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B037412(037)

B. Tech. (Fourth Semester) Examination
April-May 2022

(AICTE Scheme)

(Mechanical Engg. Branch), Automobile

FLUID MECHANICS

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. Part (a) from each question is compulsory. Attempt any* ***two*** *parts from (b), (c) and (d) of each question.*

1. (a) (i) Distinguish between ideal fluids and real fluids.

(ii) Define compressibility. How is it related to bulk modulus of elasticity? 4

(b) What is differential manometer? Explain the working principle of U-tube differential manometer with the help of a sketch. 8

(c) A cubical tank has sides of 2 m. It contains an oil of density 850 kg/m^3 for the upper 1.2 m depth. The power remaining part is filled with water. For one vertical side of the tank. Find the total pressure and position of centre of pressure. 8

(d) A wooden block C (specific gravity 0·8) of dimensions 1 m × 0·5 m × 0·4 m floats in water with its shortest axis vertical. Determine the metacentric height and state the condition of its equilibrium. 8

2. (a) (i) What do you mean by uniform and non-uniform flow of fluids?

(ii) Define flow net. 4

(b) Derive an expression for continuity for three-dimensional flow and reduce it for steady, incompressibe two-dimensional flow. 8

(c) The velocity vector in a fluid flow is given

$$V = 4x^3 i - 10x^2 yj + 2tk$$

Find the velocity and acceleration of a fluid particle (2, 1, 3) at time $t = 1$. 8

(d) In a two dimensional incompressible flow, the fluid velocity components are given by

$$u = x - 4y$$

and $v = -y - 4x$

show that velocity potential exists and determine its form. Find also the stream function. 8

3. (a) Briefly explain impulse momentum equation. 4

(b) Derive Euler's equation of motion along a stream line. 8

(c) Determine the rate of flow of water through a pipe of 300 mm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 150 mm. The difference of pressure between the main and throat is measured by a liquid of specific gravity 0·7 in an inverted U-tube which gives a reading of 260 mm. The loss of head between the main and throat is 0·3 times the kinetic head of the pipe. 8

(d) In a 45° bend rectangular air duct of 1 m^2 cross-sectional area is gradually reduced to 0·5 m^2 area. Find the magnitude and direction of force required to hold the duct in position if the velocity of flow at 1 m^2 section is 10 m/s, and pressure is 30 kN/m^2. Take the specific weight of air as 0·0116 kN/m^3. 8

4. (a) Discuss water hammer in pipes. 4

(b) A lubricating oil of viscosity 1 poise and specific gravity 0·9 is pumped through a 30 mm diameter pipe.

If the pressure drop per meter length of pipe is 20 kN/m^2, determine :

(i) The mass flow rate in kg/min

(ii) The shear stress at the pipe wall

(iii) The reynolds number of flow and

(iv) The power required per 50 m length of the pipe to maintain the flow 8

(c) Derive Darcy-Weisbach equation. 8

(d) Two reservoirs are connected by a pipeline consisting

of two pipes, one of 15 cm diameter and length 6 m and other of diameter 22·5 cm and 16 m length. If the difference of water levels in the two reservoirs is 6 m, calculate the discharge and draw the energy gradient line. Take $f = 0 \cdot 04$. 8

5. (a) What is dimensional analysis? What are the uses of dimensional analysis? 4

(b) Using Buckingham's π-theorem. show that the velocity through a circular orifice is given by

$$V = \sqrt{2\,gH}\ \phi\left[\frac{D}{H}, \frac{\mu}{\varrho \vee H}\right]$$

Where H is the head causing flow, D is the diameter of the orifice, μ is the co-efficient of viscosity, ϱ is the mass density and g is the acceleration due to gravity. 8

(c) Define and give significance of following dimension-less numbers. Develop mathematical expression for the

(i) Reynolds number

(ii) Mach number

(iii) Euler number

(iv) Froude number 8

(d) An oil of specific gravity 0·9 and viscosity 0·003 $\frac{N}{m^2}\ s$ is required to transport through a pipe of 1 m diameter at the rate of 0·3 m^3/sec. Tests were conducted on a 10 mm diameter pipe using water at 20°C.

The density and viscosity of water at 20° C are 1000 kg/m^3 and 0·001 $\frac{N}{m^2}\ s$, respectively. Determine the average velocity and rate of flow in the model. 8