# DHANALAKSHMI SRINIVASAN

**COLLEGE OF ENGINEERING AND TECHNOLOGY**
**DEPARTMENT OF MECHANICAL ENGINEERING**

**FLUID MECHAINCS AND MACHINERY-III$^{rd}$ SEMESTER**

## UNIT-1 INTRODUCTION

## PART-A

1. A soap bubble is formed when the inside pressure is 5 N/m2 above the atmospheric pressure. If surface tension in the soap bubble is 0.0125 N/m, find the diameter of the bubble formed.

**2.** The converging pipe with inlet and outlet diameters of 200 mm and 150 mm carries the oil whose specific gravity is 0.8. The velocity of oil at the entry is 2.5 m/s, find the velocity at the exit of the pipe and oil flow rate in kg/sec.

**3.** What is the variation of viscosity with temperature for fluids?

**4.** Find the height of a mountain where the atmospheric pressure is 730 mm of Hg at Normal conditions.

**5.** What is meant by vapour pressure of a fluid?

**6.** Distinguish between atmospheric pressure and gauge pressure.

**7.** What are Non-Newtonian fluids? Give examples.

**8.** Mention the uses of a manometer.

**9.** What do you mean by absolute pressure and gauge pressure?

**10.** Define the term Kinematic Viscosity and give its dimension.

**11.** What is meant by continuum?

**12.** State Pascal's hydrostatic law.

**13.** What is specific gravity? How is it related to density?

**14.** How does the dynamic viscosity of liquids and gases vary with temperature?

**15.** How does the dynamic viscosity of (a) liquids and (b) gases vary with temperature?

**16.** What is the difference between gauge pressure and absolute pressure?

**17.** Differentiate between solids and liquids.

**18.** Define the following terms:

(a)Total pressure

(b)Centre (or) position of pressure.

**19.** What is meant by capillarity?

**20.** Define buoyancy.

**21.** What is viscosity? What is the cause of it in liquids and in gases?

**22.** State Pascal's law.

## PART-B

1. 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 water surface is 2 m above the centre of the inlet and exit is 3 m above the free surface of the 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.

2. 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 whose 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 kN/m$^2$ and 80 kN/m$^2$ respectively. Find out the coefficient of discharge of Venturimeter if the flow is 0.20 m$^3$/s.

3. Explain the properties of a hydraulic fluid.

4. A 0.5 m shaft rotates in a sleeve under lubrication with viscosity 5 poise at 200 rpm. Calculate the power lost for a length of 100 mm if the thickness of the oil is 1 mm.

5. (i) Derive Bernoulli's theorem and state its limitations.

   (ii) A horizontal Venturimeter with inlet diameter 200 mm and throat diameter 100 mm is employed to measure the flow of water. The reading of the differential manometer connected to the inlet is 180 mm of mercury. If Cd = 0.98, determine the rate of flow.

6. Derive continuity equation from basic principles.

7. Derive Euler's equation of motion for flow along a stream line. What are the assumptions involved.

8. A horizontal pipe carrying water is gradually tapering. At one section the diameter is 150 mm and flow velocity is 1.5 m/s. If the drop in pressure is 1.104 bar at a reduced section, determine the diameter of that section. If the drop is 5 kN/m2, what will be the diameter — Neglect losses?

**9.** State Bernoulli theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli equation and state the assumptions made.

**10.** (i)A 15 cm diameter vertical pipe is connected to 10 cm diameter Vertical pipe with a reducing socket. The pipe carries a flow of 100 1/s. At point 1 in

15 cm pipe gauge pressure is 250 kPa. At point 2 in the 10 cm pipe located

1.0 m below point 1 the gauge pressure is 175 kPa.

(1) Find whether the flow is upwards / downwards.
(2) Head loss between the two points

(ii) Differentiate Venturimeter andOrificemeter.

## UNIT II FLOW THROUGH CIRCULAR CONDUITS

## PART A

**1.** What is the physical significance of Reynold's number?
**2.** Define boundary layer and give its significance.

**3.** List the causes of minor energy losses in flow through pipes.
**4.** What is T.E.L.?

**5.** What is Hydraulic Gradient Line?

**6.** Write down Hagen-Poiseuille equation for laminar flow

**7.** What are energy lines and hydraulic gradient lines?

**8.** Write down four examples of laminar flow.

**9.** What between laminar and turbulent flow.
**10.** What is a syphon? What are its applications?

**11.** What are the losses experienced by a fluid when it is passing through a pipe?
**12.** What is equivalent pipe?
**13.** What do you mean by flow through parallel pipes

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

**15.** What is the difference between a laminar flow and turbulent flow?

**16.** In laminar flow through a pipe the maximum velocity at the pipe axis is 0.2m/s.

Find the average velocity.

**17.** Define boundary layer thickness.

**18.** Define displacement thickness.

**19.** Define momentum thickness.

**20.** What are hydraulic gradient lines?

## UNIT II FLOW THROUGH CIRCULAR CONDUITS

## PART B

**1.** The velocity distribution in the boundary layer is given by **u/U =y/δ**, where u is the velocity at a distance y from the plate u=U at y =δ, δ being boundary layer thickness. Find the displacement thickness, momentum thickness and energy thickness.

**2.** Derive an expression for head loss through pipes due to friction.

**3.** Explain the losses of energy in flow through pipes.

**4.** Determine the equivalent pipe corresponding to 3 pipes in series with lengths and diametersL1,L2,L3,d1,d2,d3 respectively.

**5.** The rate of flow of water through a horizontal pipe is 0.25 m3/sec.The diameter of the pipe which is 20 cm is suddenly enlarged to 40 cm. The pressure intensity in the smaller pipe is 11.772 N/cm2.

Determine:

Loss of head due to sudden enlargement,

Pressure intensity in larger pipe,

Power loss due to enlargement.

**6.** An oil of sp.gravity 0.7 is flowing through a pipe of diameter 30 cm at the rate of 500 litres/sec. Find the head lost due to friction and power required to

maintain the flow for a length of 1000 m. Take υ= 0.29 stokes.

**7.** 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 pipe is same as in the single main pipe, find the diameter of parallel pipe. Coefficient of discharge to be the same for all the pipes.

**8.** A pipe line 10km, long delivers a power of 50 kW at its outlet ends. The pressure at inlet is 500 kN/m2 and pressure drop per km of pipeline is 50 kN/m. Find the size of the pipe and efficiency of transmission. Take 4f= 0.02. (12)

**9.** The velocity of water in a pipe 200mm diameter is 5m/s. The length of the pipe is 50m. Find the loss of head due to friction, if f= 0.08.

**10.** A power transmission pipe 10 cm diameter and 500 m long is fitted with a nozzle at the exit, the inlet is from a river with water level 60 m above the discharge nozzle. Assume f = 0.02, calculate the maximum power which can be transmitted and the diameter of nozzle required

## UNIT III DIMENSIONAL ANALYSIS

## PART A

1. What do you understand by fundamental units and derived units?
2. What is Dimensionally Homogeneous equation and give an example?
3. State the advantages of Dimensional and model analysis.
4. State Buckingham's π theorem.
5. What is meant by dynamic similarity?
6. What is dynamic similarity?
7. Give the dimensions of the following Physical Quantities:

   (iii) Dynamic viscosity (iv) Kinematic Viscosity
8. What are the similarities between model and prototype?
9. In Fluid Flow, What does dynamic similarity mean? What are the non-dimensional numbers associated with dynamic similarity?

10. Submarine is tested in the air tunnel. Identify the model law applicable
11. Define and explain Reynolds number, Froude's number, Euler's number and Mach number.

12. Explain the different types of similarities that must exist between a prototype and its model.

13. Explain the different types of similarities exist between a prototype and its model.

14. State the Fourier law of dimensional homogeneity.
15. What are the uses of dimensional homogeneity?

16. What are the points to be remembered while deriving expressions using dimensional analysis?

17. State the methods of dimensional analysis.

18. How are the equations derived in Raleigh's method?
19. Define Mach number.
20. State the Euler model law and give its significance.

## UNIT III DIMENSIONAL ANALYSIS

## PART B

1. What are the criteria for selecting repeating variable in this dimensional analysis?

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

3. Using Buckingham's $\pi$ theorem, show that velocity, through a circular pipe

orifice is given by *H- head* causing flow; *D-dia* of orifice μ = Coefficient of viscosity *ρ* = mass density; *g* = acceleration due to gravity.

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

5. Using Buckingham's π- theorem, show that the velocity through a circular orifice in a pipe is given by **v = √(2gH) f {d/ H , μ/ρvH}** 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.

6. Classify Models with scale ratios.

7. Write short notes on the following:
(i) Dimensionless Homogenity with example.
(ii) Euler Model Law.

(iii) Similitude.

(iv) Undistorted and Distorted Models.

8. Explain Reynold's law of similitude and Froude's law of similitude.

9. The efficiency (η of a fan depends on ρ (density), μ (viscosity) of the fluid, Ꮯ (angular velocity), d (diameter of rotor) and Q (discharge). Express η in terms of non-dimensional parameters. Use Buckingham's π theorem.

10. **(i)** Explain Reynold's law of similitude and Froude's law of similitude.
**(ii)** Explain different types of similarities.

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## UNIT IV PUMPS

## PART A

1. Define slip of reciprocating pump.

2. Mention the working principle of an Air-vessel.

3. Can actual discharge be greater than theoretical discharge in a reciprocating pump?

4. Which factor determines the maximum speed of a reciprocation pump?

5. What are the functions of an air vessel?

6. What is specific speed of a pump? How are pumps classified based on this number?

7. When does negative slip occur?
8. Define slip of a reciprocating pump.
9. When will you select a reciprocating pump?

10. What are Roto dynamic pumps? Give examples.
11. Mention the main components of reciprocating pump.
12. Define "Slip" of reciprocating pump. When does the negative slip occur?
13. When will you select a reciprocating pump?
14. What are rotary pumps? Give examples.
15. Write short notes on types of rotary pumps.
16. Draw a neat sketch. List the components ad briefly explain their functions.

17. Describe the working and principles of a reciprocating pump. List the components and briefly explain their functions.

18. Derive an expression for the work saved in a reciprocating pump by using air vessel.

19. What is indicator diagram?
20. State the main classification of reciprocating pump.

21. Classify pumps on the basis of transfer of mechanical energy.

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## UNIT IV PUMPS

## PART B

1. Show that the work done by a reciprocating pump is equal to the area of the indicator diagram.

2. Classify pumps. Explain the working of a double acting reciprocating pump with a neat diagram.

3. Explain the working principle of reciprocating pump with neat sketch.

4. Define cavitation and discuss its causes, effects and prevention

5. Calculate the work saved by fitting an air vessel for a double acting single cylinder reciprocation pump.

6. 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 rn respectively. Find out:
(i) Theoretical discharge and theoretical; power required to run the pump if its speed is 60rpm

(ii) Percentage slip, if the actual discharge is 2.35 1/s and
(iii) The acceleration head at the beginning and middle of the delivery stroke.

7. Determine the maximum operating speed in rpm and the maximum capacity in lps of a single-acting reciprocating pump with the following details. Plunger diameter = 25 cm, stroke = 50 cm, suction pipe diameter = 15 cm, length = 9 cm, delivery pipe diameter = 10 cm, length = 36 cm, static suction head = 3 m, static delivery head = 20 m, atmospheric pressure - 76 cm of mercury, vapour pressure of w A double acting pump with 35cm bore and 40cm stroke runs at 60 strokes per minute. The suction pipe is 10 m long and delivery pipe is 200m long. The diameter of the delivery pipe is 15cm.The pump is situated at a height of 2.5 m above the sump, the outlet of the delivery pipe is 70 m above the pump. Calculate the diameter of the suction pipe for the condition that separation is avoided. Assume separation to occur at an absolute pressure head is 2.5m of water. Find the

Horsepower required to drive the pump neglecting all losses other than friction in the pipes assuming friction factor as 0.02.

8. A single acting reciprocating pump running at 50 rpm, delivers 0.01 m3/s of water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine the theoretical discharge of the pump, coefficient of discharge and slip and the percentage slip of the pump.

9. Explain the working of the working of following pumps with the help of neat

sketches and mention two, applications of each.

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

10. Explain the working principle of Gear pump with neat sketch.

## UNIT V TURBINES

## PART A

1. Differentiate between the turbines and pumps.
2. How are Hydraulic turbines classified?
3. Classify turbines according to flow.
4. What are high head turbines? Give examples.
5. Define hydraulic efficiency of a turbine.
6. The mean velocity of the buckets of the Pelton wheel is 10 m/s. The jet supplies water at 0.7 $m^3$/s at a head of 30 m. The jet is deflected through an angle of 160° by the bucket. Find the hydraulic efficiency. Take Cv = 0.98.
7. Define specific speed.
8. What are the different types of draft tubes?
9. What are the functions of a draft tube?
10. What is a draft tube for Kaplan turbine?

11. Classify turbines according to head.
12. Give an example for a low head turbine, a medium head turbine and a high head turbine.
13. What are reaction turbines? Give examples.
14. Differentiate the impulse and reaction turbine.
15. Draw velocity triangle diagram for Pelton Wheel turbine.
16. Define Hydraulic efficiency.
17. What is draft tube and explain its function?
18. Define the specific speed of a turbine.
19. What is a Draft tube? In which type of turbine it is mostly used?
20. Describe the application of turbine.

## UNIT V TURBINES

## PART B

1. Give the comparison between impulse and reaction turbine.
2. Write a note on performance curves of turbine.
3. Write a short note on Governing of Turbines.
4. Derive an expression for the efficiency of a draft tube.
5. With the help of neat diagram explain the construction and working of a pelton wheel turbine.
6. Show that the overall efficiency of a hydraulic turbine is the product of volumetric, hydraulic and mechanical efficiencies.
7. Obtain an expression for the workdone per second by water on the runner of

a Pelton wheel. Hence derive an expression for maximum efficiency of the Pelton wheel giving the relationship between the jet speed and bucket speed.

8. Explain with the help of a diagram, the essential features of a KaplanTurbine.
9. A Francis turbine with an overall efficiency of 76% and hydraulic efficiency of

80% is required to produce 150 kW. It is working under a head of 8 m. The peripheral velocity is **0.25 $\sqrt{2gH}$ and** radial'velocity of flow at inlet is **0.95 $\sqrt{2gH}$.** The wheel runs at 150 rpm. Assuming radial discharge, determine

(i) Flow velocity at outlet
(ii) The wheel angle at inlet

(iii) Diameter and width of the wheel at inlet.

10. 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 mm. The discharge through the runner is radial. Find the

(i) Inlet and outlet blade angles

Taking inlet width as 150 mm and neglecting the thickness of the blades, find the power developed by the turbine