Assignment-9

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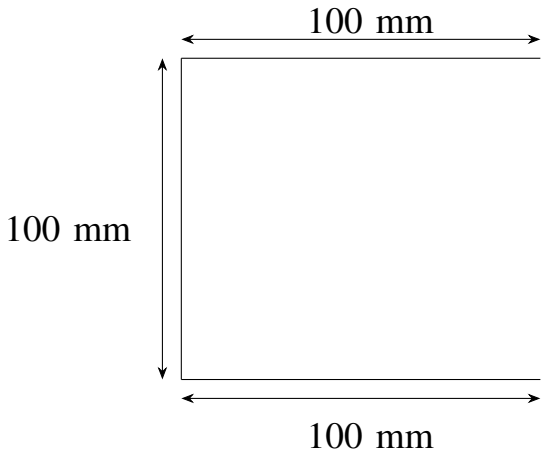
I. 2016-AE 40-52

40) A channel section shown in the figure has uniform thickness. It is subjected to an anticlockwise torque of 62.5 Nmm. The maximum possible thichness of the channel section, such that the shear stress induced in it does not exceed 100 N/mm^2, is _____ mm.



41) The governing differential equation of motion of a damped system is given by $m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = 0$. If m = 1 kg, c = 2 Ns/m and k = 2 N/m then the frequency of the damped oscillation of this system is _____ rad/s.

42) The two dimensional state of stress in a body is described by the Airy's stress function: $\phi = 5\frac{x^4}{12} + \frac{x^3y}{6} + 3\frac{x^2y^2}{2} + 7\frac{xy^3}{6} + E\frac{y^4}{12}$. The Airy's stress function will satisfy the equilibrium and the compatibility requirements if and only if the value of the coefficient E is _____.

43) The value of definite integral $\int_0^{\pi} (x \sin x)\, dx$ is _____.

44) Use Newton-Raphson method to solve the equation: $xe^x = 1$. Begin with the initial guess $x_0 = 0.5$. The solution after one step is x = _____.

45) A wall of thickness 5 mm is heated by a hot gas flowing along the wall. The gas is at a temperature of 3000 K, and the convective heat transfer coefficient is 160 W/m^{2}K. The wall thermal conductivity is 40 W/mK. If the colder side of the wall is held at 500 K, the temperature of the side exposed to the hot gas is _____ K.

46) A launch vehicle has a main rocket engine with two identical strap-on motors, all of which fire simultaneously during the operation. The main engine delivers a thrust of 6300 kN with a specific impulse of 428 s. Each strap-on motor delivers a thrust of 12000 kN with specific impulse of 292 s. The acceleration due to gravity is 9.81 m/s^2. The effective (combined) specific impulse of the vehicle

is _____ s.

47) A substance experiences an entropy change of $\Delta s > 0$ in a quasi-steady process. The rise in temperature (corresponding to the entropy change Δs) is highest for the following process:
a) isenthalpic
b) isobaric
c) isochoric
d) isothermal

48) In a particular rocket engine, helium propellant is heated to 6000 K and 95% of its total enthalpy is recovered as kinetic energy of the nozzle exhaust. Consider helium to be a calorically perfect gas with specific heat at constant pressure of 5200 J/kgK. The exhaust velocity for such a rocket for an optimum expansion is _____ m/s.

49) An aircraft is flying level in the North direction at a velocity of 55 m/s under cross wind from East to West of 5 m/s. For the given aircraft $C_{n\beta} = 0.012/\text{deg}$ and $C_{n\delta r} = -0.0072/\text{deg}$, where δr is the rudder deflection and β is the side slip angle. The rudder deflection exerted by pilot is _____ degrees.

50) An aircraft weighing 10000 N is flying level at 100 m/s and it is powered by a jet engine. The thrust required for level flight is 1000 N. The maximum possible thrust produced by the jet engine is 5000 N. The minimum time required to climb 1000 m, when flight speed is 100 m/s, is _____ s.

51) The aircraft velocity (m/s) components in body axes are given as $[u, v, w] = [100, 10, 10]$. The air velocity (m/s), angle of attack (deg) and sideslip angle (deg) in that order are
a) $[120, 0.1, 0.1]$
b) $[100, 0.1, 0.1]$
c) $[100.995, 0.1, 5.73]$
d) $[100.995, 5.71, 5.68]$

52) The Dutch roll motion of the aircraft is described by following relationship

$$\begin{bmatrix} \Delta\dot{\beta} \\ \Delta\dot{r} \end{bmatrix} = \begin{bmatrix} -0.26 & -1 \\ 4.49 & -0.76 \end{bmatrix} \begin{bmatrix} \Delta\beta \\ \Delta r \end{bmatrix}$$

The undamped natural frequency (rad/s) and damping ratio for the Dutch roll motion in that order are:
a) $4.68, 1.02$
b) $4.49, 1.02$
c) $2.165, 0.235$
d) $2.165, 1.02$