Total No. of Questions : 10]

SEAT No. :

P4002

[Total No. of Pages : 4

[4860] - 94

M.E. (Mechanical) (Design Engineering)

ADVANCED STRESS ANALYSIS

(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates :

1) ***Answer any three questions from each section.***
2) ***Answers to the two sections should be written in separate answer books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Show that the Airy stress function $\Phi = 2x_1^4 + 12x_1^2 x_2^2 - 6 x_2^4$ satisfies the bi-harmonic equation $\nabla^4 = 0$ and determine the stress components assuming plain strain. **[8]**

b) What is the significance of compatibility conditions? Derive compatibility equation by using polar-co-ordinate system. **[8]**

Q2) a) A thin walled box section of dimensions '2a × a × t' is to be compared with a solid section of diameter 'a' as shown in fig.1. Find the thickness 't' so that the two sections have **[10]**

i) The same maximum stress for the same torque.

ii) The same stiffness.

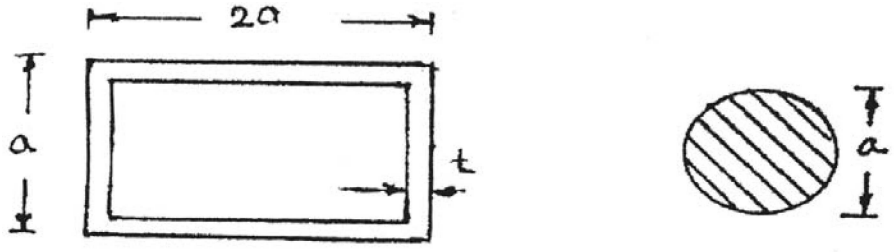

Fig.1

P.T.O.

b) Compare Kelvin's fluid - flow analogy with Prandtl's membrane analogy. **[6]**

Q3) a) Derive from fundamentals the expression for contact stresses between two spherical bodies of radii R_1 & R_2 under compressive load P. State the assumptions made. **[10]**

b) Analyze contact stresses between eccentric cam and flat follower. **[6]**

Q4) Determine the intensities of principal stresses in flat steel disc of uniform thickness having a diameter 1 m and rotating at 2400 rpm. What will be the stresses if the disc has central hole of 0.2 m diameter? Take Poisson's ratio = 0.333 and density (ρ) 7850 kg/m^3. **[16]**

Q5) Write short notes on any three : **[18]**

a) Torsion of conical shaft

b) Theorem of least work

c) Bending of circular plate

d) Elastic Behaviour of anisotropic materials like reinforced composites.

SECTION - II

Q6) a) A fringe order of 2.5 was observed at a point in a stressed plane stress model with light having a wavelength of 589 nm. Assuming that stress optic coefficient 'C' remains constant, what fringe order would be observed at the point considered when light with wavelength of 548 nm is used? Derive the formula used. Explain in details desirable properties of strain gauge material. **[10]**

b) Explain in details desirable properties of strain gauge material. **[6]**

Q7) Explain the importance of bending axis and shear centre for thin walled section elements. Locate the shear centre for section as shown in Fig.2. **[16]**

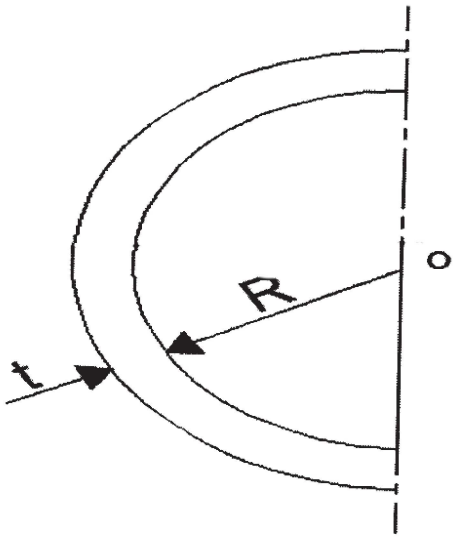

Fig.2

Q8) a) Derive an equation for stress distribution in shrink fitted compound cylinders with usual notations. **[8]**

b) A cylinder of 150 mm internal diameter is subjected to an internal pressure of 50 MPa. The material for the cylinder has permissible stress of 120 MPa in simple tension with modulus of elasticity 200 GPa and Poisson's ratio is 0.3. Neglecting the longitudinal stress, calculate required thickness of the cylinder on the basis of **[8]**

i) Maximum Principal Stress.

ii) Maximum Principal Strain.

Q9) a) Laminate of composite material has a fracture toughness of 30 MPa m½ and tensile strength of 500 MPa. A 25 mm width(b) structure made up of this material has edge crack(a) of length 3 mm.Find the critical stress that would cause unstable propagation of the crack. For this geometry of the specimen the stress intensity factor is **[8]**

$$k1 = \sigma\sqrt{\pi a} f\left(\frac{a}{b}\right)$$

where $f\left(\frac{a}{b}\right) = 1.12 - 0.231\left(\frac{a}{b}\right) + 10.55\left(\frac{a}{b}\right)^2$,

a = crack length and b = plate width.

b) Explain the fracture mechanics approach for estimation of residual life of a component. What is critical stress intensity factor? How it is useful in design of cracked components? **[8]**

Q10) Write short notes on any three : **[18]**

a) Modes of fractures.

b) Strain gauge rosette.

c) Analysis of low speed impact

d) Bending of long uniformly loaded rectangular plate.

⌘⌘⌘