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ENGINEERING COLLEGE, VILLUPURAM 605601
DEPARTMENT OF MECHANICAL ENGINEERING

FLUID MECHANICS AND MACHINERY
UNIT-I
INTRODUCTION

## PART - A

1. Define fluids and classify the different fluids.
2. What are the properties of ideal fluid?
3. What are the properties of real fluid?
4. Define density and specific weight.
5. Define Specific volume and Specific Gravity.
6. Define Surface tension and Capillarity.
7. Define Viscosity.
8. Define kinematic viscosity
9. Define Relative or Specific viscosity.
10. What is the effect of temperature on viscosity of water and that of air?
11. Define Compressibility.
12. Define Newtonian law of Viscosity.
13. Define Pascal law.
14. Define absolute, Gauge, Vaccum pressure.
15. Distinguish between manometer and mechanical Gauges
16. What are the different types of Mechanical pressure Gauges?

PART - B

1. a) What are the different types fluids? Explain each type.
b) Discuss the thermodynamic properties of fluids
2. a) One litre of crude oil weighs 9.6 N . Calculate its Specific weight, density and specific weight.
b) The Velocity Distribution for flow over a flat plate is given by
$u=(2 / 3) y-y^{2}$, Where $u$ is the point velocity in meters per second at a distance
$y$ metre above the plate. Determine the shear stress at $y=0$ and $y=15 \mathrm{~cm}$.
Assume dynamic viscosity as 8.63 poises
3. a) A plate, 0.025 mm distant from a fixed plate, moves at $50 \mathrm{~cm} / \mathrm{s}$ and requires a force of $1.471 \mathrm{~N} / \mathrm{m}^{2}$ to maintain this speed. Determine the fluid viscosity between plates in the poise.
b) Determine the intensity of shear of an oil having viscosity $=1.2$ poise and is used for lubrication in the clearance between a 10 cm diameter shaft and its journal bearing. The clearance is 1.0 mm and Shaft rotates at $200 \mathrm{r} . \mathrm{p} . \mathrm{m}$
4. a) Two plates are placed at a distance of 0.15 mm apart. The lower plate is fixed while the upper plate having surface area $1.0 \mathrm{~m}^{2}$ is pulled at $0.3 \mathrm{Nm} / \mathrm{s}$. Find the force and power required to maintain this speed, if the fluid separating them is having viscosity 1.5 poise.
b) An oil film of thickness 1.5 mm is used for lubrication between a square plate of size $0.9 \mathrm{~m} * 0.9 \mathrm{~m}$ and an inclined plane having an angle of inclination $20^{\circ}$. The weight of square plate is 392.4 N and its slides down the plane with a uniform velocity of $0.2 \mathrm{~m} / \mathrm{s}$. find the dynamic viscosity of the oil.
5. a) Assuming the bulk modulus of elasticity of water is $2.07 \times 10^{6} \mathrm{kN} / \mathrm{m}^{2}$ at standard atmospheric condition determine the increase of pressure necessary to produce one percent reduction in volume at the same temperature.
b) Calculate the capillary rise in glass tube pf 3 mm diameter when immersed in mercury, take the surface tension and angle of contact of mercury as $0.52 \mathrm{~N} / \mathrm{m}$ and $130^{\circ}$ respectively. Also determine the minimum size of the glass tube, if it is immersed in water, given that the surface tension of water is $0.0725 \mathrm{~N} / \mathrm{m}$ and Capillary rise in tube is not exceed 0.5 mm .
6. a) Explain all three Simple manometers with neat sketch.
b) Explain Differential manometer With Neat sketch.
7. A U-tube differential manometer is connected two pressure pipes A and B. Pipe A contains Carbon tetrachloride having a specific gravity 1.594 under a pressure of $11.772 \mathrm{~N} / \mathrm{Cm}^{2}$. The pipe A lies 2.5 m above pipe B . Find the difference of pressure measured by mercury as a fluid filling $U$-tube.
(16)

## UNIT II

## FLOW THROUG CIRCULAR CONDUITS

## PART - A

1. What is kinematics and dynamics of fluid flow?
2. What are the types of fluid flow?
3. Define stream line, streak line, path line flow.
4. Define Rate of flow Or Discharge.
5. Define and Write the continuity equation
6. Name different forces present in fluid flow.
7. For the Euler equation of motion, which forces are taken into consideration?
8. What is Euler's equation of motion?
9. Write the Bernoulli's Equation
10. What is Venturimeter? Write its part.
11. Define Orficemeter.
12. Define Pittot-tube.
13. Define Dimensional Analysis
14. What you meant by fundamental and derived units?
15. Define dimensionally homogeneous equation.
16. What are the methods of dimensional analysis?
17. State Buckingham's $\Pi$ theorem
18. What you meant by Repeating variables
19. What is dimensionless number?
20. Check the dimensional homogeneity for the equation $\mathrm{V}=\mathrm{u}+\mathrm{at}$

## PART - B

1. a) Explain types of fluid flow.
b) Explain all dimensional number.
2. Derive continuity equation in three dimension
3. State the Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation.
4. Water is flowing through a pipe having diameter 300 mm and 200 mm at the bottom end is $24.525 \mathrm{~N} / \mathrm{cm}^{2}$ and the pressure at the upper end is $9.81 \mathrm{~N} / \mathrm{Cm}^{2}$ Determine the difference in datum head if the rate of flow through pipe is 40 lit/s.
5. A pipe line carrying oil of specific gravity 0.87 , changes in diameter from 200 mm diameter at a position A to 500 mm diameter at a position $B$ which is 4 meters at a higher level. If the pressure at $A$ and $B$ which is 4 m at a higher level. If the pressures at $A$ and $B$ are $9.81 \mathrm{~N} / \mathrm{Cm}^{2}$ and $5.886 \mathrm{~N} / \mathrm{Cm} 2$ respectively and the discharge is 20 litres/s determine the loss of head and direction of flow.
6. The frictional torque T of a disc diameter D rotating at a speed N in a fluid of Viscosity $\mu$ and density $\rho$ in a turbulent flow is given by $T=D^{5} N^{2} \rho \Phi\left(\mu / D^{2} N \rho\right)$. Prove this Buckingham's $\Pi$ theorem.
7. A liquid of specific gravity 0.85 is flowing through in an inclined venturimeter of $250 \mathrm{~mm} \times 115 \mathrm{~mm}$ size. the difference of pressures between the main and throat is measured by a liquid of specific gravity 0.65 contained in an inverted U-tube which gives a reading of 275 mm . If the loss of head between the main and throat is 0.3 times the Kinetic head of the pipe, determine the rate of flow of liquid.
(16)

## UNIT- III

## DIMENSIONAL ANALYSIS

PART - A

1. Mention the general characteristics of laminar flow.
2. Write down the Navier-stokes equation.
3. Write down the Hagen-Poiseuille equation for laminar flow.
4. What are energy lines and hydraulic gradient lines?
5. What is a siphon? What is its application?
6. What is hydraulic Mean Depth or hydraulic radius?
7. Write the Darcy weisbach and Chezy's formulas.
8. Where the Darcy weisbach and Chezy's formulas are used?
9. What are the losses experienced by fluid when it is passing through a pipe?
10. Write the equation of loss of energy due to sudden enlargement.
11. What do you mean by flow through parallel pipes?
12. What is boundary layer?
13. Define drag and lift
14. Write the equation of loss of energy due to sudden contraction.
15. Write the equation of loss of energy due to entrance and exit of the pipe.
16. Define displacement thickness
17. Define momentum thickness.
18. Define energy thickness
19. What is the physical significance of Reynolds number?
PART - B
20. a) Derive an expression for the velocity distribution for viscous flow through a circular pipe.
b) A main pipe divides into two parallel pipes, which again forms one pipe. The length and diameter for the first parallel pipe are 2000 m and 1 m respectively, while the length and diameter of second parallel pipe are 2000 and 0.8 m respectively. Find the rate of flow in each parallel pipe, if total flow in the main is $3 \mathrm{~m}^{3} / \mathrm{s}$. The coefficient of friction for each parallel pipe is same and equal to 0.005 .
21. Two pipes of 15 cm and 30 cm diameters are laid in parallel to pass a total discharge of 100 liters/ second. Each pipe is 250 m long. Determine discharge through each pipe. Now these pipes are connected in series to connect two tanks 500 m apart, to carry same total discharge. Determine water level difference between the tanks. Neglect minor losses in both cases, $f=0.02 f_{n}$ both pipes.
b) A pipe line carry ing oil of specific gravity 0.85 , changes in diameter from 350 mm at position 1 to 550 mm diameter to a position 2, which is at 6 m at a higher level. If
the pressure at position 1 and 2 are taken as $20 \mathrm{~N} / \mathrm{cm}^{2}$ and $15 \mathrm{~N} / \mathrm{cm}^{2}$ respectively and discharge through the pipe is $0.2 \mathrm{~m}^{3} / \mathrm{s}$. determine the loss of head.
22. Obtain an expression for Hagen- Poiseuille flow. Deduce the condition of maximum velocity.
23. A flat plate $1.5 \mathrm{~m} \times 1.5 \mathrm{~m}$ moves at $50 \mathrm{~km} / \mathrm{h}$ in a stationary air density $1.15 \mathrm{~kg} /$ $\mathrm{m}^{3}$. If the coefficient of drag and lift are 0.15 and 0.75 respectively, determine (i) the lift force (ii) the drag force (iii) the resultant force and (iv) the power required to set the plate in motion.
24. a). The rate of flow of water through a horizontal pipe is $0.3 \mathrm{~m}^{3} / \mathrm{s}$. The diameter of the pipe is suddenly enlarged from 25 cm to 50 cm . The pressure intensity in the smaller pipe is $14 \mathrm{~N} / \mathrm{m}^{2}$. Determine (i) Loss of head due to sudden enlargement. (ii) Pressure intensity in the large pipe and (iii) Power lost due to enlargement.
b) Water is flowing through a tapering pipe of length 200 m having diameters 500 mm at the upper end and 250 mm at the lower end, the pipe has a slope of 1 in 40 . The rate of flow through the pipe is 250 lit/ sec. the pressure at the lower end and the upper end are $20 \mathrm{~N} / \mathrm{cm}^{2}$ and $10 \mathrm{~N} / \mathrm{cm}^{2}$ respectively. Find the loss of head and directionof flow.
25. A horizontal pipe of 400 mm diameter is suddenly contracted to a diameter of 200 mm . The pressure intensities in the large and small pipe is given as $15 \mathrm{~N} / \mathrm{cm}^{2}$ and 10 $\mathrm{N} / \mathrm{cm}^{2}$ respectively. Find the loss of head due to contraction, if $\mathrm{Cc}=0.62$, determine also the rate of flow of water.
26. Determine the length of an equivalent pipe of diameter 20 cm and friction factor 0.02 for a given pipe system discharging $0.1 \mathrm{~m}^{3} / \mathrm{s}$. The pipe system consists of the follow ing:
(i) A 10 m line of 20 cm dia with $\mathrm{f}=0.03$
(ii) Three $90^{\circ}$ bend, $\mathrm{k}=0.5$ for each.
(iii) Two sudden expansion of diameter 20 to 30 cm .
(iv) A 15 m line of 30 cm diameter with $\mathrm{f}=0.025$ and.
(v) A global valve, fully open, $\mathrm{k}=10$.

## UNIT-IV <br> ROTO DYNAMIC MACHINES

## PART - A

1. Define hydraulic machines.
2. Give example for a low head, medium head and high head turbine.
3. What is impulse turbine? Give example.
4. What is reaction turbine? Give example.
5. What is axial flow turbine?
6. Differentiate pelton wheel and Francis turbine.
7. Compare radial flow and axial flow turbo machines
8. What is the function of spear and nozzle?
9. Define gross head and net or effective head.
10. Define hydraulic efficiency.
11. Define mechanical efficiency.
12. Define volumetric efficiency.
13. Define over all efficiency
14. Define unit speed of turbine.
15. Define specific speed of turbine.
16. Give the range of specific speed values of Kaplan, Francis turbine and pelton wheels
17. Define unit discharge.
18. Define unit power.
19. What is a draft tube? In which type of turbine it is mostly used?
20. Write the function of draft tube in turbine outlet?

## PART - B

1. Obtain en expression for the work done 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.
(16)
2. a) A pelton wheel is having a mean bucket diameter of 1 m and is running at 1000 rpm . The net head on the pelton wheel is 700 m . If the side clearance angle is $15^{\circ}$ and discharge through nozzle is $0.1 \mathrm{~m} 3 / \mathrm{s}$, find (1) power available at nozzle and (2) hydraulic efficiency of the turbine. Take $\mathrm{Cv}=1$
b) A turbine is to operate under a head of 25 m at 200 rpm . The discharge is 9 $\mathrm{m}^{3} / \mathrm{s}$. If the efficiency is $90 \%$ determine, Specific speed of the machine, Power generated and type of turbine.
3. 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 (1) Quantity of water required. (2) Diameter of the wheel (3) Number of jets (4) Number and size of the bucket vanes on the runner.
4. An Outward flow reaction turbine has internal and external diameters of the runner as 0.5 m and 1.0 m respectively. The turbine is running at 250 rpm and rate of flow of water through the turbine is $8 \mathrm{~m}^{3} / \mathrm{s}$. The width of the runner is constant at inlet and out let and is equal to 30 cm . The head on the turbine is 10 $m$ and discharge at outlet 6 is radial, determine (1) Vane angle at inlet and outlet. (2) Velocity of flow at inlet and outlet.
5.The Nozzle of a pelton Wheel gives a jet of 9 cm diameter and velocity $75 \mathrm{~m} / \mathrm{s}$. Coefficient of velocity is 0.978 . The pitch circle diameter is 1.5 m and the deflection angle of the bucket is $170^{\circ}$. The wheel velocity is 0.46 times the jet
velocity. Estimate the speed of the pelton wheel turbine in rpm, theoretical power developed and also the efficiency of the turbine.
5. A Francis turbine has an inlet diameter of 2.0 m and an outlet diameter of 1.2 m . The width of the blades is constant at 0.2 m . The runner rotates at a speed of 250 rpm with a discharge of $8 \mathrm{~m}^{3} / \mathrm{s}$. The vanes are radial at the inlet and the discharge is radially outwards at the outlet. Calculate the angle of guide vane at inlet and blade angle at the outlet.
(16)
6. A Kaplan turbine develops 20000 KW at a head of 35 m and at rotational speed of 420 rpm . The outer diameter of the blades is 2.5 m and the hub diameter is 0.85 m . If the overall efficiency is $85 \%$ and the hydraulic efficiency is $88 \%$. Calculate the discharge, the inlet flow angle and the blade angle at the inlet.
(16)

## UNIT-V <br> POSTIVE DISPLACEMENT MACHINES

## PART - A

1. What is meant by Pump?
2. Mention main components of Centrifugal pump.
3. What is meant by Priming?
4. Define Manometric head.
5. Define Manometric efficiency
6. Define Mechanical efficiency.
7. Define overall efficiency.
8. Give the range of specific speed for low, medium, high speed radial flow.
9. Define speed ratio, flow ratio.
10. Mention main components of Reciprocating pump.
11. Define Slip of reciprocating pump. When the negative slip does occur?
12. What is indicator diagram?
13. What is meant by Cavitations?
14. What are rotary pumps?
PART - B
15. Write short notes on the following (1) Cavitations in hydraulic machines their causes, effects and remedies. (2) Type of rotary pumps. (16)
16. Draw a neat sketch of centrifugal pump and explain the working principle of the centrifugal pump.
17. Draw a neat sketch of Reciprocating pump and explain the working principle of single acing and double acting Reciprocating pump. (16)
18. 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 $5 \%$ 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 $95 \%$. (16)
19. Find the power required to drive a centrifugal pump which to drive a centrifugal pump which delivers $0.04 \mathrm{~m}^{3} / \mathrm{s}$ of water to a height of 20 m through a 15 cm diameter pipe and 100 m long. The over all efficiency of the pump is $70 \%$ and coefficient of friction is 0.15 in the formula $h_{f}=4 f / v^{2} / 2 \mathrm{gd}$. (16)
20. A Centrifugal pump having outer diameter equal to 2 times the inner diameter and running at 1200 rpm works against a total head of 75 m . The Velocity of flow through the impeller is constant and equal to $3 \mathrm{~m} / \mathrm{s}$. The vanes are set back at an angle of $30^{\circ}$ at out let. If the outer diameter of impeller is 600 mm and width at outlet is 50 mm . Determine (i) Vane angle at inlet (ii) Work done per second on impeller (iii) Manometric efficiency. (16)
21. The diameter and stroke of a single acting reciprocating pump are 200 mm and 400 mm respectively, the pump runs at 60 rpm and lifts 12 liters of water per second through a height of 25 m . The delivery pipe is 20 m long and 150 mm in diameter. Find (i) Theoretical power required to run the pump. (ii) Percentage of slip. (iii) Acceleration head at the beginning and middle of the delivery stroke.
