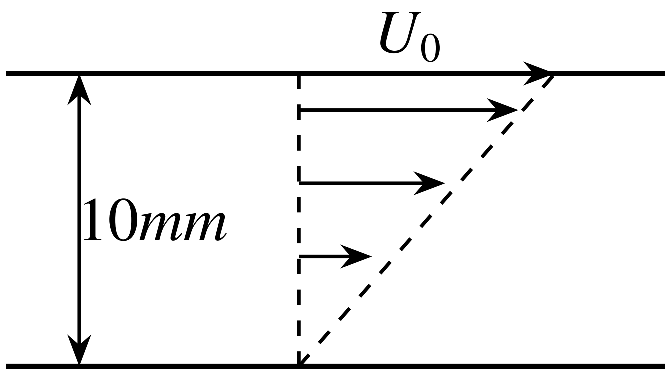
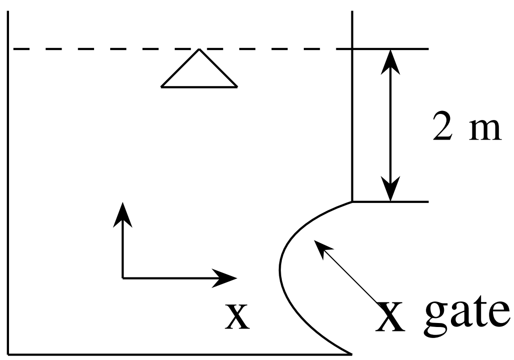
2016-XE-14-26

EE24BTECH11004 - ANKIT JAINAR

1) Which of the following is a quasi-linear partial differential equation?
   (A) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 0$
   (B) $\frac{\partial^2 u}{\partial x^2} + 2\frac{\partial^2 u}{\partial y^2} = 0$
   (C) $\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial u}{\partial y}\right)^2 = 0$
   (D) $\left(\frac{\partial u}{\partial x}\right) - \left(\frac{\partial u}{\partial y}\right)^2 = 0$
2) Let $P(x)$ and $Q(x)$ be the polynomials of degree 5, generated by Lagrange and Newton interpolation techniques respectively, both passing through six distinct points on the xy-plane. Which of the following is correct?
   (A) $P(x) \equiv Q(x)$
   (B) $P(x) - Q(x)$ is a polynomial of degree 2
   (C) $P(x) - Q(x)$ is a polynomial of degree 3
   (D) $P(x) - Q(x)$ is a polynomial of degree 5
3) The Laurent series of $f(z) = \frac{1}{(z^3 - z^4)}$ with center at $z = 0$ in the region $|z| > 1$ is:
   (A) $\sum_{n=0}^{\infty} z^{n-3}$
   (B) $-\sum_{n=0}^{\infty} \frac{1}{z^{n+4}}$
   (C) $\sum_{n=0}^{\infty} z^n$
   (D) $\sum_{n=0}^{\infty} \frac{1}{z^n}$
4) The value of the surface integral $\iint_S \mathbf{F} \cdot d\mathbf{S}$ over the sphere S given by $x^2 + y^2 + z^2 = 1$, where $\mathbf{F} = 4x\hat{i} - z\hat{k}$, and n denotes the outward unit normal, is:
   (A) π
   (B) 2π
   (C) 3π
   (D) 4π
5) A diagnostic test for a certain disease is 90% accurate. That is, the probability of a person having (respectively, not having) the disease tested positive (respectively, negative) is 0.9. Fifty percent of the population has the disease. What is the probability that a randomly chosen person has the disease given that the person tested negative?
6) Let $M = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$. Which of the following is correct?
   (A) Rank of M is 1 and M is not diagonalizable
   (B) Rank of M is 2 and M is diagonalizable
   (C) 1 is the only eigenvalue and M is not diagonalizble
   (D) 1 is the only eigenvalue and M is diagonalizable
7) Let $f(x) = 2x^3 - 3x^2 + 69$, $-5 \le x \le 5$. Find the point at which f attains the global maximum.
8) Calculate $\int_{C_1} \mathbf{F} \cdot d\mathbf{r} - \int_{C_3} \mathbf{F} \cdot d\mathbf{r}$, where $C_1 : \mathbf{r}(t) = (t, t^2)$ and $C_2 : \mathbf{r}(t) = (t, \sqrt{t})$, t varying from 0 to 1 and $F = xy\hat{j}$.
9) In the parallel-plate configuration shown, steady flow of an incompressible Newtonian fluid is established by moving the top plate with a constant speed, $U_0 = 1\,\mathrm{m/s}$. If the force required on the top plate to support this motion is $0.5\,\mathrm{N}$ per unit area (in m^2) of the plate, then the viscosity of the fluid between the plates is _________ Ns/m^2.



10) For a newly designed vehicle by some students, the volume of fuel consumed per unit distance traveled (q_f in m^3/m) depends on the viscosity (μ) and density (ρ) of the fuel, as well as the speed (U) and size (L) of the vehicle, given by $q_f = c\frac{\mu^2 U}{\rho L}$ where c is a constant. The dimensions of the constant c are:
11) A semi-circular gate of radius 1 m is placed at the bottom of a water reservoir as shown in the figure below. The hydrostatic force per unit width of the cylindrical gate in the y-direction is __________. The gravitational acceleration is $g = 9.8\,\text{m/s}^2$ and the density of water is $1000\,\text{kg/m}^3$.



12) The velocity vector in m/s for a 2-D flow is given in Cartesian coordinates (x, y) as $\mathbf{V} = \left(\frac{x^2}{2} - \frac{y^2}{2}\right)\hat{i} + xy\hat{j}$. At a point in the flow field, the x- and y-components of the acceleration vector are given as $1\,\text{m/s}^2$ and $-0.5\,\text{m/s}^2$, respectively. The velocity magnitude at that point is __________.
13) If $\phi(x, y)$ is the velocity potential and $\psi(x, y)$ is the stream function for a 2-D, steady, incompressible, and irrotational flow, which one of the following is incorrect?
   (A) $\left(\frac{\partial \psi}{\partial x}\right)_{\phi=\text{const}} = -\frac{1}{\left(\frac{\partial \psi}{\partial y}\right)_{\psi=\text{const}}}$
   (B) $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = 0$
   (C) $\left(\frac{\partial \psi}{\partial y}\right)_{\phi=\text{const}} = \frac{1}{\left(\frac{\partial \psi}{\partial x}\right)_{\psi=\text{const}}}$
   (D) $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$