USN | | | | | | | | | | |

10MEB406/10AUB406

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Distinguish between dynamic viscosity and kinematic viscosity and explain the effect of temperature on viscosity of liquids and gases. **(06 Marks)**

b. Explain:
i) Why in a capillary tube meniscus of water is concave upwards while the meniscus of mercury is convex upwards?
ii) Why concept of surface tension is not applied to gases? **(06 Marks)**

c. A stationary bearing of length 30 cm and internal radius 8.025 cm has been used to provide lateral stability to a 8 cm radius shaft rotating at constant speed of 200 rpm. The space between the shaft and the bearing is filled with a lubricant of viscosity 2.5 poise. Find the power utilized in overcoming the frictional torque. Take the velocity profile as linear. **(08 Marks)**

2 a. Define:
i) Hydrostatic law
ii) Vacuum pressure
iii) Total pressure and centre of pressure **(06 Marks)**

b. A U-tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of manometer contains mercury and is open to atmosphere. The contact between water and mercury is in the left limb. Determine the pressure of water in the main line if the difference in level of mercury in the limbs of U-tube is 10 cm and the free surface of mercury is in level with the centre of pipe. If the pressure of water in the pipeline reduces to 10 kN/m^2. Calculate the new difference in the level of mercury. Take specific weight of water as 10 kN/m^3. **(08 Marks)**

c. A pipe line which is 4 m in diameter contains a gate valve. The pressure at the centre of the pipe 19.6 N/cm^2. If pipe is filled with oil of specific gravity 0.87, find the force exerted by the oil on the gate and position of centre of pressure. **(06 Marks)**

3 a. Derive an expression for metacentric height of a floating body. **(08 Marks)**

b. Define the terms:
i) Velocity potential function
ii) Stream function **(04 Marks)**

c. A fluid flow field is given by $V = x^2y\,\vec{z} + y^2z\,\vec{j} - (2xyz + yz^2)\vec{k}$. Prove that it is a possible case of steady incompressible fluid flow. Calculate the velocity and acceleration at the point (2, 1, 3) **(08 Marks)**

4 a. Derive Euler's equation of motion along a stream line and obtain Bernoulli's equation from it. **(08 Marks)**

b. A jet of water from a 25 mm diameter nozzle is directed vertically upwards. Assuming that the jet remains circular and neglecting any loss of energy, what will be the diameter at a point 4.5 m above the nozzle, if velocity with which jet leaves the nozzle is 12 m/s? **(06 Marks)**

c. A 2m long pipe line tapers uniformly from 10 cm diameter to 20 cm diameter at its upper end. The centre line of pipe slopes upwards at an angle of 30° to the horizontal and flow direction is from smaller to bigger cross section. If the pressures at lower and upper end are 200 kPa and 230 kPa respectively, determine the flow rate and the fluid pressure at the mid length of the pipe line. Assume no energy losses. **(06 Marks)**

PART – B

5 a. Derive an expression for discharge through an orifice-meter. **(08 Marks)**

b. Define the following dimensionless numbers:
   i) Reynold's number
   ii) Froude's number **(04 Marks)**

c. The pressure difference 'Δp' in a pipe of diameter D and length 'l' due to viscous flow depends on velocity V, viscosity μ and density ρ. Using Buckingham's π theorem, obtain an expression for Δp. **(08 Marks)**

6 a. What do you understand by major energy loss and minor energy losses in pipes? **(04 Marks)**

b. Derive an expression for loss of head due to sudden enlargement. **(08 Marks)**

c. A pipe line 300 mm in diameter and 3200 m long is used to pump 50 kg/sec of an oil whose density is 950 kg/m^3, and whose kinematic viscosity is 2.1 stokes. The centre of the pipe line at the upper end is 40 m above the lower end. The discharge at the upper end is atmospheric. Find the pressure at the lower end and draw the hydraulic gradient and total energy line. **(08 Marks)**

7 a. Prove that velocity distribution for flow between two parallel stationary plates is parabolic and also prove that maximum velocity is equal to one and half times the average velocity. **(10 Marks)**

b. A laminar flow is taking place in a pipe of diameter of 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and the radius at which this occurs. Also calculate the velocity at 4 cm from the wall of the pipe. **(10 Marks)**

8 a. Explain the terms:
   i) Lift and drag
   ii) Momentum thickness
   iii) Sonic and subsonic flow **(06 Marks)**

b. Define Mach number. What is the significance of Mach number in compressible fluid flows? **(04 Marks)**

c. An aeroplane weighing 40 kN is flying in a horizontal direction at 360 km/hr. the plane has a wing surface area of 35 m^2. Determine the lift coefficient and the power required to drive the plane. Assume drag coefficient $C_D = 0.03$ and for air $\rho = 1.20$ kg/m^3. **(06 Marks)**

d. A projectile travels in air of pressure 10.1043 N/cm^2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kgK. **(04 Marks)**

* * * * *