CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, July/August 2021
Fluid Mechanics

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions.

1 a. What is surface tension? Derive equation of intensity of pressure for (i) Droplet (ii) Bubble. **(05 Marks)**

b. Briefly explain U-tube differential manometer. Derive the expression for pressure difference at two points using U-tube differential manometer. **(06 Marks)**

c. A tank contains water upto a depth of 2m and above it an oil of specific gravity 0.9 for a depth of 1m. Find the pressure intensity:
(i) at the interface of two liquids (ii) at the bottom of the tank. **(05 Marks)**

2 a. Briefly explain the conditions of equilibrium of a floating body. **(04 Marks)**

b. A circular plate 3.0 m diameter having a concentric circular hole of diameter 1.5 m is immersed in water in such a way that its greatest and least depth below the free surface are 4m and 1.5 m respectively. Determine the total pressure and position of centre of pressure on one face of the plate. **(05 Marks)**

c. Derive an expression for metacentric height analytically. **(07 Marks)**

3 a. Briefly explain different types of fluid flow. **(05 Marks)**

b. Derive expression for continuity equation for three dimensional flow in Cartesian coordinates. **(05 Marks)**

c. A stream function is given by $\psi = 3xy$, determine:
(i) Whether flow is possible
(ii) Whether flow is rotational or irrotational
(iii) Acceleration components at a point (1, 1) **(06 Marks)**

4 a. Derive Bernoullis equation from first principle. **(08 Marks)**

b. A horizontal venturimeter with inlet and throat diameters of 300 mm and 100 mm respectively is used to measure the discharge of water. The intensity of pressure is 130 kN/m^2 at inlet section whereas the vacuum pressure head at throat is 350 mm of mercury. Assuming that the 3% of head is lost between the inlet and throat, find the value of coefficient of discharge [C_d], and the amount of discharge. **(08 Marks)**

5 a. An oil of viscosity 0.1 Pa.S and relative density is 0.9 flows between two parallel plates 25 mm apart with a mean velocity of 1.8 m/sec. Determine:
(i) Maximum velocity
(ii) Shear stress at the boundary
(iii) Loss of head in a distance of 10 m
(iv) Velocity at 5 mm from the plate. **(07 Marks)**

b. Define Reynolds Number. What is its significance? **(04 Marks)**

c. Sketch the shear stress and velocity profile across a section of a circular pipe, for viscous flow. What are the expressions governing shear stress and velocity profile? **(05 Marks)**

6 a. Briefly explain, with neat sketches that types of energy or head losses through pipe. **(06 Marks)**

b. A horizontal pipe line 40 meters long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 mts of its length the pipe is 15 cm diameter and then its diameter is suddenly, enlarged to 30 cm. The height of water level in the tank is 8 meters above the center of pipe. Considering all losses of head which occur, determine the rate of flow. Take f = 0.01 for both the sections of the pipe. **(06 Marks)**

c. What do you understand by pipes in parallel? What are the characteristics of pipes in parallel? **(04 Marks)**

7 a. Briefly explain about Boundary layer separation and methods to control it. **(05 Marks)**

b. A square plate of side 2m is moved in a stationary air of density 1.2 kg/m^3, with a velocity of 50 km/hr. If coefficients of drag and lift are 0.2 and 0.8 respectively, determine:
(i) Lift force
(ii) Drag force
(iii) Resultant force and its direction
(iv) Power required to keep the plate in motion. **(06 Marks)**

c. Briefly explain (i) Friction Drag (ii) Pressure drag **(05 Marks)**

8 a. Briefly explain the following dimensionless numbers and their applications:
(i) Reynolds Number
(ii) Mach Number **(05 Marks)**

b. The capillary rise 'H' of a fluid of mass density 'e' and surface tension 'σ' in a tube of diameter 'd' depends upon the angle of contact 'α' and acceleration due to gravity 'g'. Obtain an expression for 'H' using Buckingham π theorem in the following form

$$\frac{H}{d} = \phi\left[\frac{\sigma}{egd^2}, \alpha\right]$$ **(06 Marks)**

c. What is Similitude? Briefly explain the types of similarities between a model and prototype. **(05 Marks)**

9 a. Briefly explain the basic thermodynamic relations useful for gases. **(05 Marks)**

b. Obtain an expression for velocity of sound for compressible fluid undergoing isothermal process. **(06 Marks)**

c. Find the velocity of bullet fired in standard air if the Mach angle is 30°. Take R = 287.14 J/kgK and K = 1.4 for air. Assume temperature as 15°C. **(05 Marks)**

10 a. Briefly explain about Oblique Shocks. **(05 Marks)**

b. Summarize the steps involved in CFD analysis. **(07 Marks)**

c. Write a note on CFD applications. **(04 Marks)**

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