure of 490.5 N/cm2 at inlet is flowing. Find the diameter of the pipe and efficiency of transmission if the pressure drop over the length of pipe is 98.1 N/ cm2 . Take f = 0.0065.

12) Find the maximum power transmitted by a jet of water discharging freely out of nozzle fitted to a pie = 300 m long and 100 mm diameter with co efficient of friction as 0.01. the available head at the nozzle is 90 m.

UNIT V BOUNDARY LAYER

PART-A

1.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.

2.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.

3.Classification of boundary layer.

(i) Laminar boundary layer,
(ii) Transitionzone,
(iii) Turbulent boundary layer.

4.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 boundarylayer exists is called as laminar zone. In this zone the velocity profile isparabolic.

5. 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.

6.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.

7.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.

8. 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.

9. List the various types of boundary layer thickness.
a. Displacement thickness(δ*),
b. Momentum thickness(θ),
c. Energy thickness(δ**)

10. 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.
δ* = ∫ [1 – (u/U)] dy

11. 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.
θ = ∫ [(u/U) – (u/U)2]dy

12.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.
δ = ∫ [(u/U) – (u/U)3] dy**

PART-B

1)Briefly explain the boundary layer definitions.

2)Find the displacement thickness, the momentum thickness and energy thickness for thevelocity distribution in the boundary layer given by u/U =y/δ, where u is the velocity at a distance y from the plate and u = U at y = δ, where δ = boundary layer thickness. Also calculate the value of δ*/θ.

3)Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by u/U = 2 (y/ δ) – (y/ δ)2.

4)For the velocity profile u/U = 2 (y/ δ) – (y/ δ)2, find the thickness of boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide when placed in water flowing with a velocity of 150 mm/sec. Calculate the value of co - efficient of drag also. Take μ for water = 0.01 poise.

5)For the velocity profile for laminar boundary layer u/U = 2 (y/ δ) – (y/ δ)3 +(y/ δ)4 obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co – efficient of drag in term of Reynold number.

6) For the velocity profile for laminar boundary flow u/U = sin (π y/2 δ). Obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co – efficient of drag in terms of Reynold number.

7) For the velocity profile for laminar boundary layer u/U = 3/2 (y/ δ) –1/2 (y/ δ)3 find the thickness of the boundary layer and the shear stress 1.5 m from the leading edge of a plate. The plate is 2 m long and 1.4 m wide and is placed in water which is moving with a velocity of 200 mm per second. Find the total drag force on the plate if μ for water = 0.01 poise.

8) For the velocity profile for turbulent boundary layer u/U = (y/ δ)1/7, obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co – efficient of drag in terms of Reynolds Number. Given the stress (ζo) for turbulent boundary layer as ζo = 0.0225 ρ U2 (μ/ ρ U g)1/4.

9) Determine the thickness of the boundary layer at the trailing edge of smooth plate of length 4 m and of the width 1.5 m, when the plate is moving with a velocity of 4 m/s in stationary air. Take kinematic viscosity of air as 1.5 x 10-5 m2/s.

10) For the following velocity profiles, determine whether the flow has or on the verge of separation or will attach with the surface:
(i) u/U = 3/2 (y/ δ) –1/2 (y/ δ)3
(ii) u/U = 2 (y/ δ)2 – (y/ δ)3
(iii) u/U = - 2 (y/ δ) + (y/ δ)2