SHRI ANGALAMMAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(An ISO 9001:2008 Certified Institution)
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DEPARTMENT OF MECHANICAL ENGINEERING

CE1208 FLUID MECHANICS AND MACHINERY

UNIT – I
PART – A

1. What is specific Gravity? How it is related to density?
2. What is the difference between cohesion and adhesion?
3. Some insects can walk on water. How?
4. Differentiate between specific weight and specific volume of a fluid.
5. How does viscosity of a fluid vary with temperature?
6. Define and explain Newton's low of viscosity.
7. Convert 1 kg/s-m dynamic viscosity in poise.
8. Define Newtonian and non-Newtonian fluids.
9. Explain the phenomenon of capillarity. Obtain an expression for capillary rise of a liquid.
10. Distinguish between real and ideal fluids.
11. State Newton's law of viscosity.
12. What is known as capillarity?
13. Difference between liquids and gases.
14. State the Newton's law of viscosity and give examples of it's application.
15. Define isothermal process.
16. Define adiabatic process.

PART – B

1. A 1.9mm dia tube is inserted in to an un known liquid whose density is 960kg / m3, and it is observed that the liquid rises 5 mm in the tube, making contact angle of 15 degree. Determine the surface tension of the liquid.

2. The maximum blood pressure in the upper arm of a healthy person is about 120 mm/ Hg. if a vertical tube open to the atmosphere is conducted to the vein in the arm of the person. Determine how high the blood will rise in the tube; take the density the blood to be 1050 kg / m3.

3. Determine the mass density, weight density and specific volume of the liquid whose relative density is 0.85 (6 marks)

4. A liquid of 10 litres with relative density of 1.30 is mixed with 8 litres of a liquid of relative density 0.80. If the bulk of the liquid shrinks 1% on mixing, calculate the relative density, density the volume and weight of the mixtures. (10 marks)

5. Explain about the momentum equation and moment of momentum equation

UNIT-II
PART A

1. What is a dimensionally homogeneous equation? Give example.
2. What are the uses of dimensional homogeneity?
3. State the Buckingham π theorem.
4. Define Weber's number.
5. What are the advantages of model testing?
6. What are the similarities between model and prototype?
7. State Froude's model law.
8. What is meant by undistorted models?
9. State three demerits of a distorted model.
10. Give the dimensions of the following physical quantities:
11. a) Surface tension b) Kinematics viscosity
12. What is meant by distorted model? Quote an example.
13. What is meant by dimensional homogeneity?
14. What do you mean by kinematics similarity?
15. Difference between Reynolds number and Mach number.
16. Define: a) Euler number and b) Mach number.
17. What is similarity in model study?
18. Types of similarity laws?
19. Limitations of hydraulic similitude.
20. Obtain scale ratio of discharge for distorted models.
21. State the limitations of dimensional analysis.

PART B

1. Define and explain Reynolds number, Froude's number, Euler's number and Mach's number.
2. Explain the different types of similarities that must exist between a prototype and its model.
3. Define similarity of laws and briefly explain.
4. Methods of dimensional analysis. and Explain
5. Describe the Buckingham's π theorem and procedure to solve problems using the same.
   (i) What is distorted model and also give suitable example?
   (ii) Find the discharge through a weir model by knowing the discharge over the actual (Proto type) weir is measured as 1.5 m^3/s. The horizontal dimension of the model = 1/50 of the horizontal dimension of the prototype and the vertical dimension of the model = 1/10 of the vertical dimension of the proto type. (hint: Apply Froude model Law)
   (iii) What are repeating variables? How are these selected?
   (iv) What is meant by geometric, kinematics and dynamic similarities?

   iii)In an aero plane model of size (1/10) of its prototype, the pressure drop is 7.5 kN/m^3. The models tested in water. Find the corresponding drop in the prototype. Assume: density of air = 1.24 kg/m^3, Density of water = 1000kg/m^3, Viscosity of air = 0.00018 poise, Viscosity of water = 0.01 poise.

6. State: Birmingham π - theorem. What are the considerations in the choice of repeating variables?

(ii)Resistance R, to the motion of a completely submerged body is given by; R= $\rho v^2 l^2 \psi(VL/\Upsilon)$, where '$\rho$' and '$\Upsilon$' are the mass density and kinematics viscosity of the fluid; v-velocity of flow; l-length of the body. If the resistance of a one-eighth scale air-ship model when tested in water at 12m/s is 22N, what will be the resistance of the air-ship at the corresponding speed, in air? Assume kinematics viscosity of air is 13 times that of water and density of water is 810 times of air.

7. The pressure difference p in a pipe of diameter D and length/due to viscous flow depends on the velocity V, viscosity μ, and density ρ. Using Buckingham π's theorem, obtain an expression for p.

8. (i)Define dimensional homogeneity and also give example for homogeneous equation?
   (ii)A model of a hydro electric power station tail race is proposed to built by selecting vertical scale 1 in 50 and horizontal scale 1 in 100.If the design pipe has flow rate of 600 m^3/s and the allowable discharge of 800 m^3/s. Calculate the corresponding flow rates for the model testing.

9. It is desired to obtain the dynamic similarity between a 30 cm diameters pipe carrying linseed oil at 0.5 m^3/s and a 5m diameter pipe carrying water. What should be the rate of flow of water in lps? If the pressure loss in the model is 196 N/me, what is the pressure loss in the prototype pipe? Kinematics viscosities of linseed oil and water are 0.457 and 0.0113 stokes respectively. Specific gravity of linseed oil = 0.82.

UNIT-3
PART A

1. Mention the general characteristics of laminar flow.
2. Write down Hagen-Poiseuille equation for laminar flow.
3. What is boundary layer? Give sketch of a boundary layer region over a flat plate.
4. Write down the value of Reynolds number for laminar, transition and turbulent flow.
5. Write down four examples of laminar flow.
6. What is the physical significance of Reynolds's number?
7. Differentiate between laminar and turbulent flow.
8. Write the formula for Darcy-Weisbach equation.
9. What is meant by laminar boundary layer?
10. Write down the equation for displacement thickness and momentum thickness.
11. Define displacement thickness.
12. .Define the terms, Drag and lift.
13. What are energy lines and hydraulic gradient lines?
14. What is a siphon? What are its applications?
15. What are the losses experienced by a fluid when it is passing through a pipe?
16. What is equivalent pipe?
17. What do you meant by flow through parallel pipes?
18. Distinguish between total energy line and hydraulic grade line for flow through closed conduit pipe.
19. What are the types of minor losses in flow through pipe.
20. Differentiate between steady flow and uniform flow.

PART B

1 (a)For a flow of viscous fluid flowing through a circular pipe under laminar flow conditions show that the velocity distribution is a parabola.
(b)Also show that the average velocity is half of the maximum velocity.

2 Water is flowing thorough a rough pipe of diameter 60 cm at the rate of 600litres/second. The wall roughness is 3mm. Find the power loss for 1 km length of pipe.

3 (a) Define, Boundary layer thickness; Displacement thickness; Momentum thickness and Energy thickness.
(b) Find the displacement thickness, momentum thickness and energy thickness for the velocity distribution in the boundary layer given by, $(u/v) = (y/\delta)$, Where 'u' is the velocity at a distance 'y' from the plate and u=U at $y=\delta$, where δ = boundary layer thickness, Also calculate (δ/θ).

4 (a) What is boundary layer and write its types of thickness?
(b) A smooth two-dimensional flat plate is expected to a wind velocity of 100 km/h. If laminar boundary layer exists up to a value of Rex equal to $3x10^5$, find the maximum distance up to which laminar boundary layer exists, and find its maximum thickness. Assume kinematics viscosity of air as $1.49x10^{-5}$ m^2/s.

5. (a)Obtain the Hagea-Poiseuille's equation for pressure difference between two sections 1 and 2 in a pipe is given by, $(p_1- p_2) = 32\mu uL/D^2$ with usual notations.
(b) Oil of absolute viscosity 1.5 poise and density 850 kg/m3 flows through a 30 cm I.D. pipe. If the head loss in 3000 m length of pipe is 2l0m, assuming a laminar flow, find,
(i) The average velocity, u
(ii) Reynolds number and
(iii) Fanning's friction factor.

6. (a) Derive Darcy-Weisbach formula for calculating loss of head due to friction in a pipe.
(b) What are major energy losses and minor losses in a pipe?
(c) Explain on Boundary layer separation and its control.

7. Obtain an expression for Hagen-Poiseuille flow. Deduce the condition on Maximum velocity.

8. An oil of viscosity 1.5 s/m2 flows between two parallels fixed plates which are Kept at a distance of 60mm apart. The maximum velocity of oil is 2m/s. calculates;
(i) The discharge per m length
(ii) The shear stress at the plates.
(iii) The pressure difference between two points of 10m apart along the direction of flow.
(iv) The velocity gradient at the plates.
(v) The velocity at 18mm from the plate.

9.(a) A smooth pipe conveys 9.5 lit/s of water with a head loss of 80mm per 10m l
Lengths. Viscosity of water is 10-6 m2/s. friction factor in the Darcy's
Equation is given by $f = 0.316/(R_e)^{0.25}$ Determine the diameter of the pipe.
(b) A pipe line of 250mm diameter and 3000m lond is used to pump65lit/s of an
Oil whose specific gravity is 0.92 and kinematics viscosity is 2 stokes. The centre of the pipeline as the upper end is 35m above that at the lower end. Find difference of pressures at the ends.

10. Sketch velocity distribution curves for laminar and turbulent flows in a pipe.

UNIT –IV
PART – A

1. Define Hydraulic efficiency
2. Define elementary cascade theory
3. Explain Euler's equation
4. Define centrifugal pumps
5. What are turbines?
6. What is meant by priming of pumps?
7. What is the function of draft tube?
8. What is the maximum theoretical suction head possible for a centrifugal pump?
9. Define specific speed of turbine.
10. How the centrifugal pumps are classified based on casing?
11. Classify the turbine according to the flow.
12. What are reaction turbines and give Examples.
13. What is meant by cavitations?
14. Distinguish speed ratio with flow ratio.
15. What is the role of volume chamber of a centrifugal pump?
16. Differentiate pumps with turbines
17. What is as breaking jet in a phelton wheel turbine?

PART – B

1. Explain the working principle of Pelton Wheel.
2. Explain how the net head on the reaction turbine is increased with use of draft tube
3. The pelton wheel has a mean bucket speed of 12 m/s and supplied with water at the rate of 0.7 m3/s under a head of 300 mm. If the buckets deflect the jet through an angle of 160 find the power developed and hydraulic efficiency of the turbine.
4. A centrifugal pump is to discharge 0.12m3/s at a speed of 1450 rpm against a head of 25m. The dia of the impeller is 250mm, its width at outlet is 50mm and manometric efficiency is 75%. Find the vane angle at the outer periphery of the impeller.
5. Draw a schematic diagram of a Francis turbine and explain its construction and working.
6. A phelton wheel works under a gross head of 510m One third of gross head is lost in friction in the penstock. The rate of flow through the nozzle is 202 m3 / s.The angle of deflection of jet is 165 and find a) Power given by water to the runner b) hydraulic efficiency of phelton wheel .Take v = 1.0 and speed ratio=.045

UNIT-V
PART A

1 What is the principle of reciprocating pumps? And state its displacement type.
2 Mention the main components of reciprocating pump.
3 What is the main difference between single acting and double acting reciprocating pump?
4 Write down the formula for discharge, work done and power required for double acting pump.
5 Define "slip" of reciprocating pump, When does the negative slip occur?
6 What is indicator diagram?
7 What do you meant by suction head and delivery head.
8 When will you select a reciprocating pump?
9 What are rotary pumps? Give examples.
10 Define pump & classification of Rotary pumps.
11 Classification of reciprocating pumps.
12 Draw the ideal indicator diagram.
13 Define positive displacement machines
14 What is an air vessel in reciprocating pump?
15 Differentiate between pumps and turbines.
16 Draw the single acting reciprocating pump.
17 Write down the effect of acceleration in the delivery pipe.
18 Draw the external gear pump.
19 Write down the pressure head at the beginning of the delivery stroke.
20 Write down the absolute pressure head at the end of delivery stroke.

PART B

1 (a) A 'three throw' pump has cylinders of 350mm diameter and stroke of 600mm. The pump is required to deliver 0.12m^3/s at a head of 100mm. Frictional losses are estimated to be 2m in suction pipe and 22m in delivery pipe. Velocity of water in delivery pipe is 1m/s. Overall efficiency is 80% and the slip is 4.25%. Determine (i) Speed of the pump and (ii) Power required to run the pump.
(b) Explain the working principle of gear pump with neat sketch.
What is a reciprocating pump? Describe the principle and working of a double acting reciprocating pump with a neat sketch.

2. (a) A double acting reciprocating pump has an air vessel fatted on the suctions pipe. The plunger is 150mm diameter and 300mm long. The suction pipe is 8 meters long and 100mm diameter. Determine the rate of flow into or from the air vessel at crank positions of 30˚, 90˚, and 120˚ from the inner dead centre. Take speed of the pump as 120rpm.
(b) Explain the working principle of vane pump with neat sketch.

3. The diameter and stroke length of a single acting reciprocating pump are 75mm and 150mm respectively. Supply of water to the pump is from a sump 3m below the pump through a pipe 5m long and 40mm in diameter. The pump delivers the water to a tank located at 12m above the pump through a pipe 30mm in diameter and 15m long. Assuming that separation of flow occurs at 75KN/m^2 below the atmospheric pressure, find the maximum speed at which the pump may be operated without any separation. Assume that piston executes a simple harmonic motion.

4. A single acting reciprocating pump is to raise a liquid of density $1200 kg/m^3$ through a vertical height of 11.5 meters, from 2.5 meters below pump axis to 9 metros above it. The plunger, which moves with S.H.M , has diameter 125mm and stroke 225mm. The suction and delivery pipes are 75mm diameter and 3.5 meters and 13.5 meters lung respectively. There is a larbge air vessel placed on the delivery pipe near the pump axis. But there is no air vessel on the suction pipe. If separation takes place at $8.829 N/cm^2$ below atmospheric pressure, find,
(i) Maximum speed, with which the pump can run without separation taken place, and ,(ii) Power required to drive the pump, if f = 0.02. Neglect slip for the pump.

5. (a) A single acting reciprocating pump has a plunger diameter of 250mm and stroke of 450mm and it is driven with 60rpm. The length and diameter of delivery pipe are 60m and 100mm respectively. Determine the power saved in overcoming friction ion the delivery pipe by fitting an air vessel on the delivery side of the pump. Assume friction factor = 0.01.
(b) What is an "air vessel"? What are the advantages of fitting air vessels in a reciprocating pump?

6. (a) Derive an expression for the work saved in a reciprocating pump by using air vessel.
(b) Explain the working of rotary pump and draw the performance curve.
Show from first principles that work saved in a single acting reciprocating pump, by fitting an air vessel is 84.8 percent.

7. (a) What is an air vessel? What are the uses/advantages of fitting air vessels in a reciprocating pump?
(b) A double acting reciprocating pump is running at 30rpm. Its bore and stroke are 250mm and 400mm respectively. The pump lifts water from a sump 3.8m below and delivers it to a tank located at 65m above the axis of the pump The length of suction and delivery pipes are 6m and 150m respectively. The diameter of the delivesry pipe is 100mm. If an air vessel of adequate capacity has been fitted on the delivery side of the pump, determine (i) The minimum diameter of the suction pipe to prevent separation of flow, assuming the minimum head to percent occurrence of separation is 2.5m, (ii) The maximum gross head against which the pump has to work and the corresponding power of motor. Assume the mechanical efficiency = 78%and slip = 1.5%, H atm = 10.0m, F = 0.012.

8. The diameter and stroke of a single acting reciprocating pump are 200mm and 400mm respectively, the pump runs at 60rpm and lifts 12 liters of waters per second through a height of 25m. The delivery pipe is 20m long and 150mm 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.