

# GATE Questions 13

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EE24BTECH11012 - Bhavanisankar G S

- 1) A pilot probe on an aircraft in a steady level flight records a pressure of  $55,000 \text{ N/m}^2$ . The static pressure and density are  $45,280 \text{ N/m}^2$  and  $0.6 \text{ kg/m}^3$  respectively. The wing area and the lift coefficient are  $16 \text{ m}^2$  and 0.2 respectively, then the wing loading on this aircraft is
- 2) A spacecraft forms a circular orbit at an altitude of 150 km above the surface of Earth. Assuming the gravitational parameter,  $\mu = 3.986 \times 10^{14} \text{ m}^3/\text{s}^2$  radius of Earth = 6400 km, the velocity required for the injection of the spacecraft, parallel to the local horizon is
- 3) Air at 50 kPa pressure and 400 K temperature, flows in a duct in Mach 3.0. A part of the flow leaks through a duct wall into the ambient, where the pressure is 30 kPa. The maximum Mach number achieved in the discharge is ( assume  $\gamma = 1.4$  )
- 4) Consider a  $20^\circ$  half-angle flow in a supersonic Mach 3.0 at a standard sea-level conditions. If the shock-wave angle on the wedge is  $36^\circ$ , the Mach number of tangential flow-post shock is
- 5) The boundary layer thickness at a location of a sensor on a flat plate, in an incompressible laminar flow of water is required to be restricted to 1 mm for an effective measurement. if the flow velocity is  $20 \text{ m/s}$  with 1 bar pressure and 300 K temperature, and  $1.789 \times 10^{-5} \text{ kg}/(\text{m} - \text{s})$ , the maximum distance, in mm, from the sensor location to the leading edge is
- 6) Gross weight of an airplane is 7000 N, wing area is  $16 \text{ m}^2$  and maximum lift coefficient is 2.0. Assuming density at the altitude to be  $1.23 \text{ kg/m}^3$ , the stall speed of the aircraft is
- 7) A thin-walled tube with an external radius 100 mm and thickness 2 mm, is fixed at one end. It is subjected to a force of 1N parallel to its length, the maximum normal stress experienced by the structure is
- 8) A 1m long massless cantilever beam oscillates at 2 Hz, while a 60 kg mass is attached to the tip of it. the flexural rigidity in the beam ( in  $\text{kN} - \text{m}^2$  ) is
- 9) A cantilever beam of rectangular cross-section of width 60 mm and depth 100 mm is made of aluminium alloy. The material mechanical properties are :  
Young's modulus  $E = 73 \text{ GPa}$   
Ultimate stress  $\sigma_u = 480 \text{ MPa}$   
Factor of safety = 4  
the maximum bending moment that can be applied on the beam, in  $\text{kN/m}^2$  is
- 10) The components of stress in a plane-stress condition in the absence of body-forces is

$$\sigma_{xx} = Ax^2; \sigma_{yy} = 12x^2 - 6y^2; \sigma_{xy} = 12xy$$

The value of A such that the body is under equilibrium is

- 11) An axial compressor-rotor with  $50^\circ$  reaction, operates with an axial velocity of  $200\text{m/s}$ . The flow angle at the inlet of rotor is  $22^\circ$  with reference to the axial direction. If the axial velocity is assumed to be constant throughout the rotor, the magnitude of relative velocity at the rotor exit is
- 12) The relative velocity of air leaving a straight radial impeller of a centrifugal compressor, is  $100\text{m/s}$ . If the impeller speed is  $200\text{m/s}$ , for a slip-free operation, the absolute value at the impeller exit is
- 13) An aircraft wind tunnel model, having a pitch axis mass moment of inertia of  $0.014\text{kg} - \text{m}^2$  is mounted in such a way that it has pure pitching motion. If the pitching moment(M) with respect to the angle of attack ( $\alpha$ ) is  $-0.504\text{N} - \text{m}/\text{rad}$ , the pitching moment with respect to pitch rate is  $-0.0336\text{N} - \text{m}/(\text{rad}/\text{s})$ , the damping ratio of the resulting motion due to initial disturbance in pitch angle is