U.S.N | | | | | | | | | | |

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. - Industrial and Production Engineering

Semester End Examination; Dec. - 2014

Fluid Mechanics and Hydraulic Machinery

Time: 3 hrs *Max. Marks: 100*

Note: *i) Answer **FIVE** full questions, selecting **ONE** full question from each Unit.*
ii) Assume suitable missing data if any.

Unit - I

1 a. Define the following properties of fluids mentioning their units in SI system; i) Density ii) Specific weight iii) Absolute viscosity iv) Surface tension. — 8

b. If the equation of a velocity profile over a plate is $v = 2y^{2/3}$ in which V is the velocity in m/s at a distance of γ meters above the plate, determine the shear stress at $\gamma = 0$ and $\gamma = 0.075$ m. Given; $\mu = 8.35$ poise. — 6

c. State and prove Pascal's law. Mention certain applications of the same. — 6

2 a. Represent the following on a shear stress and the velocity gradient plot : i) Newtonian fluid ii) Non – Newtonian fluid iii) Ideal fluid iv) Ideal plastic fluid. — 6

b. Establish a relationship amongst gauge, absolute and atmospheric pressure with a simple sketch. — 6

c. The left leg of a U-tube mercury manometer is connected to a pipeline conveying water, the level of mercury in the leg being 0.6 m below the centre of the pipe line and the right leg is open to atmosphere. The level of mercury in the right leg is 0.45 m above that is the left leg and the space above mercury is the right leg contains benzene (specific gravity 0.88) to a height of 0.3 m. Find the pressure in the pipe. Sketch the arrangement. — 8

Unit - II

3 a. Define total pressure and centre of pressure, Derive an expression for total pressure and centre of pressure for a vertical plane surface immersed in a static mass of liquid with usual notations. — 8

b. List the conditions of equilibrium of floating bodies. What is the position of meta centre with respect to centre of gravity in each case? — 4

c. A stream function in a two dimensional flow is $\psi = 2xy$. Show that the flow in irrotational and determine the corresponding velocity potential ϕ. — 8

4 a. Explain in brief, how the resultant pressure force is determined on a curved plane surface. What F_X and F_Y stand for? — 6

Contd…2

b. A circular plate 2.5 m diameter is immersed in oil of specific gravity 0.8, its greatest and least depth below the free surface being 3 m and 1 m respectively. Find; (i) the total pressure on the one face of the plate (ii) the position of the centre of pressure. 8

c. Explain the following: i) Stream function ii) Buoyancy iii) Metacentre 6

Unit - III

5 a. The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter 'D' of the rotor and the discharge Q. Express η interms of dimensionless parameters. 8

b. Represent Bernoulli's equation for, i) Ideal fluid and ii) Real fluid and explain the different terms. 4

c. Establish an expression for the frictional torque T of a disc of diameter D rotating at a speed N in a fluid of viscosity μ and density ρ is a turbulent flow using Buckingham π theorem. 8

6 a. A pipe of diameter 400 mm carries water at a velocity of 25 m/s. The pressure at the points A and B are given as 29.43 N/cm^2 and 22.563 N/cm^2 respectively while the datum head at A and B are 28 m and 30 m. Find the loss of head between A and B. 8

b. List the various energies possessed by a flowing fluid and write expressions for the establishing same explaining different terms. 4

c. Derive an expression for Euler's equation of motion and deduce Bernoulli's equation from it. State the assumptions made. 8

Unit - IV

7. a. A 30 cm 15 cm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, the flow being upwards. The difference in elevation of the throat section and the entrance section of the venturimeter is 30 cm. The differential U – tube mercury manometer shows a gauge deflections of 25 cm. Calculate; 8

i) The discharge of oil ii) The pressure difference between the entrance section and the throat section. Take the coefficient of discharge as 0.98 and specific gravity of mercury as 13.6.

b. Write expression for the following during pipe flow and explain the terms, i) Loss of head due to pipe friction ii) Loss of head due to sudden contractions iii) Loss of head due to sudden expansion iv) Loss of head due to bend in pipe 6

c. Derive an expression for loss of head due to pipe friction with usual notations. 6

Contd…3

8 a. Sketch a pitot tube and derive an expression for velocity of flow at any point using the same. 6

b. Draw the following velocity triangles for a pelton wheel and explain briefly,
i) Inlet velocity triangle
ii) Outlet velocity triangle when the velocity of whirl at outlet tip in negative.
iii) Outlet velocity triangle when the velocity of whirl at the outlet tip is positive. 6

c. Differentiate between impulse and reactions turbines. An inward flow reaction turbine has external and internal diameters as 1 m and 0.5 m respectively. The velocity of flow through the runner is constant and is equal to 1.5 m/sec. Determine; 8
i) Discharge through the runner
ii) Width of the turbine at outlet if the width of the turbine at inlet = 200 mm.

Unit - V

9 a. Define co-efficient of discharge and percentage slip as applied to a reciprocating pump.
A double acting reciprocating pump having piston area $0.1m^2$ has a stroke 0.30 m long. The pump is discharging 2.4 m^3 of water per minute at 45 rpm, through a height of 10 m. Find the slip of the pump and the power required to drive the pump. 8

b. Why are air vessels used in a reciprocating pump? Draw a simple sketch of the same. 4

c. Derive an expression for the work done /second on water by the double acting reciprocating pump. 8

10a. Obtain an expression for the work done by the impeller of a centrifugal pump on water per second per unit weight of water with appropriate velocity triangles. 8

b. Define specific speed of a centrifugal pump. Write an expression for the same and explain the terms. 4

c. 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 rpm. The vane angles of the impeller at inlet and outlet are 20º and 30º respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. Draw the velocity triangles. 8

* * * * *