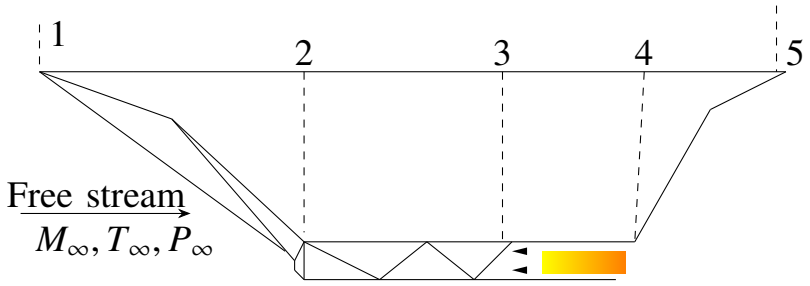
ae-2023-40 to 52

AI24BTECH11020 - Rishika

40) Consider a general aviation airplane with weight $10kN$ and a wing platform area of $15m^2$. The drag coefficient of the airplane is given as $C_D = C_{D_0} + KC_L^2$ with $C_{D_0} = 0.025$ and $K = 0.05$. For level flight at an altitude where the destiny is $0.60kg/m^3$ and thrust $1kN$, the maximum cruise speed is (rounded off to the nearest integer)
   a) $87m/s$
   b) $30m/s$
   c) $36m/s$
   d) $101m/s$

41) A scramjet engine features an intake ,isolator, combustor and a nozzle, as shown in the schematic. Station 3 indicates the combustor entry point. Assume stagnation enthalpy to be constant between Stations 1 and 3, and air to be a calorically perfect gas with specific heat ratio γ. Select the correct expression for Mach number M_3 at the inlet to the combustor from the options given.

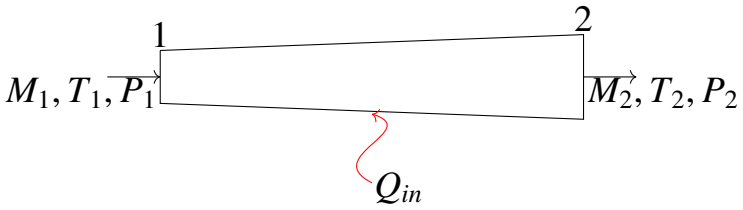


   a) $M_3 = M_\infty \sqrt{\left(\frac{2}{\gamma-1}\right)\left(\frac{T_\infty}{T_3} - 1\right)}$
   b) $M_3 = \sqrt{\left(\frac{2}{\gamma-1}\right)\left\{\frac{T_\infty}{T_3}\left[1 + \left(\frac{\gamma-1}{2}\right)M_\infty^2\right] - 1\right\}}$
   c) $M_3 = M_\infty \sqrt{\frac{T_\infty}{T_3}}$
   d) $M_3 = \sqrt{\left(\frac{\gamma+1}{2}\right)\left(\frac{T_\infty}{T_3} - 1\right)M_\infty^2 - 1}$

42) Consider the equation $\frac{dy}{dx} + \alpha y = \sin \omega x$, where α and ω are constants. Given $y = 1$ at $x = 0$, select all correct statements(s) from the following as $x \to \infty$.
   a) $y \to 0$ if $\alpha \neq 0$
   b) $y \to 1$ if $\alpha = 0$
   c) $y \to Aexp\left(|\alpha|\, x\right)$ if $\alpha < 0; A$ is a constant
   d) $y \to B\sin\left(\omega x + C\right)$ if $\alpha > 0; B$ and C are constants

43) Given the vectors
   $\mathbf{A} = 9\hat{i} - 5\hat{j} + 2\hat{k}$
   $\mathbf{B} = 11\hat{i} + 4\hat{j} + \hat{k}$
   $\mathbf{C} = -7\hat{i} + 14\hat{j} - 3\hat{k}$
   which of the following statement(s) is/are TRUE?
   a) Vectors A, B and C are coplanar
   b) The scalar triple product of the vectors A, B and C is zero
   c) A and B are perpendicular
   d) C is parallel to $A \times B$

44) Consider a one-dimensional inviscid supersonic flow in a diverging duct with heat addition(Q_m) as shown. Which of the following statement(s) is/are always TRUE?



a) Mach number, $M_2 > M_1$
b) Stagnation pressure, $P_1{}^\circ > P_2{}^\circ$
c) Static pressure, $P_2 > P_1$
d) Stagnation temperature, $T_1{}^\circ < T_2{}^\circ$

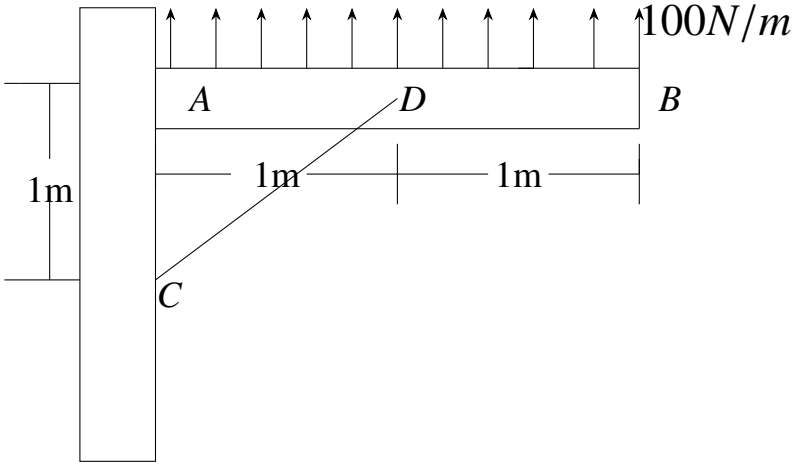
45) Consider the International Standard Atmosphere (ISA) with h being the geopotential altitude (in km) and $\frac{dT}{dh}$ being the temperature gradient (in K/m). Which of the following combination(s) of, $\left(h, \frac{dT}{dh}\right)$ is/are as per ISA?
a) $\left(7, -6.5 \times 10^{-3}\right)$
b) $\left(9, 4 \times 10^{-3}\right)$
c) $(15, 0)$
d) $\left(35, 3 \times 10^{-3}\right)$

46) For an airfoil, which of the relations given about the critical Mach number M_{cr} and drag divergence Mach number M_{dd} is/are correct?
a) $M_{cr} < M_{dd}$
b) $M_{cr} < 1.0$
c) $M_{dd} < 1.0$
d) $M_{cr} > 1.0$

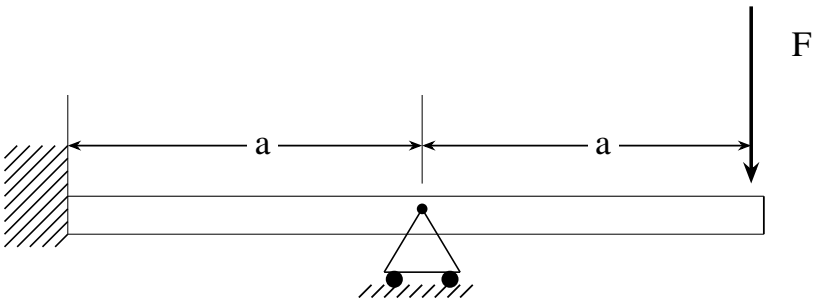
47) Which of the following statement(s) about the elastic flexural buckling load of columns is/are correct?
a) The buckling load increases with increase in flexural rigidity of the column.
b) The buckling load increases with increase in the length of the column.
c) The boundary conditions of the column affect the buckling load
d) The buckling load is NOT directly dependent on the density of the material used for the column.

48) The thickness of a uniform hollow circular shaft is equal to the difference between the outer radius and the inner radius. The ratio of the inner diameter to outer diameter of the shaft is 0.5. For the shaft reacting to an applied torque, the ratio of the maximum shear stress τ to the maximum shear stress $\tau_{thin-wall}$ obtained using the thin-wall approximation is _____ . (round off to one decimal place)

49) A rigid bar AB is subjected to a uniformly distributed load of $100N/m$ as shown in the figure. The bar is supported by rod CD, with A, C, and D as pin joints. The rod CD has axial stiffness of $40N/mm$. The vertical deflection at point D is _____ mm. (round off to nearest integer)



50) A cantilever beam of length $2a$ is loaded at the tip with force F as shown in the figure. The beam is supported in the middle by a roller with a pin. The magnitude of moment reaction at the built-in end of the beam is αFa, where α is _____. (round off to one decimal place)



51) A single degree-of-freedom spring-mass-damper system has viscous damping ratio of 0.1. The mass is given an initial displacement of $10cm$ without imparting any velocity. After exactly two complete cycles of oscillation (i.e., after time $2T_d$, where T_d is the period of the damped vibration), the amplitude of the displacement is_____ cm. (round off to two decimal place)

52) The shear flow distribution in a single cell, thin-walled beam under the action of an arbitrary shear load s_y applied at the shear centre S is shown in the figure. The cell has horizontal symmetry with booms marked by 1 to 4 that carry direct stresses. The shear modulus G is the same for all the walls, and the area of the cell is $135000mm^2$. With respect to the point O marked in the figure, the distance to the shear centre S is _____ mm. (round off to the nearest integer)