ASSIGNMENT-4
GATE ME-2018

EE24BTECH11019 - DWARAK A

A : ENGINEERING MATHEMATICS

Q.1 to Q.7 carry one mark each.

1) A solid block of $2.0kg$ mass slides steadily at a velocity V along a vertical wall as shown in the figure below. A thin oil film of thickness $h = 0.15mm$ provides lubrication between the block and the wall. The surface area of the face of the block in contact with the oil film is $0.04m^2$. The velocity distribution within the oil film gap is linear as shown in the figure. Take dynamic viscosity of oil as $7 \times 10^{-3} Pa - s$ and acceleration due to gravity as $10m/s^2$. Neglect weight of the oil. The terminal velocity V (in m/s) of the block is _____ (correct to one decimal place).

2) A tank of volume $0.05m^3$ contains a mixture of saturated water and saturated steam at $200°C$.The mass of the liquid present is $8kg$. The entropy (in kJ/kgK) of the mixture is _____ (correct to two decimal places).
   Property data for saturated steam and water are:
   At $200°C, p_{sat} = 1.5538MPa$
   $v_f = 0.001157m^3/kg, v_g = 0.12736m^3/kg$
   $s_{fg} = 4.1014kJ/kgK, \ s_f = 2.3309kJ/kgK$

3) Steam flows through a nozzle at a mass flow rate of $\dot{m} = 0.1kg/s$ with a heat loss of 5 kW. The enthalpies at inlet and exit are 2500 kJ/kg and 2350 kJ/kg, respectively. Assuming negligible velocity at inlet ($C_1 \approx 0$), the velocity C_2 of steam (in m/s) at the nozzle exit is _____ (correct to two decimal places).

   a) $\frac{1}{y}$
   b) $\frac{1}{y^2}$
   c) $\frac{1}{y^3}$
   d) $\ln y$

4) If a cubic polynomial passes through the points $(0, 1)$, $(1, 0)$, $(2, 1)$ and $(3, 10)$, then it also passes through the point

   a) $(-2, -11)$
   b) $(-1, -2)$
   c) $(-1, -4)$
   d) $(-2, -23)$

Q.8 to Q.11 carry two marks each.

5) Let the function $f : [0, \infty) \to \mathbb{R}$ be such that $f'(x) = \frac{8}{x^2+3x+4}$ for $x > 0$ and $f(0) = 1$. Then $f(1)$ lies in the interval

   a) $[0, 1]$
   b) $[2, 3]$
   c) $[4, 5]$
   d) $[6, 7]$

6) The perimeter of a rectangle having the largest area that can be inscribed in the ellipse $\frac{x^2}{8} + \frac{y^2}{32} = 1$, is _____.

7) If the work done in moving a particle once around a circle $x^2 + y^2 = 4$ under the force field $\mathbf{F}(x, y) = (2x - ay)\hat{i} + (2y + ax)\hat{j}$ is 16π, then $|a|$ is equal to _____.

8) Let r and s be real numbers. If $A = \begin{pmatrix} 1 & 2 & 0 \\ 2 & 0 & 3 \\ r & s & 0 \end{pmatrix}$ and $b = \begin{pmatrix} 1 \\ 1 \\ s-1 \end{pmatrix}$, then the system of linear equations $AX = b$ has

   a) no solutions for $s \neq 2r$.
   b) infinitely many solutions for $s = 2r \neq 2$.
   c) a unique solution for $s = 2r = 2$.
   d) infinitely many solutions for $s = 2r = 2$.

B : FLUID MECHANICS

Q.1 to Q.9 carry one mark each.

9) A dam with a curved shape is shown in the figure. The cross sectional area of the dam (shaded portion) is $100m^2$ and its centroid is at $\bar{x} = 10m$. The vertical component of the hydrostatic force, F_z, is acting at a distance x_p. The value of x_p is _____m.
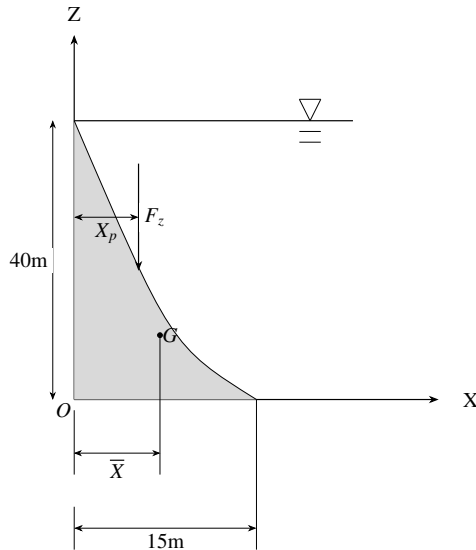
10) For an unsteady incompressible fluid flow, the velocity field is $\mathbf{V} = \left(3x^2 + 3\right)t^3\,\hat{\imath} - 6xyt\,\hat{\jmath}$, where x, y are in meters and t is in seconds. Acceleration in m/s^2 at the point $x = 10m$ and $y = 0$, as measured by a stationary observer is

a) 303
b) 162
c) 43
d) 13

11) For an incompressible flow, the existence of components of acceleration for different types of flow is described in the table below.

Type of Flow	Components of Acceleration
P: Steady and uniform	1: Local exists, convective does not exist
Q: Steady and non-uniform	2: Both exist
R: Unsteady and uniform	3: Both do not exist
S: Unsteady and non-uniform	4: Local does not exist, convective exists

Which one of the following options connecting the left column with the right column is correct?

a) P-1; Q-4; R-3; S-2
b) P-4; Q-1; R-2; S-3
c) P-3; Q-2; R-1; S-4
d) P-3; Q-4; R-1; S-2

12) Velocity in a two-dimensional flow field is specified as $u = x^2y; v = -y^2x$. The magnitude of the rate of angular deformation at a location ($x = 2m$ and $y = 1m$) is _____ s^{-1}.

13) For a plane irrotational flow, equi-potential lines and streamlines are

a) parallel to each other.
b) at an angle of $90°$ to each other.
c) at an angle of $45°$ to each other.
d) at an angle of $60°$ to each other.