2017-ME-27-39

EE24BTECH11001 - ADITYA TRIPATHY

1) For the vector $\mathbf{V} = 2yz\mathbf{i} + 3xz\mathbf{j} + 4xy\mathbf{k}$, the value of $\nabla \cdot (\nabla \times \mathbf{V})$ is (2017 − ME)

2) A parametric curve defined by $x = \cos\left(\frac{\pi u}{2}\right), y = \sin\left(\frac{\pi u}{2}\right)$ in the range $0 \leq u \leq 1$ is rotated about the x-axis by 360 degrees. Area of the surface generated is (2017 − ME)

    a) $\frac{\pi}{2}$
    b) π
    c) 2π
    d) 4π

3) $P(0,3), Q(0.5,4)$, and $R(1,5)$ are three points on the defined by $f(x)$. Numerical integration is carried out using bothe trapezoidal rule and Simpson's rule within limits $x = 0$ and $x = 1$ for the curve. The difference between the two results will be (2017 − ME)

    a) 0
    b) 0.25
    c) 0.5
    d) 1

4) The velocity profile inside the boundary layer flow for flow over a flat plate is given by $\frac{u}{u_\infty}$ is the free stream velocity and δ is the local boundary layer thickness, If δ^* is the local displacement thickness, the value of $\frac{\delta^*}{\delta}$ is (2017 − ME)

    a) $\frac{2}{\pi}$
    b) 1 - $\frac{2}{\pi}$
    c) 1 + $\frac{2}{\pi}$
    d) 0

5) Consider steady flow of an incompressible fluid through two long and straight pipes of diameters d_1 and d_2 arranged in series. Both pipes are of equal lenght and the flow is turbulent in both pipes. The friction factor for turbulent flow thorought pipes is of the form $f = K(Re)^{-n}$, where K and n are known positive constants and Re is the Reynolds number. Neglecting minor losses, the ration of the frictional pressure drop in pipe 1 to that in pipe 2, $\frac{\Delta P_1}{\Delta P_2}$, is given by (2017 − ME)

    a) $\left(\frac{d_2}{d_1}\right)^{(5-n)}$
    b) $\left(\frac{d_2}{d_1}\right)^{5}$
    c) $\left(\frac{d_2}{d_1}\right)^{(3-n)}$
    d) $\left(\frac{d_2}{d_1}\right)^{(5+n)}$

6) For a steady flow, the velocity field is $\mathbf{V} = \left(-x^2 + 3z\right)\mathbf{i} + (2xy)\mathbf{j}$. The magnitude of the acceleration of a particle at $(1,-1)$ is (2017 − ME)

    a) 2
    b) 1
    c) $2\sqrt{5}$
    d) 0

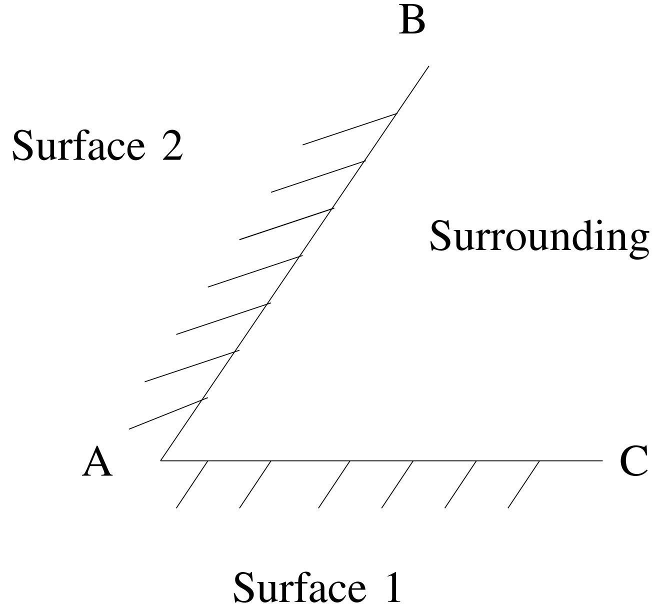
7) One kg of an ideal gas (gas constant, R = 400J/kg K; specific heat at constant volume$c_v = 1000J/kgK$) at 1 bar, and 300K is contained in a sealed rigid cylinder. During an adiabatic processs, $100kJ$ of work is done on the system by a stirrer. The increase in entropy of the system is (2017 − ME)

8) The pressure ratio across a gas turbine for air,(specific heat at constant pressure,$C_p = 1040J/kgK$ and ratio of specific heats $\gamma = 1.4$) is 10. If the inlet temperature to the turbine is 1200 K and the isoentropic efficiency is 0.9, the gas temperature at turbine exit is (2017 − ME)

9) Moist air is treated as an ideal gas mixture of water vapor and dry air (molecular weight of air = 28.84 and molecular weight of water = 18). At a location, the total pressure is $100kPa$, the temperature is 30° and the relative humidity is 55%. Given that the saturation pressure of water at 30° is $42646Pa$, the mass of water vapor per kg of dry air is (2017 − ME)

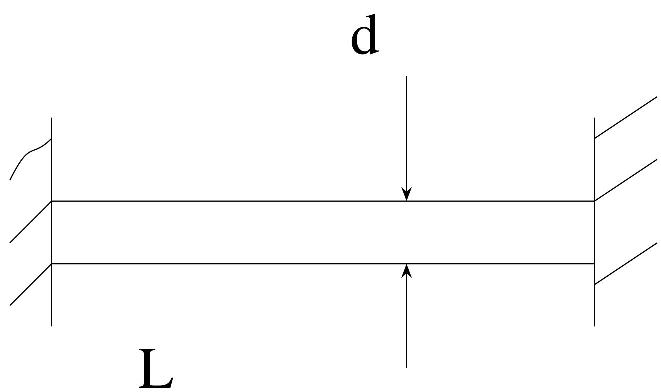
10) Air contains $79\% N_2$ and $21\% O_2$ on a molar basis. Methane (CH_4) is burned with 50% excess air than required stoichiometrically. Assuming complete combustion of methane, the molar percentage of N_2 in the products is (2017 − ME)

11) Two black surfaces, AB and BC, of lengths $5m$ amd $6m$, respectively, are oriented as shown. Both surfaces extend infinitely into the third dimension. Given that view factor $F_{12} = 0.5, T_1 = 800K, T_2 = 600K, T_{surrounding} = 300K$ and Stefan Boltzman constant $\sigma = 5.67 \times 10^{-8} W/\left(m^2 K^4\right)$ the heat transfer from Surface 2 to the surrounding environment is (inkW) (2017 − ME)



12) Heat is generated uniformly in a long solid cylindrical rod (diameter = $10mm$) at the rate of $4 \times 10^7 W/m^3$. The thermal conductivity of the rod material is 25 W/mK. Under steady state conditions, the temperature difference between the centre and the surface of the rod is $\left(\text{in } ^\circ C\right)$ (2017 − ME)

13) An initially stress free massless elastic beam of length L and circular cross-section with diameter d ($d << L$) is held fixed between two walls as showm. The beam material has Young's modulus E and coefficient of thermal expansion α. If the beam is slowly and uniformly heated, the temperatture rise required to cause the beam to buckle is proportional to



(2017 − ME)

a) d b) d^2 c) d^3 d) d^4