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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 06
FINAL EXAMINATION 2010/2011
MEX 6330 – MECHANICS OF MATERIALS
DATE : 31ST MARCH 2011
TIME : 1400 HRS - 1700 HRS
DURATION : 03 HOURS

ANSWER ANY FIVE (05) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

Question 01:

Write shorts notes on the following.

a) Stress relaxation
b) Creep test
c) Griffith crack theory

Question 02:

An aluminum alloy panel of width 100 mm was found to contain a 3mm long edge crack oriented normal to the applied stress after 2 years of service. The material properties of Aluminum panel and the service conditions are as follows.
Fracture toughness of alloy = 30 MN/m^2 and the component was designed to withstand one startup/shut down 5000 cycles per day for 20 years (assuming there are 250 operating days per year), the cyclic stress range is 0 to 60 MN/m^2, rate of crack growth has the form $da/dN = 3.3\times10^{-10}(\Delta K)^{3.5}$
where '*a' crack size in (m), 'N'- number of cycles and* 'ΔK' is given in MN/m$^{3/2}$.

i) Comment on the safety of the product of which the panel is an integral part, and
ii) State how the safety is affected if the crack was found to originate from a rivet hole

Take $K = 1.12\sigma\sqrt{\pi a}$ for a n edge crack and $K = 3.36\sigma\sqrt{\pi a}$ for a crack originating from a rivet hole.

Question 03:

a) State the following stress theories
   i) Tresca stress Criteria
   ii) Von-Mises stress Criteria

b) A uniform thick cylinder has an outer radius of 150 mm and an inner radius of 75 mm. It has rigid end closures and is subjected to only an internal pressure. It is made from a material of which the yield stress is σ_y = 260 MN/m^2. Using the above stress criteria determine the values of the pressure at which yielding would occur. The axial stress may be assumed to be uniform over the cross-section of the cylinder

Question 04:

i) List the main components of the plane polariscope
ii) Describe the difference between isoclinics and isochromatics
iii) How do you identify isoclinics and isochromatics separately using plane polariscope?
iv) Describe the main difference between plane polariscope and circular polariscope.

Question 05:

i) Explain why electrical resistance strain gauges are very popular for strain measurements.
ii) Describe briefly how you would experimentally determine the principal stresses present in a machine element under the action of a complex stress system, with the aid of a strain gauge.
iii) The state of strain at a point on a bracket is measured using the strain rosette shown in Fig.Q5.

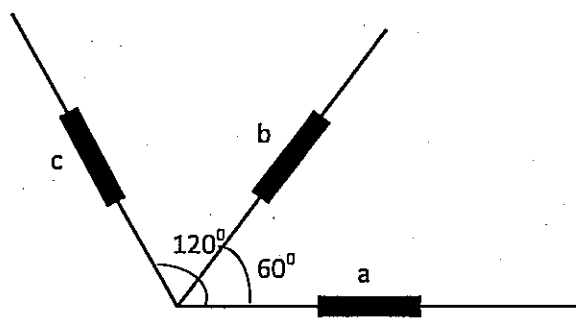


Fig.Q5

The readings from the respective strain gauges are

$\epsilon_a = 225 \times 10^{-3}$, $\epsilon_b = 220 \times 10^{-3}$, $\epsilon_c = 130 \times 10^{-3}$

Determine the in-plane principal strains and the directions along which they act at the point under consideration.

Question 06:

(a) Explain the following terms

(i) Stress tensor (ii) Volumetric strain

(b) What is meant by the term "index notation"?
(c) List out the properties of the stress tensor.
(d) The state of stress at a point is given by,

$$\sigma_{xx} = 100MPa \qquad \sigma_{yy} = 45MPa \qquad \sigma_{zz} = -80MPa$$
$$\sigma_{xy} = -45MPa \qquad \sigma_{yz} = 33MPa \qquad \sigma_{zx} = -75MPa$$

Find the values of three invariants and hence write down the equation to calculate principal stresses.

Question 07:

The stresses in a thin rotating disk (under plane stress conditions) are given by:

$$\sigma_{rr} = A + \frac{B}{r^2} - \frac{(3+\nu)}{8}\rho\varpi^2 r^2 \quad ; \quad \sigma_{\theta\theta} = A - \frac{B}{r^2} - \frac{(1+3\nu)}{8}\rho\varpi^2 r^2$$

where 'r' is the radial distance, 'ν' is the Poisson's ratio and 'ω' is the angular velocity.

A thin circular disk of uniform thickness has an outside radius 'b' and a concentric hole of radius 'a' at the centre. Material properties of the disk are E and ν. It is shrink fitted to a solid rigid shaft with a uniform circular cross section of radius $a+\delta$. (This means that the interference at the interface is δ) .The shaft along with the disk mounted on it is rotated at an angular velocity of ω. If ω is increased very slowly find the value of ω at which the disk will separate from the rigid shaft.

Question 08:

a) State the Airy's stress function for 2-D state of stress

b) The Airy's stress function $\phi = A\,y^3 + B\,y^2 + Cx$ represents the 2-D plane stress beam problem shown in Fig.Q4. The beam is of unit thickness and depth't'. Determine the values of the constants A, B and C.

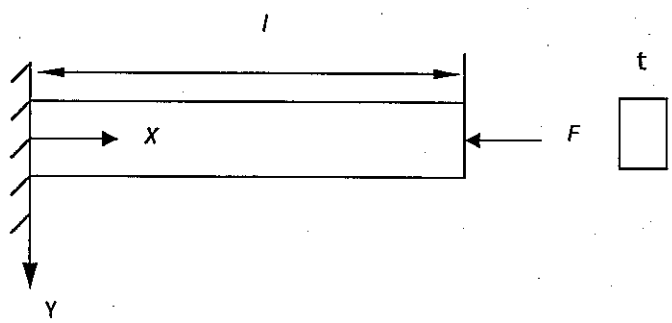


Fig.Q4

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