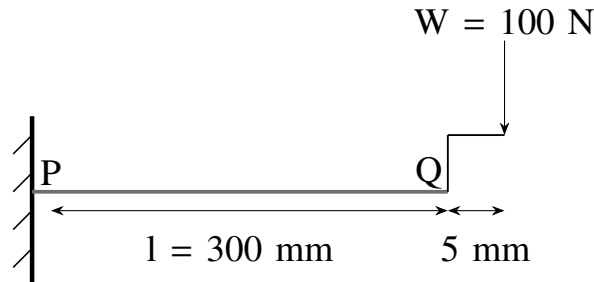


2015-AE-40-52

EE24BTECH11003 - Akshara Sarma Chennubhatla

- 1) A cube made of linear elastic isotropic material is subjected to a uniform hydrostatic pressure of 100 N/mm^2 . Under this load, the volume of the cube shrinks by 0.05% . The Young's modulus of the material, $E = 300 \text{ GPa}$. The Poisson's ratio of the material is _____. (2015)
- 2) A massless cantilever beam PQ has a solid square cross section ($10 \text{ mm} \times 10 \text{ mm}$). This beam is subjected to a load W through a rigid massless link at the point Q , as shown below (figure not to scale). If the Young's modulus of the material $E = 200 \text{ GPa}$, the deflection (in mm) at point Q is _____. (2015)



- 3) An aircraft, with a wing loading $\frac{W}{S} = 500 \text{ N/m}^2$, is gliding at $\left(\frac{L}{D}\right)_{\max} = 10$ and $C_L = 0.69$. Considering the free stream density $\rho_{\infty} = 0.9 \text{ kg/m}^3$, the equilibrium glide speed (in m/s) is _____. (2015)
- 4) For a thin flat plate at 2° angle of attack, the pitching moment coefficient about the trailing edge is _____. (2015)
- 5) A satellite is to be transferred from its geostationary orbit to a circular polar orbit of the same radius through a single impulse out-of-plane maneuver. The magnitude of the change in velocity required is _____ times the magnitude of the escape velocity. (2015)
- 6) A planetary probe is launched at a speed of 200 km/s and at a distance of $71,400 \text{ km}$ from the mass center of its nearest planet of mass $1.9 \times 10^{28} \text{ kg}$. The universal gravitational constant $G = 6.67 \times 10^{-11} \frac{\text{m}^3}{\text{kg s}^2}$. The ensuing path of the probe would be (2015)
 - a) ellipse
 - b) hyperbolic
 - c) parabolic
 - d) circular
- 7) The velocity of an incompressible laminar boundary layer over a flat plate developing under constant pressure is given by $\frac{u(y)}{U_{\infty}} = \frac{3y}{2\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$. The freestream velocity $U_{\infty} = 10 \text{ m/s}$ and the dynamic viscosity of the fluid $\mu = 1.8 \times 10^{-5} \frac{\text{kg}}{\text{m s}}$. At a streamwise station where the boundary layer thickness $\delta = 5 \text{ mm}$, the wall shear stress is _____ $\times 10^{-3} \text{ Pa}$. (2015)
- 8) the Pitot tube of an aircraft registers a pressure $p_0 = 54051 \text{ N/m}^2$. The static pressure, density and the ratio of specific heats of the freestream are $p_{\infty} = 45565 \text{ N/m}^2$, $\rho_{\infty} = 0.6417 \text{ kg/m}^3$ and $\gamma = 1.4$, respectively. The indicated airspeed (in m/s) is (2015)
 - a) 157.6
 - b) 162.6
 - c) 172.0
 - d) 182.3
- 9) Consider a NACA 0012 airfoil of chord c in a freestream with velocity V_{∞} at a non-zero positive angle of attack α . The average time-of-flight for a particle to move from the leading edge to the

trailing edge on the suction and pressure sides are t_1 and t_2 , respectively. Thin airfoil theory yields the velocity perturbation to the freestream as $V_\infty \frac{(1+\cos\theta)\alpha}{\sin\theta}$ on the suction side and as $-V_\infty \frac{(1+\cos\theta)\alpha}{\sin\theta}$ on the pressure side, where θ corresponds to the chordwise position $x = \frac{c}{2}(1 - \cos\theta)$. Then $t_2 - t_1$ is (2015)

- a) $-\frac{8\pi\alpha c}{V_\infty(4-\pi^2\alpha^2)}$
- b) 0
- c) $\frac{4\pi\alpha c}{V_\infty(4-\pi^2\alpha^2)}$
- d) $\frac{8\pi\alpha c}{V_\infty(4-\pi^2\alpha^2)}$

- 10) Air enters an aircraft engine at a velocity of 180 m/s with a flow rate of 94 kg/s. The engine combustor requires 9.2 kg/s of air to burn 1 kg/s of fuel. The velocity of gas exiting from the engine is 640 m/s. The momentum thrust (in N) developed by the engine is (2015)
- a) 43241
 - b) 45594
 - c) 47940
 - d) 49779
- 11) A solid rocket motor is designed with a cylindrical end-burning propellant grain of length 1 m and diameter 32 cm. The density of the propellant grain is 1750kg/m^3 . The specific impulse of the motor is 190 s and the acceleration due to the gravity is 9.8m/s^2 . If the propellant burns for a period of 150 s, then the thrust (in N) produced by the rocket motor is _____ (2015)
- 12) A liquid propellant rocket has the following component masses:

Mass of payload = 180kg

Mass of fuel = 470kg

Mass of oxidizer = 1170kg

Mass of structures = 150kg

Mass of guidance systems = 20kg

The effective exhaust velocity is 3136 m/s. The velocity increment (in km/s) of the rocket at burnout, while operating in outer space, is _____. (2015)

- 13) If all the eigenvalues of a matrix are real and equal, then (2015)
- a) the matrix is diagonalizable
 - b) its eigenvectors are not necessarily linearly independent
 - c) its eigenvectors are linearly independent
 - d) its determinant is necessarily zero