SYED AMMAL ENGINEERING COLLEGE

(Approved by the AICTE, New Delhi, Govt. of Tamilnadu and Affiliated to Anna University, Chennai)

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Dr. E.M.Abdullah Campus,Ramanathapuram – 623 502.

Phone: 304001, 304002 (04567) Fax: 304123(04567)

Web: www.syedengg.ac.in E.mail:saec@syedengg.ac.in

Course Name: **FLUID MECHANICS AND MACHINERY**

Course Code: **CE6451**

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UNIT I - FLUID PROPERTIES AND FLOW CHARACTERISTICS

1. Define fluids.

Fluid may be defined as a substance which is capable of flowing. It has no definite shape of its own, but confirms to the shape of the containing vessel.

2. What are the properties of ideal fluid?

Ideal fluids have following properties

i)It is incompressible

ii) It has zero viscosity

iii) Shear force is zero

3. What are the properties of real fluid?

Real fluids have following properties

i)It is compressible

ii) They are viscous in nature

iii) Shear force exists always in such fluids.

4. Explain the Density

Density or mass density is defined as the ratio of the mass of the fluid to its volume. Thus mass per unit volume of a fluid is called density. It is denoted by the symbol (ρ).

Density = Mass of the fluid (kg)

Volume of the fluid (m3)

5. Explain the Specific weight or weight density

Specific weight or weight density of a fluid is the ratio between the weight of a fluid to its volume. Thus weight per uint volume of a fluid is called weight density and is denoted by the symbol (W).

(W) = Weight of the fluid = Mass x Acceleration due to gravity

Volume of fluid Volume of fluid

W = pg

6. Explain the Specific volume

Specific volume of a fluid is defined as the volume of the fluid occupied by a unit Mass or volume per unit mass of a fluid is called specific volume.

Specific volume = Volume = m3 = 1

Mass kg p

7. Explain the Specific gravity

Specific gravity is defined as the ratio of weight density of a fluid to the weight density of a standard fluid. For liquid, standard fluid is water and for gases, it is air.

Specific gravity = Weight density of any liquid or gas

Weight density of standard liquid or gas

8.Define Viscosity.

It is defined as the property of a liquid due to which it offers resistance to the movement of one layer of liquid over another adjacent layer.

9. Define kinematic viscosity.

It is defined as the ratio of dynamic viscosity to mass density. (m^2/sec)

10. Define Relative or Specific viscosity.

It is the ratio of dynamic viscosity of fluid to dynamic viscosity of water at 20°C.

11. State Newton's law of viscosity and give examples.

Newton's law states that the shear stress ( ) on a fluid element layer is directly proportional to the rate of shear strain. The constant of proportionality is called coefficient

of viscosity.

$r = \mu \, du/dy$

12. Give the importance of viscosity on fluid motion and its effect on temperature.

Viscosity is the property of a fluid which offers resistance to the movement of one layer of fluid over another adjacent layer of the fluid. The viscosity is an important property which offers the fluid motion.

The viscosity of liquid decreases with increase in temperature and for gas it Increases with increase in temperature.

13. Explain the Newtonian fluid

The fluid which obeys the Newton's law of viscosity i.e., the shear stress is directly proportional to the rate of shear strain, is called Newtonian fluid.

$r = \mu \, du/dy$

14. Explain the Non-Newtonian fluid

The fluids which does not obey the Newton's law of viscosity i.e., the shear stress is not directly proportional to the ratio of shear strain, is called non-Newtonian fluid.

15. Define compressibility.

Compressibility is the reciprocal of bulk modulus of elasticity, k which is defined as the ratio of compressive stress to volume strain.

k = Increase of pressure

Volume strain

Compressibility 1 = Volume of strain

k Increase of pressure

16. Define surface tension.

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

17. Define Capillarity.

Capillary is a phenomenon of rise or fall of liquid surface relative to the adjacent general level of liquid.

18.What is cohesion and adhesion in fluids?

Cohesion is due to the force of attraction between the molecules of the same liquid.
Adhesion is due to the force of attraction between the molecules of two different Liquids or between the molecules of the liquid and molecules of the solid boundary surface.

19. State momentumof momentumequation?

It states that the resulting torque acting on a rotating fluid is equal to the rate of change of moment of momentum.

20.What is momentum equation

It is based on the law of conservation of momentum or on the momentum principle
It states that,the net force acting on a fluid mass is equal to the change in momentum of flow per unit time in that direction.

21. What is Euler's equation of motion

This is the equation of motion in which forces due to gravity and pressure are taken into consideration. This is derived by considering the motion of a fluid element along a stream line.

22. What is venturi meter?

Venturi meter is a device for measuring the rate of fluid flow of a flowing fluid through a pipe. It consisits of three parts.
a. A short converging part b. Throat c.Diverging part.
It is based on the principle of Bernoalli's equation.

23. What is an orifice meter?

Orifice meter is the device used for measuring the rate of flow of a fluid through a pipe. it is a cheaper device as compared to venturi meter. it also works on the priniciple as that of venture meter. It consists of a flat circular plate which has a circular sharp edged hole called orifice.

24. What is a pitot tube?

Pitot tube is a device for measuring the velocity of a flow at any point in a pipe or a channel.
It is based on the principle that if the velocity of flow at a point becomes zero, the pressure there is increased due to the conversion of kinetic energy into pressure energy.

25. What are the types of fluid flow?

Steady & unsteady fluid flow
Uniform & Non-uniform flow
One dimensional, two-dimensional & three-dimensional flows
Rotational & Irrotational flow

26. State the application of Bernouillie's equation ?

It has the application on the following measuring devices.
1.Orifice meter.
2.Venturimeter.
3.Pitot tube.

UNIT II - FLOW THROUGH CIRCULAR CONDUITS

1. Define viscosity (u).

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.Viscosity is also defined as the shear stress required to produce unit rate of shear strain.

2. Define kinematic viscosity.

Kniematic viscosity is defined as the ratio between the dynamic viscosity and density of fluid. It is denoted by μ.

3. What is minor energy loss in pipes?

The loss of head or energy due to friction in a pipe is known as major loss while loss of energy due to change of velocity of fluid in magnitude or direction is called minor loss of energy.

These include,

a. Loss of head due to sudden enlargement.
b. Loss of head due to sudden contraction.
c. Loss of head at entrance to a pipe.
d. Loss of head at exit of a pipe.
e. Loss of head due to an obstruction in a pipe.
f. Loss of head due to bend in a pipe.
g. Loss of head in various pipe fittings.

4. What is total energy line?

Total energy line is defined as the line which gives the sum of pressure head, datum head and kinetic head of a flowing fluid in a pipe with respect to some reference line. It is also defined as the line which is obtained by joining the tops of all vertical ordinates showing sum of the pressure head and kinetic head from the centre of the pipe.

5. What is hydraulic gradient line?

Hydraulic gradient line gives the sum of (p/w+z) with reference to datum line. Hence hydraulic gradient line is obtained by subtracting v2 / 2g from total energy line.

6. What is meant by pipes in series?

When pipes of different lengths and different diameters are connected end to end, pipes are called in series or compound pipe. The rate of flow through each pipe connected in series is same.

7. What is meant by pipes in parallel?

When the pipes are connected in parallel, the loss of head in each pipe is same. The rate of flow in main pipe is equal to the sum of rate of flow in each pipe, connected in parallel.

8. What is boundary layer and boundary layer theory?

When a solid body immersed in the flowing fluid, the variation of velocity from zero to free stream velocity in the direction normal to boundary takes place in a narrow region in the vicinity of solid boundary. This narrow region of fluid is called boundary layer. The theory dealing with boundary layer flow is called boundary layer theory.

9. What is turbulent boundary layer?

If the length of the plate is more then the distance x, the thickness of boundary layer will go on increasing in the downstream direction. Then laminar boundary becomes unstable and motion of fluid within it, is disturbed and irregular which leads to a transition from laminar to turbulent boundary layer.

10. What is boundary layer thickness?

Boundary layer thickness (S) is defined as the distance from boundary of the solid body measured in y-direction to the point where the velocity of fluid is approximately equal to 0.99 times the free steam (v) velocity of fluid.

11. Define displacement thickness

Displacement thickness (S*) is defined as the distances, measured perpendicular to the boundary of the solid body, by which the boundary should be displaced to compensate for the reduction inflow rate on account of boundary layer formation.

12. What is momentum thickness?

Momentum thickness (0) 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 flowing fluid on account of boundary layer formation.

13.Mention the general characteristics of laminar flow.

- There is a shear stress between fluid layers
- 'No slip' at the boundary
- The flow is rotational
- There is a continuous dissipation of energy due to viscous shear

14. What is Hagen poiseuille's formula ?

$P_1-P_2 / \rho g = h_f = 32\ \mu UL / \_gD^2$

The expression is known as Hagen poiseuille formula .

Where $P_1-P_2 / \_g$ = Loss of pressure head U = Average velocity

μ = Coefficient of viscosity D = Diameter of pipe

L = Length of pipe

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

Frictional resistance for the turbulent flow is

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

Proportional to the density of fluid .

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

Independent of pressure .

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

16. What is the expression for head loss due to friction in Darcy formula ?

$h_f = 4fLV^2 / 2gD$

Where f = Coefficient of friction in pipe L = Length of the pipe

D = Diameter of pipe V = velocity of the fluid

17.What do you understand by the terms

a) major energy losses , b) minor energy losses

Major energy losses : -

This loss due to friction and it is calculated by Darcy weis bach formula and chezy's formula .

Minor energy losses :- This is due to

i. Sudden expansion in pipe .ii. Sudden contraction in pipe .

iii. Bend in pipe .iv. Due to obstruction in pipe .

18. Give an expression for loss of head due to sudden enlargement of the pipe :

he = (V1-V2)2 /2g

Wherehe = Loss of head due to sudden enlargement of pipe .

V1 = Velocity of flow at section 1-1

V2 = Velocity of flow at section 2-2

19.Give an expression for loss of head due to sudden contraction :

hc =0.5 V_2/2g Where hc = Loss of head due to sudden contraction .

V = Velocity at outlet of pipe.

20. Give an expression for loss of head at the entrance of the pipe

hi =0.5V2/2g where hi = Loss of head at entrance of pipe .

V = Velocity of liquid at inlet and outlet of the pipe

21.What is sypon ? Where it is used: _

Sypon is along bend pipe which is used to transfer liquid from a reservoir at a higher elevation to another reservoir at a lower level .

Uses of sypon : -

1. To carry water from one reservoir to another reservoir separated by a hill ridge
2. To empty a channel not provided with any outlet sluice

UNIT III - DIMENSIONAL ANALYSIS

1. What are the methods of dimensional analysis

There are two methods of dimensional analysis. They are,

a. Rayleigh - Retz method

b. Buckingham's theotem method.

Nowadays Buckingham's theorem method is only used.

2. Describe the Rayleigh's method for dimensional analysis.

Rayleigh's 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 dependent variable.

3. What do you mean by dimensionless number

Dimensionless numbers are those numbers which are obtained by dividing the inertia force by viscous force or gravity force or pressure force or surface tension or elastic force. As this is a ratio of one force to other force, it will be a dimensionless number.

4. Name the different forces present in fluid flow

Inertia force

Viscous force

Surface tension force

Gravity force

5. State Buckingham's Π theorem

It states that if there are 'n' variables in a dimensionally homogeneous equation and if these variables contain 'm' fundamental dimensions (M,L,T), then they are grouped into (n-m), dimensionless independent Π-terms.

6. State the limitations of dimensional analysis.

1. Dimensional analysis does not give any due regarding the selection of variables.

2.The complete information is not provided by dimensional analysis.

3.The values of coefficient and the nature of function can be obtained only by experiments or from mathematical analysis.

7. Define Similitude

Similitude is defined as the complete similarity between the model and prototype.

8. State Froude's model law

Only Gravitational force is more predominant force. The law states 'The Froude's number is same for both model and prototype'

9.What are the similarities between model and prototype?

(i) Geometric Similarity

(ii) Kinematicc Similarity

(iii) Dynamic Similarity

10.Define Weber number.

It is the ratio of the square root of the inertia force to the surface tension force.

UNIT IV - PUMPS

1. What is meant by Pump?

A pump is device which converts mechanical energy into hydraulic energy.

2. Define a centrifugal pump

If the mechanical energy is converted into pressure energy by means of centrifugal force cutting on the fluid, the hydraulic machine is called centrifugal pump.

3. Define suction head (hs).

Suction head is the vertical height of the centre lines of the centrifugal pump above the water surface in the tank or pump from which water is to be lifted. This height is also called suction lift and is denoted by hs.

4. Define delivery head (hd).

The vertical distance between the center line of the pump and the water surface in the tank to which water is delivered is known as delivery head. This is denoted by hd.

5. Define static head (Hs).

The sum of suction head and delivery head is known as static head. This is represented by 'Hs' and is written as,

$$Hs = hs + hd$$

6. Mention main components of Centrifugal pump.

i) Impeller ii) Casing

iii) Suction pipe,strainer & Foot valve iv) Delivery pipe & Delivery valve

7. What is meant by Priming?

The delivery valve is closed and the suction pipe, casing and portion of the delivery pipe upto delivery valve are completely filled with the liquid so that no air pocket is left. This is called as priming.

8. DefineManometric head.

It is the head against which a centrifugal pump work.

9. Describe multistage pump with the arrangement of vanes

a. impellers in parallel b. impellers in series. In multi stage centrifugal pump,

b. when the impellers are connected in series (or on the same shaft) high head can be developed.

c. When the impellers are in parallel (or pumps) large quantity of liquid can be discharged.

10.. Define specific speed of a centrifugal pump (Ns).

The specific speed of a centrifugal pump is defined as the speed of a geometrically circular pump which would deliver one cubic meter of liquid per second against a head of one meter. It is denoted by 'Ns'.

11. What do you understand by characteristic curves of the pump?

Characteristic curves of centrifugal pumps are defined those curves which are plotted from the results of a number of tests on the centrifugal pump.

12. Why are centrifugal pumps used sometimes in series and sometimes in parallel?

The centrifugal pumps used sometimes in series because for high heads and in parallel for high discharge

13.DefineMechanical efficiency.

It is defined as the ratio of the power actually delivered by the impeller to the power supplied to the shaft.

14. Define overall efficiency.

It is the ratio of power output of the pump to the power input to the pump.

15. Define speed ratio, flow ratio.

Speed ratio: It is the ratio of peripheral speed at outlet to the theoretical velocity of jet corresponding to manometric head.

Flow ratio: It is the ratio of the velocity of flow at exit to the theoretical velocity of jet corresponding to manometric head.

16..Mention main components of Reciprocating pump.

Piton or Plunger
Suction and delivery pipe
Crank and Connecting rod

17.. Define Slip of reciprocating pump.When the negative slip does occur?

The difference between the theoretical discharge and actual discharge is called slip of the pump. But in sometimes actual discharge may be higher then theoretical discharge, in such a case coefficient of discharge is greater then unity and the slip will be negative called as negative slip.

18.What is indicator diagram?

Indicator diagram is nothing but a graph plotted between the pressure head in the cylinder and the distance traveled by the piston from inner dead center for one complete revolution of the crank

19.What is meant by Cavitations?

It is defined phenomenon of formation of vapor bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapor pressure and the sudden collapsing of theses vapor bubbles in a region of high pressure.

20.What are rotary pumps?

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, It has the combined advantages of both centrifugal and reciprocating pumps.

UNIT V - TURBINES

1. Define hydraulic machines.

Hydraulic machines which convert the energy of flowing water into mechanical energy.

2. Give example for a low head, mediumhead and high head turbine.

Low head turbine – Kaplan turbine
Medium head turbine – Modern Francis turbine
High head turbine – Pelton wheel

3. What is impulse turbine? Give example.

In impulse turbine all the energy converted into kinetic energy. From these the turbine will develop high kinetic energy power. This turbine is called impulse turbine.
Example:Pelton turbine

4. What is reaction turbine? Give example.

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

5. What is axial flow turbine?

In axial flow turbine water flows parallel to the axis of the turbine shaft. Example: Kaplan turbine

6. What is mixed flow turbine?

In mixed flow water enters the blades radially and comes out axially, parallel to the turbine shaft. Example: Modern Francis turbine.

7. What is the function of spear and nozzle?

The nozzle is used to convert whole hydraulic energy into kinetic energy. Thus the nozzle delivers high speed jet. To regulate the water flow through the nozzle and to obtain a good jet of water spear or nozzle is arranged.

8. Define gross head and net or effective head.

Gross Head: The gross head is the difference between the water level at the reservoir and the level at the tailstock. Effective Head: The head available at the inlet of the turbine.

9. Define hydraulic efficiency.

It is defined as the ratio of power developed by the runner to the power supplied by the water jet.

10. Definemechanical efficiency.

It is defined as the ratio of power available at the turbine shaft to the power developed by the turbine runner.

11. Define volumetric efficiency.

It is defied as the volume of water actually striking the buckets to the total water supplied by the jet.

12. Define over all efficiency.

It is defined as the ratio of power available at the turbine shaft to the power available from the water jet.

13. Define the terms

(a) Hydraulic machines (b) Turbines (c) Pumps.
a. Hydraulic machines:
Hydraulic machines are defined as those machines which convert either hydraulic energy into mechanical energy or mechanical energy into hydraulic energy.

b. Turbines; The hydraulic machines which convert hydraulic energy into mechanical energy are called turbines.

c. Pumps: The hydraulic Machines which convert mechanical energy into hydraulic energy are called pumps.

14. What do you mean by gross head?

The difference between the head race level and tail race level when no water is flowing is known as gross head. It is denoted by Hg.

15. What do you mean by net head?

Net head is also known as effective head and is defined as the head available at the inlet of te turbine. It is denoted as H

16. What is draft tube? why it is used in reaction turbine?

The pressure at exit of runner of a reaction turbine is generally less than the atmospheric pressure. The water at exit cannot be directly discharged to tail race. A tube or pipe of gradually increasing area is used for discharging water from exit of turbine to tail race. This tube of increasing area is called draft tube.

17. What is the significance of specific speed?

Specific speed plays an important role for selecting the type of turbine. Also the performance of turbine can be predicted by knowing the specific speed of turbine.

18.. What are unit quantities?

Unit quantities are the quantities which are obtained when the head on the turbine is unity. They are unit speed, unit power unit discharge.

19. Why unit quantities are important

If a turbine is working under different heads, the behavior of turbine can be easily known from the values of unit quantities.

20. What do you understand by characteristic curves of turbine?

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

21. Define the term 'governing of turbine'.

Governing of turbine is defined as the operation by which the speed of the turbine is kept constant under all conditions of working. It is done by oil pressure governor.

22. What are the types of draft tubes?

The following are the important types of draft tubes which are commonly used.

a. Conical draft tubes

b. Simple elbow tubes

c. Moody spreading tubes and

d. Elbow draft tubes with circular inlet and rectangular outlet.