APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGR EE EXAMINATION, MAY2019

Course Code: CE203

Course Name: FLUID MECHANICS -I

Max. Marks: 100 Duration: 3 Hours

Scheme of evaluation

PART A

1. a) $p = \gamma h$ …… 1 mark

$p = 350$ kN/m^2

For water , $\gamma = 9.810$ kN/m^3, $\therefore h = 35.68$ m ……1 mark

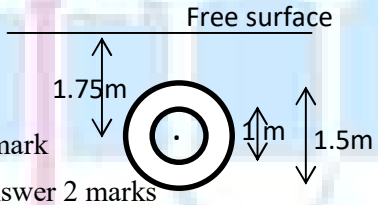
For mercury , $\gamma = 13.6 \times 9.810$ kN/m^3, $\therefore h = 2.62$ m …… 1 mark

$p_{absolute} = p + p_{atmosphere}$ ……1 mark

$= 350 + 101.3 = 451.3$ kN/m^2 ……1 mark

Total -5 marks

b) Figure ….. 1 mark



$F = \gamma A\bar{x}$ ….. 1 mark

$\bar{x} = 1.75$ m, $\gamma = 0.9 \times 9810$,

$A = \frac{\pi}{4}(1.5^2 - 1^2) = 0.981$ m^2…. 1 mark

$F = 15.16$ kN…… Substitution & answer 2 marks

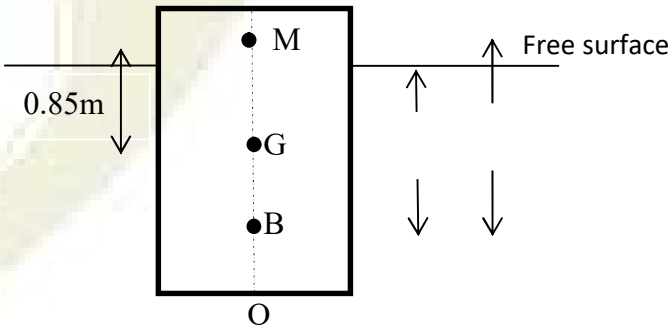
$\bar{h} = \bar{x} + \frac{I_g}{A\bar{x}}$ …… 2 marks

$I_g = \frac{\pi}{64}(1.5^4 - 1^4) = 0.1993$ m^4 ….. 1 mark

$\bar{h} = 1.866$ m ….. Substitution & answer 2 marks

Total -10 marks

2. (a) $\overline{GM} = \frac{wx}{W \tan\theta}$ ……. 1 mark



$W = 15000$ kN, $w = 200$ kN, $x = 5$ m, $\theta = 4.5^0$

$\overline{GM} = 0.85$ m …… 2 marks

$\overline{BM} = \frac{I}{V}$ ……. 1 mark

$I = 0.8 \times \frac{60 \times 10^3}{12} = 4000$ m^4 ……. 2 marks

$V = \frac{15000}{9.81 \times 1.03} = 1484.5$ m^3 ……. 1 mark

$\overline{BM} = 2.695$ m …… 1 mark

$\overline{GB} = 1.845$ m …… 1 mark

Depth of G below water surface = 0.155 m …… 1 mark

Total -10 marks

(b) proof ……**5 marks**

3. (a) Eulerian and Lagrangian methods…… 1.5 marks each

Total - 3 marks

(b) $v = \frac{\partial \psi}{\partial x} = 2y$……..1 mark

$u = -\frac{\partial \psi}{\partial y} = -2x$……..1 mark

$\frac{\partial u}{\partial x} = -2$……..0.5 mark

$\frac{\partial v}{\partial y} = 2$……..0.5 mark

$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$. So flow exists……..1 mark

$\frac{\partial^2 \psi}{\partial x^2} = 0$……..1 mark

$\frac{\partial^2 \psi}{\partial y^2} = 0$……..1 mark

$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = 0$. Therefore flow is irrotational. ……..1 mark

Total - 7 marks

(c) (i) steady flow and unsteady flow. ……..2.5 marks

(ii) uniform flow and Non uniform flow. ……..2.5 marks

Total - 5 marks

PART B

4. (a) Sketch-2 Marks; Areas (0.0707 mm^2 and 0.0177 m^2)- 1Mark

Computing Venturi head, from Bernoullis' Equation; h =7.356 m (3 Marks)

Discharge equation-2 Marks

C_d=0.979 (2 Marks)

$$h = x\left(\frac{S_m}{S} - 1\right)$$ (1 Mark)

x=0.472 m (1 Mark)

(b) Explanation with sketch……. **3 marks**

5. (a) 3 coefficients- 2 Marks each **(3*2=6 Marks)**

(b) L= 1 m, H = 0.3 m, n = 2

Without considering velocity of approach,

$Q = \frac{2}{3} C_d \sqrt{2g}(L - 0.1nH)H^{1.5}$…. 1 Mark

= 0.2828 m^3/s…….Substitution & answer 2 Marks

$A = 0.9 \times 2 = 1.8\ m^2$

$V_a = \frac{Q}{A} = 0.157$ m/s…. 1 mark

$h_a = \frac{{V_a}^2}{2g} = 0.00126$ m…. 1 mark

$H_1 = H + h_a$

Considering velocity of approach,

$Q = \frac{2}{3} C_d \sqrt{2g}(L\text{-}0.1nH_1)({H_1}^{1.5} - {h_a}^{1.5})$ …. 2 mark

= 0.2845 m^3/s…….Substitution & answer 2 marks

Total - 9 marks

6. (a) Derivation of Euler's equation of motion……. 5 marks
   Obtaining Bernoulli's equation……. 1 mark
   Assumptions……. 2 marks

   Total - 8 marks

   (b) Definition of orifice ……. 1 mark
   Classification ……. 4 marks

   Total - 5 marks

   (c) Cipolletti weir ….**2 marks**

PART C

7. (a) Derivation …..4 marks
   Dupuit's equation $\frac{L_e}{{D_e}^5} = \frac{L_1}{{D_1}^5} + \frac{L_2}{{D_2}^5} + \frac{L_3}{{D_3}^5}$ ……1 mark

   Total - 5 marks

   (b) $\mu = 0.097\ Ns/m^2$, $\rho = 900\ kg/m^3$, ……1 mark
   $A = \frac{\pi}{4} \times 0.1^2 = 0.0079\ m^2$, $Q = \frac{100}{900 \times 30} = 0.0037\ m^3/s$……2 marks
   $V = \frac{Q}{A} = 0.471$ m/s……1 mark
   $R_e = \frac{\rho VD}{\mu}$……1 mark
   = 435 ……1 mark
   Flow is laminar……1 mark
   $p_1 - p_2 = \frac{32\mu VL}{D^2}$ ……1 mark
   = 1462 N/m^2 Substitution & answer 2 marks

   Total - 10 marks

   (c) minor losses ……4 marks
   major loss……1 mark

   Total - 5 marks

8. (a) $\delta^* = \int_0^\delta (1 - \frac{v}{V})dy$……. 2 marks
   $\frac{v}{V} = \frac{y}{\delta}$
   Substitution and simplification……. 1 mark
   $\delta^* = \frac{\delta}{2}$……. 1 mark
   $\theta = \int_0^\delta \frac{v}{V}(1 - \frac{v}{V})dy$……. 2 marks
   Substitution and simplification……. 2 marks
   $\theta = \frac{\delta}{6}$……. 1 mark

$\delta_E = \int_0^{\delta} \frac{v}{V}\left(1 - \left(\frac{v}{V}\right)^2\right)dy$……. 2 marks

Substitution and simplification……. 2 marks

$\delta_E = \frac{\delta}{4}$……. 1 mark

Total – 14 marks

(b) Derivation of the Darcy-Weisbach equation with sketch - **6 marks**

9. (a)

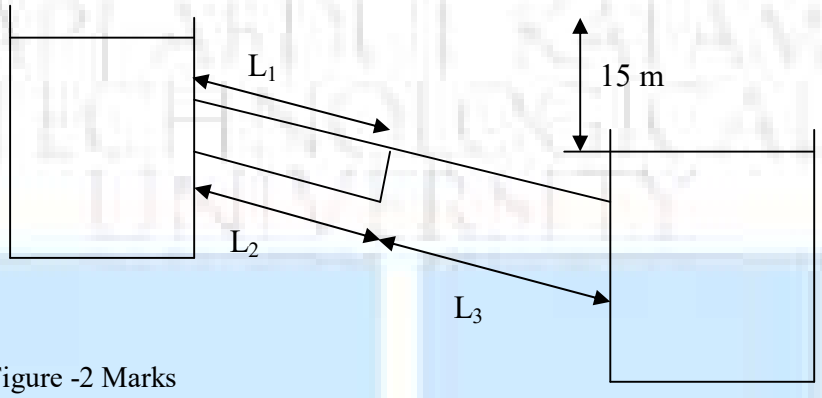


Figure -2 Marks

First case

$15 = \frac{fLV^2}{2gD}$ (2 Marks)

D=0.256 m

L=1000 m

$hf_1 = hf_2$

From which,

$Q_1=Q_2$ (2 Marks)

$hf_1 + hf_3 = 15$

$Q_1+Q_2=Q_3=1.3Q_1=1.3*0.1$

From which $Q_1=Q_2=0.065\ m^3/sec$

$\frac{f_1 L_1 V_1^2}{2gD_1} + \frac{f_3 L_3 V_3^2}{2gD_3} = 15$ (2 Marks)

$L_3=L-L_1$

$V_1=Q/A_1$ and $V_3=Q/A_3$

Substituting, L1=544.4 m (2 Marks)

(b) Figure ….2 marks

Explanation……3 marks

Total – 5 marks

(c) Explanation with sketch….. **5 marks**