UNIT I FLUID PROPERTIES AND FLUID STATICS

(2 MARKS)

1. **What is fluid? How are fluids classified?**
A fluid is a substance which is capable of flowing or a fluid is a substance which deforms continuously when subjected to external shearing force. It may be classified as: liquid, gas, and vapor.

2. **Differentiate between liquids and gases?**
Liquid: it is a fluid which possesses a definite volume. It has bulk elastic modulus when under compression.
Gas: it possesses no definite volume and it is compressible.

3. **Define mass density or density or specific mass?**
Density or mass density of a fluid is defined as the ratio- of the mass of a fluid to its volume. It is denoted by the symbol ρ (rho). Unit of mass density in SI unit is kg per cubic metre, i.e., kg/m3. ρ= Mass of fluidVolume of fluid
The value of density of water is 1 gm/cm3 or 1000 kg/m3.

4. **Weight density or specific weight – Define? Nov/Dec 2012**
Specific weight or weight density of a fluid is the ratio between the weight of a fluid to its volume. It is denoted by the symbol w.
w=Weight of fluid Volume of fluid=Mass of fluid ×Acceleration due to gravityVolume of fluid = Mass of fluid ×gVolume of fluid=ρ×g w = ρg

5. **Define specific volume?**
Specific volume of a fluid is defined as the volume of a fluid occupied by a unit mass . Specific volume= Volume of fluidMass of fluid=1Mass of fluidVolume of fluid=1ρ
Thus specific volume is the reciprocal of mass density.
It is expressed as m3/kg.
For example, the specific gravity of mercury is 13.6, hence density of mercury = 13.6 x 1000 = 13600 kg/m3.

6. **Define viscosity or dynamic viscosity or co- efficient of dynamic viscosity? May/June 2013**
Viscosity is defined as the property of a fluid which offers resistance to the movement of one layer of fluid over another adjacent layer of the fluid.
Shear stress is proportional to the rate of change of velocity with respect to y. It is denoted by symbol τ (Tau). τ∝dudy
τ=μdudy Newton‟s Law of Viscosity
Where, μ (mu) viscosity or coefficient of dynamic viscosity
dudy rate of shear strain or velocity gradient or shearstress
Thus viscosity is also defined as the shear stress required to produce unit rate of shear strain.

7. **Define kinematic viscosity?**
It is defined as the ratio between the dynamic viscosity and density of fluid. It is denoted by the Greek symbol (**ν**) called 'nu'. **ν**=**ViscosityDensity**=**μρ** unit is m2/sec

8. **Define Newton's Law of Viscosity & give example of its application? Nov/Dec 2009, May/June 2014**
It states that the shear stress (τ) 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. Mathematically, it is expressed as given by equation
τ=μdudy Newton‟s Law of Viscosity

9. **Distinguish between ideal and real fluids? May/June 2010, 2012,2016**

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.

Real fluid: A fluid, which possesses viscosity, is known as real fluid. All the fluid, in actual practice, are real fluids.

10. **State the types of fluids?**

* Ideal fluids
* Real fluids
* Newtonian fluids
* Non- newtonian fluids
* Ideal plastic fluids

11. Define ideal plastic fluids?

An ideal plastic or Binigham plastic has a definite yield stress and a constant linear relation between shear stress & the rate of angular defination.

Eg: sewage sludge, drilling muds etc…

12. Define Newtonian and non- Newtonian fluids? May/June 2013

Newtonian fluid: (Nov' 2011) A real fluid is one in which the shear stress is directly proportional to the rate of shear strain is known as newtonian fluid. Eg: water, kerosene, etc…

Non- newtonian fluid: A real fluid is one in which the shear stress is not proportional to the rate of shear strain is known as non newtonian fluid.Eg: mudflous, polymer solutions.

13. What is the effect of temperature & pressure on viscosity of liquid & gases?

The viscosity of liquid decreases but that of gases increses with increses in tempreraturе. The viscosity under ordinary conditions is not appreciably affected by the changes in pressure.

14. Write the different types of fluid properties ?

1. Mass density 2. Viscosity 3. Capillarity 4.Surface tension
5. Specific volume 6. Specific weight 7. Specific gravity

15. Define Control Volume? Nov/Dec 2011

A specified large number of fluid and thermal devices have mass flow in and out of a system called as Control volume.

(16 MARKS)

1. **Briefly explain the properties of fluids.**
2. **Calculate the specific weight, density and specific gravity of one litre of liquid which weighs 7N.**
3. **Define viscosity. Explain the effect of temperature and pressure on viscosity of liquids and gases. (Nov/Dec 2010, Apl/May 2010, May/June 2012)**
4. **Define the Newton's law of viscosity and give some examples for Newtonian and Non-Newtonian fluids. (May/June 2013)**
5. **Explain the following: (i) Causes of viscosity in liquids, (ii) Bulk modulus**
6. **A flat plate of area 1.5 X 106 mm2 is pulled with a speed of 0.4 m/s relative to another plate located at a distance of 0.15 mm from it. Find the force and power required to maintain this speed, if the fluid separating them is having viscosity 1 poise.**
7. **A flat plate 0.1m2 area is pulled at 30cm/s relative to another plate located at a distance of 0.01cm from it, the fluid separating them being water with μ = 0.001NS/m2. Find the force & power required to maintain the velocity.**
8. **Determine the intensity of shear of an oil having μ =1.2 p and is used for lubricating in the clearance between a 10cm dia shaft and its journal bearing. The clearance is 1mm and shaft rotates at 200rpm and length of sleeve 100cm. Also find power required. (Nov/Dec 2011, 2013)**

9. **Dynamic viscosity of 6 poise of oil used for lubrication b/w the shaft and sleeve. The shaft dia is 0.4m and rotate at 190 rpm. Calculate the power lost in the beam for sleeve length of 90mm and thickness of oil film 1.5mm. (Nov/Dec 2012, 2013,May 2014)**
10. **The space between two square flat parallel is filled with oil. Each side of the plate is 60cm. the thickness of the oil film is 12.5mm. The upper plate which moves at 2.5m/s requires a force of 98.1N to maintain the speed, Determine**
    (i) The dynamic viscosity of the oil in poise and
    (ii) he kinematic viscosity of the oil stokes if the specific gravity of the oil is 0.95

UNIT II FLIUD KINEMATICS AND DYNAMICS

(2 MARK)

1. **What are the methods of describing of fluids flow?**
   Lagrangian method: A signal fluid particle is followed during its motion and its velocity, acceleration, density, etc are described.
   Eulerian method: The velocity, acceleration, pressure, density, etc are described at a point in flow field. It is commonly used in fluid mechanics.

2. **Differentiate between laminar flow and turbulent flow?**
   Laminar flow: It is defined as the type of flow in which the fluid particles move along well defined paths. This type of flow is also called stream line flow or viscous flow.
   Eg: Flow through capillary tube, flow of blood in veins& arteries.
   Turbulent flow: It is that type of flow in which the fluid particles move in zig- zag way.

3. **Differentiate between compressible & incompressible flow?**
   Compressible flow: It is that type of flow in which the density of the fluid changes from point to point. Mathematically $\rho \neq$constant
   Eg: Flow of gases through orifices, nozzles gas turbines, etc..
   Incompressible flow: It is that type of flow in which density is constant for the fluid flow. Mathematically, ρ =constant Eg: subsonic, aerodynamics.

4. **Differentiate between rotational & Irrotational flow?**
   Rotational flow: t is that type of flow in which the fluid particles while following along stream lines also rotate about their own axis. Eg: motion of liquid in a rotating tank.
   Irrotational flow: It is that type of flow in which the fluid particles while flowing along stream lines, do not rotate about their own axis. Eg: flow above a drain hole of a stationary tank (or) a wash basin.

5. **Differentiate between steady flow & unsteady flow?**
   Steady flow: It is defined as that as that type of flow in which the fluid characteristics like velocity, pressure, density, etc, at a point do not change with time.($\boldsymbol{dvdt}$)at x0, y0, z0 = 0
   Eg: flow through a prismatic or non-prismatic conduit at a constant flow rate
   Unsteady flow: It is that type of flow in which the velocity, pressure and density at a point changes with respect to time. ($\boldsymbol{dvdt}$) at x0, y0, z0 $\neq$ 0
   Eg: The flow in a pipe whose valve is being opened or closed gradually

6. **Differentiate between uniform & non uniform flow? Nov 2010, May 2014 ,Nov 2015**
   Uniform flow: It is defined as that type of flow in which the velocity at any point given time does not change with respect to space. Eg: Flow through a straight pipe of constant diameter.
   Non- uniform flow: It is that type of flow in which a velocity at any given time changes with respect to space. Eg: flow through a non- prismatic conduit.

7. **What is one dimensional two dimensional three dimensional flow?**
   One dimensional flow: The flow in which the velocity is a function of time and one dimensional flow.
   Two dimensional flows: The flow in which the velocity is a function of time and two space co-ordinate is called two dimensional flow.
   Three dimensional flows: The flow in which the velocity is a function of time and three mutually perpendicular direction are called as three dimensional flow.
8. **Distinguish between path lines, stream lines & streak lines? Nov'09, May'10, Nov'10 & June'12 ,May 2016**
   Path line: It is the path followed by fluid particles in motion. It shows the direction of particular particle as it moves ahead.

Stream line: It is defined as the imaginary line within the flow so that the tangent at any point on it indicates the velocity at that point.
Equation of a stream line, $dxu=dyv=dzw$
A path line gives the path of one particular mode at successive instants of time, a stream line indicates the direction of a numbers of particular at the same instant.
Streak line: The streak line is a curve which gives an instaneous picture of a location of the fluid particles, which have passed through a given point.

9. **Define continuity equation?**
The continuity equation is based on the principal of conservation of mass. It states that in a running fluid (ie). if no fluid is added or removed from the pipe in any length, the mass passing across different section shall be same,
$\rho 1A1v1 = \rho 2A2v2$ for compressible fluid and
$A1v1 = A2v2$for incompressible fluid.
for three dimensional flow $\partial u\partial x+\partial v\partial y+\partial w\partial z=0$

10. **Explain briefly the flowing (i) velocity potential function and (ii) Stream function?**
Velocity potential function: It is a defined as a scalar function of face and time such that its negative derivative with respect to any direction gives the fluid velocity in that direction.
Mathematically,
$\Phi \neq \rho$ (x, y, z, t) - for unsteady flow
$\Phi = \rho$ (x, y, z, t)-for steady flow
-∂φ -∂φ -∂φ
Such that u = ------, v = -----, w = ------
∂x ∂y ∂z
Where u, v and w are the components of velocity in x, y, z directions.
(1) If velocity potential exists, the flow should be irrational flow.

(2) If velocity potential satisfies, the Laplace equation represents the possible steady incompressible irrigational flow.
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.

11. **If the stream function is known, it is possible to determine the rate of flow between any two stream lines?**
Yes, from the value of ψ which are the stream function values of any two stream lines can be found. The rate of flow between the stream lines is per unit thickness.

12. **Give the Euler's equation of motion?**
$dp\rho+ gdz+vdv=0$

13. **What are the assumptions made in deriving Bernoulli's equation? (Nov/Dec 2009, May/June 2013, May/June 2012, Nov/Dec 2011)**
    1. The fluid is ideal 2. The flow is steady and continuous. 3. The flow is incompressible. 4. The flow is irrotational. 5. The flow is along the streamline.

14. **What is Bernoulli's equation for real fluid?**
$P1\rho g+v122g+z1= P2\ \rho g+v222g+z2+hf$
Where
hf is the loss of energy
(p/ ρg) Pressure energy.
(v2/ 2g) Kinetic energy.
Z Datum energy.

15. **State the application of Bernoulli's equation?**
It has the application on the following measuring devices.

1. Orifice meter. 2. Venturimeter. 3. Pitot tube.

(16 MARK)

1. **What are the types of flow?**
2. **Derive continuity equation from basic principles.**
3. **Obtain an expression for continuity equation in Cartesian co-ordinates (ie- three dimensional continuity equation derivations) or differential equation of continuity. (Nov/Dec 2010)**
4. **Briefly explain the stream function and velocity potential function. (Nov/Dec 2011)**
5. **Briefly explain the velocity and acceleration**
6. **The diameter of a pipe at the sections 1 and 2 are 10cm and 15cm respectively. Find the discharge through the pipe if the velocity of water flowing through the pipe at section 1 is 5m/s . Determine also the velocity at section 2.**
7. **Water flows through a pipe AB 1.2m diameter at 3m/s and then passes through a pipe BC 1.5m diameter. At C , the pipe branches . Branch CD is 0.8m in diameter and carries one-third flow in AB . The flow velocity in branch CE is 2.5m/s. Find the volume rate of flow in AB, the velocity in BC ,the velocity in CD , and the diameter of CE. (May 2016)**
8. **The velocity vector in a fluid flow is given V=$4x^3i-10x^2yj+2tk$.**
   The following cases represent the two velocity components , determine the third component of velocity such that they sastify the continuity equation :
   (i) u = $x^2+ y^2 + z^2$; v = $xy^2 - yz^2 + xy$
   (ii) v = $2y^2$, w = $2xyz$
9. **A fluid flow field is given by v= $x^2yi + y^2zj$ - $(2xyz+yz^2)$k**
   prove that it is a case of possible steady incompressible fluid flow . calculate the velocity and acceleration at the point (2,1,3).(May 2012)
10. **The velocity potential function is given by $\emptyset=5\ (x^2-y^2)$. Calculate the velocity components at the point (4,5)**

UNIT- III - FLOW THROUGH PIPES

(2MARK)

1. Define Reynold number in laminar flow.

The flow through the circular pipe will be viscous or laminar, if the Reynold number (Re*) is less than 2000. The expression for Reynold number is given by

Re=ρVDμ

Where ρ = Density of fluid flowing through pipe

V = Average velocity of fluid

D = Diameter of pipe

μ = Viscosity of fluid

2. What are the characteristics of laminar flow? April/May 2010

It is defined as that type of flow in which the fluid particles move along well-defined paths stream lines and all the stream lines are straight and parallel.

If the Reynold number less than 2000, the flow is called laminar flow.

3. Discuss the importance of Darcy-Weisbach formula? (Nov/Dec 2011)

The Darcy–Weisbach equation is a phenomenological equation, which relates the head loss or pressure loss due to friction along a given length of pipe to the average velocity of the fluid flow. The equation is named after Henry Darcy and Julius Weisbach.

The Darcy–Weisbach equation contains a dimensionless friction factor, known as the Darcy friction factor. This is also called the Darcy–Weisbach friction factor or Moody friction factor. The Darcy friction factor is four times the Fanning friction factor.

4. Write the Darcy-Weisbach formula to find the head loss? Nov/Dec 2011

Head loss can be calculated with

$hf=fDLDV22g$

where

- *hf* is the head loss due to friction (SI units: m);
- L is the length of the pipe (m);
- D is the hydraulic diameter of the pipe (for a pipe of circular section, this equals the internal diameter of the pipe) (m);
- *V* is the average velocity of the fluid flow, equal to the volumetric flow rate per unit cross-sectional wetted area (m/s);
- *g* is the local acceleration due to gravity (m/s2);
- *fD* is a dimensionless coefficient called the Darcy friction factor.

5. What is Moody diagram and its use in pipe flow? (OR) Write the significance of Moody diagram? (Nov/Dev 2009) (Apr/May 2011) (Nov/Dec 2007)

The Moody chart or Moody diagram is a graph in non-dimensional form that relates the Darcy-Weisbach friction factor, Reynolds number and relative roughness for fully developed flow in a circular pipe.

It can be used for working out pressure drop or flow rate down such a pipe.

It is used to find out the roughness of the pipe.

6. Write Reynolds equation, Navier-Stokes equation and Euler's equation of motion?

Reynolds equation: (Fg)x+(Fp)x+(Fv)x+(Ft)x

Navier-Stokes equation: (Fg)x+(Fp)x+(Fv)x
Eulers equation of motion: (Fg)x+(Fp)x

7. **Explain Couette flow? (May/June 2012)**
Couette flow is the laminar flow of a viscous fluid in the space between two parallel plates, one of which is moving relative to the other. The flow is driven by virtue of viscous drag force acting on the fluid and the applied pressure gradient parallel to the plates.

8. **Define the terms major energy loss and minor energy loss in pipe? Nov/Dec 2009, 2012, Nov/Dec 2014 (or) List major and minor losses of flow in a pipe? May 2016**
The loss of head (or) energy due to friction in a pipe is known as major energy (head) loss.
The loss of energy due to the change of velocity of the following fluid in magnitude or direction (due to sudden expansion, sudden contraction, bend, pipe fittings, obstruction in pipe, entrance of a pipe, the exit of pipe and various pipe fitting) is called minor energy loss.

9. **What do you understand by (a) total energy line, (b) hydraulic gradient line? (Nov/Dec 2011, 2013, Nov/Dec 2007) (Or) What is hydraulic gradient line? State its application? (May 2016)**
Total energy line: It 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.
Hydraulic gradient line: It is defined as the line which gives the sum of pressure head, datum head of a flow fluid in a pipe with respect to some reference line. Sometimes, the hydraulic grade line is also known as piezometric head. It is very useful in the study of flow of fluids through pipes.

10. **What is an equivalent pipe? (April / May 2009)**
An equivalent pipe is defined as the pipe of uniform diameter having loss of head and discharge equal to the loss of head and discharge of a compound pipe consisting of several pipes of different length and diameters.

$$\boldsymbol{Ld5}=\boldsymbol{L1d15}+\boldsymbol{L2d25}+\ \boldsymbol{L3d}$$

11. **Under what conditions does a minor loss become a major loss?**
In long pipes, minor losses are insignificant in magnitude compared to friction losses which is justifiably treated as major loss. If the pipe is short, minor losses may be become the major component of the total head loss.

12. **Define water hammer in pipes?**
In a long pipe ,when the following water is suddenly brought to rest by closing the valve (or) by any similar causes, there will be a sudden rise in pressure due cot the momentum of water being destroyed.
*A pressure wave is transmitted along the pipe.
*A sudden rise in pressure has the effect of hammering action on the walls of the pipe. *This phenomenon of sudden rise in pressure is known as water hammer (or) hammer blow.

13. **Write the expression for calculating the loss of head due to sudden expansion of pipe. Nov/Dec 2011**

$$he=(V1-V2)2g$$

14. **What is scale of turbulence? Nov/Dec 2010**
If the Reynold number is more than 4000, the flow is called turbulent flow.

15. **Differentiate between pipes in parallel and pipes in series. May/June 2013**

Pipes in Series: Pipes in serious (or) compound pipes are defined as the pipes of different length and of different diameters are connected end to end to form a pipe line. Q = A1V1 = A2V2 =A3V3

Pipes in Parallel: Pipe are said to be parallel, when a main pipes divide in to two are more parallel pipes which again join together downstream and continues as a main line. The pipes are connected in a parallel in order to increase the discharge passing through the main. Q = Q1+Q2

(16 MARK)

1. **Derive an expression for the velocity distribution for the viscous flow through circular pipe and sketch the shear stress distribution and distribution across the section of pipe. (Or) derive the Hagen-Poisuille equation and state the assumptions made. (May 12, 13, 09, 07). Prove that the ratio of maximum velocity to average velocity is 2 for the viscous flow through a circular pipe. (Nov 07)**
2. **Derive an expression for the velocity distribution for the viscous flow through a two parallel plates and sketch the shear stress distribution and distribution across the section of plates and drive drop of pressure head. Prove that the ratio of maximum velocity to average velocity is 3/2 for the viscous flow through a two parallel plates.**
3. **An oil of viscosity 0.096 Nsm-2 and specific gravity of 1.59 flows through a horizontal pipe of 50 mm diameter with a pressure drop of 6 kN/m2 per metre length of pipe. Determine (1) Rate of flow (2) The shear stress at the pipe wall (3) The power required for 100 m length of the pipe to maintain the flow. (May/June 2012)**
4. **Determine the pressure drop when a fluid flows through a tube of 20 cm diameter and 120 meters length at a flow rate of 0.19 m3 per second. Take kinematic viscosity = 1.22X10-5 m2/sec, Specific gravity=1.59. (Nov/Dec 2010)**
5. **Determine (a) the pressure gradient, (b) the shear stress at the two horizontal parallel plates and (c) the discharge per meter width for the laminar flow of oil with a maximum velocity of 2m/s between two horizontal parallel fixed plates which are 100 mm apart. Given μ=2.4525 $Ns/m2$.**
6. **An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2m be 0.3 N/cm3. The width of the plates is 200 mm. if the drop of pressure.**
7. **Two parallel plates kept 100 mm apart have laminar flow of oil between them with a maximum velocity of 1.5 m/sec. Calculate (i) the discharge per metre length (ii) the shear stress at the plates (iii) the difference in pressure between two points 20 m apart (iv) the velocity gradient at the plates and (v) the velocity at 20 mm from the plates. Assume viscosity of oil to be 24.5 poise. (Nov/Dec 2013)**
8. **Derive the equation for the friction loss in pipe line. Or derive an expression for Darcy-Weisbach equation? (or) Derive an expression for loss of head due to friction. (May 13, Nov'06)**
9. **A fuel oil is pumped in a 300 mm diameter and 1.6 kilometer long pipeline eat the rate of 100 lit/se. The pipe is laid at an upgrade of 1:100. The specific weight of the fuel oil is 9 kN/m3 and its kinematic viscosity is 21.4 stokes. Find the power required to pump the oil. (Nov/Dec 2012)**
10. **An oil specific gravity 0.7 is flowing through a pipe of diameter 300 mm at the rate of 500 litres/s. Find the head lost due to friction and power required to maintain the flow for a length of 1000 m. Take ν = 0.29 stokes.**

UNIT- IV- DIMENSIONAL ANALYSIS AND MODEL STUDIES
(2MARKS)

1. **Define boundary layer? Write its types of thickness. (Nov/Dec 2009, May/June 2013)** When a solid body is immersed in a flowing fluid, there is a narrow region of the fluid in the neighborhood of the solid body, where the velocity of fluid varies from zero to free stream velocity .this narrow region of fluid is called boundary layer.

   Types of Thickness

   1. Boundary layer thickness (δ)

   2. Displacement thickness (δ*)

   3. Momentum thickness (θ)

2. **Define laminar sub layer?**

   In turbulent boundary layer region, adjacent to the solid boundary velocity for a small thickness variation is influenced by viscous effect. This layer is called as laminar sub layer.

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

. 3. **Differentiate between laminar boundary layer (Nov 2011) and turbulent boundary layer? (Nov/Dec 2009, 2010)**

   If the Reynolds number of the flow is less than 5 X 105, then the boundary layer is called laminar boundary layer.

   If the Reynolds number (UXx)ν is more than 5×105and less than 107 than the boundary layer is called turbulent layer.

4. **Define boundary layer thickness? (Nov/Dec 2006)**

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

5. **Define displacement thickness (April/May 2010, Nov/Dec 2011, 2012,May 2016)**

   It is defined as the distance measure perpendicular to the boundary of the solid body, by which the boundary should be displaced to the compensate for the reduction in flow rate on account of boundary layer formatting.

6. **Define momentum thickness (θ)? (April/May 2008, Nov/Dec 2012,2013)**

   It is defined as the distance, measured perpendicular to the boundary of the solid body, by which the boundary should be displaced to compensate for the reduction in momentum of the flowing fluid of boundary layer for motion.

7. **Define energy thickness (δ**)? (Nov/Dec 2007,2013, April/May 2006)**

   It is defined as the distance, measured perpendicular to the boundary of the solid body, bywhich the boundary should be displaced to compensate for the reduction in kinetic of the flowing fluid on account of boundary layer formation.

8. **Give the von -Karman momentum integral equation.** τoρU2= ∂θ∂x

Where,

θ = momentum thickness

τo= shear stress at surface

U = free stream velocity

This equation applicable to laminar, transition and turbulent boundary layer flow.

9. What are the different methods of preventing the separation of boundary layer? (Nov/Dec 2015)

- Suction of the slow moving fluid by a suction slot.
- Supplying additional energy from a blower.
- Providing bypass in the slotted wing.
- Rotating boundary in the direction of flow.
- Providing small divergence in diffuser.
- Providing guide - blades in a bend.

10. What is meant by boundary layer separation? (Nov/Dec 2010)

The boundary layer is formed on the flat plate when it is held immersed in a flowing liquid. If the immersed plate or body is curved or angular one, the boundary layer does not stick to the whole surface of the body. The boundary leaves the surface and gets separated from its. This phenomenon is known as boundary layer separation.

11. State the effects of boundary layer separation?

Separation of boundary layer greatly affects the flowing as a hole. In particular, the formation of eddies and wake zone of disturbed flow on the downstream causes continuous loss of energy. This separation of boundary layer is undesirable, unstable and in efficient process.

12. When a surface will be called as hydro dynamically smooth?(May 2016)

When the average depth of the surface irregularities is lessthan the laminar sub-layer of the surface is known as hydro dynamically smooth surface.

13. Define laminar boundary layer. (Nov/Dec 2011, May 2014)

The leading edge of the surface plate, where the thickness is small, the flow in the boundary layer is laminar though the main flow is turbulent. This layer of the fluid is said to be laminar boundary layer.

14. What are the characteristics of laminar flow? April/May 2010

It is defined as that type of flow in which the fluid particles move along well-defined paths stream lines and all the stream lines are straight and parallel.

If the Reynold number less than 2000, the flow is called laminar flow.

15. What is scale of turbulence? Nov/Dec 2010

If the Reynolds number is more than 4000, the flow is called turbulent flow.

(16 MARKS)

1. **Define and explain the Laminar Boundary layer, Turbulent Bounary layer and Laminar Sub-layer (or) With the aid of a net sketch, explain the characteristics of the boundary layer by**

considering a free approaching parallel to a sharp-edged, thin, smooth, flat plate under zero pressure gradient.(Nov 2010,May 2012)

2. **Derive the expression for displacement thickness in boundary layer with the necessary assumptions. (Nov 2007,May 2011,2013)**
3. **Derive the expression for Momentum thickness in boundary layer with the necessary assumptions.(Nov 2007)**
4. **Derive the expression for energy thickness in boundary layer with the necessary assumptions.**
5. **Derive the Von-Karman momentum Integral equation for flow past a flat plate. (May 2009) or Derive the expression for drag force on a flat plate due to boundary layer?**
6. **What is separation of boundary layer? When it occurs? Discuss the methods for the control of boundary layer separation. (Nov 2011)**
7. **Determine the thickness of the boundary layer at the trailing edge of smooth plate of length 4m and of 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× 10-5 m2/s**.
8. **Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by**uU=yδ**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. (Nov 2011, Dec 2015)**
9. **For the velocity profile for laminar boundary layer** $uU=2(y\delta)-2(y\delta)3+(y\delta)4$ **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.(Nov 2009)**
10. **A plate of 600 mm length and 400 mm wide is immersed in a fluid of sp.gr. 0.9 and kinematic viscosity (v) = 10-4m2/s. The fluid is moving with a velocity of 6m/s. Determine (i) boundary layer thickness, (ii) Shear stress at the end of the plate, and (iii) drag force on one side of the plate. (Nov/Dec 2012, 2013)**

UNIT – V- FLOW THROUGH PIPES

(2 MARKS)

1. **What is dimensional analysis?**
Dimensional analysis is a mathematical technique used in research work for design and for conducting model tests, which makes use of the study of the dimensions for soling several engineering problems. It deals with the dimensions of the physical quantities involved in the phenomenon.

2. **Write the uses of dimensional analysis?**
Testing the dimensional homogeneity of any equation of fluid motion o
Deriving equation expressed in terms of non- dimensional parameters to show the relative significance of each parameter.

3. **What do you mean by fundamental units and derived units? Give example.**
The various of physical quantities used in flied phenomenon can be expressed in terms of fundamental or primary quantities
E.g.: Mass (M), length (L), time (T)
The quantities which are expressed in terms of the fundamental or primary quantities are called derived or secondary quantities
E.g.: Velocity, area, density
Velocity = distance per unit time (L/T2)

4. **Explain the term dimensional homogeneity. How is it attained in a fluid equation?(Nov/Dec 2013, 2012)**
Dimensional homogeneity means the dimensions of each term in an equation on both sides are equal. Thus if the dimensions of each term on the both sides of an equation are the same is known as dimensionally homogenous equation.
E.g.: $\mathbf{V=\sqrt{2gH}}$

5. **State Buckingham pi-theorem . (May/June 2014, Nov/Dec 2013)**
It states that, if there are n variables (independent and dependent variables) in a physical phenomenon and if these variables contain m fundamental dimensions (M, L, T), the variable are arranged into (n-m) dimensions terms.

6. **Enumerate the applications of dimensional homogeneity. (Apr/May 2010)**
 Dimensional analysis thus helps to check that equations might be true.

 However, it does not prove that they are correct as well.

7. **What are the advantages and applications of model testing/dimensional analysis/model analysis ?(Apr/May 2010, Nov/Dec 2009)**
Advantages: The merits of alternative designs can be predicated with the help of model testing. Model testing can be used to detect and rectify the defects if an existing structure which is not functioning properly. The performance of the hydraulic structure or hydraulic machine can be easily predicted in advance from its model.
Applications
 Civil engineering structures such as dams spillways weirs canals etc

 Turbines pumps and compressors

 Design of harbors ships & submarine ,Aero planes rockets & missiles

 Flood control investigation of silting and scour in rivers irrigation channels

8. **What is model analysis?**

Model analysis is an experimental method of finding solution of complex flow problems the model is the small scale replace of the actual structure or machine. The actual structure or machine is called prototype the study of models of actual machine is called model analysis

9. **What is meant by geometric, kinematic and dynamic similarities? (Nov/Dec 2011) (or) List the similitude involved in the model analysis? (May 2013)**

Similitude involved in the model analysis:

Geometric Similarity: (Nov/Dec 2012)

It is said to exist between the model and the prototype. The ratio of all corresponding linear dimension in the model and prototype are equal.

Kinematic Similarity: (Nov/Dec 2012, 2011, May/June 2012)

It means the similarity of motion between the model & prototype. The kinematic similarity is said to exist between model and the prototype if the ratios of the velocity and acceleration at the corresponding points in the model and at the corresponding points in the prototype are the same.

Dynamic Similarity: (Apl/May 2011)

It means the similarity of forces between the model & prototype. Thus dynamic similarity is said to exist between the model and the prototype if the ratios of the corresponding forces acting points are equal.

10. **Define similitude? (Nov/Dec 2010)**

Similitude's is defined as the similarity between the model & prototype in every respect, which means that the model and prototype have similar properties or model and prototype completely similar.

11. **Define: 1. Reynolds number 2. Euler's numbers 3. Weber numbers 4. Mach numbers write their significances for fluid flow problems? (May/June 2014)**

(1) Reynold's Number (Re): It is defined as the ratio of inertia force of a flowing fluid and the gravity force of the fluid.

E.g.: flow through open channels, Flow over matches wires

(2) Euler's Number (Eu): It is defined as the square root of the ratio of inertia force of a flowing fluid to pressure force.

E.g.: discharge through orifices sluices and mouth pieces, Flow through pipes and pressure rise due to sudden closure of values

(3) Weber's Number (We):

It is defined as the square root of the ratio of the inertia force of a flowing fluid to the surface tension force

E.g.: capillary movement of water in soils, Flow of blood in veins & arteries

(4) Mach's Number (M): It is defined as the square root of the ratio of the inertia force to the elastic force

E.g.: significance Compressible fluid problem at high velocities such as motion of high speed projections and missiles

12. **How are hydraulic models classified?**

o Undistorted models
o Distorted models

13. Give the dimensions of the following physical quantities (a)pressure, (b) surface tension, (c) dynamic viscosity, (d) kinematic viscosity.

o Pressure ML-1 T-2
o Surface tension ML-1 T-2
o Dynamic viscosity ML-1 T-1
o Kinematic viscosity L2 T-1

14. State the methods of dimensional analysis?

o Rayleigh's method
o Buckingham's π-theorem

15. What are the similarities between model and prototypes? List the similitude involved in the model analysis.

o Geometric similarity
o Kinematic similarity
o Dynamic similarity

(16 MARKS)

1. **1. Write short note on dimensional analysis. What are the secondary or derived quantities?**
2. **Determine the dimensions of the quantities given below : (i) Angular velocity., (ii) Angular acceleration, (iii) Discharge, (iv) Kinematic viscosity, (v) Force, (vi) Specific weight, and (vii) Dynamic viscosity. (Nov/Dec 2013)**
3. **Check the dimensional homogeneity of the following common equations in the field of hydraulics. (Nov/Dec 2012)**
4. **Write short on Rayleigh's method. (May/June 2013, Apr/May 2015)**
5. **The time period (t) of a pendulum depends upon the length (L) of the pendulum and acceleration due to gravity (g). Derive an expression for the time period by using Rayleigh's method .(Nov 2015)**
6. **Find an expression for the drag force on smooth sphere of diameter D. moving with a uniform velocity V in a fluid of density ρ and dynamic viscosity μ. (Nov/Dec 2011)**
7. **Find the expression for the power P. developed by a pump when P depends upon the head H. the discharge Q and specific weight w of the fluid.**
8. **The efficiency η of a fan depends on the density p, the dynamic viscosity p of the fluid, the angular velocity at diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. (May/June 2014)**
9. **The resisting force R of a supersonic plane during flight can be considered as dependent upon the length of the 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.**
10. **A partially sub-merged body is towed in water. The resistance R to its motion depends on the density ρ, the viscosity μ of the water, length l of the body, velocity V of the body and the acceleration due to gravity g. Show that the resistance to the motion can be expressed in the form**

    R=ρL2V[(μρVL)(lgV2)] (Nov/Dev 2011)