The Open University of Sri Lanka
Faculty of Engineering Technology

00023

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX 6230 – Mechanics of materials**
Academic Year	:	2015/2016
Date	:	27th November 2016
Time	:	0930hrs – 1230hrs
Duration	:	03 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. Answer any 5 questions only.

Question 01

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,

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

Question 02

Write down all six independent stress components in terms of strains using the constants E and υ.

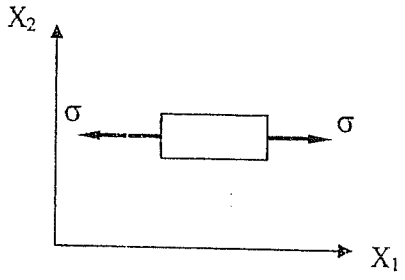


Fig.Q1

For an element subjected to a two dimensional stress as shown in Fig.Q1, verify that the Young's Modulus (E) and the Poission's ratio (υ) are given by

$E = \mu(3\lambda + 2\mu)/(\lambda + \mu)$ and $\nu = \lambda/(\lambda + \mu)$

Where λ and μ are constants.

Question 03

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

The Airy's stress function $\emptyset = Ay^3 + By^2 + Cx$ represents the2-D plane stress beam problemshown in Fig.Q3. The beam is unit thickness and depth 't'. Determine the values of the constants A,B, and C.

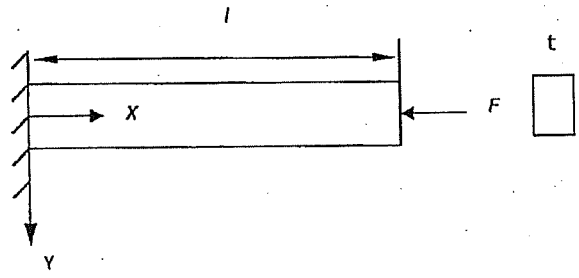


Fig.Q3

Question 04

Determine the intensities of principal stress in a flat steel disc of uniform thickness having a diameter of 1m and rotating at a speed of 2400 rpm.

What will be the stresses if the disk has a central hole of 0.2m diameter?

Take Poisson's ratio = 1/3 and the density of the material ρ = 7850 kg/m^3.

Note: The intensities of radial and circumferential (or hoop) stresses are given by:

$$\sigma_r = \frac{c_1}{2} + \frac{c_2}{r^2} - \left[\frac{3+\frac{1}{m}}{8}\right]\rho\omega^2 r^2$$

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Question 05

a) Discuss five causes of fatigue failures and five methods by which we can improve the fatigue strength of materials.

b) Write short notes on the following.

I. Stress relaxation

II. Creep test

III. Griffith crack theory

Question 06

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.Q6.

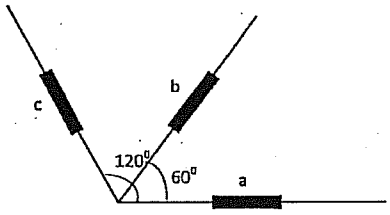


Fig.Q6

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 07

a) Briefly discuss the following, underlining the main differences among them.
(i) Plane Polarisation (ii) Circular Polarisation (iii) Elliptical Polarisation.

b) Describe how you would use a polariscope to determine the principal stresses and the principal directions at different points in a given specimen.

c) Describe the difference between isoclinics and ischromatics.

Question 08

a) By giving suitable examples describe how you would improve fatigue resistance in machine components.

b) A shaft is made of alloy steel for which KIC = 87 MNm-3/2. Nondestructive testing by ultrasonic methods shows that the component contains a crack of up to 2a =0.2 mm in length. Laboratory tests show that the crack growth rate under cyclic loading is given by, da/dN = A(ΔK)4, where A = 5 x 10-13 (MNm-3/2)-4m. The component is subjected to an alternating stress of range Δσ = 220 MNm-2 about a mean stress of Δσ/2.

Given that $\Delta K = \Delta\sigma\sqrt{\pi a}$, calculate the number of cycles to failure.

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