

GATE AE - 2011

EE24BTECH11061 - Rohith Sai

MULTIPLE CHOICE TYPE

- 1) An aircraft with a mass of 5000 kg takes off from sea level with a forward speed of 50 m/s and starts to climb with a climb angle of 15° . The rate of climb and excess thrust available at the start of the climb respectively (assume $g = 9.81 \text{ ms}^{-2}$) are

a) 13.40 m/s and 13146.0 N	c) 13.40 m/s and 12694.1 N
b) 12.94 m/s and 12694.1 N	d) 12.94 m/s and 13146.0 N

- 2) A glider having a mass of 500 kg is taken to an altitude of 1000 m with a jeep moving on ground at 54 kmph. Upon reaching the required altitude in 50 s, the glider is released and starts its descent. Under the assumption of equilibrium glide, the range and endurance of the glider for a constant lift-to-drag ratio of 15 are

a) 15.0 km and 1002.2 s respectively	c) 1.0 km and 601.3 s respectively
b) 15.0 km and 601.3 s respectively	d) 1.0 km and 50 s respectively

- 3) An elliptic orbit has its perigee at 400 km above the Earth's surface and apogee at 3400 km above the Earth's surface. For this orbit, the eccentricity and semi-major axis respectively are (assume radius of Earth = 6400 km)

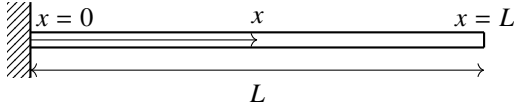
a) 0.18 and 8300 km	c) 0.22 and 8300 km
b) 0.18 and 1900 km	d) 0.22 and 1900 km

- 4) An aircraft in level flight encounters a vertical gust, which excites the phugoid mode. The phugoid motion completes 10 cycles in 50 s and its amplitude reduces to half of its maximum value in 25 s. The eigenvalues of the phugoid mode are

a) $-0.05 \pm 0.02i$	c) $-0.028 \pm 1.26i$
b) $-0.5 \pm 0.2i$	d) $0.028 \pm 1.26i$

- 5) Consider the inviscid, adiabatic flow of air at free stream conditions, $M_1 = 2$, $p_1 = 1$ atm and $T_1 = 288$ K around a sharp expansion corner ($\theta = 20^\circ$) as shown below. The Prandtl-Meyer function, ν , is given as a function of Mach number, M , as $\nu(M) = \sqrt{\frac{\gamma+1}{\gamma-1}} \tan^{-1} \sqrt{\frac{\gamma-1}{\gamma+1}} (M^2 - 1) - \tan^{-1} \sqrt{M^2 - 1}$ Assume air to be calorically perfect with

is the coordinate along the beam length, t is time and L is the beam length



9) To solve the PDE, the number of boundary conditions (BC) and initial conditions (IC) needed are

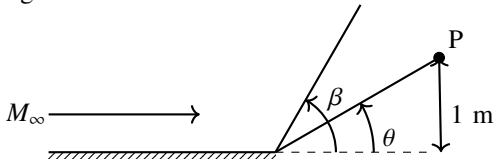
- | | |
|---------------|---------------|
| a) 4 BC, 3 IC | c) 2 BC, 4 IC |
| b) 2 BC, 2 IC | d) 4 BC, 2 IC |

10) For the cantilever beam shown in the figure, which of the following **CANNOT** be a possible boundary condition?

- | | |
|--|--|
| a) $w(0, t) = 0$ | c) $\frac{\partial^2 w}{\partial x^2}(0, t) = 0$ |
| b) $\frac{\partial^2 w}{\partial x^2}(L, t) = 0$ | d) $\frac{\partial^3 w}{\partial x^3}(L, t) = 0$ |

Common Data for Questions 50 & 51:

Consider an inviscid, adiabatic flow of air at free stream Mach Number, $M_\infty = 2$, across a compression corner ($\theta = 20^\circ$) as shown. The free stream total enthalpy is $h_{0\infty} = 810 \text{ kJ kg}^{-1}$. Assume that air is calorically perfect with $\gamma = 1.4$, $R = 287 \text{ J kg}^{-1} \text{ K}^{-1}$



11) The shock angle β is

- | | |
|----------------------------------|-----------------|
| a) $= 20^\circ$ | c) $= 30^\circ$ |
| b) $> 20^\circ$ and $< 30^\circ$ | d) $> 30^\circ$ |

12) The total temperature at point P is

- | | |
|--------------|--------------|
| a) 806.37 K | c) 1612.74 K |
| b) 1128.92 K | d) 2257.84 K |

LINKED ANSWER QUESTIONS

Statement for Linked Answer Questions 52 & 53:

A thin-walled (thickness \ll radius), hollow shaft of length 1m and mean radius, $R = 5 \text{ cm}$ has to be designed such that it can transmit a torque, $T = 7 \text{ kN-m}$. A survey of different commercially available materials was made and following data was obtained from the suppliers (E : Young's Modulus, τ_y : yield stress in shear, ρ : density): [h!]

13) Which of the above materials would you choose such that weight of the shaft is minimum?

Material	E(GPa)	τ_y (MPa)	ρ (kg/m ³)
X	200	550	7700
Y	70	225	2700
Z	110	375	4875

- a) X only
- b) Y only
- c) Z only
- d) X or Y

14) If you assume a factor of safety of 2, what should be the approximate thickness of such a shaft?

- a) 0.5 mm
- b) 1 mm
- c) 2 mm
- d) 4 mm