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.

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