GateAssignment4

EE24BTECH11048-NITHIN.K

1 Q.26 to Q.55 carry two marks each

1) The value of definite integral $\int_0^{\pi} xsinxdx$ is _____.
2) 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 $x =$ _____
3) 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^2K. 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.
4) 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.
5) 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
6) 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 _____.
7) 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 $C_{n\beta} = 0.012/deg$ and $C_{n\delta r} = -0.0072/deg$, where δr is the rudder deflection and β is the side slip angle. The rudder deflection exerted by pilot is _____ degrees.
8) 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 5000N. The minimum time required to climb 1000 m, when flight speed is 100 m/s, is _____ s.
9) 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) $[100.95, 0.1, 5.73]$

d) $[100.995, 5.71, 5.68]$

10) The Dutch roll motion of the aircraft is described by following relationship
$\begin{pmatrix}\Delta\beta\\ \Delta r\end{pmatrix} = \begin{pmatrix}-0.26 & -1\\ 4.49 & -0.76\end{pmatrix}\begin{pmatrix}\Delta\beta\\ \Delta r\end{pmatrix}$
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

11) A glider weighing 3300 N is flying at 1000 m above sea level. The wing area is 14.1 m^2 and the air density is 1.23 kg/m^3. Under zero wind conditions, the velocity for maximum range is _____ m/s.

α (deg)	C_L	C_D	C_L/C_D
11	1.46	0.0865	16.9
9	1.36	0.0675	20.1
7	1.23	0.0535	22.9
5	1.08	0.0440	24.5
3	0.90	0.0350	25.7
1	0.70	0.0275	25.4
-1	0.49	0.0220	22.2
-3	0.25	0.0180	13.8

12) A rocket, with a total lift-off mass of 10000 kg, moves vertically upward from rest under a constant gravitational acceleration of 9.81 m/s^2. The propellant mass of 8400 kg burns at a constant rate of 1200 kg/s. If the specific impulse of the rocket engine is 240 s, neglecting drag, the burnout velocity in m/s is
a) 3933.7
b) 4314.6
c) 4245.9
d) 4383.3

13) A satellite is injected at an altitude of 350 km above the Earths surface, with a velocity of 8.0 km/s parallel to the local horizon. (Earth radius=6378 km, μ_E (GM=Gravitational constant x Earth mass) = $3.986 \times 10^{14} m^3 s^{-2}$
The satellite
a) forms a circular orbit.
b) forms an elliptic orbit.
c) escapes from Earths gravitational field.
d) falls back into earth.