APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B.TECH DEGREE(S) EXAMINATION, MAY2019		
Course Code: ME203		
Course Name: MECHANICS OF FLUIDS		
Max. Marks: 100		Duration: 3 Hours
PART A		
Answer any three full questions, each carries 10marks.		

1. (a) statement 2 marks, Proof 3 marks

   (b) $\tau = \mu$ (du/dy) = 1591.6 N/ m^2 F= τ x A= 180 NT = F x D/2 = 36 Nm

   Power lost = T x ω = T ($2\pi N/60$) = 716.283 W 6 marks

2. Derivation - Total pressure 5 mark

   Derivation - Centre of pressure 5 mark

3. Classification of fluid flow 10 marks

4. (a) Velocity vector for 2D is given by

   V =ui + vj

   Case a :

   The continuity equation for steady, 2D incompressible flow is given by

   $$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

   The continuity equation for steady incompressible flow is satisfied hence the flow is possible 5 mark

   Case b:

   The expression for rotation of a fluid particle in the X-Y plane about Z axis is given by

   $$w_z = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$$

   $w_z = 0$

   hence the flow is irrotational. 5 mark

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

5. Hagen Poiseuille equation Derivation 10 mark

6. Bernoulli's equation 2 marks

   $Q = a_1 v_1 = a_2 v_2$ = 5400 L/min = 0.09 m^3/s

$V_1 = 0.079$ m/s, $V_2 = 0.319$ m/s , Slope = 1 in 100

$\tan\theta = 1/100 = 0.01 \quad \theta = 0.572°$

$Z_1 = 3$m, $Z_2 = 0$

$P_1/\rho g + V_1^2/2g + Z_1 = P_2/\rho g + V_2^2/2g + Z_2$

$P_2 = 98.046$ kPa

Pressure at the lower end. 8 mark

7. Vmax = 2 m/s Average velocity, V = Vmax/2 = 1m/s

Re = ρ V d/μ Flow is Laminar

Pressure gradient in the direction of flow, $\Delta P/L = 32\mu V/d^2$ N/m^2 per m length of pipe

shear stress at the pipe wall, $\tau = (\Delta P/L)\, r/2$ N/m^2

velocity at a distance 30 mm from the wall = $(1/8\mu)\,(\Delta P/L) r^2$ m/s

Average velocity 2 marks

(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. (4 x 2= 8 marks),

8. Sketch of venturimeter 2 marks

Bernoulli's equation 2 marks

Rate of flow - Derivation 6 marks

PART C
Answer any four full questions, each carries 10marks.

9. boundary layer 2marks

Sketch 3 marks

Illustration 5 marks

10. Sketch – 2 marks,

Boundary Layer Thickness

Laminar Boundary Layer

Turbulent boundary Layer

Laminar Sub Layer (2x4 = 8 marks)

11. Re = VL/υ = 400000, laminar 1 mark

Blassius relations 1 mark each (1x3 = 3 marks)

(a) Boundary layer thickness at the end of the plate

$\delta = 5x/\sqrt{Re} = 7.906$x10^-3 m

(b) Shear stress at the middle of the plate

$\tau = 0.332\rho\, U^2/\sqrt{Rex} = 0.0321$ N/m^2, x = 0.5 m

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

$C_D = 1.328/\sqrt{Re} = 2.0997$x10^-3

$F_D = (1/2\ \rho AU^2) \times C_D = 0.04535$ N

Answer (3 x 2= 6 marks)

12. Buckingham's π theorem 3 marks , Relation 7 marks
    $\Delta P = f(D, L, \rho, \mu, V, K)$
    n = 7, m = 3, n-m = 7- 3 = 4
    $f(\pi 1, \pi 2, \pi 3, \pi 4) = 0$,
    $\pi 1 = \Delta P / \rho V^2$, $\pi 2 = \frac{L}{D}$, $\pi 3 = \mu / \rho VD$, $\pi 4 = K/D$

13. Hydraulic similarities 3 types 3 marks

    Explanations 7 marks

14. Model law- 3 marks
    Lp/Lm= 40/2.5
    Froude's model law
    $(Fe)_{model} = (Fe)_{prototype}$
    $[V/\sqrt{(gL)}]_{model} = [V/\sqrt{(gL)}]_{prototype}$, L_p/L_m
    $V_p/V_m = /\sqrt{(\frac{Lp}{Lm})}$
    velocity of prototype, V_p 3 marks
    $\rho_p/\rho_m = 1025/1000$
    $Fp/Fm = (\rho L^2V^2)_{prototype} / (\rho L^2V^2)_{model}$
    Force required to drive the prototype , Force - 4 marks