Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2022

AU3CO08 / FT3CO08 / ME3CO06 Fluid Mechanics

Programme: B.Tech. Branch/Specialisation: AU/FT/ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c, or d.

Q.1 i. Centre of the pressure is defined as point of application of the _____ on the surface. **1**

(a) Total pressure (b) Static pressure
(c) Gauge pressure (d) Both (a) & (b)

ii. The submerged body is said to be in stable equilibrium if- **1**

(a) B is below G (b) Point B is above G
(c) B & G are at same point (d) Hardly matters

iii. The quantity of fluid flowing per second through a section of a pipe is- **1**

(a) Volumetric flow (b) Discharge
(c) Rate of flow (d) All of these

iv. The flow coming from a point and moving out radially in all direction of a plane at uniform rate is- **1**

(a) Sink flow (b) Source flow
(c) Potential flow (d) Ideal flow

v. Pitot tubes measures the- **1**

(a) Mean velocity (b) Static velocity
(c) Average velocity (d) Point velocity

vi. Mouthpiece is having dimension- **1**

(a) Diameter = 3 times Length
(b) Length = 2-3 times Diameter
(c) Length = Diameter
(d) Length = 4 times Diameter

P.T.O.

vii. If there are n variable containing m fundamental dimension, then the variable may be arranged into- **1**

(a) m-n terms (b) m terms

(c) n-m terms (d) Both (a) & (b)

viii. The laws for dynamic are- **1**

(a) Reynolds's law (b) Froude Model law

(c) Weber model law (d) All of these

ix. Hagen Poiselle equation is applicable for- **1**

(a) Turbulent flow (b) Laminar flow

(c) Both (a) & (b) (d) None of these

x. The boundary layer takes place- **1**

(a) For ideal fluids (b) For pipe flow

(c) For real fluids (d) For flow over flat plate

Q.2 i. Explain surface tension & metacentric height. **2**

ii. Define total pressure & centre of pressure. **3**

iii. A solid cylinder of 4 m diameter has a height of 3 m. Find the meta-centric height of the cylinder when it is floating with its vertical axis. The sp. gravity of the cylinder is 0.6. **5**

OR iv. Determine the total pressure on a circular plate of diameter 1.5 m which is placed vertically in water in such a way that the centre of the plate is 3 m below the free surface of water. Find the position of centre of pressure also. **5**

Q.3 i. Define flow net. **2**

ii. Explain velocity potential function & stream function and its significance. **3**

iii. Define the equation of continuity and derive for one-dimensional, two-dimensional and three-dimensional flow? **5**

OR iv. $u = x^2 + y^2 + z^2$: $v = xy^2 - yz^2 + xy$ represent the two velocity components, determine the third component of the velocity such that they satisfy the continuity equation. **5**

Q.4 i. Explain Euler's equation of motion. **3**

ii. Derive the expression for actual discharge from venturi meter. Also explain working of venturi meter with neat diagram. **7**

OR iii. A rectangular orifice 0.9 m wide and 1.2 m deep is discharging water from a vessel. The top edge of the orifice is 0.6 m below the water surface in the vessel. Calculate the discharge through the orifice is Cd = 0.6 and the percentage error if the orifice is treated as small orifice. **7**

Q.5 i. Explain dynamic similarity & dimensional homogeneity. **4**

ii. State Buckingham's pi theorem and its method of selecting repeating variables. **6**

OR iii. The efficiency η of a fan depends on density, dynamic viscosity μ of the fluid, angular velocity, the diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. **6**

Q.6 Attempt any two:

i. Write short note on- **5**

(a) Boundary layer (b) Stokes law

ii. Define Reynolds number & discuss Reynolds experiment in brief. **5**

iii. A laminar flow is taking place in a pipe of diameter 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and the radius at which it occurs. Also calculate the velocity at 4 cm from the wall of the pipe. **5**

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14/05

Answer Sheet

End Sem (Even) Examination ①

May 2022

Fluid Mechanics (AU-FT3C008)

Q.1.

(i) a (ii) b (iii) d (iv) b (v) d (vi) b (vii) c (viii) d

(ix) b (x) c

Q.2 (i) Surface tension - defined as the tensile force acting on the surface of the liq in contact with a gas or on the surface of two immiscible liquids such that the contact surface behaves like a membrane under tension. (1)

Metacentre - defined as the point about which a body starts oscillating when the body is tilted by a small angle. It is the point at which line of action of the force of buoyancy will meet the normal axis of the body when the body is given small angular displacement (1)

(ii) Total Pressure - $F = \rho g A \bar{h}$

where $\bar{h}$ = distance of CG from free surface

The total pressure is defined as the force exerted by a static fluid on a surface either plane or curved when the fluid comes in contact with the surfaces. This force always acts normal to the surface (1½)

Centre of Pressure - It is the point of application of the total pressure on the surface. Calculated using "Principle of Moments"

$$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$$ (1½)

(iii)

$$GM = \frac{\frac{\pi}{64}\times(4)^4}{\frac{\pi}{4}(4)^2\times 1.8} - 0.6 \qquad (2)$$

$$= -0.05\ m.$$

as $GM = \frac{I}{V} - BG$

M is below G.

Q3 (i) Flow Net – Grid obtained by drawing a series of equipotential lines & stream lines in flow net. It is used in analysis of two dimensional irrotational flow problem. (2)

(ii) Velocity Potential function.

$$u = -\frac{\partial \phi}{\partial x}\ ;\quad v = -\frac{\partial \phi}{\partial y}\ ;\quad w = -\frac{\partial \phi}{\partial z} \qquad (1\frac{1}{2})$$

ϕ – Velocity Potential function.

Stream function –

$$v = \frac{\partial \psi}{\partial x}\ ;\quad -u = \frac{\partial \psi}{\partial y} \qquad (1\frac{1}{2})$$

ψ – stream function.

Q 2 (OR) (iii)

$$F = \rho g A \bar{h} \qquad \{A = \frac{\pi}{4}(1.5)^2 = 1.767\ m^2$$

$$= 1000\times 9.81\times 1.767\times 3 \qquad (2\frac{1}{2})$$

$$= 52003.81\ N$$

$$I_h = \frac{\pi d^4}{64} = .2485\ m^4$$

$$h^* = \frac{.2485}{1.767\times 3} + 3 = 3.0468\ m \qquad (2\frac{1}{2})$$

Q 3 (iii)

$A_1V_1 = A_2V_2$ one dimensional (1)

$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$ two dimensional (1)

$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$ three dimensional (3)

Q.3 (iv) $2x + 2xy - z^2 + x + \frac{\partial w}{\partial z} = 0$ (3)

$\frac{\partial w}{\partial z} = (-3x - 2xy + z^2)$

$\partial w = (\quad\quad)\partial z$

$w = -3xz - 2xyz + \frac{z^3}{3} + C$

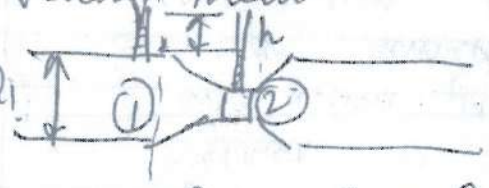
$w = \quad\quad + f(x,y)$ (5)

Q.4 (i) Eulers eqn of motion –

eqn of motion in which forces due to gravity & pressure are taken into consideration. (1)

$\frac{dp}{\rho} + g\,dz + V\,dv = 0$ (2)

(ii) Venturi meter



(2)

$Q_{ac} = C_d \times \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \sqrt{2gh}$ (5)

(iii) $Q = \frac{2}{3} C_d b \sqrt{2g} \left[H_2^{3/2} - H_1^{3/2}\right]$

$= \frac{2}{3} \times 0.6 \times 0.9 \times \sqrt{2 \times 9.81} \left[(1.8)^{3/2} - (0.6)^{3/2}\right]$

$= 3.1097 \text{ m}^3/\text{sec}$. (3)

$Q_1 = C_d a \sqrt{2gh} = 0.6 (.9 \times 1.2) \sqrt{2 \times 9.81 \times \left[.6 + \frac{1.2}{2}\right]}$

$= 3.1442 \text{ m}^3/\text{sec}$ (3)

% error $= \frac{Q_1 - Q}{Q} = 1.109\%$ (1)

Q.5 (i) Dynamic Similarity – means the similarity of forces between the model and prototype. It is said to exist between model & prototype if the ratio of corresponding forces acting at the corresponding points are equal (2)

- Dimensional homogeneity

means the dimensions of each terms in an equation on both sides are equal. The powers of fundamental dimensions (L, M, T) on both sides of the eqn will be identical for a dimensionally homogeneous eqn.

(ii) Buckingham's π theorem

If there are n variables (independent & dependent) & if these variable contains m fundamental dimensions (M, L, T) then variables are arranged into n-m dimensionless terms. each term is called π term.

(iii)

$$f_1\left(\eta, \frac{\mu}{D^2 w\rho}, \frac{Q}{D^2 w}\right) = 0 \text{ or } \eta = \phi\left[\frac{\mu}{D^2 w\rho}, \frac{Q}{D^2 w}\right]$$

Q.6 (i) Stoke's law -

$C_D = \frac{24}{Re}$ is defined as stoke's law

~~Lubrication Principal~~ Boundary layer - Just adjacent layer

~~The principle of Supporting Sliding load on a film is frictional reducing film is known as B.L. Lubrication~~

(ii) Reynolds no. $N_{Re} = \frac{DV\rho}{\mu}$

(iii) Laminar flow through ~~Porous media~~ Pipe -

(a) mean velocity $\frac{U_{max}}{\bar{u}} = 2.00$ or $\frac{1.5}{\bar{u}} = 2$

$\bar{v} = .75 m/s.$

(b) Radius -

$$u = -\frac{1}{4\mu}\frac{\partial p}{\partial x}(R^2 - r^2) \; ; \; u_{max} = -\frac{1}{4\mu}\frac{\partial p}{\partial x} \cdot R^2$$

$r = 70.7$ mm.

(iii) $r = R - 4 = 10 - 4 = 6$ Cm $= .06$ m

$$v = u_{max}\left[1 - \left(\frac{r}{R}\right)^2\right] = 1.5\left[1 - \left(\frac{.07}{.1}\right)^2\right] = .96 \text{ m/sec}$$