SLOT: C2+TC2

**SCHOOL OF MECHANICAL ENGINEERING**
**CONTINUOUS ASSESSMENT TEST – I**
**FALL SEMESTER 2023-2024**

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| **Programme Name & Branch** | **: B.Tech. (Mechanical/Automotive)** |
| **Course Code** | **: BMEE202L** |
| **Course Name** | **: Mechanics of Solids** |
| **Faculty Name(s)** | **: DEVENDIRAN S, ASHIRBAD SWAIN, SENTHILNATHAN N, AKASH MOHANTY, MANIKANDAN M** |
| **Class Number(s)** | **: VL2023240101698/ 1701/ 1702/ 1696/ 1699** |
| **Exam Duration** | **: 90 minutes** **Maximum Marks: 50** |

**General instruction(s):** Answer all the questions. Assume the missing data (if any). Answer to-the-point and tabulate your final results.

| Q. No | Questions | Marks |
|---|---|---|
| 1. | A rigid horizontal bar of negligible mass is connected to two rods as shown in Fig 1. If the system is initially stress-free. Calculate the temperature change that will cause a tensile stress of 90 MPa in the brass rod. Assume that both rods are subjected to the change in temperature. The coefficient of expansion $\alpha_{brass}$ = 18.7 x $10^{-6}$ /$^{o}$C and $\alpha_{copper}$ = 16.8 x $10^{-6}$ /$^{o}$C. | 10 |

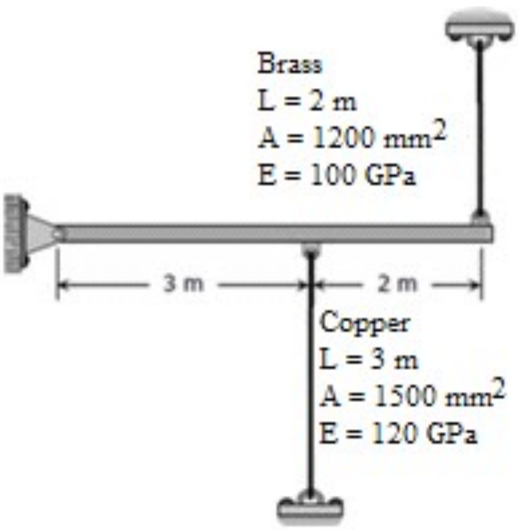
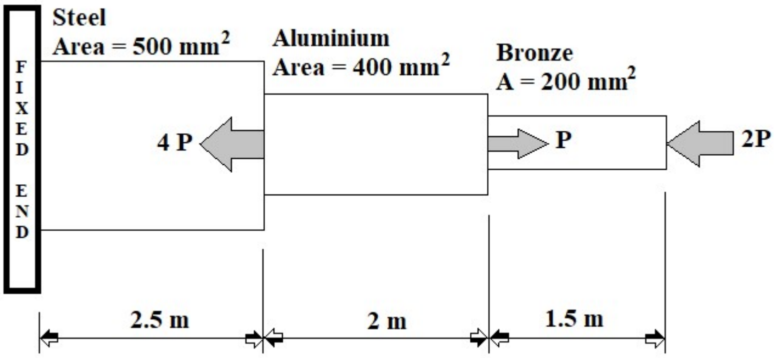
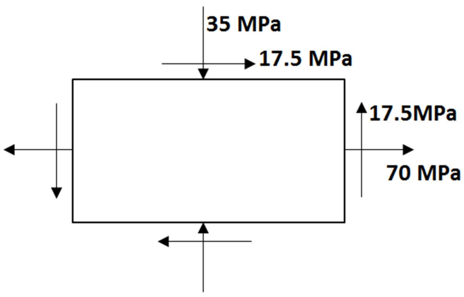
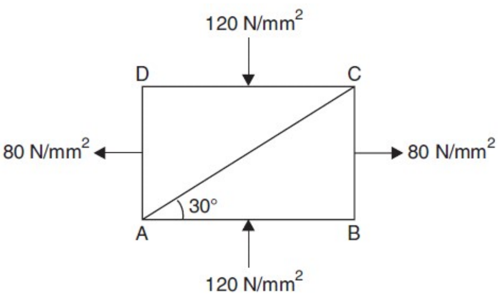



Fig. No. 1

| Q. No | Questions | Marks |
|---|---|---|
| 2. | A prismatic bar of circular cross-section is loaded by a tensile force of 85 kN. The length and diameter of the bar is 3.0 m and 30 mm respectively. It is made of aluminium with modulus of elasticity 70 GPa and Poisson's ratio of 1/3. Calculate the elongation, decrease in diameter and increase in volume of the bar. | 10 |

| | | |
|---|---|---|
| 3. | An aluminium rod is rigidly attached between a steel rod and a bronze rod, as shown in Fig 2. Axial loads are applied at the positions indicated. Find the maximum value of P that will not exceed a stress in steel of 140 MPa, in aluminium of 90 MPa, or in bronze of 100 MPa.   Fig. No. 2 | 10 |
| 4. | A point in a strained member is subjected to stresses as shown in Fig 3. Using Mohr's circle method, determine (i) the magnitude of the principal stresses and the inclination of the principal planes, (ii) the maximum shear stress and the plane on which it acts.   Fig. No. 3 | 10 |
| 5. | The direct stresses at a point in the strained material are 120 $N/mm^2$ compressive and 80 $N/mm^2$ tensile as shown in Fig 4. Find the normal and tangential stresses on the plane AC. Also find the resultant stress on AC. Use the numerical method.   Fig. No. 4 | 10 |

1. $\Sigma M_{support} = 0$

$5P_b - 3P_c = 0$

$5\sigma_b A_b - 3\sigma_c A_c = 0$

$\boxed{\sigma_c = 120\,MPa}$

$\delta = \frac{\sigma L}{E}$

Amount of deformation prevented in brass rod,

$\delta_b = 1.8\,mm.$

|||ly $\delta_c = 3\,mm.$

Net deformation in brass rod

$= \delta_b - \delta_{free\,deform(b)}$

Net deformation in copper rod

$= \delta_{free\,deform(c)} - \delta_c$

From geometry,

$$\frac{\delta_{free\,defom(c)} - \delta_c}{3} = \frac{\delta_b - \delta_{free\,defom(b)}}{5}$$

$$\frac{\alpha_c \Delta T l_c - \delta_c}{3} = \frac{\delta_b - \alpha_b \Delta T l_b}{5}$$

$\boxed{\Delta T = 56.01°C}$

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2. $\sigma = 120.25\ N/mm^2$

$\delta l = \frac{Pl}{AE} = \frac{\sigma l}{E} = 5.153\,mm$

Poisson's ratio $= \frac{\delta d/d}{\delta l/l}$

$\delta d = 0.0171\,mm.$

$$\frac{\delta V}{V} = \frac{\delta l}{l} - 2\frac{\delta d}{d}$$

$$\frac{\delta V}{V} = 0.5726 \times 10^{-3}$$

$\delta V = 1214.28\,mm^3$

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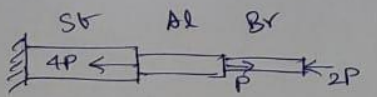
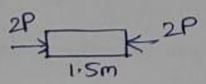
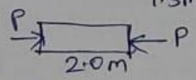
3.

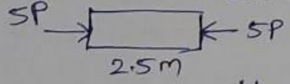



$\sigma = \frac{P}{A}$ $P = 10,000$ N




$P = 36,000$ N




$P = 14,000$ N.

Max. value of $P = \underline{\underline{10,000 \text{ N}}}$.

4. From Mohr Circle,

Major Principal Stress $= 72.84$ N/mm$^2$

Minor Principal Stress $= 37.84$ N/mm$^2$

Principal Plane angles $= 9°.215'$ & $99°.215'$

Max. shear Stress (radius) $= 55.34$ N/mm$^2$

Plane carrying max. shear stress $= 54°.215'$ & $144°.215'$.

5.

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta$$

$$= 30 \text{ N/mm}^2$$

$$\tau = \frac{\sigma_x - \sigma_y}{2} \sin 2\theta = 86.6 \text{ N/mm}^2.$$

Resultant Stress, $= 91.65$ N/mm$^2$ $\angle 19.1$.