

Reg. No. _____ Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, JANUARY 2017

ME 203: MECHANICS OF FLUIDS (ME)

Max. Marks: 100

Duration: 3 Hours

PART A

(Answer any three questions)

1. Explain the characteristic fluid properties to which the following phenomenon are attributable:
 - a. Rise of sap in a tree; (2)
 - b. Spherical shape of a drop of a liquid; (2)
 - c. Cavitation ; (2)
 - d. Flow of a jet of oil in an unbroken stream; (2)
 - e. Water hammer (2)

2. a. 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° with the free surface of water. Determine the total pressure and position of centre of pressure when the upper edge is 1.5 m below the free water surface. (5)
- b. Write the conditions for the equilibrium of floating and submerged bodies. (5)

3. (a). Define the following:
 - (i) Steady flow: (1)
 - (ii) Laminar flow: (1)
 - (iii) Turbulent flow: (1)
 - (iv) Uniform flow and (1)
 - (v) Compressible flow (1)
- (b). The velocity vector in a fluid flow is given by $V = 4x^3i - 10x^2yj + 2tk$. Find the acceleration of fluid particle at (2,1,3) at time $t=1$ (5)

4. In a 2D 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. (10)

PART B

(Answer any three questions)

5. (a) Derive Euler's equation of motion. How will you obtain Bernoulli's equation from Euler's equation (6)
- (b) What are the assumptions made in deriving Bernoulli's equation? (4)

6. (a) What is a Venturimeter? Derive an expression for the discharge through a venturimeter. (6)

- (b) An oil of specific gravity 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The oil-mercury differential manometer shows a reading of 15 cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d=0.98$ (4)
7. (a) What are minor losses? (4)
(b) Derive Darcy-Weisbach equation (6)
8. (a) Define hydraulic gradient line and total energy line. (4)
- (b) A crude oil of viscosity 0.97 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 100 mm and of length 15 m. Calculate the difference of pressure at the two ends of the pipe, if 100kg of oil is collected in a tank in 25 seconds. (6)

PART C

(Answer any four questions)

- 9 With a neat sketch explain the development of boundary layer over a horizontal flat plate which is kept in a flow field. (10)
- 10 For the velocity profile in a laminar flow $\frac{u}{U} = \sin\left(\frac{\pi y}{2\delta}\right)$. Obtain the expression for boundary layer thickness, shear stress, drag force on one side of the plate and coefficient of drag in terms of Reynolds number. (10)
- 11 Describe the methods of preventing the separation of boundary layer. (10)
- 12 The pressure drop ΔP in flow of incompressible fluid through rough pipes is found to depend on the length L , average velocity u , fluid density ρ , dynamic viscosity μ , diameter D and average roughness height e . Obtain a dimensionless expression using π - theorem (10)
13. Explain similarity requirements between the model and prototype (10)
14. Water tunnel operates with a velocity of 3 m/s at the test section and power required was 3.75 kW. If the tunnel is to operate with air, determine for similitude the flow velocity and the power required. (10)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017

Course Code: **ME203**Course Name: **MECHANICS OF FLUIDS (ME)**

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three questions.

1. (a) Differentiate between Newtonian fluids and Non-Newtonian fluids. (4)
(b) In a stream of glycerine in motion at a certain point the velocity gradient is 0.25 s^{-1} . If for the fluid, the density is 1268 kg/m^3 and kinematic viscosity is $6.3 \times 10^{-4} \text{ m}^2/\text{s}$. Calculate the shear stress at the point. (6)
2. (a) Differentiate between gauge pressure and absolute pressure. (4)
(b) Determine the total pressure and position of centre of pressure on an isosceles triangular plate of base 5m and altitude 5m when the plate is immersed vertically in an oil of specific gravity 0.8. The base of the plate is 1m below the free surface of oil. (6)
3. (a) Define metacentre and metacentric height. (4)
(b) A solid cylinder of diameter 5m has a height of 4m. Find the metacentric height of the cylinder when it is floating in water with its axis vertical. The specific gravity of the cylinder = 0.6. (6)
4. (a) Define streak lines and path lines. (4)
(b) If for a two dimensional potential flow, the velocity potential is $\Phi = x(2y-1)$, determine the velocity at the point P(2,3). Determine also the value of stream function ψ at the point P. (6)

PART B

Answer any three questions.

5. (a) Derive Euler's equation of motion. Obtain Bernoulli's equation from Euler's equation. (6)
(b) What are the assumptions made in deriving Bernoulli's equation? (4)
6. (a) What is a Venturimeter? Derive an expression for the discharge through a venturimeter. (6)
(b) An oil of specific gravity 0.8 is flowing through a venturimeter having inlet diameter 20cm and throat diameter 10cm. The oil-mercury differential manometer

shows a reading of 15cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d = 0.98$ (4)

7. (a) What are minor losses? (4)
- (b) Derive Darcy-Weisbach equation. (6)
8. (a) Define hydraulic gradient line and total energy line. (4)
- (b) A crude oil of viscosity 0.97 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 100mm and of length 15m. Calculate the difference of pressure at the two ends of the pipe, if 100kg of oil is collected in a tank in 25 seconds. (6)

PART C

Answer any four questions.

9. Obtain Von-Karman momentum integral equation. (10)
10. For the velocity profile in laminar boundary layer is given as $u/U = 3/2(y/\delta) - 1/2(y/\delta)^3$ where u = velocity in boundary layer at a distance y , U = Free stream velocity and δ = Boundary layer thickness.
Find the thickness of the boundary layer and shear stress 1.8m from the leading edge of a plate. The plate is 2.5m long and 1.5m wide and is placed in water and which is moving with a velocity of 12cm/s. Find the drag on one side of the plate. Viscosity of water = 0.01 poise. (10)
11. The resistance R to the motion of completely submerged body depends upon the length of the body L , velocity of flow V , mass density of fluid ρ and kinematic viscosity of fluid ν . By dimensional analysis prove that $R = \rho V^2 L^2 \Phi(VL/\nu)$. (10)
12. (a) Define boundary layer thickness and momentum thickness. (4)
- (b) State Buckingham's π theorem. How are the repeating variables selected in dimensional analysis? (6)
13. Define the following:
 - (i) Froude number
 - (ii) Reynolds number
 - (iii) Weber number
 - (iv) Cauchy number
 - (v) Euler number (10)
14. The velocity distribution in a laminar boundary layer is given by $u/u_a = 3/2(y/\delta) - 1/2(y/\delta)^2$. Calculate the displacement thickness and momentum thickness. (10)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

Course Code: ME203

Course Name: MECHANICS OF FLUIDS (ME)

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks.

Marks

- | | | |
|---|---|-----|
| 1 | a) Differentiate between ideal fluids and real fluids. Mark those on rheological diagram. | (4) |
| | b) A plate weighing 150N and measuring 0.8m x 0.8m slides down an inclined plane over an oil film of 1.2mm thickness for an inclination of 30° and a velocity of 0.2m/s. Compute the dynamic viscosity of the fluid. | (6) |
| 2 | a) What is metacentre? Explain the equilibrium conditions of floating bodies. | (4) |
| | b) A triangular plate of base width 2m and height 3m is immersed in water with its plane making an angle of 60° with the free surface of water. Determine the hydrostatic pressure force and the centre of pressure when the apex of the triangle lies 5m below the free water surface. | (6) |
| 3 | a) Explain the working principle and use of the following devices.
i) Hydraulic lift ii) Piezometer iii) Bourden tube pressure gauge | (6) |
| | b) Differentiate between rotational and irrotational fluid flow. | (4) |
| 4 | a) Define the following with example.
i) Stream lines ii) Stream tube iii) Path lines iv) Streak lines | (4) |
| | b) The stream function for a flow field is given by $\psi = 2xy$. Check whether the flow is continuous or irrotational. | (6) |

PART B

Answer any three full questions, each carries 10marks.

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|---|---|-----|
| 5 | a) Derive Euler's equation of motion. Obtain Bernouli's equation from Euler's equation. | (6) |
| | b) What are the applications and limitations of Bernouli's equation? | (4) |
| 6 | a) What is Venturimeter? Derive an expression for discharge through a venturimeter. | (6) |
| | b) Water flows at the rate of 15litre/s through a pipe 100mm diameter orifice used in a 200 mm diameter pipe. What is the difference of pressure head between upstream section and vena contracta section? Take coefficient of contraction as 0.6 and coefficient of velocity as 1. | (4) |
| 7 | a) Differentiate between laminar and turbulent flows. | (4) |
| | b) Derive Darcy- Weisbach equation. | (6) |
| 8 | a) Explain the causes of major and minor energy losses in pipe flows. | (4) |

- b) Glycerine flows at a velocity of 5m/s in a 10cm diameter pipe. Dynamic viscosity and density of glycerine is assumed as 1.50Pa.s and 1260kg/m³ respectively. (6)
 Estimate: i) The boundary shear stress in the pipe due to the flow.
 ii) Head loss in a length of 10m of pipe.
 iii) Power developed by the flow in a distance of 10m.

PART C

Answer any four full questions, each carries 10marks.

- 9 Determine the displacement thickness, momentum thickness and energy thickness in terms of normal boundary layer thickness δ in respect of the following velocity profile in the boundary layer on a flat plate $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$ where u is the velocity at height y above plate surface and U is the free stream velocity. (10)
- 10 Obtain Von – Karman momentum integral equation from conservation principles. (10)
- 11 a) Derive an expression for i) displacement thickness and ii) momentum thickness. (6)
 b) A 2.5m ship model was tested in fresh water ($\rho=1000\text{kg/m}^3$) and measurements indicated that there was a resistance of 45N when the model was moved at 2m/s. Work out the velocity of 40m prototype. Also calculate the force required to drive the prototype at this speed through sea water ($\rho =1025\text{kg/m}^3$). (4)
- 12 a) Define the following: i) boundary layer thickness ii) displacement thickness iii) momentum thickness and iv) energy thickness. (4)
 b) Explain: i)Geometric similarity ii)Kinematic similarity iii) Dynamic similarity. (6)
- 13 Show that the power P developed in a water turbine can be expressed as: $P = \rho N^3 D^5 \Phi \left\{ \frac{D}{B}, (\rho D^2 N)/\mu, \frac{H}{D}, ND/\sqrt{gH} \right\}$ where D and B are diameter and width of runner, N is the speed in rpm; H is the operating head, μ and ρ are respectively the coefficient of dynamic viscosity and mass density of the liquid. (10)
- 14 Define the following dimensionless number with their field of application: (10)
 i) Froude Number ii) Weber Number iii) Newton number iv) Mach number

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: ME203

Course Name: MECHANICS OF FLUIDS (ME)

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks

Marks

- 1 a) Explain technical reason for the following: (4)
 i) Certain insects are able to walk on surface of water.
 ii) Rise of water in trees
- b) A U-tube differential mercury manometer is connected between two pipes X and Y. (6)
 Pipe X contains a fluid (Sp.gr. = 1.59) under a pressure of 103 kN/m² and pipe Y contains oil (Sp.gr. = 0.8) under a pressure of 172 kN/m². Pipe X is 2.5 m above pipe Y. The mercury level in the limb connected to pipe X is 1.5 m below the centreline of pipe Y. The level of mercury in the limb connected to pipe Y is below the level of mercury (Sp.gr. = 13.6) in the other limb. Find the manometer reading in centimetres of mercury and show the same as a schematic diagram.
- 2 a) State and explain the Newton's law of viscosity. Explain with examples the classification of fluids on the basis of this law. (4)
- b) A vertical rectangular gate of 4m width and 2m depth is hinged at a point 0.25 m below the centre of gravity of the gate. If the top edge of gate is 5 m below free surface of water and total depth of water is 7 m, what horizontal force must be applied at the bottom to keep the gate closed? (6)
- 3 Distinguish between: (10)
 i) Steady flow and unsteady flow ii) Uniform flow and non-uniform flow
 iii) Rotational and irrotational flow iv) Laminar flow and Turbulent flow
- 4 a) Describe the following terms: (4)
 i) Stream lines ii) Path lines iii) Streak lines iv) Stream tubes.
- b) A velocity field is defined by $V = 2y^2\hat{i} + 3xy\hat{j} + 0\hat{k}$. Compute the velocity, local acceleration and convective acceleration at point (1, 2, 0). (6)

PART B

Answer any three full questions, each carries 10 marks

- 5 a) Compare Venturimeter and orifice meter with respect to construction, principle, merits and demerits. (4)
- b) A Venturimeter whose throat diameter is $1/3^{\text{rd}}$ of pipe diameter is fitted in a horizontal pipe of 300 mm diameter carrying water. The pressure in pipe line is 13.8 N/cm² (gauge) and vacuum in throat is 37.5 cm of mercury. Determine the rate of flow through the pipeline. Take $C_d=0.98$. (6)
- 6 a) Compare rectangular notch and triangular notch with respect to construction and advantages. (4)
- b) Explain the working principle of Pitot tube and Pitot-static tube with neat sketches. (6)

- 7 a) An existing compound piping system to transport water from one station to another station consists of 1800 m of 50 cm, 1200 m of 40 cm and 600 m of 30 cm diameter pipes of same material connected in series. It is decided to change these existing pipes with new pipes of uniform diameter. Calculate diameter of new pipes to be used so as maintain same discharge and loss of head as in previous situation. (4)
- b) Derive Chezy's formula for loss of head due to friction in a circular pipe. (6)
- 8 a) Define hydraulic gradient and total energy line. Explain its significance in fluid mechanics. (4)
- b) Explain the major and minor (any five) energy losses related to pipe flow. (6)

PART C

Answer any four full questions, each carries 10 marks

- 9 Explain the following:
- a) Displacement thickness (2)
- b) Momentum thickness (2)
- c) Energy thickness (2)
- d) Separation of boundary layer with figure. (4)
- 10 Draw a neat diagram and explain the concept of boundary layer development along a long thin plate. Describe the details of various regions in the boundary layer. (10)
- 11 For the velocity profile for laminar boundary layer $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^3 + \left(\frac{y}{\delta}\right)^4$ (10)
obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and coefficient of drag in terms of Reynolds number.
- 12 a) State Buckingham's - π theorem. Explain dimensional homogeneity with the help of an example. (4)
- b) Define and explain Froude number, Reynold's number, Weber's number and Mach number (6)
- 13 The variables controlling the motion of a floating vessel (ship) through water are the drag force F , the speed V , the length L , dynamic viscosity μ , the density ρ and acceleration due to gravity g . Derive an expression for drag force F by dimensional analysis. Hence show that the drag force is a function of Reynold's number and Froude number. (10)
- 14 Explain different laws on which models are designed for dynamic similarity. (10)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: ME203

Course Name: MECHANICS OF FLUIDS (ME)

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks.

Marks

- | | | |
|---|--|------|
| 1 | Differentiate the following
(a) Newtonian and Non Newtonian fluid.
(b) Compressible and incompressible fluid.
(c) Ideal and real fluid.
(d) Specific weight and Specific Gravity | (10) |
| 2 | A rectangular pontoon 10m long 7 m broad & 2.5m deep weights 686.7KN. It carries on its upper deck an empty boiler of 5 m diameter weighing 588.6 KN. The centre of gravity of the boiler and the pontoon are at their respective centers along a vertical line. Find the metacentric height and check the stability of the body. Weight density of sea water is 10.104 KN/m^3 | (10) |
| 3 | Define the following terms
i. Stream line
ii. Streak line
iii. Path line
iv. Stream tube | (10) |
| 4 | The velocity vector in a fluid flow is given by $V = 4x^3i - 10x^2yj + 2tk$. Find the velocity and acceleration of a fluid particle at (2,1,3) at time $t = 1$. | (10) |

PART B

Answer any three full questions, each carries 10 marks.

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|---|--|------|
| 5 | Find the head loss due to friction in a pipe of diameter 250mm and length 60m, through which water is flowing at a velocity of 3m/s, using (i) Darcy's formula and (ii) Chezy's formula for which $C = 55$ and kinematic viscosity = 0.1 stoke. | (10) |
| 6 | A submarine moves horizontally in sea and has its axis below the water surface. A pitot tube is placed in front of the submarine along its axis is connected to the two limbs of a U- tube containing mercury. The difference in mercury level is found to be 170 mm. Find the speed of submarine in km/hr, knowing that specific gravity of sea water is 1.025. | (10) |
| 7 | Explain briefly major and minor losses in pipe lines. | (10) |
| 8 | Derive Euler's equation and hence deduce the expression for Bernoulli's Equation. State the assumptions made for such derivation. | (10) |

PART C

Answer any four full questions, each carries 10 marks.

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|---|---|------|
| 9 | Define momentum thickness. Derive an expression for momentum thickness. | (10) |
|---|---|------|

- 10 Find the ratio of displacement thickness to momentum thickness and momentum thickness to energy thickness for the velocity distribution in the boundary layer is given by $(u/U_\infty) = 2(y/\delta) - (y/\delta)^2$ (10)
- 11 A thin plate is moving in still atmospheric air at a velocity of 5m/s. The length of the plate is 0.6m and width 0.5m. Calculate (i) Thickness of the boundary layer at the end of the plate and (ii) drag force on one side of the plate. Take density of air as 1.25kg/m^3 and kinematic viscosity 0.15 stokes. (10)
- 12 a) State Buckingham's π theorem and mention the conditions for selecting repeating variables. (5)
- b) Define the following dimensionless numbers: Reynold's number, Froude's number and Mach's number. Mention its applications in fluid flow problems. (5)
- 13 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 (10)
- 14 A 1:10 scale model of a passenger car is tested in a wind tunnel. The prototype velocity is 40Kmph. If the model drag is 350N, what is the drag and the power required to overcome the drag in the prototype. Assuming the air in the model and prototype has same properties. (10)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: ME203

Course Name: MECHANICS OF FLUIDS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three full questions, each carries 10marks.

Marks

- | | | |
|---|--|------|
| 1 | a) Deduce Pascal's Law. | (5) |
| | b) Dynamic viscosity of oil used for lubrication between a shaft (journal) and bearing is 6 poise. The shaft is of diameter 400 mm and rotates at 190 rpm. Calculate the power lost in the bearing for 90 mm long Journal bearing arrangement. Thickness of oil is 1.5 mm. | (5) |
| 2 | Derive an expression for total pressure and centre of pressure on an inclined plane surface submerged in a liquid. | (10) |
| 3 | How can you classify fluid flow? | (10) |
| 4 | The velocity vector for 2D incompressible , fluid flow is given by
$V = (y^3/3 + 2x - x^2y)i + (xy^2 - 2y - x^3/3)j$
Find a) whether the flow is possible or impossible.
b) Whether the flow is rotational or irrotational. | (10) |

PART B

Answer any three full questions, each carries 10marks.

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|---|---|------|
| 5 | Derive Hagen Poiseuille equation for fully developed laminar flow in a circular pipe. | (10) |
| 6 | A pipe 300 m long has a slope of 1 in 100 and tapers from 1.2 m diameter at the higher end to 0.6 m diameter at the lower end. Quantity of water flowing is 5400 litres per minute. If the pressure at the higher end is 68.67 kPa. Find the pressure at the lower end. | (10) |
| 7 | An oil of specific gravity 0.9 and viscosity 10 poise is flowing through a pipe of diameter 110 mm. The velocity at the centre is 2 m/s, find :
(i) the pressure gradient in the direction of flow
(ii) shear stress at the pipe wall; (iii) Reynold's number; and (iv) velocity at a distance 30 mm from the wall. | (10) |
| 8 | Explain the principle of venturi meter with a neat sketch and establish an expression for the rate of flow through it. | (10) |

PART C

Answer any four full questions, each carries 10marks.

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|----|--|------|
| 9 | What do you understand by boundary layer? Illustrate with reference to flow over flat plate. | (10) |
| 10 | Define the following
i. Laminar Boundary Layer
ii. Turbulent boundary Layer
iii. Laminar Sub Layer
iv. Boundary Layer Thickness | (10) |
| 11 | Air flows over a flat plate of 1 m x 1m at a velocity of 6 m/s. Determine
(a) Boundary layer thickness at the end of the plate
(b) Shear stress at the middle of the plate | (10) |

(c) Total drag per unit length on the sides of the plate.

Take density of air = 1.2 kg/m^3 and Kinematic viscosity of air = $0.15 \times 10^{-4} \text{ m}^2/\text{s}$

- 12 The pressure drop ΔP in a pipe of diameter D , length L , due to turbulent flow (10)
depends on mass density ρ and viscosity μ of the flowing fluid, mean velocity of flow V and average height K of roughness projections on the pipe surface. Obtain a dimensionless expression for ΔP by Buckingham's π theorem. Hence show that
- 13 $h_f = 4fLV^2/2dg$. Explain the different types of hydraulic similarities that must exist between a (10)
prototype and its model.
- 14 A 2.5m ship model was tested in fresh water ($\rho = 1000 \text{ kg/m}^3$) and measurements (10)
indicated that there was a resistance of 45 N when the model was moved at 2 m/s. Workout the velocity of 40m prototype. Also calculate the force required to drive the prototype at this speed through sea water ($\rho = 1025 \text{ kg/m}^3$).

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: ME203

Course Name: MECHANICS OF FLUIDS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three full questions, each carries 10marks.

Marks

- 1 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 the manometer contains mercury and 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 over the centre of the pipe. If the pressure of water in pipe line is reduced to 9810 N/m^2 , calculate the new difference in the level of mercury. Sketch the arrangement in both cases. (10)
- 2 a) Differentiate between (5)
 i. Absolute and gauge pressure
 ii. Piezometer and pressure gauges
- b) An open tank contains water up to a depth of 2m and above it an oil of specific gravity 0.9 for a depth of 1m. Find the pressure intensity (5)
 i. At the interface of the two liquids
 ii. At the bottom of the tank
- 3 Differentiate the following. (10)
 (a) Lagrangian method and Eulerian method
 (b) Steady and unsteady flow
 (c) Laminar and turbulent flow
 (d) Stream line and streak line flow.
- 4 An idealized flow is given by $V = 2x^3i - 3x^2yj$. Is the flow steady or unsteady ? (10)
 Is it 2D or 3D ? Make calculations for the velocity, local acceleration and convective acceleration of a fluid particle in the flow field at the point (2,1,3).

PART B

Answer any three full questions, each carries 10marks.

- 5 Derive Darcy -Weisbach equation for head loss due to friction. (10)
- 6 A pipe carrying water has a 30 cm x 15 cm venturimeter which is positioned inclined at 30° to the horizontal, the flow being upwards. The converging cone is 45 cm in length and the co-efficient of discharge of the meter is 0.98. A differential U tube manometer with mercury as indicating fluid is connected to the inlet and to the throat and shows a differential column height of 30 cm. Calculate the discharge in the pipe (10)
 If the pressure at inlet section is 50 kPa, determine the pressure at the throat. And the head loss in the converging section of the venturimeter.
- 7 Water is flowing through a taper pipe of length 100 mm having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 liters/s. The (10)

pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is 19.62 N/cm^2 .

- 8 Obtain the condition for maximum power transmission through pipes and corresponding efficiency of transmission. (10)

PART C

Answer any four full questions, each carries 10marks.

- 9 Define displacement thickness. Derive an expression for the displacement thickness. (10)

- 10 Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by (10)

$$(u/U_\infty) = 2(y/\delta) - (y/\delta)^2$$

- 11 What is meant by boundary layer separation? What are the different methods of preventing boundary layer separation? (10)

- 12 The resisting force R of supersonic plane during flight can be considered as dependent upon the length of the aircraft L , velocity V , air viscosity μ , air density ρ and bulk modulus of air K . Express the functional relationship between these variables and the resisting force by using Buckingham's theorem (10)

- 13 Define the following (10)

- i. Reynold's Number.
- ii. Froude's Number.
- iii. Euler's Number.
- iv. Weber's Number.
- v. Mach's Number.

- 14 The pressure drop in an aeroplane model size $1/40$ of its prototype is 80 N/cm^2 . The model is tested in water. Find the corresponding pressure drop in the prototype take density of air = 1.24 kg/m^3 . The viscosity of water is 0.01 poise while the viscosity of air is 0.00018 poise. (10)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third semester B.Tech examinations (S) September 2020

Course Code: ME203**Course Name: MECHANICS OF FLUIDS**

Max. Marks: 100

Duration: 3 Hours

PART A*Answer any three full questions, each carries 10marks.*

Marks

- 1 a) Explain absolute pressure and gauge pressure with a neat graph. (4)
b) Define Pascal's law and derive its proof. (6)
- 2 a) Describe what is vapour pressure? How can water boil at room temperature? (4)
b) The right limb of a simple U-tube manometer containing mercury is open to the atmosphere while the left limb is connected to a pipe in which a fluid of Sp.gr. 0.9 is flowing. The centre of the pipe is 12 cm below the level of mercury in the right limb. Find the pressure of the fluid in the pipe if the difference of mercury level in the two limbs is 20 cm. (6)
- 3 a) Deduce the relation between stream function and velocity potential function. (4)
b) Derive Euler's equation of motion. (6)
- 4 A fluid flow is given by $V = x^2y \mathbf{i} + y^2z \mathbf{j} - (2xyz + yz^2) \mathbf{k}$, Prove that it is a case of possible steady incompressible flow. Calculate the velocity and acceleration at the point (2,1,4). (10)

PART B*Answer any three full questions, each carries 10 marks.*

- 5 a) State Bernoulli's theorem and any two applications of it. State any one difference between a notch and weir. (6)
b) Write the Bernoulli's equation for real fluids and explain the terms in it. (4)
- 6 a) State the use of a venturimeter. Derive the expression for the rate of flow through the venturimeter. (6)
b) An oil of sp.gr. 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter of 10 cm. the oil-mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d = 0.98$. (4)

- 7 Derive Hagen-Poiseuille equation. (10)
- 8 a) Explain the phenomenon of water hammer. (4)
- b) Determine the rate of flow of water through a pipe of diameter 20 cm and length 50 m when one end of the pipe is connected to a tank and other end of the pipe is open to the atmosphere. The pipe is horizontal and the height of water in the tank is 4 m above the centre of the pipe. Consider all minor losses and take coefficient of friction, $f = 0.009$. (6)

PART C

Answer any four full questions, each carries 10 marks.

- 9 a) Explain the following terms : i) boundary layer ii) boundary layer thickness iii) drag iv) lift (6)
- b) Differentiate between laminar and turbulent boundary layers (4)
- 10 Define energy thickness and derive an expression for the energy thickness. (10)
- 11 a) Explain the process of separation of boundary layer with a neat sketch. (6)
- b) List the different methods to prevent the separation of boundary layer. (4)
- 12 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 discharge Q . Express η in terms of dimensionless parameters. (10)
- 13 Explain Froude model law and derive the scale ratio for time, acceleration and discharge using this law. List any two fluid flow problems where Froude law is applied. (10)
- 14 A 7.2 m height and 15 m long spillway discharges $94 \text{ m}^3/\text{s}$ discharge under a head of 2.0 m. If a 1:9 scale model of this spillway is to be constructed, determine model dimensions, head over spillway model and the model discharge. If a model experiences a force of 7500 N, determine the force on the prototype. (10)
