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**University Examinations 2016/2017**

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN ELECTRICAL ENGINEERING.

**EMT 3253: SOLID AND STRUCTURAL MECHANICS**

**DATE: DECEMBER, 2016 TIME: 2 HOURS**

**INSTRUCTIONS: -** *Answer question* ***one*** *and any other* ***two*** *questions*

**QUESTION ONE (30 MARKS)**

1. (i) Differentiate between stress and strain (2 marks)

(ii) Name and briefly describe four types of strain (4 marks)

1. A steel wire is used to raise a load of 500 N. If the stress in the rod is not to exceed 95MN/M2, find the minimum diameter of the steel wire. (4 marks)
2. A tensile load of 80 KN is gradually applied to a circular bar of 6 cm diameter and 7.5 m long. If the value of $E$=2.0x105 N/MM2; determine;
3. Stress in the rod (2 marks)
4. Strain energy absorbed by the load (3 marks)
5. A body is subjected to two mutually perpendicular principle tensile stresses of unequal intensities of 180 N/mn and 75Nmm2 for major and minor tensile stresses respectively. Using Mohr’s circle, determine the magnitude of the normal and tangential stress acting on a plane inclined at 300 to the axis of the minor tensile stress. (5 marks)
6. A steel rod of 20 mm diameter passes centrally through a copper tube of 60 mm external diameter and 40 mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened lightly on the projecting parts of the rod. If the temperature of the assembly is raised by 600C, calculate the stresses developed in copper and steel. Take $E$ for steel and copper as 200GN/m2 and 100 GN/m2 and for steel and copper is 12x10-6 per 0C and 18x10-6 per 0C respectively. (6 marks)
7. The poisson’s ratio and Young’s modulus of a material are given as 0.25 and 1.2x105 N/MM2 respectively. Calculate the bulk modulus. (4 marks)

**QUESTION TWO (20 MARKS)**

1. A three dimensional body is subjected to three orthogonal normal stresses  citing in the directions of $x,y$ and $z$ respectively. If  and  are total strains in the directions of $x,y$ and $z$ respectively. Using a neat sketch, show that







Where = poisson’s ratio (10 marks)

1. A tensile test was conducted on a mild steel bar. The following data was obtained from the test;
2. Diameter of the steel bar = 3cm
3. Lange length of the bar = 25 cm
4. Load at elastic limit = 300 KN
5. Extension at a load of 150 KN = 0.25 MM
6. Maximum load = 400 KN
7. Total extension = 65mm
8. Diameter of the rod after failure = 2.25 cm

Determine:

1. The young’s modulus (3 marks)
2. Stress at elastic limit (2 marks)
3. The percentage elongation (2 marks)
4. The percentage decrease in are (3 marks)

**QUESTION THREE (20 MARKS)**

1. A cylindrical rod is subjected to an axial load P, leading to an increase in length and corresponding decrease in diameter. Using a diagram, show that volumetric strain induced in the rod is given by



Where

D=Diameter of the rod

L= length of the rod

increase in length of the rod

decrease in diameter of rod

volumetric strain. (11 marks)

1. A steel rod 6 m long and 40 mm in diameter is subjected to an axial tensile load of 50KN. Determine;
2. Change in length of the rod (3 marks)
3. Change in diameter of the rod (3 marks)
4. Change in volume of the rod (3 marks)

Take $E$=2x105 N/MM2

**QUESTION FOUR (20 MARKS)**

1. A cylindrical thin drum 100cm in diameter and 4m long has a shell thickness of 1 cm. If the drum is subjected to an internal pressure of 2.5 N/mm2, determine;
2. Change in diameter (3 marks)
3. Change in length (3 marks)
4. Change in volume (3 marks)
5. A cylindrical vessel whose ends are closed by means of rigid flange plates is made of steel 4 mm thick. The length and internal diameter of the vessel are 60 cm and 25 m respectively. For an internal fluid pressure of 4 N/mm2, determine
6. Longitudinal stresses in the vessel (2 marks)
7. Increase in length of vessel ( 3 marks)
8. Increase in diameter of vessel (3 marks)
9. Increase in volume of the vessel (3 marks)

Take $E$=2x105 N/mm2



**QUESTION FIVE (20 MARKS)**

1. (i) Define springs (1 mark)
2. Using well labelled diagrams, describe two main types of springs (6 marks)
3. A leaf spring carries a control load of 3000N. The leaf spring is to be made of 10 steel plates 5 cm wide and 6 mm thick. If the banding stress is limited to 150N/mm2, determine;
4. Length of the spring (3 marks)
5. Deflection at the centre of the spring (3 marks)

Take $E$=2x105 N/mm2

1. A closely coiled helical spring of round steel wire 10mm in diameter having 10 complete turns with a mean diameter of 12 cm is subjected to an axial load of 200N. Determine;
2. Deflection of the spring (3 marks)
3. Maximum shear stress in the wire (2 marks)
4. Stiffness of the spring (2 marks)

Take $C$=8x104 N/mm2