

SRINIVASAN ENGINEERING COLLEGE, PERAMBALUR
DEPARTMENT OF MECHANICAL ENGINEERING
CE6451-FLUID MECHANICS AND MACHINERY
QUESTION BANK

UNIT -1
INTRODUCTION

Part -A

1. State Newton's law of viscosity?(Apr/May04,05,10,Nov/Dec 09)

According to the Newton's law of viscosity ,the shear force F acting between two layers fluid is proportional to the difference in their velocities (du)and area A of the plate and inversely proportional to the distance between them.

2. List of assumption of Bernoulli's equation (Apr/May05,06,08,10,Nov/Dec '04,09)

The liquid is ideal and incompressible

The flow is steady and continuous

The velocity is uniform over the cross section and is equal to mean velocity

The only forces acting on the fluid are the gravity force and the pressure force

all the frictional losses are negligible

3. Define compressibility?(Apr /May 02,10)

Compressibility is defined as the ratio of the change in pressure to the rate of change of volume due to the change in pressure.

$$\text{Bulk modulus} = \frac{\text{Change in pressure}}{\text{change in volume per unit volume}}$$

4. State continuity equation?(Apr /May 10,Nov/Dec 05)

According to the law of conservation of mass, at all cross section the rate of flow is constant.

5. what is a real fluid? Give examples.(Apr /May 03)

The fluid which is having the following properties is known as real fluids.

it is compressible

they are viscous in nature.

6. Define vapour pressure? (Apr/May 05,09)

When evaporation takes place with in enclosed surface partial pressure created on the liuid surface by the vapour molecules is called as vapour pressure

7.Give the units for mass density ,sp.weight,comprssibility?(Apr/May 05)

1.Mass density = $M/V \text{ kg/m}^3$

2.sp.weight = $W/V \text{ N/m}^3$

3.compressibility = $1/K$

8.Define capillarity?(Nov/Dec 04)

It is defined as the phenomenon of rise or fall of liquid surface relative to out side liquid surface

9.What is Newtonian fluid ?(Nov/Dec 04)

A real fluid in which shear stress is dirctly proportional to the rate of shear strain

$$\text{shear stress} = U / (du/dy)$$

10.What is the difference between the adhesion and cohesion?(Apr/May 08)

Adhesion is the property of fluid ,and the molecules of fluid attraction will be the different kind of material ,like solid to liquid attraction.

Cohesion molecules attraction will be same kind of materials like ,liquid to liquid .

11.How are fluid flows classified?(Apr /May 08)

Fluid flow,s are classified into the following categories.

Laminar flow

turbulent flow

steady and unsteady flow

compressible and in compressible

rotational and irrotational flow

12.Define surface tension?(Apr/May 08,Jan/Feb 10)

It is defined as the tangential force per unit lenth acting at right angels on either side of the surface. it's unit is N/m

13.What is the effect of temperature on viscosity of water and that of oil?(Jan/Feb 10)

If the water temperature is increasing means, density of water will be reduced. temperature decrease means density will be increasing.

If the air temperature increasing means pressure will be increasing

14. Why are some fluids classified as Newtonian fluids? Give example (Nov/Dec 02)

In Newtonian fluids, a linear relationship exists between the magnitude of shear stress and the resulting rate of deformation

Ex: Water, kerosene

15. What effect does temperature have on the absolute viscosity of a liquid? Explain. (Nov/Dec 07)

The absolute viscosity of liquids *decreases* as the temperature increases. Energy added to the system in the form of heat increases the kinetic energy of the molecules. With higher kinetic energy, the molecules are able to overcome the intermolecular attraction forces resulting in a less viscous liquid.

16. What is the difference between guage pressure and absolute pressure? (Nov/Dec 07)

Gage pressure is measured from atmospheric, and absolute is measured from 0 (as all absolute scales are measured from). They both use the same scale for measuring.

Standard atmosphere at sea level is 14.7lb/in² of pressure absolute and 0 pressure gage. If you had 7psi gage pressure you'd have 14.7+7psi absolute.

17 .Distinguish between ‘mass density’ and ‘weight density’.(May/June 09)

S.no	Mass density	Weight density
1	It is mass per unit volume	It is weight possessed per unit volume
2	Unit is kg/m ³	Unit is N/m ³
3	It does not vary from place to place	It varies from place to place because of acceleration due to gravity

18. Define compressibility of a system.(May/June 09)

Compressibility is defined as the ration of the change in pressure to the rate of change of volume under the action of external pressure.

19.What are the units and dimensions for kinematic and dynamic viscosity of a fluid(Nov/Dec 06)

The units and dimensions of kinematic viscosity is m^2/s

The units and dimensions of dynamic viscosity is Ns/m^2

20. Define Newtonian law of viscosity and write the relationship between shear stress and velocity gradient? (Nov/Dec 06)

According to Newton's law of viscosity, the shear force F acting between two layers of fluid is proportional to the difference in their velocities du and area A of the plate and inversely proportional to the distance between them.

Part -B

1. Show for a perfect gas the bulk modulus for a elasticity equals its pressure for (i) An isothermen process (ii) times the pressure for an isentropic process. **(Apr /May 03)**

2. A drainage pipe is tapered in a section running with full of water. The pipe diameters at the inlet and exit are 1000 mm and 500 mm respectively. The difference between the inlet and throat 3m head of water. The pressure at the exit is 250 mm of Hg vacuum. The friction loss between the inlet and exit of the pipe is $1/10$ of the velocity head at the exit. Determine the discharge through the pipe. **(Apr /May 10)**

3. A pipe of 300 mm diameter inclined at 30° to the horizontal is carrying gasoline (specific gravity = 0.82). A venturimeter is fitted in the pipe to find out the flow rate hose throat diameter is 150 mm. The throat is 1.2 m from the entrance along its length. The pressure gauges fitted to the venturimeter read $140 \text{ kN}/\text{m}^2$ and $80 \text{ kN}/\text{m}^2$ respectively. Find out the coefficient of discharge of venturimeter if the flow is $0.20 \text{ m}^3/\text{s}$. **(Apr /May 10)**

4. (i) Does a velocity given by represent possible fluid motion of an in-compressible fluid. (ii) Two components of velocity in an in-compressible fluid flow are given by and Determine the third component, assuming that the origin is a stagnation point. (4)
(iii) The velocity in flow field is given by $u=3\text{m}/\text{s}$ $v=6\text{m}/\text{s}$ Determine the equation of the

streamline passing through the origin and the one passing through the point (2m, 3m).
(Apr/May 03)

5. A thin plate is moving in still atmospheric air at a velocity of 5 m/s. The length of the plate is 0.6m and width 0.5 m. Calculate (a) the thickness of the boundary layer at the end of the plate, and (b) drag force on one side of the plate. Take the density of air as 1.24 Kg/m³ and kinematic viscosity 0.15 stokes. **.(Nov/Dec 09)**

6. Find the convective acceleration at the middle of a pipe which converges uniformly from 0.6 m diameter to 0.3 m diameter over 3 m length. The rate of flow 40 lit/s. If the rate of the rate of changes uniformly from 40lit/s to 80 lit/s in 40 seconds, find the total acceleration at the middle of the pipe at 20 th second. **(Jan/Feb 10)**

7. (i). Determine the mass density, weight density and sp. Volume of a liquid whose relative density is 0.85

(ii) A liquid of 10 lit with relative density of 1.30 is mixed with 8 lit of a liquid of relative density 0.80. if the bl of the liquid shrinks one percent on mixing. Calculate the relative density, the density, the volume and weight of mixture. **(Apr /May 08)**

8. A vertical cylinder of dia 180 mm rotates concentrically inside another cylinder of dia 181.2 mm. Both the cylinders are 300 mm high. The space between the cylinders is filled with the liquid. Find the viscosity of the fluid if torque of 20 Nm is required to rotate the inner cylinders at 120 r.p.m. **(Nov/Dec 04)**

9. Determine the minimum size of glass tube that can be used to measure water level, if the capillarity rise in the tube is not to exceed 0.3 mm. Take surface tension of water in contact with air as 0.0735 N/m **(Nov/Dec 04)**

10. The space between two parallel plate 5 mm apart, is filled with crude oil of specific gravity 0.9. A force of 2 N is required to drag the upper plate at a constant

velocity of 0.8 m/s. The lower plate is stationary. The area of the upper plate is 0.09 m^2 . Determine (1) The dynamic viscosity in poise and (2) Kinematic viscosity of the oil in Stokes. **(May/Jun 09)**

11. Determine the bulk modulus of elasticity of a liquid, if the pressure of the liquid is increased from 7 MN/m^2 to 13 MN/m^2 , the volume of liquid decreases by 0.15%. **(May/Jun 09)**

12. The velocity components in a three dimensional fluid flows are **(May/Jun 09)** Determine the missing component of velocity such that continuity equation is satisfied.

13. Derive from first principles, the Euler's equation of motion for steady flow along a stream line. Hence derive Bernoulli's equation. State the various assumptions involved in the above derivation **(May/June 09)**

14.(i) Define surface tension and also compressibility of a fluid?

(ii) A Newtonian fluid is filled in the clearance between a shaft and a concentric sleeve. The sleeve attains a speed of 50 cm/s, when a force of 40 N is applied to the sleeve parallel to the shaft. Determine the speed of the shaft, if a force of 200N is applied **(Nov/Dec 06)**

15. (i) Determine the minimum size of glass tubing that can be used in measure water level. If the capillary rise in the tube is not to exceed 2.5 mm. Assume surface tension of water in contact with air at 0.0746 N/m .

(ii) What is the bulk modulus of elasticity of a liquid which is compressed in a cylinder from a volume of 0.0125 m^3 at pressure 150 N/cm^2 ? **(Nov/Dec 06)**

16. A horizontal venturimeter with inlet and throat diameter 300mm and 100 mm respectively is used to measure the flow of water. The pressure intensity at inlet is 130 KN/m^2 . While the vacuum pressure head at throat is 350 mm of mercury . Assuming that

3 percent head lost between the inlet and throat. Find the value of coefficient of discharge for the venturimeter and also determine the rate of flow. (Nov/Dec 06)

17. Derive the Euler's equation of motion, for a two – dimensional inviscid steady flow. List the assumption underlying. (Nov/Dec 02)

18. Derive from the first principle the Euler's equation of motion for steady flow along a streamline .obtain Bernoulli's equation from Euler's equation.(Apr/May 08)

19. A 45° reducing bend is connected in a pipe line, the diameters at the inlet and the outlet of the end being 600mm and 300mm respectively. Find the force exerted by the water on the bend if the intensity of pressure at the inlet to bend is 8.829N/cm^2 and rate of flow of water is 600litres/s (Nov/Dec 09)

20. Derive the continuity equation of differential form. Discuss whether the equation is valid for a steady or unsteady flow, viscous or inviscid flow, compressible or incompressible flow. (Apr/May 03)

UNIT-2

FLOW THROUGH CIRCULAR CONDUITS

Part -A

1. what is the formula for calculating co-efficient of contraction? (Apr /May, 02, 10)

It is the ratio of area vena at contraction area² orifice area of the pipe.

$$\text{Co-efficient of contraction} = \frac{\text{Area at vena contracta}}{\text{Area at orifice}}$$

2. Define boundary layer thickness?(Apr /May,05,10)

The fluid layer in the vicinity of the solid boundary where the effects of fluid friction i.e., the variation of velocity are predominant is known as the boundary layer.

3. Define mach number?(Apr /May 03,10)

It is defined as the square root of the inertia force of a flowing fluid to the elastic force.

$$\text{mach number} = \frac{\text{inertia force}}{\text{Elastic force}}$$

4. What are the minor losses in pipe flow?(Apr/May 09,10)

- Loss of energy due to sudden enlargement
- Loss of head due to sudden contraction
- loss of energy at the exit from the pipe.
- Loss of energy due to gradual contraction or enlargement.
- Loss of energy due to an obstruction in pipe.
- Loss of energy at the entrance to a pipe.
- Loss of energy in bends
- loss of energy in various pipe fittings.

5. State momentum equation and impulse momentum equation?(Apr/May 05)

The momentum equation states that net force acting on a fluid mass is equal to the change in momentum per second in direction.

$$F = d(mv)/dt$$

the impulse momentum equation is given by $\int f \cdot dt = d(mv)$

6. Define the bernoulli's theorem? (Apr/May 03)

It states that in a steady ideal flow of an incompressible fluid the total energy at any point of fluid is constant. total energy consists of pressure energy, kinematic energy and potential energy

7. what is the equipotential line?(Nov/Dec 05)

A line along which the velocity potential Q is constant is called equipotential line

8.Name the different forces present in the fluid flow?(Apr/May 05,09)

The following force are present in the fluid flow,and which affect the fluid flowing path.

- gravity force
- pressure force
- force due to viscosity
- force due to turbulence
- force due to incompressibility

9.what is pitot -static tube? (Nov/Dec 09)

The pitot tube consists of glass tube bent at right angles. it is based on the principle that if velocity of flow at a point becomes zero the pressure there is increased due to conservation of kinetic energy into pressure energy.

10.Differentiate between the laminar flow and turbulent flow(Nov/Dec 04)

Laminar flow	turbulent flow
Fluid particle moving along the pipe well defined path	Fluid particle moving along the pipe in a zig- zag path
Reynolds number < 2000	Reynolds number >4000

11.State the unsteady flow?(Jan/Feb 09)

Unsteady flow is that is that type of flow in which the velocity. pressure at a point changes with time.

$$(dv/dt)(0,0,0)=0$$

12. When is a flow considered steady?(Nov/Dec 02)

Steady flow is that type of flow in which the velocity ,pressure at a point does not changes with respect with the time .

13.Define stream line flow? (Nov/Dec 2007)

The type of flow in a fluid system characterized by the presence of laminae, or parallel streams of fluid. Also called laminar flow, streamline flow is desirable because of its efficiency

14. Write the Bernoulli's equation in terms of head? Explain each term? (Nov/Dec 07)

The Bernoulli's equation is one of the most useful equations that is applied in a wide variety of fluid flow related problems. This equation can be derived in different ways, e.g. by integrating Euler's equation along a streamline, by applying first and second laws of thermodynamics to steady, irrotational, inviscid and incompressible flows etc.

$$\frac{\partial}{\partial s} \left(\frac{v^2}{2} + \frac{p}{\rho} + g \cdot h \right) = 0$$

where

v = flow speed

p = pressure

ρ = density

g = gravity

h = height

15. State at least two assumptions in Bernoulli's equation. (May/June 09)

The assumptions of Bernoulli's equation are:

The liquid is ideal and incompressible.

The flow is steady and continuous.

16. Differentiate between 'hydraulic gradient line and 'energy gradient line (May/June 09)

Energy lines:

If at different sections of the pipe total energy is plotted in scale and joined by a line, the line is called as energy grade line.

Hydraulic gradient line:

The pressure head in a pipe decreased gradually from section to section of the pipe in the direction of fluid flow due to loss of energy. If pressure heads at the different sections

of the pipe are joined by a straight line. This line is called hydraulic grade line of pressure line.

17. Define Stream line in fluid flow (Nov/Dec 06)

Part-B

1.What is the application of Darcy-Weisbach equation? Derive an expression for the same.(**Nov/Dec 09**)

2.For a turbulent flow in a pipe of diameter 300 mm, find the discharge when the centre-line velocity is 2.0 m/s and the velocity at a point 100 mm from the centre as measured by pitot-tube is 1.6 m/s.(**Apr /May10**)

3.For a town water supply, a main pipe line of diameter 0.4 m is required. As pipes more than 0.35m diameter are not readily available, two parallel pipes of same diameter are used for water supply. If the total discharge in the parallel pipes is same as in the single main pipe, find the diameter of parallel pipe. Assume coefficient of discharge to be the same for all the pipes.(**Apr/May 10**)

4.water is pumped at the rate of 300 lit/sec. Through a 30 cm pipe upto a hill top. On the hill top which has an elevation of 50 m, the diameter of pipeline reduces to 20 cm .if the pump maintains pressure of 981 bar at the hill top ,what is the pressure at the foot hill having zero elevation? What is the power required to pump the water?(**Nov/Dec 04**)

5.water is to be supplied to a hostel of 4000 students ,through a supply main. Water consumption per student per day is 180 lit. length of supply main from reservoir is 3000

m, loss of head due to friction is 18 m. coefficient of friction for the pipe is 0.007. if half of the daily supply is pumped in 8 hours, find the size of the supply main. **(Nov/Dec 04)**

6. water enters a reducing pipe horizontally and comes out vertically in the downward direction, if the inlet velocity is 5 m/s and pressure is 80 kpa (gauge) and the diameters at the entrance and exit section of the reaction acting on the pipe **(Apr /May 08)**

7. A jet of water with velocity U and jet area " A " strikes a flat plate normal to it. Determine the force of impingement, power developed and efficiency when the plate is at rest and when the plate is permitted to move along the direction of jet at a velocity " u ". What will happen if a series of plates were to face the jet in quick succession? **(Nov/Dec 02)**

8. A uniform circular tube of bore radius R_1 has a fixed co-axial cylindrical solid core of radius R_2 . An incompressible viscous fluid flows through the annular passage under a pressure gradient $-\partial p/\partial x$. Determine the radius at which shear stress in the stream is zero, given that the flow is laminar and under steady state condition. **(May/June 09)**

9. An existing 300mm diameter pipeline of 3200m length connects two reservoirs having 13m differences in their water level. Calculate the discharge Q_1 . If a parallel pipe 300mm in diameter is attached to the last 1600m length of the above existing pipeline, find the new discharge Q_2 . What is the change in discharge? Express it as a percentage of Q_2 . Assume friction factor $(f) = 0.04$ in Darcy-Weisbach formula. **(May/June 09)**

10.(i) Define the term 'boundary layer' **(May/June 09)**

Define 'minor losses'. How they are different from 'major losses'?

11. The discharge of water through a horizontal pipe is 0.25m/s. The diameter of above pipe which is 200mm, suddenly enlarges to 400mm at a point. If the pressure of water in the smaller diameter of pipe is 120 kN/m, determine; loss of head due to sudden

enlargement. Pressure of water in the larger pipe and the power lost due to sudden enlargement (**May/Jun 09**)

12. (i) State Bernoulli's theorem for steady flow of an incompressible fluid
(ii) Derive an expression for Bernoulli's equation for a fluid flow. (**Nov/Dec 06**)

13. A 30 cm diameter pipe, conveying water, branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the 30 cm diameter pipe is 2.5 m/s, find the discharge in this pipe. Also determine the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s (**Nov/Dec 06**)

14. Derive the Hagen-Poiseuille equation for laminar flow through a round pipe and show that the average velocity 'U' is given by (**Nov/Dec 02**)

$$U = \frac{1}{8} \frac{\Delta p}{\mu L} R^2$$

15. (i) Derive the Darcy – Weisbach equation. (**Apr/May 04**)
ii) A horizontal pipe carries water at the rate of 40 lit/sec. its diameter, which is 0.3 m, reduces abruptly to 0.15 m. Calculate the pressure change across the contraction if the coefficient of contraction is 0.62 and head loss due to contraction is 0.0978.

16. a piping system consists of three pipes arranged in series.; the lengths of the pipes are 1200 m , 750 m and 600 m and diameters 750 mm , 600 mm and 450 mm respectively.

- a) transform the system to an equivalent 450 mm diameter pipe and
b) determine an equivalent diameter for the pipe 2550 m long. (**Apr/May 04**)

17. (i) oil of absolute viscosity 1.5 poise and density 848.3 kg/m³ flows through a 300 mm pipe. If the head loss in 3000m length of pipe is 200m, assuming a laminar flow , determine the following. . **(Apr/May 08)**

The velocity b) reynold`s number

(ii)for sudden expansion in a pipe flow, workout the optimum ratio between the diameter of the before expansion and the diameter of the pipe after expansion so that pressure rise is maximum.

18. Three pipes of diameters 300mm, 200mm and 400mm and lengths 300m, 170m and 210m respectively are connected in series, the difference in water surface levels in two tanks is 12m. Determine the rate of flow if co-efficient of friction are 0.005, 0.0052 and 0.0048 respectively considering A) Minor losses and b) Neglecting minor loss. **(Apr/May 08)**

19. Derive hagen Poiseuille`s equation from a flow through the circular pipe? **(Jan/Feb 09)**

20. A horizontal pipe of 400 mm diameter is suddenly contracted to a diameter of 200mm, the pressure intensives in the large and smaller pipe is given as 15N/cm² and 10 N/cm² respectively. Find the loss of head due to contraction, if $C = 0.61$, determine also the rate of flow of water. **(Jan/Feb 09)**

21. Derive an expression for Darcy–Weisbach formula to determine the head loss due to friction. Give the expression for relation between friction factor ‘ f ’ and Reynolds's number ‘ Re ’ for laminar and turbulent flow. **(Apr/May 03)**

22. A 30 cm diameter pipe of length 30 cm is connected in series to a 20 cm diameter pipe of length 20 cm to convey discharge. Determine the equivalent length of pipe of diameter 25 cm, assuming that the Friction factor remains the same and the minor losses are negligible. **(Apr/May 03)**

23. Determine the length of an equivalent pipe of diameter 20 cm and friction 0.02 for a given pipe system discharging $0.1 \text{ m}^3/\text{s}$. The pipe system consists of the following :
(Nov/Dec 02)

- I. A 10 m line of 20 cm dia with $f = 0.03$
- II. Three 90° bend, $k = 0.5$ for each.
- III. Two sudden expansion of diameter 20 to 30 cm.
- IV. A 15 m line of 30 cm diameter with $f = 0.025$ and.
- V. A global value, fully open $k = 10$.

24. A pipe of 0.6 m diameter is 1.5 km long. In order to augment the discharge another line of the same diameter is introduced parallel to the first in the second half of the length. Neglecting minor losses. Find the increase in discharge, if friction factor $f=0.04$. The head at inlet is 40 m **(Nov/Dec 06)**

25. Three pipes of diameters 300mm, 200mm and 400mm and lengths 450m, 255m and 315m respectively are connected in series. The difference in water surface levels in two tanks is 18m. Determine the rate of flow of water if coefficients of friction are 0.0075, 0.0078 and 0.0072 respectively considering 1) Minor losses and 2) Neglecting minor losses. **(Nov/Dec 04)**

DIMENSIONAL ANALYSIS

Part-A

1. What is boundary layer? Give a sketch of a boundary–layer region over a flat plate.(Apr/May 03)

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 layer leaves the surface and gets separated from it. This phenomenon is known as boundary layer separation.

2. What do you understand by fundamental units and derived units? (Apr/May 10)

A SI base unit is the single and direct measurement unit for a physical entity. E.g. For mass it is kg, for time it is sec, A derived unit is determined by a physical equation with the base units, like for velocity equals distance divided by time, in SI units: unit of v (velocity)= m (meter) divided by sec (seconds).

3. What are the minor losses in pipe flow? (Nov/Dec 09)

The minor losses are due to sudden expansion of the pipe, sudden enlargement of the pipe, bend in a pipe, pipe fittings and obstruction in the pipe.

4. Explain Rayleigh's method? (Nov/Dec 09)

This method is used for determining the expression for a variable which depends upon maximum three or four variables only. If the number of independent variables becomes more than four, then it is very difficult to find the expression for the dependent variable.

5. Define geometric similarity (Nov/Dec 09)

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.

Length of the model , Breadth of model

Diameter of model , Area of model

Volume of model

6. Give the applications of Euler's model. (Nov/Dec 09)

Flow of aero plane and projectile through air at supersonic speed, i.e., at a velocity more than the velocity of sound

Aerodynamic testing

Under water testing of torpedoes

Water hammer problems.

7. Distinguish between laminar flow and turbulent flow? (Jan/Feb 09)

Laminar flow is an ideal flow type in which all the liquid particles at a given point travel in a straight line and uniform velocity[mostly theoretical], but turbulent is an zigzag type of flow with varying velocity and phase[most practical] used in flow analysis.

**8. Define the terms total energy line and hydraulic gradient line? (Jan/Feb 09)
(Nov/Dec 04)**

The line representing the sum of pressure head, datum head and velocity head with respect to some reference line is known as total energy line.

The line representing the sum of pressure head, datum head with respect to some reference line is called hydraulic gradient line

9. Give an expression to determine the loss of head due to bend in pipe?(Jan/Feb 09)

When there is any bend in a pipe, the velocity of flow changes, due to which the separation of the flow from the boundary and also formation of eddies, takes place. Thus the energy is lost. It's expressed as

$$H_b = kv^2/2g$$

Where

H_b = loss of head due to bend

v = velocity of flow

g = co-efficient of bend. The value of k depends on 1. Angle of bend. 2. Radius of curvature of bend and 3. Diameter of pipe.

10. Define displacement thickness in a boundary layer? (Apr/May 05)

The boundary layer thickness, δ , is defined as the distance required for the flow to nearly reach U_e . The displacement thickness is defined by considering the total mass flow

through the boundary layer. This mass flow is the same as if the boundary layer were completely at rest, with a thickness, δ^*

11. What is the use of a Moody diagram? (Apr/May 05)

Moody's chart is the chart showing the variation of friction factor "f" for the full range of Reynolds's numbers. 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.

12. Define term equivalent pipe? (Nov/Dec 04), (Apr/May 08)

Two pipes or two systems of pipes are in which the losses of head for equal rates of flow are the same. A single pipe is equivalent to a system of pipes when the same loss-of-head condition is satisfied.

13. In fluid flow, what does dynamic similarity mean? What are the non-dimensional numbers associated with dynamic similarity? (Nov/Dec 02)

- (i) it is the similarity of the forces . the flows in the model and prototype are similar.
- (ii) dimensional numbers are weight, force, dynamic viscosity, surface tension ,capillarity etc.

14. What is the physical significance of Reynolds number (Nov /Dec 07)

It is a ratio of inertial forces / viscous forces. Inertial forces can be greater than 1 and still be laminar, i think the standard transition points are 500,000 for external flow and 2800 for internal flow, so the inertial forces need to be much greater than the viscous forces to have fully turbulent flow, but mixed conditions occur with a smaller ratio.

15. Define the terms: Drag and lift? (Nov /Dec 07)

The relative wind acting on the airplane produces a certain amount of force which is called (unsurprisingly) the *total aerodynamic force*. This force can be resolved into components, called lift and drag.

Lift is the component of aerodynamic force perpendicular to the relative wind.

Drag is the component of aerodynamic force parallel to the relative wind.

16. Define: (May/Jun 09)

- (a) Euler number
- (b) Mach number

(a) **Euler number:** It is defined as the square root of the ratio of inertial force to the pressure force of a flowing fluid.

(b) **Mach number:** It is defined as the square root of the inertia force of a flowing fluid to the elastic force.

17. Define 'specific speed' as applied to pumps (May/Jun 09)

Specific speed is the speed of the geometrically turbines (ie a turbine identical in shape, dimensions, blade angles and gate opening etc) which will develop unit power when working under unit head.

18 . What is boundary layer and write its types of thickness?(Nov/Dec 06)

The fluid layer in the vicinity of the solid boundary where the effects of fluid friction i.e the variations of velocity are predominant is known as the boundary layer.

19. Differentiate between pipes in series and pipes in parallel (Nov/Dec 06)

Pipes in series: It is defined as the pipes of different diameters and length are connected with one another to form a single pipeline.

Pipes in parallel: When a main pipeline divides into two or more parallel pipes, which again join together to form a single pipe and continue as a main line. These pipes are said to be pipes in parallel.

Part-B

1. (i) Discuss in detail about boundary layer separation and control, with sketches.

(Apr/May 05)

(ii) the model of a turbine develops 20 KW, while running at 500 rpm Against a head of 8m in a laboratory with overall efficiency of 0.8. the prototype is required to produce 50MW under ahead of 120m. estimate the discharge, speed and overall efficiency of the prototype if the scale ratio is 1:10.

2. What is the application of Darcy-Weisbach equation? Derive an expression for the same. State Buckingham's π theorem. Write down the procedure for solving problems by Buckingham's π theorem. **(Nov/Dec 09)**

3. Using Buckingham's π theorem, show that the velocity through a circular orifice in a pipe is given by $v = \sqrt{2gH} f\left\{\frac{d}{H}, \frac{\mu}{\rho vH}\right\}$ where v is the velocity through orifice of diameter d and H is the head causing the flow and ρ and μ are the density and dynamic viscosity of the fluid passing through the orifice and g is acceleration due to gravity. **(Apr/May 10)**

4. The efficiency (η) of a fan depends on ρ (density), μ (viscosity) of the fluid, ω (angular velocity), d (diameter of rotor) and Q (discharge). Express η in terms of non-dimensional parameters. Use Buckingham's theorem. **(Apr/May 10)**

5. Compare the rate of growth of the laminar boundary layer over a smooth flat plate in the following cases : **(Nov/Dec 02)**

i). Flat plate placed in a water stream flowing at 2 m/s.

ii). Flat plate in an air stream flowing at 2 m/s.

iii). Flat plate placed in an air stream flowing at 8 m/s.

Given that the densities of water and air are 1000 and kg/m^3 respectively and the viscosities of water and air are 0.001 and 0.000019 Ns/m^2 respectively.

6. State Buckingham's theorem. Mention the important principle for selecting the repeating variables. **(May/Jun 09)**

7. The resistance R , to the motion of a completely submerged body depends upon the length of the body (L), velocity of flow (V), mass density of fluid (ρ), kinematic viscosity of fluid (ν). Prove by dimensional analysis that

$$R = \rho V^2 L^2 \phi\left(\frac{\nu}{VL}\right) \quad \text{(May/Jun 09)}$$

8. What is meant by geometric, kinematic and dynamic similarities? Are these similarities truly 'attainable'? If not, why? **(May/Jun 09)**

9. In order to predict the pressure drop in a large air duct a model is constructed with linear dimensions $(1/10)$ th that of the prototype and that water was used to the testing fluid. If water is 100 times denser than that of air and has 100 times the viscosity the viscosity of air, determine the pressure drop in the prototype, for the conditions corresponding to a pressure drop of 70 kPa in the model **(May/Jun 09)**

10. A pipeline 2000m long is used for power transmission. 110kW is to be transmitted through the pipe in which water having a pressure of 5000kN/m² at inlet is flowing. If the pressure drop over a length of pipe is 1000kN/m². And co-efficient of friction is 0.0065, find the diameter of the pipe and efficiency of transmission. **(Apr/May 08)**

11. A rectangular channel of width 5 m flows 1.5 m in uniform flow. Bed slope of the channel is 0.005. The uniform flow is blocked by a air and flow depth of 4 m from bed of the channel. Determine the length of the back water profile between 4 m to 2 m. Use direct step method and assume Manning's as 0.015 **(Nov/Dec 06)**

12. State Buckingham's theorem. Write down the procedure for solving problems by Buckingham's theorem. **(Nov/ Dec 09)**

13. a) Determine the dimensions of the following quantities :

Discharge, kinematics viscosity, Force and Specific weight

b) What are distorted models? What are the merits and demerits of distorted models.

(Apr/May 08)

14. State Buckingham's Theorem and describe how the Buckingham's method differ from Raleigh's Method? **(Apr/May 08)**

15. The efficiency of a fan depends on density ρ , dynamic viscosity μ of the fluid, angular velocity ω , diameter D of the rotor and the discharge Q. Express η in terms of the dimensionless parameters. **(Nov/ Dec 09)**

16. Consider force F acting on the propeller of an aircraft, which depends upon the variable U , D and N . Derive the non-dimensional functional form (**Apr/May 03**)

17. Check the following equations are dimensionally homogenous (14)

(i) Drag force = $C_d \frac{1}{2} \rho U^2 A$ where C_d is coefficient of drag which is constant.

(ii) $F = \gamma Q (U_1 - U_2) / g - (P_1 A_1 - P_2 A_2)$

(iii) Total energy per unit mass = $V^2/2 + gz + P/\rho$

(iv) $Q = 8/15 C_d \tan(\theta/2) \sqrt{(2g)} H^{(5/2)}$ where C_d is coefficient of discharge (constant)

(**Nov/Dec 02**)

UNIT-4
ROTO DYNAMIC MACHINES

Part-A

1. Give the dimensions of the following physical quantities: (Apr/May 03)

- (a) Pressure
- (b) Surface tension
- (c) Dynamic viscosity
- (d) Kinematic viscosity.

Pressure	$\text{kg.m}^{-1}.\text{s}^{-2}$ N.m ⁻² , Pa (pascal) [Force]/[Area].
Surface tension	kg.s^{-2} N/m [Force]/[Length]. Same as surface energy.
Viscosity, dynamic	$\text{kg.m}^{-1}.\text{s}^{-1}$ Pa.s ([Force]/[Area])/[ΔVelocity]
Viscosity, kinematic	$\text{m}^2.\text{s}^{-1}$ [Dynamic viscosity]/[Density]

2. What is a Mach number? Mention its field of use. (Apr/May 03)

It is defined as the square root of the inertia force of a flowing fluid to the elastic force.

3. Define Manometric head. (Nov/Dec 09)

It is defined as the head against which a centrifugal pump has to work. It is denoted by 'H_m'. It is given by the following expressions:

$$H_m = h_s + h_d + h_{fs} + h_{fd} + v_d^2 / 2g$$

H_m = head imparted by the impeller to the water – loss of head in the pump

H_m = total head at outlet of the pump - total head at the inlet of the pump

4. What is specific speed of a centrifugal pump? (Nov/Dec 09)

The specific speed of a centrifugal pump is defined as the speed of a geometrically similar pump which would deliver one cubic meter of liquid per second against a head of one meter.

$$N_s = n \times \sqrt{Q} / H^{0.75}$$

N_s = specific speed, n = pump rotational speed (rpm), Q = flow (gallons per minute), H = head (feet)

5. What do you mean by hydraulic viscosity? (Nov/Dec 09)

Viscosity is a fluid property that measures the resistance of the fluid to deforming due to a shear force. Viscosity is the internal friction of a fluid which makes it resist flowing past a solid surface or other layers of the fluid. The viscosity of a fluid is usually significantly dependent on the temperature of the fluid and relatively independent of the pressure. For most fluids, as the temperature of the fluid increases, the viscosity of the fluid decreases.

**6. Write the expression used to find the jet ratio in a pelton wheel. (Nov/Dec 09)
(Jan/Feb 09)**

Jet ratio - m represents the ratio of the pitch circle diameter of the jet diameter.

$$\text{i.e. } m = D/d$$

Where **D** - Refers to the diameter of the wheel measured upto the centers of the buckets

d - Jet diameter

7. Differentiate between impulse and reaction turbines (Jan/Feb 09)

In impulse turbine the entire water energy is first converted in kinetic energy but there is no energy conversion in reaction turbine.

In impulse turbine the water impinges on the buckets with kinetic energy where as in reaction turbine the water glides over the moving vanes with pressure energy.

In impulse turbine the work is done only by the change in the kinetic energy of the jet but in reaction turbine the work is done partly by the change in the velocity head, but almost entirely by the change in pressure head.

In impulse turbine the remains unchanged and is equal to the atmospheric pressure but in reaction turbine the pressure of flowing water is reduced after gliding over the vanes.

In impulse turbine it is not essential that the wheel should run full. Moreover, there should be free access of air between the vanes and the wheel where as it is essential that the wheel should always run full and kept full of water in reaction turbine.

In impulse turbine the water may be admitted over a part of the circumference or over the whole circumference of the wheel but in reaction turbine the water must be admitted over the whole circumference of the wheel.

It is possible to regulate the flow of water without loss in impulse turbine but in reaction turbine it is not possible to regulate the flow without loss.

8. Define hydraulic efficiency of a turbine? (Jan/Feb 09)

The efficiency of turbines is a function of the available head. The lower head the lower the efficiency. This will be of great importance in the utilization of Tidal Power. Whilst there is usually plenty of water the available heads is low.

It is defined as the ratio of the power given by water to the runner of a turbine to the power supplied by the water at the inlet of the turbine

9. Distinguish between unit speed and specific speed of a turbine? (Apr/May 05)

The turbo machines in which energy is transferred from working fluid to rotor are called turbines.

10. Define the specific speed of a turbine? (Nov/Dec 04)

The primary numerical classification of a turbine is its specific speed. This number describes the speed of the turbine at its maximum efficiency with respect to the power and flow rate. The specific speed is derived to be independent of turbine size. The specific speed is defined as

$$N_s = n \cdot \sqrt{P} / H^{1.25}$$

where,

n is rotational speed of turbine in rpm,

P is output power in kW and

H is net head in meter. The

range of the specific speeds for various turbines is:

Pelton 10 – 30

Turgo 20 – 70

Crossflow 20 – 200

Francis 30 – 400

Propeller and Kaplan 200 – 1000

11. What are draft tube and its function? (Jan/Feb 09)

A draft tube is one important part of a turbine, which is used to transform water into energy. A turbine draft tube is found within the piping system of a turbine. These draft tubes are used in turbines that function in jets, dams, or anywhere else where turbines help do difficult mechanical work.

12. Mention the components of a Reciprocating pump (Nov/Dec 02)

The following components are contained in reciprocating pump which are given below

- (i) Cylinder
- (ii) Suction chambers
- (iii) Piston
- (iv) Connecting rod
- (v) Motor or actuating devices

13. Define specific speed? (Nov/Dec 07)

Specific speed is a term used to describe the geometry (shape) of a pump impeller. People responsible for the selection of the proper pump can use this Specific Speed information to :

- Select the shape of the pump curve.
- Determine the efficiency of the pump.
- Anticipate motor overloading problems.
- Predict N.P.S.H. requirements.
- Select the lowest cost pump for their application.

Specific speed is defined as "the speed of an ideal pump geometrically similar to the actual pump, which when running at this speed will raise a unit of volume, in a unit of time through a unit of head".

14. Distinguish between major and minor losses with reference to flow through pipes. (May/Jun 09)

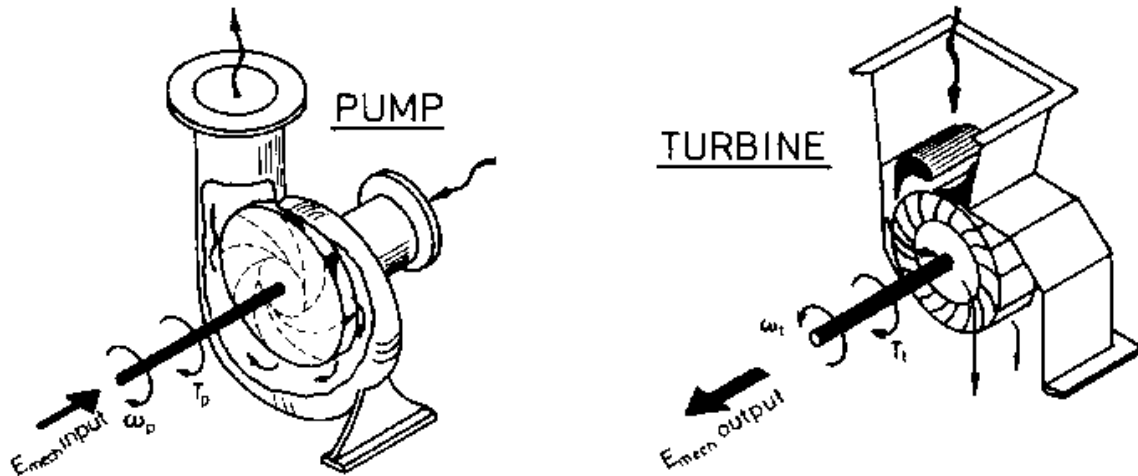
Major losses:

The loss of energy due to friction in a pipe is known as major losses

Minor losses:

The loss of energy caused on account of the change in velocity of flowing fluid is called minor losses

15. Differentiate between the turbine and pumps? {(Nov/Dec 2007)}



	Turbine	Pump
Flow of energy	Input of hydraulic energy (water under pressure) Output of mechanical energy (torque on the shaft)	Input of mechanical energy (torque on the shaft) Output of hydraulic energy (water under pressure)
Hydraulic pressure head	Available turbine head decreases with increasing flow (friction losses)	Total dynamic head to be generated by the pump increases with increasing flow
Direction of rotation	Turbine runner rotates in the OPPOSITE direction of a pump impeller	
Direction of torque	In both modes the same direction	

(for more details on engineering hydraulics and hydraulic machines see Appendices A and B)

FIGURE 2.2 :
Main difference of fluid and energy flow in pumps and turbines

16..What is an indicator diagram?(May/Jun 09)

Indicator diagram is the graph the pressure head in the cylinder and the distance travelled by piston from inner dead centre for one complete revolution of the crank.

17. What is dimensional homogeneity and write any one sample equation?(Nov/Dec 06)

Dimensionally homogeneous equations means, the dimensions of the terms on left hand side should be same as the dimensions of the terms on right hand rule.

18. What is scale effect in physical model study?(Nov/Dec 06)

It is impossible to product the exact behavior of the prototype by model of testing alone. The two models of same prototype behavior will be different> Scale ratios will not be same. So discrepancy between models and prototype will always occur, It is known as scale effect.

Part –B

1.A Francis turbine works under a head of 150m while running at 750rpm.the outer and inner diameter of the runner is 1.4m and 0.85m. the water enters the runner with a velocity of 30m/sec. the outlet angle of the guide blades is 10^0 . Estimate the runner blade angles at inlet and outlet,if the discharge is axial and velocity of flow is constant through the runner.Also calculate the hydraulic efficiency. **(Apr/May 05)**

2. A centrifugal pump delivers 300lit/sec of water at a head of 20m.the blades are radial at outlet and the velocity of flow is constant through and is equal to 3m/sec. Estimate the leading dimensions of the impeller if the diameter at inlet is half the diameter at the outlet ,breadth at outlet is 0.1 times the diameter at outlet and manometric efficiency is 0.80. **(Apr/May 05)**

3.A Pelton wheel is to be designed for the following specifications. Power is 9560kW; head is 350m; speed is 750rpm; overall efficiency is 85% jet diameter is $1/6^{\text{th}}$ of

the wheel diameter; determine the following: 1) the wheel diameter 2) diameter of the jet and 3) number of jets required. Take $C_n=0.985$ and speed ratio $=0.45$. **(Nov/Dec 04)**

4. With the help of a neat diagram explain the construction and working of a Pelton wheel turbine. Derive an expression for hydraulic efficiency of a Pelton wheel?

(Jan/Feb 09)

5. A Pelton turbine is required to develop 9000 KW when working under a head of 300 m the impeller may rotate at 500 rpm. Assuming a jet ratio of 10 and an overall efficiency of 85% calculate

(i) Quantity of water required

(ii) Diameter of the wheel

(iii) Number of jets

(iv) Number and size of the bucket vanes on the runner. **(Apr/May 03)**

6. In an inward radial flow turbine, water enters at an angle of 22° to the wheel tangent to the outer rim and leaves at 3 m/s. The flow velocity is constant through the runner. The inner and outer diameters are 300 mm and 600 mm respectively. The speed of the runner is 300 rpm. The discharge through the runner is radial. Find the (i) Inlet and outlet blade angles (ii) Taking inlet width as 150 mm and neglecting the thickness of the blades, find the power developed by the turbine. **(Apr/May 10)**

7. A Kaplan turbine working under a head of 20 m develops 15 MW brake power. The hub diameter and runner diameter of the turbine are 1.5 m and 4 m respectively. The guide blade angle at the inlet is 30° . $\phi = 0.9$ and $\psi = 0.8$. The discharge is radial. Find the runner vane angles and turbine speed. **(Apr/May 10)**

8. Draw neat sketch of a centrifugal pump. List components and briefly explain their function of each of them. **(Nov/Dec 02)**

9. A turbine is to operate under a head of 25 cm at 200 rpm, the available discharge is $9 \text{ m}^3/\text{s}$ assuming an efficiency of 90% determine. **(Nov/Dec 02)**

VI. Specific speed

VII. Power generated

VIII. Performance under a head of 20 cm.

IX. The type of turbine.

15. Enumerate the losses that occur during the operation of a centrifugal pump **(May/Jun 09)**

10. A centrifugal pump with 1.2m dia, runs at 200 rpm and discharges 1880 l/s, against an average lift of 6m. The angle which the vanes make at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2.5m/s. Find the manometric efficiency and the least speed to start the pump against the head of 6m. Assume the inner diameter of the impeller as 0.6 m **(May/Jun 09)**

11. How is a 'specific speed of a turbine', defined? Explain briefly **(May/Jun 09)**

12. A Francis turbine with an overall efficiency of 75% is required to produce 149.26 kW. It is working against a head of 7.62m. The peripheral velocity is $0.262\sqrt{gH}$ and the radial velocity of flow at inlet is $0.962\sqrt{gH}$. The wheel runs at 150 rpm and the hydraulic losses in the turbine account for 22% of the available energy. Assume radial discharge, determine the guide blade angle, the wheel vane angle at inlet, diameter of the wheel at inlet and width of the wheel at inlet **(May/Jun 09)**

13.(i) Define Buckingham's theorem.

(ii) Model of an air duct operating with water produces a pressure drop of 10 kN/m² and density of air is 1.2 kg/m³. Viscosity of water is 0.001 N/m² and viscosity of air is 0.000002Ns/m². Estimate corresponding drop in a 20 m long air duct(**Nov/Dec 06**)

14. (i) What is breaking jet in Pelton wheel turbine? (**Nov/Dec 06**)

(ii) A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 0.7m³/s under a head of 30 m. The buckets deflects the jet through an angle of 160 degrees. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.98.

UNIT-5
POSITIVE DISPLACEMENT MACHINES

Part -A

1. What are reaction turbines? Give example (Apr/May 03)

In a reaction turbine, the runner utilizes both potential and kinetic energies. Here, the portion of potential energy is converted into kinetic energy before entering into the turbine

Eg: Francis and Kaplan turbines

2. What are rotary pumps? Give example (Apr/May 03)

Rotary pumps resemble like a centrifugal pumps in appearance. But, the working method differs. Uniform discharge and positive displacement can be obtained by using these rotary pumps. So we can clearly say, it has the combined advantage of both centrifugal and reciprocating pumps. The various types of rotary pumps are

1. External pump
2. Internal gear pump
3. Lobe pump

3. Why is priming necessary for a centrifugal pump? (Apr/May 05)

Before starting the pump it must be primed in order to remove air pockets placed inside the impeller, unless it gives rise to vortices and causes discontinuity of flow. After proper priming and closing the discharge valve, the pump is started.

4. What are the uses of air vessels? (Apr/May 05)

Due to these air vessels, amount of work to be supplied to the reciprocating pump is reduced. Simultaneously, it indicates the work saving

5. What is called as cavitation? (Nov/Dec 04)

It is defined as the phenomenon of formation of vapour bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapour pressure and the sudden collapsing of these vapour bubbles in a region of higher pressure

6. Define the term net positive suction band?. (Nov/Dec 04)

It is the vertical height of the liquid surface in the tank/reservoir to which the liquid is delivered above the centre line of the pump shaft.

7. Define specific speed of a turbine?. (Apr/May 08)

Specific speed is the speed of a geometrically similar turbine (i.e. a turbine identical in shape, dimensions, blade angles and gate opening etc.,) which will develop unit power when working under unit head.

8. Define slip of reciprocating pump. (Apr/May 10)

The difference between the theoretical discharge and actual discharge is called slip of reciprocating pump

9. Mention the working principle of an air vessel. (Apr/May 10)

Initially the vessel is filled by air. Air vessels are connected with both suction and delivery pipes separately. During pumping of water, the piston moves inside the cylinder with acceleration in the first half of the delivery stroke. So the water is forced at higher velocity than the mean velocity. Due to this large quantity of water flows through the delivery pipe.

10. What is the application of the air vessel? (Apr/May 05)

Air vessel is in following applications which are given below

Air compressor

vacuum pump

reciprocating pump

pneumatic systems.

11. List the advantage of double acting reciprocating pump. (Nov/Dec 09)

The following applications are having through using the reciprocating pump

it has simple construction

efficiency of pump is high

less cost to produce

continuous fluid supply is possible

low wear and tear.

12. Give an example for a low head turbine, a medium head turbine and a high head turbine. (Nov/Dec 02)

- (i) High head turbine [above 250mm] eg: pelton wheel
- (ii) Medium head turbine [60mm to 250 mm] eg: morden francic turbine
- (iii) Low head turbine [less than 60mm] eg: Kaplan turbine

13. Define the slip of reciprocating pump? (Nov/Dec 07)

Slip- The difference of theoretical discharge and actual discharge is known as slip of the pump, mathematically

$$\text{Slip} = Q_{th} - Q_{act}$$

$$\text{Percentage slip} = \frac{Q_{th} - Q_{act}}{Q_{th}} \times 100 = \left(1 - \frac{Q_{act}}{Q_{th}}\right) \times 100$$

$$= (1 - C_d) \times 100 = \text{Coefficient of discharge.}$$

14. What do you mean by manometric efficiency and mechanical efficiency of a centrifugal pump? (Nov/Dec 07)

Manometric Efficiency

This is defined as the Manometric head divided by the work done by the impeller on the water.

$$\therefore \eta = H_m \div \frac{V_{w1}v_1 - V_wv}{g}$$

and V_w is usually zero.

15. State the 'momentum equation'. When can it be applied (May/June 09)

The momentum equation states that net force acting on a fluid mass is equal to the change in momentum per second in direction.

$$F = d(mv)/dt$$

16. State the advantage of fitting air vessels in a reciprocating pump(May/Jun 09)

Due to these air vessels, amount of work to be supplied to the reciprocating pump is reduced. Simultaneously, it indicates the work saving.

17.What are the different efficiencies of turbines to determine the characteristics of turbine?(Nov/Dec 06)

The different efficiencies of turbines to determine the characteristics of turbine are:

- (i) Hydraulic efficiency
- (ii) Mechanical efficiency
- (iii) Volumetric efficiency
- (iv) Overall efficiency

18. What is percentage slip in reciprocating pump ? (Nov/Dec 06)

$$\begin{aligned}\text{Percentage Slip} &= (Q_{th}-Q_{act})/Q_{th})*100 \\ &= (1-C_d)*100\end{aligned}$$

Part-B

1.Draw a neat sketch of a reciprocating pumps. List the components and briefly explain their functions. (Apr/May 03)

2. The diameter and stroke of a single acting reciprocating pump are 120 mm and 300 mm respectively. The water is lifted by a pump through a total head of 25 m. The diameter and length of delivery pipe are 100 mm and 20 m respectively. Find out: (i) Theoretical discharge and theoretical power required to run the pump if its speed is 60 rpm, (ii) Percentage slip, if the actual discharge is 2.95 l/s and (iii) The acceleration head at the beginning and middle of the delivery stroke.(Apr/May 10)

3.A radial flow impeller has a diameter 25 cm and width 7.5 cm at exit. It delivers 120 liters of water per second against a head of 24 m at 1440 rpm. Assuming the vanes block the flow area by 5 percent and hydraulic efficiency of 0.8, estimate the vane angle at exit. Also calculate the torque exerted on the driving shaft if the mechanical efficiency is 95 percent(Apr/May 03)

4.Explain the working of the following pumps with the help of neat sketches and mention two applications of each .(**Apr/May 10**)

- (i) External gear pump
- (ii) Lobe pump
- (iii) Vane pump
- (iv) Screw pump.

5. The internal and external diameters of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. The pump is running at 1200 r.p.m. The vane angles of the impeller at inlet and outlet 20° and 30° respectively. The water enters the impeller radially and the velocity of flow is constant. Determine the work done by the impeller per unit weight of water. (**Apr/May 09**)

6.Sketch and explain the working principle of a reciprocating pump.(**Apr/May 09**)

7. A vertical reaction turbine operates under 6 m head at 400 rpm the area and diameter of the runner at inlet are 0. m² and 1 m respective the absolute and relative velocities of the fluid entering are 15^0 and 60^0 to the tangential direction. The swirl free entry to the draft tube is at 2 m above the tailrace. If inlet and exit diameters are 0.6m, 0.8m respectively. Calculate.

I.Hydraulic efficiency

II. The head saved by draft tube through diffuse. (**Nov/Dec 02**)

8.Write short notes on the following . (**Nov/Dec 02**)

Cavitations in hydraulic machines their cause, effects and remedies.

- I.Function of draft tube in turbines, and the various type of draft tubes.
- II. Various types of casings in centrifugal pumps and their advantages.
- III. Types of rotary pumps.

9. Define: slip, percentage slip and negative slip with respect to a reciprocating pump. . (May/Jun 09)

10. The diameter and length of stroke of a single acting reciprocating pump are 100mm and 200 mm respectively. The pump is used to deliver water to a tank 14m above the pump through a pipe 30mm in diameter and 18m long by taking its supply from a sump 4m below the pump, through a pipe 40mm in diameter and 6m long. If separation occurs at 78.48 kN/m^2 , below the atmospheric pressure find the maximum speed at which the pump can be operated without separation. Assume 1 atm pressure = 10.3 m of water column and the plunger undergoes simple harmonic motion. . (May/Jun 09)

11. Prove that work done by the pump is proportional to the area of indicator diagram. (May/Jun 09)

12. The plunger diameter and stroke length of a single-acting reciprocating pump are 300mm and 500 mm, res. The speed of the pump is 60 rpm. The diameter and length of delivery pipe are 150mm and 60m res. If the pump is equipped with an air vessel on the delivery side at the centre line of the pump, find the power saved in overcoming friction in the delivery pipe. Assume Darcy's Friction factor as 0.04, and the plunger undergoes a simple harmonic motion. (May/Jun 09)

13.(i) What is specific speed of a pump? (Nov/Dec 06)

(ii) The cylinder bore diameter of a single acting reciprocating pump is 150 mm and its stroke length is 300 mm. The pump runs at 50 rpm. And lifts water through a height of 25m. The delivery pipe is 22m long and 100 mm in diameter. Find the theoretical discharge and the theoretical power required to run the pump. If the actual discharge is 4.2 liters/s. Find the percentage slip.