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AI24BTECH11015 - Harshvardhan Patidar

1) Shown in the figure 1 below is a model of an Euler-Bernoulli beam made up of two materials subjected to pure bending moment M. The Young's modulus of material A and B are E_A and E_B, respectively. The sectional moment of area, about the neutral axis, of the cross-sectional areas made of materials A and B, are I_A and I_B, respectively. The radius of curvature ρ of the flexural deflection of this composite beam to the bending moment M is then

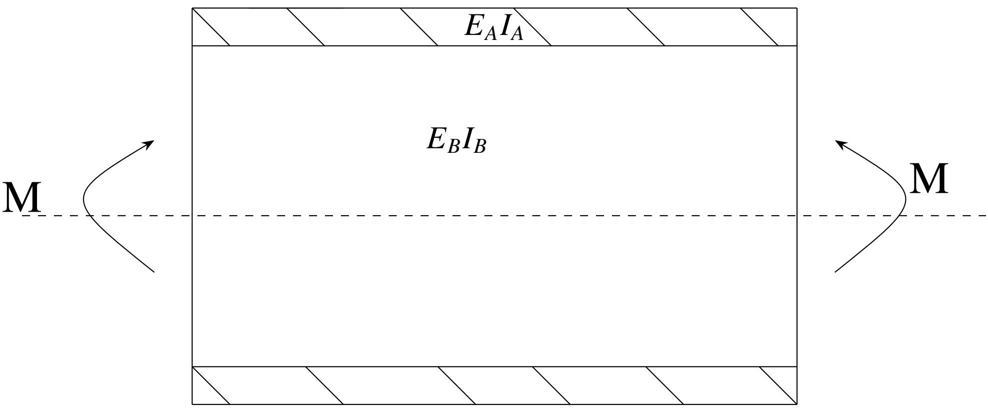

Fig. 1.1

a) $\rho = \frac{E_AI_A+E_BI_B}{M}$
b) $\rho = \frac{E_BI_A+E_AI_B}{M}$
c) $\rho = \frac{M}{E_AI_A+E_BI_B}$
d) $\rho = \frac{(E_A+E_B)(I_A+I_B)}{M}$

2) Two pipes of constant sections but different diameters carry water at the same volume flow rate. The Reynolds number, based on the pipe diameter, is
   a) the same in both pipes
   b) larger in the narrower pipe
   c) smaller in the narrower pipe
   d) depends on the material of the pipes
3) Two airfoils of the same family are operating at the same angle of attack. The dimensions of one airfoil are twice as large as the other one. The ratio of the minimum pressure coefficient of the larger airfoil to the minimum pressure coefficient of the smaller airfoil is
   a) 4.0

b) 2.0
c) 1.0
d) 0.5

4) Wing A has a constant chord c and span b. Wing B is identical but has a span $4b$. When both wings are opening at the same geometric angle of attack at subsonic speed, then:
   a) wings A and B produce the same lift coefficient
   b) wing A produces a smaller lift coefficient than wing B
   c) wing A produces a greater lift coefficient than wing B
   d) the freestream Mach number decides which wing produces the greater lift coefficient

5) A spring-mass-damper system is excited by a force $F_0 \sin \omega t$. The amplitude at resonance is measured to be $1cm$. At half the resonant frequency, the amplitude is $0.5cm$. The damping ratio of the system is
   a) 0.1026
   b) 0.3242
   c) 0.7211
   d) 0.1936

6) The eigenvalues of the matrix, $A = \begin{pmatrix} 2 & 1 \\ 0 & 3 \end{pmatrix}$. are
   a) 1 and 2
   b) 1 and 2
   c) 2 and 3
   d) 2 and 4

7) The eigenvalues of the matrix A^{-1}, where $A = \begin{pmatrix} 2 & 1 \\ 0 & 3 \end{pmatrix}$, are
   a) 1 and $\frac{1}{2}$
   b) 1 and $\frac{1}{3}$
   c) 2 and 3
   d) $\frac{1}{2}$ and $\frac{1}{3}$

8) The radius of the earth is $6.37 \times 10^4 m$ and the acceleration due to gravity at its surface is $9.81m/s^2$. A satellite is in circular orbit at a height of $35.9 \times 10^6 m$ above the earth's surface. This orbit is inclined at 10.5 degrees to the equator. The velocity change needed to make the orbit equatorial is:
   a) $561m/s$ at 84.75 degrees to the initial direction
   b) $561m/s$ at 95.25 degrees to the initial direction
   c) $281m/s$ at 84.75 degrees to the initial direction
   d) $281m/s$ at 95.25 degrees to the initial direction

9) A piston-prop airplane having propeller efficiency, $\eta_p = 0.8$ and weighing $73108N$ could achieve maximum climb rate of $15m/s$ at flight speed of $50m/s$. The excess Brake Power (BP) at the above flight condition will be
   a) 1700 kW
   b) 2100 kW

c) 1371 kW
d) 6125 kW

10) An airplane model with a symmetric airfoil was tested in a wind tunnel $C_{m,0}$ (C_m at angle of attack, $\alpha = 0$) was estimated to be 0.08 and 0 respectively for elevator settings (δ_e) of 5 degrees up and 5 degrees down. The estimated value of the elevator control power $\left(\frac{\partial C_m}{\partial \delta_e}\right)$ of the model will be
   a) 0.07 per deg
   b) -1.065 per deg
   c) -0.008 per deg
   d) -0.762 per deg
11) The lateral-directional characteristic equation for an airplane gave the following set of roots: $\lambda_1 = -0.6, \lambda_2 = -0.002, \lambda_{3,4} = -0.06 \pm f1.5$, where $f = \sqrt{-1}$. The damping ratio corresponding to the Dutch-roll mode will be
   a) 0.04
   b) 0.66
   c) 0.35
   d) 0.18
12) An airplane is flying at an altitude of $10km$ above the sea level. Outside air temperature and density at $10km$ altitude are $223K$ and $0.413kg/m^3$ respectively. The airspeed indicator of the airplane indicates a speed of $60m/s$. Density of air at sea level is $1.225kg/m^3$ and value of the gas constant R is $288J/kg/K$. The stagnation pressure (P_e) measured by the Pitot tube mounted on the wing tip of the airplane will be of magnitude
   a) $3.5 \times 10^4 N/m^2$
   b) $2.0 \times 10^4 N/m^2$
   c) $2.87 \times 10^4 N/m^2$
   d) $0.6 \times 10^4 N/m^2$
13) If the center of gravity of an airplane is moved forward towards the nose of the airplane, the C_{Lmax}(maximum value fo the lift coefficient) value for which the airplane can be trimmed ($C_m = 0$) will
   a) decrease
   b) increase
   c) remain same
   d) depend upon rudder deflection
14) If the contribution of only the horizontal tail of an airplane was considered for estimating $\frac{\partial C_m}{\partial \alpha}$, and if the tail moment arm l, was doubled, then how many times the original value would the new $\frac{\partial C_m}{\partial \alpha}$ become ?
   a) two times
   b) three times
   c) 1.414 times
   d) 1.732 times
15) If the vertical tail of an airplane is inverted and put below the horizontal tail, then the contribution to roll derivative, $\frac{\partial C_l}{\partial \beta}$, will be

a) negative
b) positive
c) zero
d) imaginary

16) Let a system of linear equations be as follows:

$$x - y + 2z = 0$$
$$2x + 3y - z = 0$$
$$2x - 2y + 4z = 0$$

This system of equations has
a) No non-trivial solution
b) Infinite number of non-trivial solutions
c) An unique non-trivial solution
d) Two non-trivial solutions

17) A turbulent boundary layer remains attached over a longer distance on the upper surface of an airfoil than does a laminar boundary layer, because
a) the turbulent boundary layer is more energetic and hence can overcome the adverse pressure gradient better
b) the laminar boundary layer develops more skin friction and hence slows down more rapidly
c) turbulence causes the effective coefficient of viscosity to reduce, resulting in less loss of momentum in the bounday layer
d) the turbulent boundary layer is thicker, hence the velocity gradients in it are smaller, therefore viscous losses are less