THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 03
FINAL EXAMINATION 2007/2008
MEX 3231– STRENGTH OF MATERIALS I
DATE :13th MAY 2008
TIME :0930 HRS - 1230 HRS
DURATION :03 HOURS

WRITE YOUR INDEX NUMBER CLEARLY

WRITE YOUR REGISTRATION NUMBER

READ THE FOLLOWING INSTRUCTIONS CAREFULY BEFORE ANSWERING THE QUESTION PAPER

PART – B

1. *PART – B consists of **eight** questions. Answer **only five** questions.*
2. *All questions carry equal marks.*
3. *Time allocation for Part B is **2 hrs and 15 minutes.***
4. *Do not spend more than **20 – 25 minutes** for each question.*
5. *Hand over **PART- B** separately.*

PART - B

QUESTION 01:

(a) A steel transmission shaft is 510 mm long and 50 mm external diameter. For part of its length it is bored to a diameter of 25mm and for the rest to 38 mm diameter. Find the maximum power that may be transmitted at a speed of 210 rev/min if the shear stress is not to exceed 70 MN/m^2.

(b) If the angle of twist in the length of 25 mm bore is equal to that in the length of 38 mm bore, find the length bored to the latter diameter.

QUESTION 02:

Two wooden planks 200 mm x 50 mm each connected to form a T-section of a beam as shown in FigQ2. If a moment of 6.4 kNm is applied around the horizontal neutral axis, inducing tension below the neutral axis, find the bending stresses at the extreme fibres of the cross section.

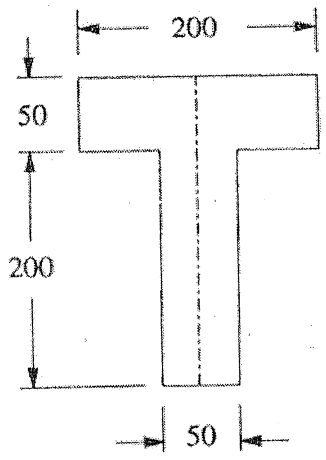

Fig.Q2

QUESTION 03:

Draw the shear force (S.F.) and bending moment (B.M.) diagrams for the beam loaded as shown in Fig.Q3, and determine

(a) the position and magnitude of the maximum B.M, and

(b) the position of any point of contraflexure.

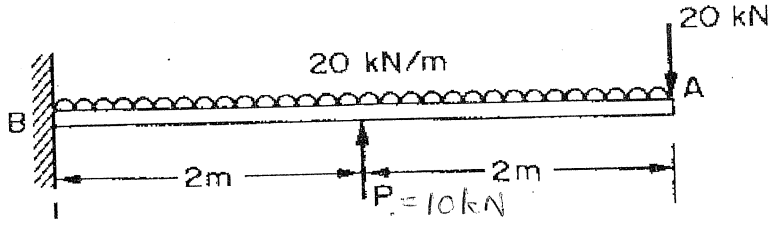

Fig.Q3

QUESTION 04:

(a) A copper tube, external diameter 40 mm, 6mm thick fits over a steel rod 25mm diameter. The tube is secured to the bar by 2 pins 10 mm diameter fitted transversely one at each end. If the temperature after the assembly is raised by 50^0 C, calculate the shear stress in the pins.

(b)

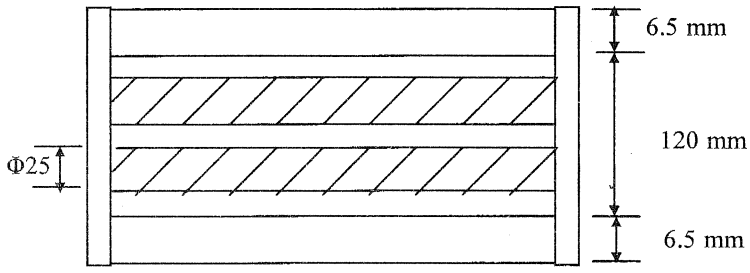

Fig.Q4

A copper tube of mean diameter 120 mm and 6.5 mm thick as shown in Fig.Q4 has its open ends sealed by two rigid plates connected by two steel bolts of 25mm diameter, initially tensioned to 20 kN at a temperature of 30^0 C, thus forming a pressure vessel. Determine the stresses in the copper and steel at freezing point, and the temperature at which the vessels would cease to be pressure tight.

E_{copper} = 100 GPa $\quad\quad$ E_{steel} = 200 GPa

$\alpha_{copper} = 2\times10^{-5} / {}^0C$ $\quad\quad$ $\alpha_{steel} = 1.2\times10^{-5} / {}^0C$

QUESTION 05:

(a) A reinforced concrete beam is 240 mm wide and 450 mm deep to the center of the reinforcing steel rods. The rods are of total cross-sectional area 1.2×10^{-3} m^2 and the maximum allowable stresses in the steel and concrete are 150 MN/m^2 and 8 MN/m^2 respectively. The modular ratio (steel : concrete) is 16. Determine the moment of resistance of the beam.

(b) If, after installation, it is required to up-rate the service loads by 30% and to replace the above beam with a second beam of increased strength but retaining the same width of 240 mm, determine the new depth and area of steel for tension reinforcement required.

QUESTION 06:

(a)

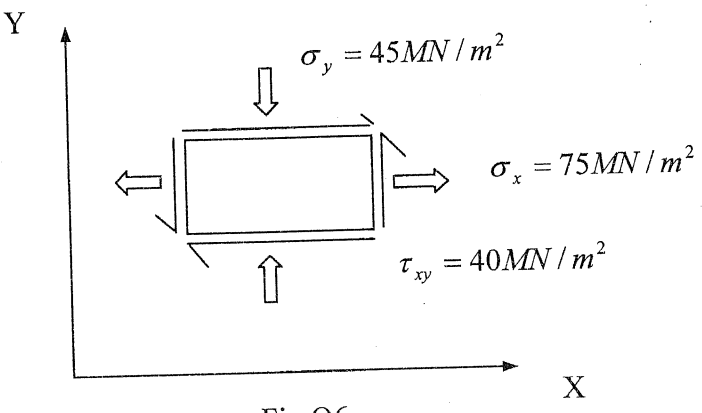

Fig.Q6

A thin plate whose stress element is shown in Fig.Q6 is made of a material with poison's ratio $\upsilon = 0.3$ and modulus of elasticity E = 200 GN/m^2 . If the plate is subjected to stresses

$\sigma_x = 75MN/m^2$ (tensile)

$\sigma_y = 45MN/m^2$ (compressive) and

$\tau_{xy} = 40MN/m^2$, draw a Mohr's circle of stresses and determine the principal stresses and maximum shear stress.

(b) (i) Find the shear modulus (G) for the above element.
(ii) Determine ϵ_x , ϵ_y and γ_{xy} for the element. (i.e. strain components in the x-y plane).

(c) (i) Draw a Mohr's circle of strains from the values obtained in (b) (ii)
(ii) Obtain the principal strains and maximum shear distortion using the above.

QUESTION 07:

Briefly discuss the following;

(i) fatigue failure
(ii) methods to improve the fatigue life of a given specimen
(iii) factors effecting the S-N curve
(iv) Creep

QUESTION 08:

(a) For a strain gauge rosette, with gauges oriented 45^0 apart, derive an expression for the principal strains based on the measurements of the gauges and hence calculate the principal strains.

(b) A strain gauge rosette (with gauges oriented 45^0 apart) is placed on the surface of a metallic beam. The beam is loaded and the measurements recorded by the three gauges are

$$\epsilon_0 = 592 \times 10^{-6} \text{ m/m} \quad \epsilon_{45} = -326 \times 10^{-6} \text{ m/m} \quad \epsilon_{90} = 740 \times 10^{-6} \text{ m/m}$$

(i) Calculate the principal strains
(ii) Calculate the maximum shear strain
(iii) How can this experiment be used to determine Poission's ratio for the material of which the beam is made?