AE : GATE 2008

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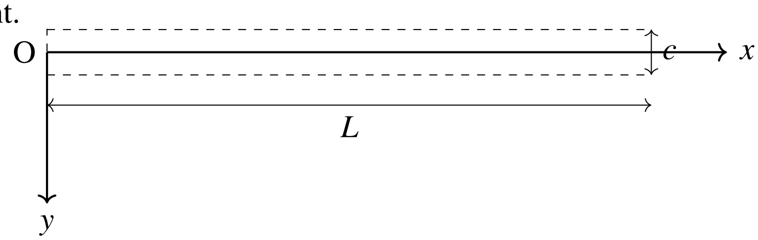
I. 69-85

1) A beam occupies a region $0 \leq x \leq L$; $-c \leq y \leq c$; $-0.5 \leq z \leq 0.5$ as shown below. The beam can be considered to be in plane stress condition in $x - y$ plane. Airy's stress function for the beam is given as:

$$\phi(x, y) = -\frac{Pxy^3}{4c^3} + \frac{3Pxy}{4c} \tag{1}$$

where P is a constant.



The above stress function pertains to a

a) simply supported beam carrying a point load P at mid span
b) simply supported beam carrying a uniform distributed load of intensity P per unit length
c) cantilever beam clamped at end $x = L$ and carrying a shear load P at $x = 0$
d) cantilever beam clamped at end $x = 0$ and carrying a shear load P at $x = L$

2) The equation of motion of a uniform slender beam of length L in flexural vibration is given as $EI\frac{\partial^4 w}{\partial x^4} + \rho A\frac{\partial^2}{\partial wt^2} = 0$, where EI is the flexural rigidity, w is the lateral displacement and ρA is the mass per unit length. The beam is simply supported at the two ends $x = 0$ and $x = L$. Assuming the mode shape in fundamental mode to be $\sin\left(\frac{\pi x}{L}\right)$, the natural frequency in fundamental mode is

a) $0.5\sqrt{\frac{EI}{\rho AL^4}}\pi^2$ b) $\sqrt{\frac{EI}{\rho AL^4}}\pi^2$ c) $2\sqrt{\frac{EI}{\rho AL^4}}\pi^2$ d) $4\sqrt{\frac{EI}{\rho AL^4}}\pi^2$

II. Common Data Questions

Common Data Questions 3, 4 and 5: A two-dimensional state of stress in an isotropic material is given by

$$[\sigma] = c\begin{pmatrix} -8 & 5 \\ 5 & 16 \end{pmatrix} MPa \tag{2}$$

where c is linearly proportional to the applied loading. The failure stress is $\sigma_f = 350MPa$ (which is 0.2% offset yield stress)

3) The principal stresses are

a) $\sigma_1 = 17cMPa, \sigma_2 = -9cMPa$
b) $\sigma_1 = 9cMPa, \sigma_2 = 17cMPa$
c) $\sigma_1 = -17cMPa, \sigma_2 = -9cMPa$
d) $\sigma_1 = -17cMPa, \sigma_2 = 9cMPa$

4) The maximum shear stress is

a) $\tau_{\max} = 7cMPa$ b) $\tau_{\max} = 10cMPa$ c) $\tau_{\max} = 13cMPa$ d) $\tau_{\max} = 15cMPa$

5) The maximum value of c for safe loading of the structure, based on von-Mises failure criterion is

a) 10.2 b) 15.3 c) 25.4 d) 31.8

Common Data Questions 6 and 7:A liquid rocket engine with oxidiser to fuel ratio 5 : 1 produces a thrust of $1MN$. The initial mass of the rocket engine is $100,000kg$ and its mass at burn out is $10,000kg$. The charracteristic velocity **C** and thrust coefficient C_f for the engine are $2386m/s$ and 1.4, respectively.

6) The mass flow rate of fuel is

a) $300.3kg/s$ b) $269.5kg/s$ c) $87.4kg/s$ d) $49.9kg/s$

7) Neglecting gravity and drag effects, if the initial velocity of the liquid rocket engine is $2.5km/s$, the velocity of the rocket at burnout is

a) $1.2km/s$ b) $2.5km/s$ c) $10.2km/s$ d) $11.8km/s$

Linked Answer Questions: 8 and 9 The following two questions relate to Simpson's rule for approximating the

$$\int_a^b f(x)\,dx \text{on the interval} [a, b] \tag{3}$$

8) Which of the following gives the correct formula for Simpson's rule?

a) $\frac{(b-a)}{2}\left[f(b) + f\left(\frac{a+b}{2}\right)\right]$
b) $\frac{(b-a)}{2}\left[\frac{f(a)+f(b)}{2} + f\left(\frac{a+b}{2}\right)\right]$
c) $\frac{(b-a)}{2}\left[\frac{f(a)+f(b)}{3} + \frac{4}{3}f\left(\frac{a+b}{2}\right)\right]$
d) $\frac{(b-a)}{2}\left[\frac{f(a)+f(b)}{3} + \frac{4}{3}f\left(\frac{a+b}{2}\right)\right]$

9) The percentage error (with respect to the exact solution) in estimation of the integral $\int_0^1 x^3 dx$ using Simpson's rule

a) 5.3 b) 3.5 c) 2.8 d) 0

Statement for Linked Answer Questions 10 and 11: An aircraft has a zero-lift drag coefficient $C_{\mathrm{Do}} = 0.0223$, wing aspect ratio $AR_w = 10.0$, and Oswald's efficiency factor $e = 0.7$

10) The trust required for steady level flight will be minimum when the aircraft operates at a lift coefficient of

a) 0.65 b) 0.70 c) 0.75 d) 0.80

11) The glide angle that results in maximum range in a power-off glide is

a) $1.82degrees$ b) $2.68degrees$ c) $3.64degrees$ d) $5.01degrees$

Statement for Linked Answer Questions 11 and 12: Consider an unwisted wing of elliptical planform in inviscid incompressible irrotational flow at an angle of attack of 4 degrees. The wing aspect ratio is 7 and the zero lift angle of attack is -2 degrees.

12) The wing lift coefficient C_{L} is

a) 0.66 b) 0.51 c) 0.44 d) 0.34

13) The induced drag coefficient of the wing C_D is

a) 0.0053 b) 0.0087 c) 0.0118 d) 0.0197

Statement for Linked Answer Questions 13 and 14: A multi-stage axial flow compressor operating at an adiabatic efficiency of 0.9 develops a total pressure ratio of 11. The total temperature at inlet to the compressor is $335K$ and the stagnation enthalpy rise across each stage is $37kJ/kg$. Ratio of specific heats is 1.4 and specific heat at constant pressure is $1.005kJ/kgK$.

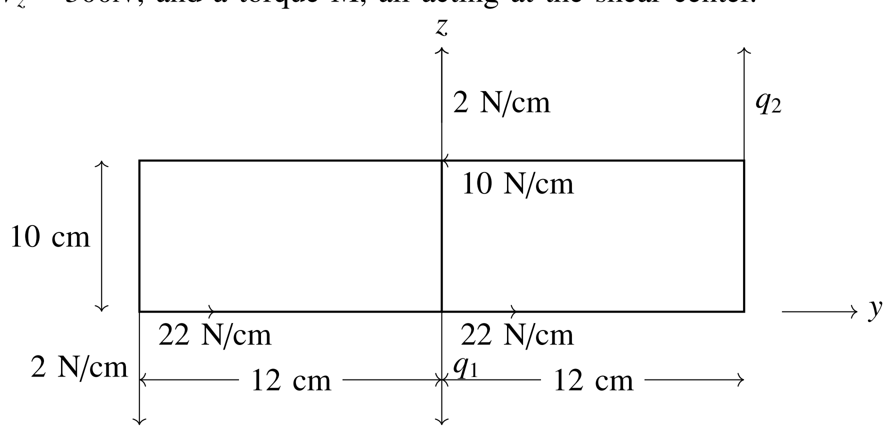
14) The total temperature rise across the compressor is

a) $310.1K$ b) $366.3K$ c) $392.1K$ d) $405.4K$

15) The total number of stages required are

a) 9 b) 10 c) 11 d) 12

Statement for Linked Answer Questions 15 and 16: An idealized thin walled two cell symmetric box beam is as shown. The shear flows in the walls are due to the applied shear forces $V_y = 480N$, $V_z = 300N$, and a torque M, all acting at the shear center.



16) The shear flows q_1 and q_2 are

a) $q_1 = -2N/cm, q_2 = +22N/cm$
b) $q_1 = +2N/cm, q_2 = +22N/cm$
c) $q_1 = +2N/cm, q_2 = -22N/cm$
d) $q_1 = -2N/cm, q_2 = -22N/cm$

17) The torque M is

a) $3360N.cm$ b) $5760N.cm$ c) $6960N.cm$ d) $8160N.cm$