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The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX6530 Mechanics of Materials**
Academic Year	:	2017/18
Date	:	17th February 2019
Time	:	0930 hours -1230 hours
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of Eight (08) questions in Four (04) pages.
3. Answer any 05 questions only. All questions carry equal marks.

Question 01 – *(20 Marks)*

Write shorts notes on the following.

i) Stress Tensor
ii) Volumetric Strain
iii) Stress relaxation
iv) Creep test
v) Griffith crack theory

Question 02 - *(20 Marks)*

i) Given the following matrix of components of the stress tensor corresponding to a point in a loaded mechanical element,

$$\sigma = \begin{bmatrix} 20 & 16 & 10 \\ 16 & 6 & 15 \\ 10 & 15 & 12 \end{bmatrix} MPa$$

Determine the principle stresses and their original orientations with respect to the original coordinate system.

ii) The stress at a point in a body;

$$\sigma = \begin{bmatrix} 35 & 20 & 40 \\ 20 & 12 & 0 \\ 40 & 0 & 50 \end{bmatrix} MPa$$

Determine the normal strains and shear strains in the x, y and z directions if E= 70 GPa and $v = 0.30$

Question 03 - *(20 Marks)*

The square metal block in Figure Q 03 is loaded so that the block is in a state of plane strain ($\epsilon_{zz} = \epsilon_{zx} = \epsilon_{zy} = 0$)

i) Determine the displacements for the metal block for the deformation shown and the strain components for the (x, y) coordinate axes.

ii) Determine the strain components for the X, Y coordinate axes.

iii) What is the magnitude of maximum shear strain and its directions?

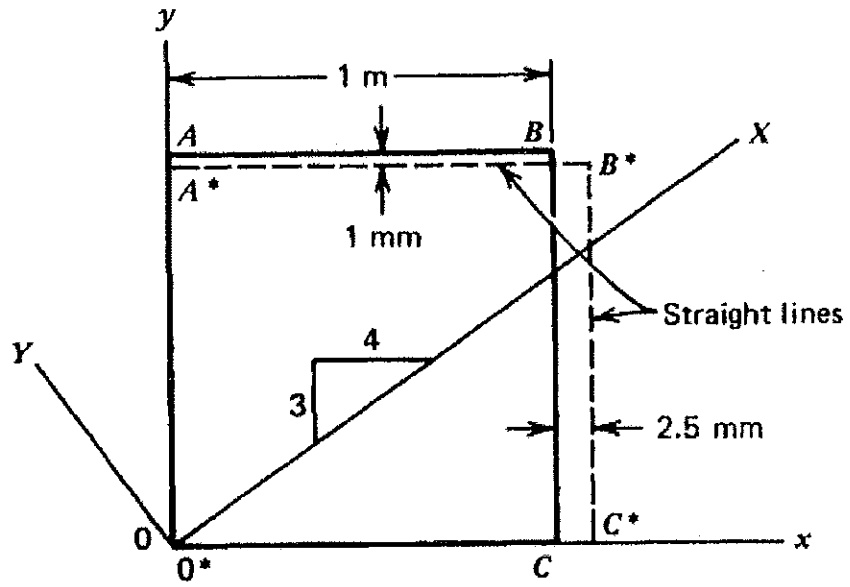

Figure. Q03

Question 04 - *(20 Marks)*

i) Airy stress function $\emptyset = \frac{My^3}{6I}$ represents the 2-D plane stress beam problem illustrated in Figure. Q04. Show that the boundary loading conditions are satisfied.

ii) Given that at the origin (O) both x, y displacements as well as the gradient of the neutral axis are zero and on the y-z plane the x displacement is zero, find expressions for u, v as functions of x, y.

iii) Show that the deflected form of the neutral axis (y = 0) is given by $v = \frac{Mx^2}{2EI}$

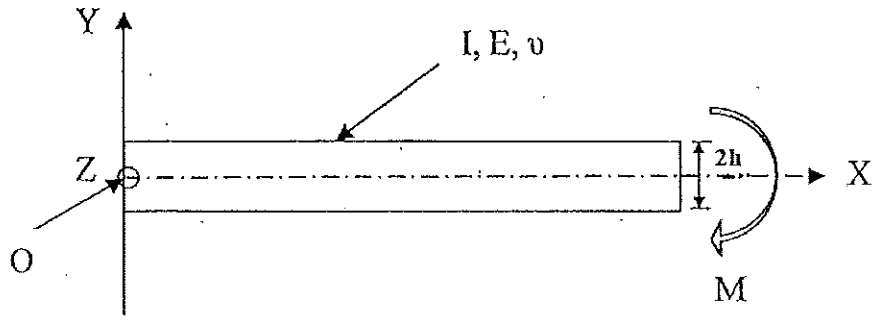

Figure. Q04

Question 05 - *(20 Marks)*

(a) i) What is the basic principle behind strain gauges?
ii) List out the required properties of strain gauges.

(b) The state of strain at a point on a bracket is measured using the strain rosette shown n Figure Q 05. The readings from the respective strain gauges ϵ_a, ϵ_b and ϵ_c are 80 x 10^{-6}, 140 x 10^{-6} and 250 x 10^{-6} respectively.
i) Determine the plain principle strains and directions along which they act at the point under consideration.
ii) Also determine the principle stress at the point. The Young's Modulus and the Poisson's ratio are respectively 190 GN/m^2, and 0.3.

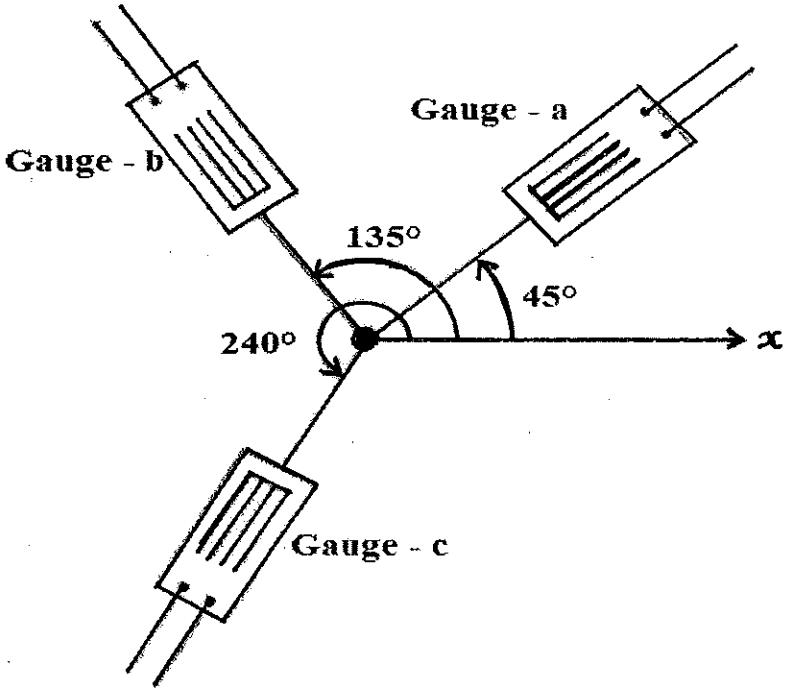

Figure. Q 05

Question 06 - *(20 Marks)*

(a) State the following theories.
- Tresca Stress criterion
- Von-Mises Stress criteria

(b) A structure is composed of circular members of diameter d. At a certain position along one member the loading is found to consist of a shear force of 10 kN together with an axial tensile load of 20 kN. If the elastic limit in tension of the material of the members is 270 MN/m^2 and there is to be a factor of safety of **4**, estimate the magnitude of ***d*** required according to,
i) the maximum principal stress theory, and
ii) the maximum shear strain energy per unit volume theory. Poisson's ratio $\nu = 0.283$.

Question 07 - *(20 Marks)*

(a) i) Why do most materials exhibit fracture strengths much lower than their theoretical capacities to support load?

ii) Explain why boring a hole in a part may extend its lifetime.

(b) A rectangular bar is notched on two sides as shown in Figure Q06. The dimensions of the bar are thickness **t = 0.2 cm, D = 2 cm, d =1.8 cm, h = 0.1 cm**, and **r = 0.15 cm**. If an elastic load of **15 kN** is applied along the axis of the bar, what is the maximum stress in the vicinity of the notches? If the yield strength of the material is **950 MPa**, will the material yield near the notches under this load?

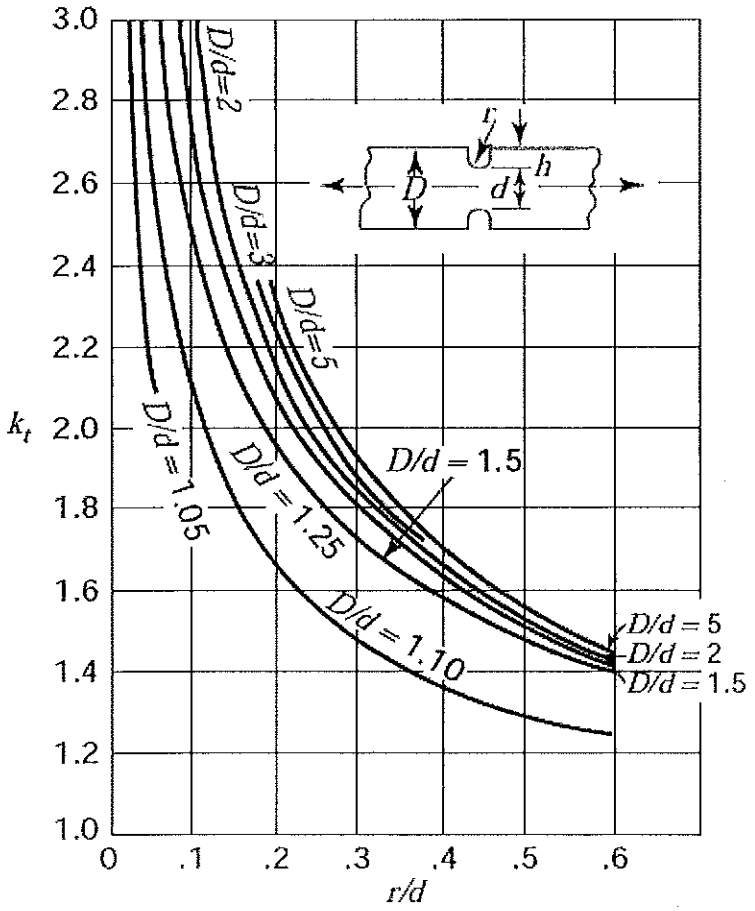

Figure. Q 06 Stress-concentration factors for axial loading of notched bar

Question 08 - *(20 Marks)*

(a) Briefly explain the word 'Photoelasticity'.

(b) What are the important properties you have to consider when selecting a material for photoelasticity?

(c) List main components of a plane polariscope and describe the function of each of them.

(d) What is the difference between a plane polariscope and a circular polariscope?

(e) Write down the Stress Optic Law of Photoelasticity.