Reg No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JANUARY 2017

Course Code**: CE203**

Course Name**: FLUID MECHANICS – I (CE)**

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two Questions.

1. a) A triangular plate of 1 metre base and 1.5 metre altitude is immersed in water. The plane of the plate is inclined at 30^0 with free water surface and the base is parallel to and at a depth of 2 metres from water surface. Find the total pressure on the plate and the position of centre of pressure. (10)
   b) Explain the terms circulation and vorticity. (5)

2. a) Show that a cylindrical buoy 1.25m diameter and 3.25m high weighing 11127 N will not float vertically in sea water weighing 10055 N/m^3. Find the tension necessary in a vertical chain attached to the centre of the base of the buoy that will just keep the cylinder vertical. (13)
   b) Differentiate between the Eulerian and Lagrangian methods of representing fluid flow. (2)

3. a) The velocity vector in an incompressible flow is given by $V= (6xt + yz^2)i + (3t + xy^2)j + (xy – 2xyz – 6tz)k$ (i) Verify whether continuity equation is satisfied. (ii) Determine the acceleration and velocity at point A (1,1,1) at t =1. (12)
   b) Differentiate betweensimple manometer and differential manometer (3)

PART B

Answer any two Questions

4. The diameter of a pipe bend is 30 cm at inlet and 15 cm at outlet and the flow is turned through 120^0 in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of the inlet section. Total volume of water in the bend is 0.9 m^3. Neglecting friction, calculate the magnitude and direction of the force exerted by the bend on the water flowing at 250 litres/s and when the inlet pressure is 0.15 N/mm^2. (15)

5. a) What are the forces and assumptions considered in the derivation of Euler's equation of motion? (5)
   b) The flow in a 2 m wide rectangular channel is measured by a rectangular weir 1m long and 0.6 m high. Find the discharge in the channel when the head over the weir is 0.3 m. Take C_d as 0.62. Consider end contractions and velocity of approach.(10)

6. a)A circular tank of diameter 3 m contains water up to a height of 4 m. The tank is provided with an orifice of diameter 0.4 m at the bottom. Find the time taken by water, (i) to fall from 4 m to 2 m and (ii) for completely emptying the tank. Take C_d = 0.6. (10)
   b) Define energy correction factor and momentum correction factor. (5)

PART C

Answer any two Questions

7. a) Derive the Hagen –Poiseulle equation for laminar flow in circular pipes.(10)
   b) A piping system consists of three pipes arranged in series; the lengths of the pipes are 1200 m, 750 m and 600 m and diameters 750 mm, 600 mm and 450 mm respectively. (i) Transform the system to an equivalent 450 mm diameter pipe, and (ii) Determine an equivalent diameter for the pipe, 2550 m long. (10)

8. a) The velocity distribution in the boundary layer is given by
   $u/U = 2(y/\delta) - (y/\delta)^2$, δ being boundary layer thickness. Find (i) the displacement thickness, (ii) the momentum thickness and (iii) the energy thickness. (10)
   b) What are the major and minor losses in a pipeline? (5)
   c) Define momentum thickness and energy thickness. (5)

9. a) What is the difference between friction drag and pressure drag? (5)
   b) Calculate the friction drag on a plate 0.15 m wide and 0.45 m long placed longitudinally in a stream of oil flowing with a free stream velocity of 6 m/s. Also find the thickness of the boundary layer and shear stress at the trailing edge. Specific gravity of oil is 0.925 and its kinematic viscosity is 0.9×10^{-4} m^2/s. (10)
   c) Define Hydraulic Grade Line and Total Energy Line. (5)

***

Total Pages: 2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

Course Code: CE203

Course Name: FLUID MECHANICS – I (CE)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Two pipelines, one carrying oil of relative density 0.9 and other carrying water are connected to a manometer as shown in Figure 1. By what amount, the pressure in water pipeline should be increased so that mercury levels in both the limbs of the manometer become equal? (8)

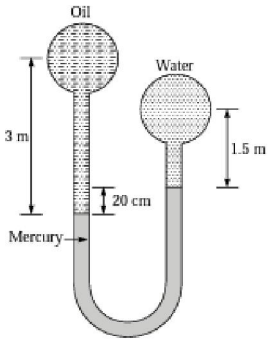


Figure 1.

b) Obtain an expression for centre of pressure of a lamina paced in inclined position. (7)

2 a) Derive continuity equation in three dimensional Cartesian coordinates. (7)

b) A rectangular barge 16 m x 5 m has a depth of immersion of 1.6 m when floating horizontally. The centre of gravity of the barge is 1.9 m above the bottom. Determine the angle of tilt if a 50 kN weight is moved across the deck by 3.5 m. (8)

3 a) In a 2-dimensional steady incompressible flow, the velocity components *u, v* are given by $u = 2x - x^2 y + \frac{y^3}{3}$, $v = xy^2 - 2y - \frac{x^3}{3}$. Determine the acceleration at P(1,3). (6)

b) A door in a tank retaining water is in the form of a quadrant of a cylinder of 1.5 m radius and 1.8 m wide as shown in Figure 2. Calculate the resultant force on the gate. (9)

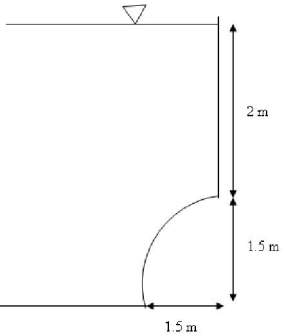


Figure 2

PART B

Answer any two full questions, each carries 15 marks.

4 a) Water is flowing through an inclined venturimeter in the upward direction. The inlet and throat diameters of the venturimeter are 200 mm and 100 mm respectively. The pressure at inlet is 19.62 N/cm^2 (gauge) and at throat is 3.92 N/cm^2(vaccum). The length between inlet and throat of the venturimeter is 500 mm and is inclined at 60^o with horizontal. Find the discharge through the venturimeter. Take C_d=0.98. (9)

b) Differentiate kinetic energy correction factor and momentum correction factor. (6)

5 a) A tank has an upper cylindrical portion of 2.5 m diameter and 3 m high with hemispherical base. Find the time required to empty it through an orifice of 8 cm diameter at the bottom, if the tank is initially full of water. Take C_d=0.6. (10)

b) Explain the experimental method of determination of orifice coefficients. (5)

6 a) Water flows first over a 1 m wide trapezoidal weir at a depth of 0.2 m with a water surface width of 1.5 m and then through a right angled triangular weir installed in a channel. Find the depth of water over the triangular weir if the coefficient of discharge of trapezoidal and triangular weir are 0.62 and 0.6 respectively. (8)

b) Obtain the condition for maximum discharge over a broad crested weir. Also state its discharge equation. (7)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive Hagen-Poiseulle equation for laminar flow through circular pipes. (10)

b) Two parallel plates kept 100 mm apart have laminar flow of oil between them with a maximum velocity of 1.5 m/s. Calculate (i) velocity at 2 cm from the plate (ii) pressure difference between two points 20 m apart, if the viscosity of oil is 24.53 Poise. (10)

8 a) Differentiate hydraulic gradient line and total energy line. (5)

b) A 250 mm diameter, 3 km long straight pipe runs between two reservoirs of surface elevation135 m and 60 m. A 1.5 km long 300 mm diameter pipe is laid parallel to the 250 mm diameter pipe from its mid-point to the lower reservoir. Neglecting all minor losses and assuming a friction factor of 0.02 for both pipe, find the increase in discharge caused by addition of 300 mm diameter pipe. (15)

9 a) State the characteristics of boundary layer growth over a flat plate. (5)

b) Explain the methods for controlling boundary layer separation. (5)

c) A smooth flat plate 2 m wide and 2.5 m long is towed in oil of relative density 0.8 at a velocity of 1.5 m/sec along its length. Find the boundary layer thickness at the trailing edge of the plate and power required for towing the plate. Take kinematic viscosity of oil as 1 stokes. (10)

****

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: CE203

Course Name: FLUID MECHANICS – I (CE)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks Marks

1 a) Define metacentre and Metacentric height. (5)

b) Calculate the pressure due to a column of 0.4 m of (i) water, (ii) an oil of specific gravity 0.9 and (iii) mercury of sp. gr. 13.6. Take density of water as 1000kg/m^3. (5)

c) A circular plate 5 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of centre of pressure. (5)

2 a) Derive continuity equation in three-dimensions. (7)

b) A fluid flow is given by $V = xy^2\boldsymbol{i} - 2yz^2\boldsymbol{j} - \left(zy^2 - \frac{2z^3}{3}\right)\boldsymbol{k}$. Prove that it is a possible case of steady incompressible fluid flow. Calculate the velocity and acceleration at the point (1,2,3). (8)

3 a) Differentiate between piezometer and pressure gauges. (2)

b) In a 2D incompressible fluid flow, the fluid velocity components are given by $\boldsymbol{U = x - 4y}$ and $\boldsymbol{V = -y - 4x}$. Show that velocity potential exists and determine its form. Find also the stream function. (13)

PART B

Answer any two full questions, each carries 15 marks

4 a) State Bernoulli's theorem for a steady flow of an incompressible fluid. Derive an expression for Bernoulli's theorem from the first principle and state the assumptions made for such a derivation. (10)

b) Describe with the help of sketch, the operation and use of Pitot-static tube. (5)

5 a) Define the following: (5)

i) Coefficient of discharge ii) Coefficient of velocity

iii) Coefficient of contraction iv) Vena-contracta

b) A rectangular orifice of 1.5 m wide and 1.2 m deep is fitted in one side of a large tank. Thewater level on one side of the orifice is 2 m above the top edge of the orifice, while on the other side of the orifice, the water level is 0.4 m below the top edge. Calculate the discharge through the orifice if $C_d = 0.62$. (10)

6 a) Find the discharge of water flowing through a pipe 20cm diameter placed in an inclined position, where a Venturi meter is inserted, having a throat diameter of 10 cm. the difference of pressure between the main and throat is measured by a liquid of sp. gr. 0.4 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 pipe. (10)

b) What is a Cipolletti weir? Derive an expression for discharge through it. (5)

PART C

Answer any two full questions, each carries 20 marks

7 a) A fluid of viscosity 0.7Ns/m^2 and specific gravity 1.3 is flowing through a circular pipe of diameter 200mm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2. Find: (10)

i) Pressure gradient ii) Average velocity

iii) Reynold's number of the flow.

b) Derive an expression for the loss of head due to friction in pipes. (10)

8 a) Define the following: (10)

i) Laminar boundary layer ii) Turbulent boundary layer

iii) Laminar sub layer

b) What is meant by boundary layer separation? What is the effect of pressure gradient on boundary layer separation. (10)

9 a) A horizontal pipe-line 50 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 30 m of its length from the tank, the pipe is 200 mm diameter and its diameter is suddenly enlarged to 400 mm. The height of water level in the tank is 10 m above the centre of the pipe. Considering all minor losses, determine the rate of flow. Take $f = 0.01$ for both sections. Also draw the hydraulic gradient line and total energy line. (10)

b) Water is flowing over a thin smooth plate of length 4 m and width 2m at a velocity of 1 m/s^2. If the boundary layer flow changes from laminar to turbulent at a Reynold number 5 x 10^5. Find: (10)

i) Distance from leading edge up to which boundary layer is laminar.

ii) Thickness of boundary layer at the transition point

iii) the drag force on one side of the plate.

Assume viscosity of water as 9.81 x 10^{-4} Ns/m^2.

****

C **B3C032S** **Pages: 3**

Reg. No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017

CE203: FLUID MECHANICS -I

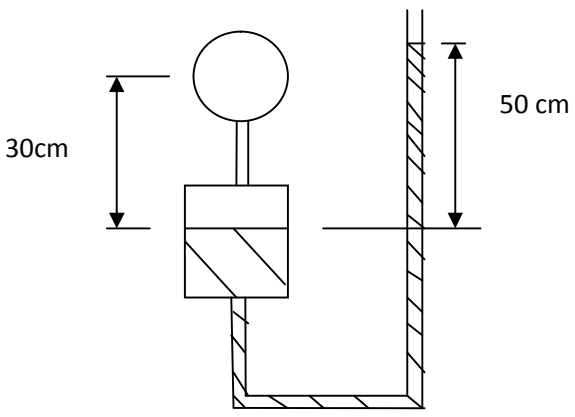
Max. Marks: 100 Duration: 3Hours

PART A

Answer any two full questions.

1. a. A wooden block of 1m side cube of relative density 0.7 floats in water. Determine the volume of concrete of relative density 2.5 that needs to be placed on it so that the block is just immersed in water. (8)

   b. A single column vertical manometer with a reservoir to is connected to a pipe containing oil of specific gravity 0.9. The area of reservoir is 100 times the area of the manometric tube. The reservoir contains mercury of specific gravity 13.6. The level of mercury in the reservoir is at depth 30cm below the centre of pipe. If the difference of mercury levels in the reservoir and the right limb is 50cm, calculate the pressure in the pipe. (7)



2. a. A circular plate of 0.3m diameter is immersed in water at an inclination 60^o to the free surface with its top edge at 1m below the water surface. Find the total pressure and the centre of pressure on the plate. (7)

b. Show that $u= 3x+y$ *and* $v= 2x-3y$ are the velocity components of a fluid flow. Also find the circulation around a rectangle *A(-2 , 0) , B(2,0) , C(2, 2) , D(-2 , 2)* (8)

3. A pipe diameter changes from 0.5m to 1m in a length of 0.785m^3/s flows from 0.5m diameter section towards 1m diameter section. Determine the convective acceleration at 0.3m from the entrance. If the discharge is increased from 0.785m^3/s to 1.570m^3/s in10 seconds, determine the total acceleration at the exit. (15)

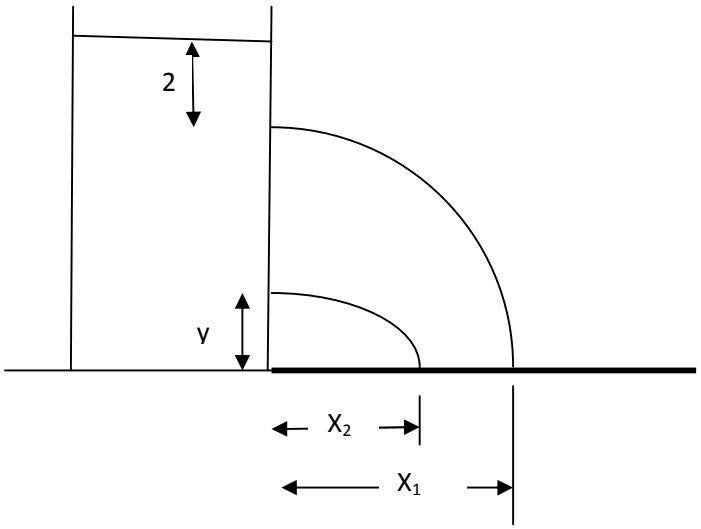
PART B

Answer any two full questions.

4. a. Water under pressure of $4x10^{-3}$ N/m^2 is flowing through a pipe at the rate of 0.25m^3/s. If the pipe is bent such that the internal angle between the two limbs of the bend is 135^o, find the magnitude and direction of the resultant force on the bend. (10)

   b. What is Cippoletti weir? Show how the effect of end contraction is compensated in a Cippoletti weir. (5)

5. A rectangular tank resting on ground is filled with water for a depth of 10m. There are two orifices on the side of the tank, one at 2m below the water surface and the other at a height of *y* from the bottom. The water jets coming out of the two orifices strike on the ground such that $X_2 = \frac{3X_1}{4}$ as shown in the figure. Find the value of *y*



(15)

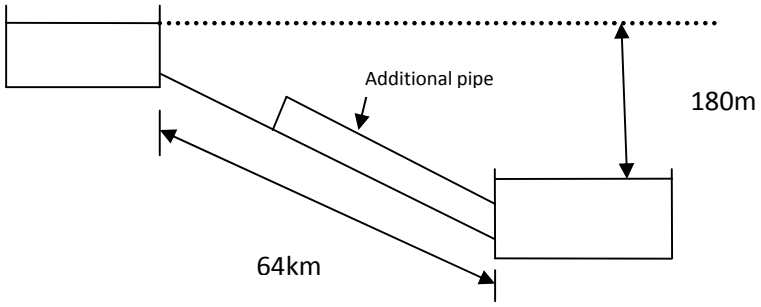
6. a. A submerged weir 2m long has height of water on the upstream 0.15m and downstream 0.075m above the top of the weir. Find the discharge over the weir, if the coefficients of discharge for free and drowned portions are 0.58 and 0.8 respectively. (8)

   b. Oil of specific gravity 0.75 flows through a 15cm diameter pipe under a pressure of 98.1kN/m^2. If the datum is 3m below the centre of the pipe and the total energy per unit weight with respect to datum is 20m, calculate the discharge (7)

PART C

Answer any two full questions.

7. Derive the Hagen – Poiseuille equation for laminar flow through a pipe. (20)
8. Two reservoirs with a difference in water levels of 180m are connected by a 64km long pipe of 600mm diameter and darcy's friction factor f= 0.015. Determine the discharge through the pipe. Inorder to increase this discharge by 50% another additional pipe of the same diameter is laid from the first pipe and connected to the reservoir. Determine the length of the additional pipe. (20)



9. a. A rectangular flat plate of length *a* and width *b* is towed length-wise through water with velocity U_a and subsequently width-wise with velocity U_b. The boundary layer is laminar and the plate experiences equal drag in both cases. Determine the ratio of velocities U_a and U_b in terms of dimensions of the plate. (10)

   b. Water is delivered by a 15cm diameter pipe at 60 litres per second. Calculate the pressure difference between two points 300m apart on the same horizontal line.

   (Take friction factor = 0.022) (10)

***

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: CE203

Course Name: FLUID MECHANICS – I (CE)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Define the terms gauge pressure, vacuum pressure and absolute pressure. Indicate their relative positions on a chart. (5)

b) A cubical tank has sides of 1.5 m. It contains water in the lower 0.6 m depth. The upper remaining portion is filled with oil of relative density 0.9. Calculate for one vertical side of the tank (i) the pressure force and (ii) position of the centre of pressure. (10)

2 a) A solid cylinder of diameter 30 cm and height 15 cm is to float in in water with its axis vertical in sea water (specific gravity 1.03). If the relative density of the cylinder material is 0.9, examine the stability of cylinder. (9)

b) Derive the continuity equation for one dimensional flow. (6)

3 a) Differentiate between forced vortex flow and free vortex flow (4)

b) A velocity field is given by $u = t^2 + 3y$ and $v = 4t + 5x$. Calculate the acceleration at the point (5, 3) at time t = 2 units. (7)

c) Distinguish between: (4)

(i) rotational flow and irrotational flow.

(ii) streamline and path-line.

PART B

Answer any two full questions, each carries 15 marks.

4 a) A bend in pipeline conveying water gradually reduces from 0.6 m to 0.3 m diameter and deflects the flow through 60^0 in the anticlockwise direction. At the larger end the gauge pressure is 171.675 kN/m^2. Determine the magnitude and direction of the force exerted on the bend when the flow is 876 litres/s. The pipe is lying on a horizontal plane. Neglect the losses in the bend. (12)

b) Define kinetic energy correction factor. (3)

5 a) A 40 metres long weir is divided into 12 equal bays by vertical posts, each 0.6 m wide. Taking $C_d = 0.623$, calculate the discharge over the weir if the head over the crest is 1.20 m and velocity of approach is 2 m/s. (7)

b) A reservoir discharges through a sluice 0.915 m wide and 1.22 m deep. The top of the opening is 0.61 m below the water level in the reservoir and the downstream water level is below the bottom of the opening. Calculate (8)

(i) discharge through the opening if C_d=0.6

(ii) the percentage error if the opening is treated as a small orifice

6 a) A venturimeter 30 cm x 10 cm is provided in a vertical pipeline to measure the flow of oil of relative density 0.85. The difference in elevations of the throat section and entrance section is 40 cm, the direction of flow of oil being vertically upwards. The oil-mercury differential U tube manometer shows a gauge deflection of 20 cm. Calculate the discharge of oil and the pressure difference between the entrance section and throat section. Take the coefficient of discharge as 0.97 and specific gravity of mercury as 13.6. (10)

b) Define coefficient of velocity, coefficient of contraction and coefficient of discharge. Find out the relation among the three. (5)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the Hagen –Poiseulle equation for laminar flow in circular pipes. (10)

b) A horizontal pipe carrying water suddenly increases its diameter from 10 cm to 20cm. Find out the loss of head due to sudden increase in diameter if the discharge through the pipe is 150 litres/s. Also find out the pressure difference between the two sections. (6)

c) Define Hydraulic Grade Line and Total Energy Line. (4)

8 a) The velocity distribution in the boundary layer is given by: $\frac{v}{V} = \frac{3}{2}\eta - \frac{1}{2}\eta^3$ (10)
where v is the velocity at a distance y from the plate, $\eta = \frac{y}{\delta}$ and v = V at y = δ, δ being the boundary layer thickness. Find the displacement thickness and the momentum thickness in terms of δ

b) Differentiate between friction drag and pressure drag (4)

c) What are the factors affecting the boundary layer thickness along a flat plate? (6)

9 a) A 0.3 m diameter pipe 2340 m long is connected with a reservoir whose surface is 72 m above the discharging end of the pipe. If for the last 1170 m, a second pipe of the same diameter is laid beside the first and connected to it, what would be the increase in discharge? Neglect minor losses. Take f=0.02. (10)

b) Oil of specific gravity 0.85 and viscosity 2.5 Poise is flowing through a 30cm diameter pipe kept horizontally. The length of pipe is 2.5 km and the head loss is 20 m. If the flow is laminar, estimate (i) shear stress at the pipe wall (ii) shear stress at a radial distance of 10 cm from the pipe axis and
(iii) the friction factor f. (10)

****