Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)

Fourth B. Tech. (Mechanical Engineering)

Summer – 2018

Course Code: MEU401

Course Name: Fluid Mechanics

Time: 2 hr. 30min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
3) Diagrams/sketches should be given wherever necessary.
4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1. Solve Any **TWO** questions.

(a) Explain the following terms. **6**

i. Viscosity
ii. Compressibility
iii. Vapour pressure

(b) State and derive the Pascal's law. Also derive the hydrostatic law. **6**

(c) A rectangular plane surface 2 m wide and 3 m deep lies in water in such a way that its plane makes an angle of 30^0 with the free surface of water. Determine the total pressure and position of centre of pressure when the upper edge is 1.5 **6**

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m below the free water surface.

2. Solve Any **TWO** questions.

(a) The velocity vector in a fluid flow is given by **6**

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

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

(b) If for a two-dimensional potential flow, the velocity potential is given by **6**

$$\emptyset = x\,(2y - 1)$$

Determine the velocity at the point P (4, 5). Also determine the stream function ψ and its value at the point P.

(c) Derive an expression for continuity equation in cylindrical polar co-ordinates. **6**

3. Solve Any **TWO** questions.

(a) Define an orifice meter. Prove that the discharge through an orifice-meter is given by the relation **6**

$$Q = C_d \frac{a_0 . a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

where,

a_1 = area of the pipe in which orifice-meter is fitted

a_0 = area of orifice

(b) Find the discharge of water flowing through a pipe 30 cm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 15 cm. The difference of **6**

pressure between the main and throat is measured by a liquid of specific gravity 0.6 in an inverted U-tube which gives a reading of 30 cm. The loss of head between the main and throat is 0.2 times the kinetic head of the pipe.

(c) A cylindrical vessel 12 cm in diameter and 30 cm deep is filled with water upto the top. The vessel is open at the top. Find the quantity of liquid left in the vessel, when it is rotated about its vertical axis with a speed of (a) 300 rpm, and (b) 600 rpm. **6**

4. (a) The pressure difference Δp in a pipe of diameter D and length l due to turbulent flow depends on the velocity V, viscosity μ, density ρ and roughness k. using Buckingham's π-theorem, obtain an expression for Δp. **6**

(b) Explain the dynamic similarity of flows governed by viscous, pressure and inertia forces. **6**

5. (a) Explain with neat sketch boundary layer concept. **6**

(b) A 150 mm diameter pipe reduces in diameter abruptly to 100 mm diameter. If the pipe carries water at 30 litres per second, calculate the pressure loss across the contraction. Take the co-efficient of contraction as 0.6. **6**

Government College of Engineering, Amravati

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Fourth Semester B. Tech. (Mechanical Engineering)

Summer - 2017

Course Code: MEU401

Course Name: Fluid Mechanics

Time: 2 hr. 30 min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
3) Diagrams/sketches should be given wherever necessary.
4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1 Solve Any **TWO** questions.

(a) What is manometer? How are they classified? Differentiate between manometers and mechanical gauges. 6

(b) How does the viscosity of a fluid vary with temperature? Also explain the terms Dynamic viscosity and Kinematic viscosity with dimensions. 6

(c) A pipe line which is 4 m in diameter contains a gate valve. The pressure at the centre of the pipe is 19.6 N/cm^2. If the plate is fitted with oil of specific gravity 0.87, find the force exerted by the oil upon the gate and position of centre of 6

pressure.

2 (a) Solve Any **TWO** questions. 6

Derive from first principles, the conditions for irrotational flow. Prove that, the potential flow, both the stream function and velocity potential function satisfy the Laplace equation.

(b) A fluid flow is given by 6

$$V = xy^2 i - 2yz^2 j + \left(-zy^2 + \frac{2z^3}{3}\right) k$$

Prove that it is a case of possible steady incompressible fluid flow. Calculate the velocity and acceleration at the point [1, 2, 3].

(c) In a two-dimensional incompressible flow, the fluid velocity components are given by 6

$$u = x - 4y \quad \text{and} \quad v = -y - 4x$$

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

3 Solve Any **TWO** questions.

(a) Explain the principle of venturimeter with neat sketch. Derive an expression for the rate of flow of fluid through it. 6

(b) The pressure difference is measured by the two tappings of a pitotstatic tube, one tapping pointing upstream and other perpendicular to the flow, placed in the centre of a pipe line of diameter 40 cm is 10 cm of water. The mean velocity in the pipe is 0.75 times the central velocity. Find the discharge through the pipe. Take the co-efficient of pitot-tube as 0.98. 6

(c) Define and explain the following terms: 6

i. Total energy line

ii. Hydraulic gradient line

4 (a) Define the following non-dimensional numbers: 6

i. Reynold number
ii. Froude number
iii. Mach number

What are their significances for fluid flow problems?

(b) The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. 6

5 (a) An old water supply distribution pipe of 250 mm diameter of a city is to be replaced by two parallel pipes of smaller equal diameter having equal lengths and identical friction factor values. Find out the new diameter required. 6

(b) Explain the phenomenon on Water Hammer in pipes. 6

Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)

Fourth Semester B. Tech. (Mechanical Engineering)

Summer – 2016

Course Code: MEU401 **Course Name: Fluid Mechanics**

Time: 2 hr. 30 min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
3) Diagrams/sketches should be given wherever necessary.
4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1 Solve Any **TWO** questions

(a) State and derive the Pascal's law. Also derive the hydrostatic law. **6**

(b) A vertical gap 2.2 cm wide of infinite extent contains a fluid of viscosity 2 N.s/m2 and specific gravity 0.9. A metallic plate 1.2 m X 1.2 m X 0.2 cm is to be lifted up with constant velocity of 0.15 m/s, through the gap. If the plate is in the middle of the gap, find the force required. The weight of the plate is 40 N. **6**

(c) A circular opening, 3 m diameter, in a vertical side of a tank is closed by a disc of 3 m diameter which can rotate about a horizontal diameter. Calculate: **6**

i. The force on the disc, and
ii. The torque required to maintain the disc in equilibrium in the vertical position when the head of water above the horizontal diameter is 4 m.

Cont.

2 Solve Any TWO questions.

(a) Derive from first principles, the condition for irrotational flow. Also prove that, for potential flow both the stream function and velocity potential function satisfy the Laplace equation. 6

(b) Find the convective acceleration at the middle of the pipe which converges uniformly from 0.6 m diameter to 0.3 m diameter over 3 m length. The rate of flow changes uniformly from 40 lit/s to 80 lit/s in 40 seconds; find the total acceleration at the middle of the pipe at 20^{th} seconds. 6

(c) What is the difference between the Lagrangian and Eulerian methods of describing the fluid motion. Which method is commonly used in fluid mechanics? Explain with reasons. 6

3 Solve Any TWO questions.

(a) The length of the divergent outlet part in a venturimeter is usually made longer compared with that of the converging inlet part. Why? 6

(b) Derive an expression for the discharge through an orifice-meter. 6

(c) Describe the Reynold's experiments with various types of flow. 6

4 (a) Derive Darcy-Weisbach equation for the head loss due to friction in pipe. 6

(b) Define momentum correction factor and energy correction factor. Also show that the momentum correction factor for laminar flow through a circular pipe is 4/3. 6

5 (a) State and explain Buckinghum's π-theorem. 3

(b) The pressure difference ΔP in a pipe of diameter D and length l due to turbulent flow depends on the velocity V, viscosity μ, density ρ, and roughness k. Using Buckinghum's π-theorem, obtained an expression for ΔP. 9

Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)

Second Year B. Tech. (Mechanical)

Summer - 2015

Course Code: MEU401 **Course Name: Fluid Mechanics**

Time: 2 hr. 30min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
3) Diagrams/sketches should be given wherever necessary.
4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1. Solve Any **TWO** questions.

(a) Differentiate between the following terms: 6

i. Absolute pressure and gauge pressure

ii. Simple manometer and differential manometer

iii. Piezometer and pressure gauges.

(b) A trapezoidal channel 2 m wide at the bottom and 1 m deep has side slopes 1:1. Determine: 6

i. The total pressure, and

ii. The centre of pressure on the vertical gate closing the channel when it is full of water.

(c) A single column vertical manometer is connected to a pipe containing oil of specific gravity 0.9. The 6

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area of the reservoir is 80 times the area of the manometer tube. The reservoir contains mercury of specific gravity 13.6. The level of the mercury in the reservoir is at a height of 30 cm below the centre of the pipe and difference of mercury levels in the reservoir and right limb is 50 cm. Find the pressure in the pipe.

2. Solve Any **TWO** questions.

(a) Derive an expression for continuity equation in cylindrical polar co-ordinates. 6

(b) Define velocity potential function and stream function. What are the conditions for flow to be irrotational. 6

(c) A fluid flow is given by: 6

$$V = xy^2 i - 2yz^2 j - \left(zy^2 - \frac{2z^3}{3}\right) k$$

Prove that it is a case of possible steady incompressible fluid flow. Also calculate the velocity and acceleration at the point [1, 2, 3].

3 Solve Any **TWO** questions.

(a) Explain the principle of venturimeter with a neat sketch. Derive an expression for the rate of flow of fluid through it. 6

(b) A 30 cm X 15 cm venturimeter is provided in a vertical pipe line carrying oil of specific gravity 0.9, the flow being upwards. The difference in elevation of the throat section and the entrance 6

section of the venturimeter is 30 cm. The differential U-tube mercury manometer shows a gauge deflection of 25 cm. Calculate:

i. The discharge of oil, and

ii. The pressure difference between the entrance section and the throat section.

Take, the co-efficient of meter as 0.98 and the specific gravity of mercury as 13.6.

(c) A closed cylinder of radius R and height H is completely filled with water. It is rotated about its vertical axis with a speed of, ω radians/s. Determine the total pressure exerted by water on the top and bottom of the cylinder. 6

4. (a) Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ, elasticity of the fluid medium which can be denoted by the speed of the sound in the medium C. Use Buckingham's π-theorem. 6

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(b) Explain the various types of similarities. 6

i. Geometric similarities

ii. Kinematic similarities

iii. Dynamic Similarities.

5. (a) Derive Darcy-Weisbach equation for the head loss due to friction in pipe. 6

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(b) Explain with neat sketch boundary layer concept. 6

Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)

Fourth Semester B. Tech. (Mechanical Engineering)

Summer – 2014

Course Code: MEU401 **Course Name: Fluid Mechanics**

Time: 2 hr. 30 min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
3) Diagrams/sketches should be given wherever necessary.
4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1 Solve Any **TWO** questions.

(a) Explain the following terms. **6**

i. Surface tension
ii. Capillarity
iii. Compressibility and Bulk Modulus

(b) Calculate the capillary effect in millimeters in a glass tube of 4mm diameter, immersed in (*i*) water and (*ii*) mercury. The temperature of the liquid is 20°C and the values of surface tension of water and mercury at 20°C in contact with air are 0.0735 N/m and 0.51 N/m respectively. The contact angle for water $\theta = 0^\circ$ and for mercury $\theta = 130^\circ$. Take specific weight of water at 20°C is 9790 N/m^3. **6**

(c) A U-tube differential manometer connects two pressure pipes A and B. Pipe A contains carbon tetrachloride having specific gravity 1.594 under a pressure of 11.772 N/cm^2 and pipe B contains oil of specific gravity 0.8 under a pressure of 11.772 N/cm^2. The pipe A lies 2.5 m above pipe B. Find the difference of pressure measured by mercury as fluid filling U-tube. 6

2 Solve Any **TWO** questions.

(a) Derive an expression for continuity equation in cylindrical polar co-ordinates. 6

(b) A pipe line which is 4 m in diameter contains a gate valve. The pressure at the centre of the pipe is 19.6 N/cm^2. If the pipe is filled with oil of specific gravity 0.87, find the force exerted by the oil upon the gate and position of centre of pressure. 6

(c) In a two-dimensional incompressible flow, the fluid velocity components are given by 6

$$u = x - 4y \text{ and } v = -y - 4x$$

Show that velocity potential exists and determine its form. Find also stream function.

3 Solve Any **TWO** questions.

(a) Derive an equation of motion for free vortex flow. 6

(b) Define an orifice meter. Prove that the discharge through an orifice-meter is given by the relation 6

$$Q = C_d \frac{a_0 . a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

where,

a_1 = area of the pipe in which orifice-meter is fitted

a_0 = area of orifice

(c) A 45° reducing bend is connected in a pipe line, the diameters at the inlet and outlet of the bend being 600 mm and 300 mm respectively. Find the force exerted by water on the bend if the intensity of pressure at inlet to bend is 8.829 N/cm^2 and rate of flow of water is 600 liters per second. **6**

4 (a) Define momentum correction factor and energy correction factor. Also show that the momentum correction factor and energy correction factor for laminar flow through a circular pipe are 4/3 and 2.0 respectively. **8**

(b) Explain the method of selecting the repeating variables in the dimensional analysis. **4**

5 (a) Explain the boundary layer concept for the flow over flat plate. Also derive an expression for displacement thickness. **6**

(b) Derive an expression for drag and lift force on immersed body. **6**