Assignment 13

AI24BTECH11008- Sarvajith

40. The stagnation temperatures at the inlet and exit of a combustion chamber are 600 K and 1200 K, respectively. If the heating value of the fuel is $44\frac{MJ}{kg}$ and specific heat at constant pressure for air and hot gases are $1.005\frac{kJ}{kg.K}$ and $1.147\frac{kJ}{kg.K}$ respectively, the fuel-to-air ratio is (2012)
    (A) 0.0018
    (B) 0.018
    (C) 0.18
    (D) 1.18
41. A solid propellant of density 1800 $\frac{kg}{m^3}$ has a burning rate law $r = 6.65 \times 10^{-3} p^{0.45} \frac{mm}{s}$, where p is pressure in Pascals. It is used in a rocket motor with a tubular grain with an initial burning area of $0.314m^2$. The characteristic velocity is 1450 $\frac{m}{s}$. What should be the nozzle throat diameter to achieve an equilibrium chamber pressure of 50 bar at the end of the ignition transient? (2012)
    (A) 35 mm
    (B) 38 mm
    (C) 41 mm
    (D) 45 mm
42. A bipropellant liquid rocket motor operates at a chamber pressure of 40 bar with a nozzle throat diameter of 50 mm. The characteristic velocity is 1540 $\frac{m}{s}$. If the fuel-oxidizer ratio of the propellant is 1.8, and the fuel density is 900 $\frac{kg}{m^3}$, what should be the minimum fuel tank volume for a burn time of 8 minutes (2012)
    (A) $1.65m^3$
    (B) $1.75m^3$
    (C) $1.85m^3$
    (D) $1.95m^3$
43. The propellant in a single stage sounding rocket occupies 60% of its initial mass. If all of it is expended instantaneously at an equivalent exhaust velocity of $3000\frac{m}{s}$, what would be the altitude attained by the payload when launched vertically? Neglect drag and assume acceleration due to gravity to be constant at 9.81 $\frac{m}{s^2}$. (2012)
    (A) 315 km
    (B) 335 km
    (C) 365 km
    (D) 385 km
44. The Airy stress function, $\phi = \alpha x^2 + \beta xy + \gamma y^2$ for a thin square panel of size $l \times l$ automatically satisfies compatibility. If the panel is subjected to uniform tensile stress,σ_0 on all four edges, the traction boundary conditions are satisfied by (2012)
    (A) $\alpha = \frac{\sigma_0}{2}; \beta = 0; \gamma = \frac{\sigma_0}{2}$

(B) $\alpha = \sigma_0; \beta = 0; \gamma = \sigma_0$
(C) $\alpha = 0; \beta = \frac{\sigma_0}{4}; \gamma = 0$
(D) $\alpha = 0; \beta = \frac{\sigma_0}{2}; \gamma = 0$

45. The boundary condition of a rod under longitudinal vibration is changed from fixed-fixed to fixedfree. The fundamental natural frequency of the rod is now k times the original frequency, where k is (2012)
(A) $\frac{1}{2}$
(B) 2
(C) $\frac{1}{\sqrt{2}}$
(D) $\sqrt{2}$

46. A spring-mass system is viscously damped with a viscous damping constant c. The energy dissipated per cycle when the system is undergoing a harmonic vibration $x \cos w_0 t$ is given by (2012)
(A) $\pi\omega_d cX^2$
(B) $\pi\omega_d X^2$
(C) $\pi\omega_d cX$
(D) $\pi\omega_d^2 cX$

47. Buckling of the fuselage skin can be delayed by (2012)
(A) increasing internal pressure.
(B) placing stiffeners farther apart.
(C) reducing skin thickness.
(D) placing stiffeners farther and decreasing internal pressure.

Common Data Questions Common Data for Questions 48 and 49: A wing and tail are geometrically similar, while tail area is one-third of the wing area and distance between two aerodynamic centres is equal to wing semi-span $\left(\frac{b}{2}\right)$. In addition, following data is applicable: $\epsilon_\alpha = 0.3, C_L = 1.0, C_{L_\alpha} = 0.08/deg, \bar{c} = 2.5m, b = 30m, C_{M_{ac}} = 0, \eta_t = 1$. The symbols have their usual meanings.

48. The maximum distance that the centre of gravity can be behind aerodynamic centre without destabilizing the wing-tail combination is (2012)
(A) 0.4m
(B) 1.4m
(C) 2.4m
(D) 3.4m

49. The angle of incidence of tail to trim the wing-tail combination for a 5% static margin is (2012)
(A) $-1.4°$
(B) $-0.4°$
(C) $0.4°$
(D) $1.4°$

Common Data for Questions 50 and 51:

A thin long circular pipe of 10 mm diameter has porous walls and spins at 60 rpm about its own axis. Fluid is pumped out of the pipe such that it emerges radially relative to the pipe surface at a velocity of 1 $\frac{m}{s}$. [Neglect the effect of gravity.]

50. What is the radial component of the fluid's velocity at a radial location 0.5 m from the pipe axis? (2012)

(A) $0.01\frac{m}{s}$
(B) $0.1\frac{m}{s}$
(C) $1\frac{m}{s}$
(D) $10\frac{m}{s}$

51. What is the tangential component of the fluid's velocity at the same radial location as above? (2012)

(A) $0.01\frac{m}{s}$
(B) $0.03\frac{m}{s}$
(C) $0.10\frac{m}{s}$
(D) $0.31\frac{m}{s}$

Linked Answer Questions 52 and 53

Statement for Linked Answer Questions 52 and 53:

Air at a stagnation temperature of 15°C and stagnation pressure 100 kPa enters an axial compressor with an absolute velocity of $120\frac{m}{s}$. Inlet guide vanes direct this absolute velocity to the rotor inlet at an angle of 18° to the axial direction. The rotor turning angle is 27° and the mean blade speed is 200 $\frac{m}{s}$. The axial velocity is assumed constant through the stage.

52. The blade angle at the inlet of the rotor is (2012)

(A) 25.5°
(B) 38.5°
(C) 48.5°
(D) 59.5°