GATE - 2018- XE

EE1030 : Matrix Theory
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1) If the stream function ($\psi(x, y)$) for a two-dimensional incompressible flow field is given as $2y\left(x^2 - y^2\right)$, the corresponding velocity field is
   a) $\overrightarrow{V} = 2\left(x^2 - 3y^2\right)\hat{i} + 4xy\hat{j}$
   b) $\overrightarrow{V} = 2\left(x^2 - 3y^2\right)\hat{i} - 4xy\hat{j}$
   c) $\overrightarrow{V} = 2\left(x^2y\right)\hat{i} - 4xy\hat{j}$
   d) $\overrightarrow{V} = 2\left(x^2y\right)\hat{i} + 4xy\hat{j}$

2) Water is flowing in two different tubes of diameters D and $2D$, with the same velocity. The ratio of laminar friction factors for the larger diameter tube to the smaller diameter tube is
   a) 0.5
   b) 1.0
   c) 2.0
   d) 4.0

3) If the velocity field is $\overrightarrow{V} = x^2y\hat{i} + 4xy\hat{j}$ m/s, vorticity of the fluid element in the field at $(x = 1, y = 2)$ in s^{-1} is ____.

4) A pitot-static tube is used to measure air velocity in a duct by neglecting losses. The density of air is 1.2 kg/m^3. If the difference between the total and static pressures is 1 kPa, the velocity of air at the measuring location, in m/s, is ____.

5) A parallelepiped of (2 m $\times$ 2 m) square cross-section and 10 m in length, is partially floating in water upto a depth of 1.2 m, with its longest side being horizontal. The specific gravity of the block is
   a) 0.8
   b) 0.6
   c) 0.5
   d) 0.4

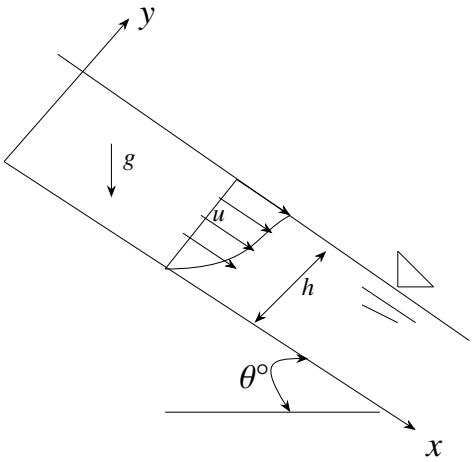
6) The velocity field in a two-dimensional, unsteady flow is given by $\vec{V}(x, y, t) = 2xy^2\hat{i} + 3xyt\hat{j}$ m/s. The magnitude of acceleration of a fluid particle located at $x = 1$ m, $y = 1$ m at the time $t = 1$ s, in m/s^2, is

a) 16.0
b) 18.1
c) 24.1
d) 34.1

7) In a two-dimensional, incompressible and irrotational flow, fluid velocity (v) in the y-direction is given by $v = 2x - 5y$. The velocity (u) in the x-direction is

a) $u = 2x - 5y$
b) $u = 2x + 5y$
c) $u = 5x + 2y$
d) $u = 5x - 2y$

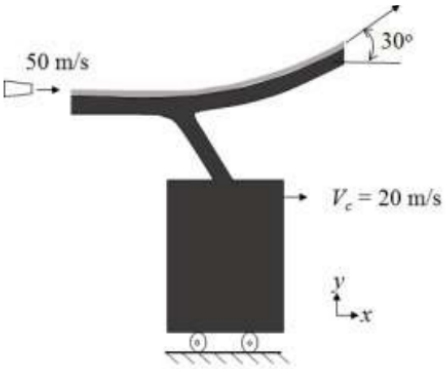
8) A two-dimensional laminarviscous liquid film of constant thickness (h) steadily flows down an incline as shown in figure. Acceleration due to gravity is g. If the velocity profile in the liquid film is given as, $u = ky(2h - y)\,; v = 0$, the value of constant k is



a) $\frac{\rho g \sin(\theta)}{2\mu}$
b) $\frac{\rho g \cos(\theta)}{2\mu}$
c) $\rho g \sin(\theta)$
d) $\rho g \sin(\theta)$

9) A water jet of 100 mm diameter issuing out of a nozzle at a speed of 50 m/s strikes a vane and flows along it as shown in figure. The vane is attached to a cart which is moving at a constant speed of 20 m/s on a frictionless track. The jet is deflected

at an angle of 30°. Take the density of water as 1000 kg/m^3. Neglecting the friction between the vane and the fluid, the magnitude of the force exerted by water on the cart in the x-direction, in N, is _____.



10) Capillary waves are generated in the sea. The speed of propagation (C) of these waves is known to be a function of density (ρ), wave length (λ), and surface tension (σ). Assume, ρ and λ to be constant. If the surface tension is doubled, in the functional form of the relevant non-dimensional group, the percentage increase in propagation speed (C) is _____.

11) Consider a fully developed, two-dimensional and steady flow of a viscous fluid between two fixed parallel plates separated by a distance of 30 mm. The dynamic viscosity of the fluid is 0.01 kg/m-s and the pressure drop per unit length is 300 Pa/m. The fluid velocity at a distance of 10 mm from the bottom plate, in m/s, is _____.

12) A 2.6 gram smooth table-tennis (ping-pong) ball has a diameter of 38 mm. Density (ρ) of air is 1.2 kg/m^3. Neglect the effect of gravity. Take coefficient of drag as 0.5. If the ball is struck with an initial velocity of 30 m/s, the initial deceleration, in m/s^2, is _____.

13) On a flat plate, transition from laminar to turbulent boundary layer occurred at a critical Reynolds number ($\mathrm{Re_{cr}}$). The empirical relations for the laminar and turbulent boundary layer thickness are given by $\frac{\delta_{lam}}{x} = 5.48\mathrm{Re}_x^{-0.5}$ and $\frac{\delta_{turb}}{x} = 0.37\mathrm{Re}_x^{-0.2}$, respectively. The ratio of laminar to turbulent boundary layer thickness, at the location of transition, is 0.3. The value of $\mathrm{Re_{cr}}$ is _____.