AE: GATE 2008

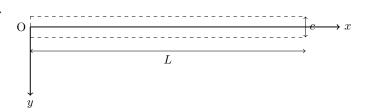
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I. 69-85

1) A beam occupies a region $0 \le x \le L$; $-c \le y \le c$; $-0.5 \le z \le 0.5$ 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:

$$\phi(x,y) = -\frac{Pxy^3}{4c^3} + \frac{3Pxy}{4c}$$
 (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)
$$0.5 \sqrt{\frac{EI}{\rho A L^4}} \pi^2$$
 b) $\sqrt{\frac{EI}{\rho A L^4}} \pi^2$ c) $2 \sqrt{\frac{EI}{\rho A L^4}} \pi^2$ d) $4 \sqrt{\frac{EI}{\rho A L^4}} \pi^2$

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) $\sigma_1 = 17cMPa$, $\sigma_2 = -9cMPa$

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

b)
$$\sigma_1 = 9cMPa, \sigma_2 = 17cMPa$$

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

4) The maximum shear stress is

5) The m	aximum value o	of c for safe loading of th	e structure, based on von	n-Mises failure criterion is
a) 10.2	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) 269.5 <i>kg</i> / <i>s</i>	c) 87.4 <i>kg</i> / <i>s</i>	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) 1.2k	zm/s	b) 2.5 <i>km</i> / <i>s</i>	c) 10.2 <i>km</i> / <i>s</i>	d) 11.8km/s
Linked Answer Questions: 8 and 9 The following two questions relate to Simpson's rule for approximating the				
		$\int_{a}^{b} f(x) dx$	the interval $[a, b]$	(3)
8) Which of the following gives the correct formula for Simpson's rule?				
	$\frac{1}{2} \left[f(b) + f\left(\frac{a+b}{2}\right) \right]$ $= \frac{f(a) + f(b)}{2} + f\left(\frac{a+b}{2}\right)$		c) $\frac{(b-a)}{2} \left[\frac{f(a)+f(b)}{3} + \frac{4}{3}f(\frac{a}{2}) \right]$ d) $\frac{(b-a)}{2} \left[\frac{f(a)+f(b)}{3} + \frac{4}{3}f(\frac{a}{2}) \right]$	$\left(\frac{a+b}{2}\right)$
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 $C_{\text{Do}} = 0.0223$, wing aspect ratio $AR_w = 10.0$, and Oswald's efficiency factor $e = 0.7$ The trust required for steady level flight will be minimum when the aircraft operates at a lift coefficient of				
a) 0.65	5	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) 1.82	2degrees	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) $\tau_{\text{max}} = 7cMPa$ b) $\tau_{\text{max}} = 10cMPa$ c) $\tau_{\text{max}} = 13cMPa$ d) $\tau_{\text{max}} = 15cMPa$

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) 366.3*K*
- c) 392.1K
- d) 405.4K

15) The total number of stages required are

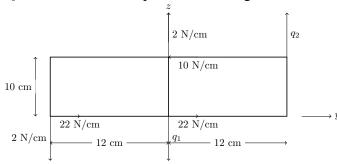
a) 9

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)
$$q_1 = -2N/cm, q_2 = +22N/cm$$

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

b)
$$q_1 = +2N/cm, q_2 = +22N/cm$$

d)
$$q_1 = -2N/cm, q_2 = -22N/cm$$

17) The torque M is

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