Total No. of Questions—**12**] [Total No. of Printed Pages—**8+1**

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**[4757]-118**

**S.E. (Mechanical/Automobile) (Second Semester) EXAMINATION, 2015**

**STRENGTH OF MACHINE ELEMENTS**

**(2008 PATTERN)**

**Time : Three Hours** **Maximum Marks : 100**

***N.B.* :—** (*i*) Answer *three* questions from Section I and *three* questions from Section II.

(*ii*) Answers to the two sections should be written in separate answer-books.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*vi*) Assume suitable data, if necessary.

## SECTION I

**1.** (*a*) Draw and explain typical stress strain diagram for ductile materials indicating all the salient points. [6]

(*b*) Define and explain the following terms : [6]

(*i*) Modulus of Elasticity

(*ii*) Factor of safety

(*iii*) Thermal stress.

(*c*) A wooden tie is 60 mm wide, 120 mm deep and 1.5 m long. It is subjected to an axial pull of 30 kN. The stretch of the member is found to be 0.625 mm. Find the Young's Modulus for the tie material. [6]

*Or*

**2.** (*a*) Define and explain the following terms : [6]

(*i*) Hooke's Law

(*ii*) Poisson's Ratio

(*iii*) Bulk Modulus.

(*b*) Show that in a bar subjected to an axial load, the instantaneous stress due to sudden application of load is twice the stress caused by gradual application of load. [6]

$$\Sigma = 2\left(\frac{P}{A}\right).$$

(*c*) A rod of steel is 20 m long at a temperature of 20°C. Find the free expansion of the rod, when the temperature is raised to 65°C. Find the temperature stress produced : [6]

(*i*) When the expansion of the rod is prevented.

(*ii*) When the rod is permitted to expand by 5.8 mm.

Take $\alpha = 12 \times 10^{-6}$ per °C and $E = 2 \times 10^5$ N/mm$^2$.

**3.** (*a*) Derive the following equation of bending moment with usual notations and further write the relations of shear force and rate of loading. [6]

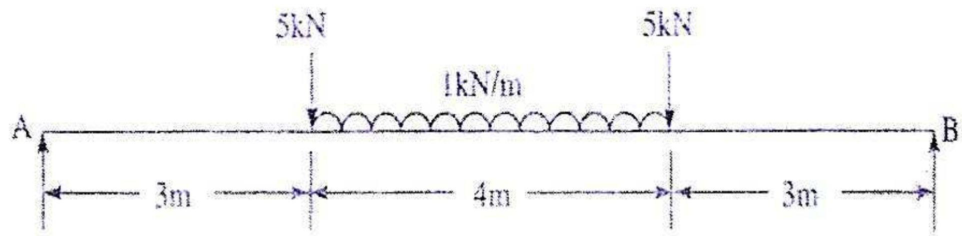
$$E.I.\left(\frac{d^2y}{dx^2}\right) = M.$$

(*b*) A beam is 10 m long and is simply supported at its ends. It carries concentrated loads of 100 kN and 60 kN at distances of 2 m and 5 m respectively from the left end. Calculate deflection under each load. Find also the maximum deflection.

Take $I = 18 \times 10^8\ mm^4$ and $E = 200\ kN/mm^2$. [10]

*Or*

**4.** (*a*) A beam AB 10 m long has supports at its end A and B. It carries a load of 5 kN at 3 m from A and a point load of 5 kN at 7 m from A and a udl of 1 kN/m between the point loads. Draw SF and BM diagrams for the beam. [12]



(*b*) Explain the following terms : [4]

(*i*) Point of contraflexure

(*ii*) Slope and deflection.

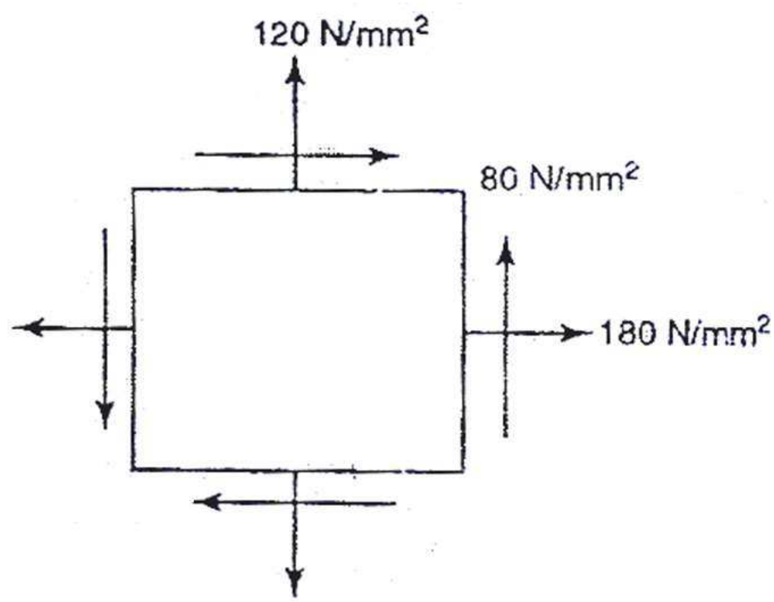
**5.** (*a*) The state of stress at a point in a strained material is as shown in following fig. Determine : [8]

(*i*) The direction of principal planes

(*ii*) The magnitude of principal stresses

(*iii*) The magnitude of maximum shear stress and its direction.

Use Mohr's circle method.



(*b*) A solid circular shaft is subjected to a bending moment of 40 kNm and a torque of 10 kNm. Determine the diameter of the shaft according to : [8]

(*i*) Maximum principal stress theory

(*ii*) Maximum shear stress theory.

Take $\mu$ = 0.25; stress at elastic limit = 200 N/mm$^2$ and factor of safety = 2.

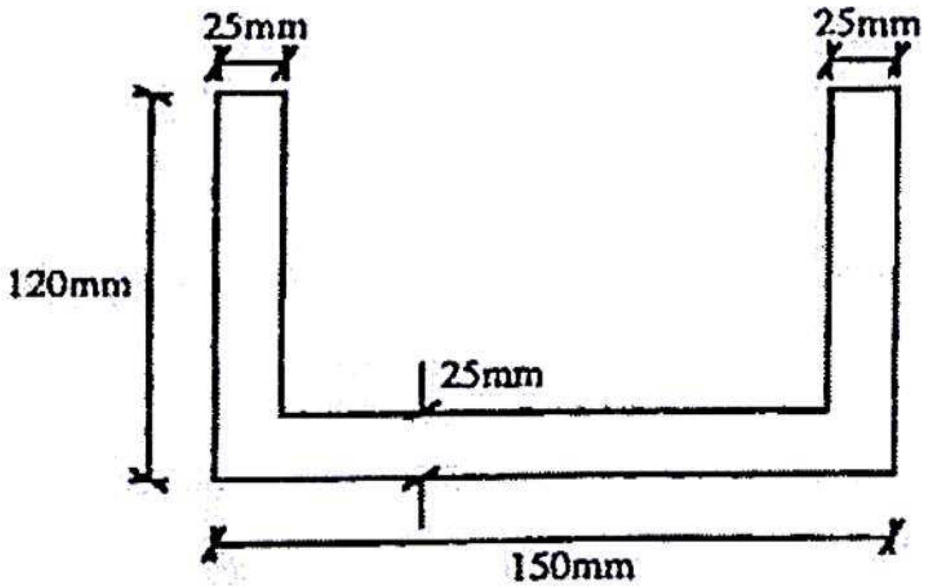
*Or*

**6.** (*a*) What are the various theories of failure ? Explain maximum principal stress theory and maximum shear stress theory. [8]

(*b*) The principal stresses at a point in a bar are 200 N/mm$^2$ (tensile) and 100 N/mm$^2$ (comp). Determine the resultant stress in magnitude and direction on a plane inclined at 60° to the axis of the major principal plane. Also determine the maximum intensity of shear stress in the material at the point. [8]

## SECTION II

**7.** (*a*) A horizontal beam of section 3 m long and is simply supported at its ends. Find the maximum udl it can carry, if the compressive and tensile stress must not exceed 55 N/mm$^2$ and 30 N/mm$^2$ respectively. Draw bending stress distribution diagram. [10]




(*b*) Show the shear stress variation in the following sections : [6]

(*i*) Rectangle

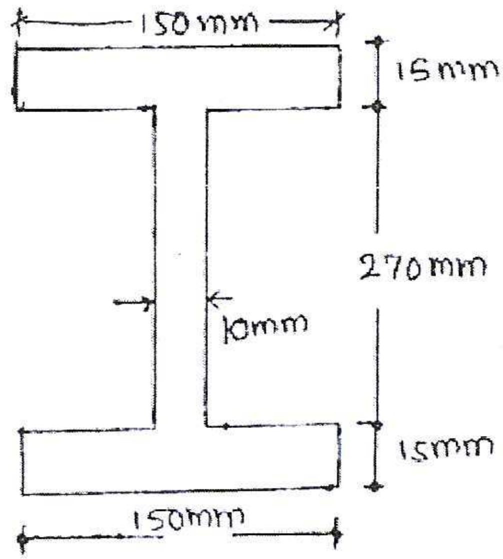
(*ii*) Hollow circle

(*iii*) I section

(*iv*) Triangle.

*Or*

**8.** (*a*) Draw shear stress distribution diagram for beam as shown. The section is subjected to S.F. of 150 kN. [8]




(*b*) Consider the beam subjected to pure bending by bending moment M and radius of curvature of neutral layer is R, moment of inertia is I and modulus of elasticity E. Derive an equation for magnitude of bending moment M in terms of E,I,R. [8]

**9.** (*a*) Compare the weights of equal lengths of hollow and solid shaft to resist same torsional moment for same maximum stress. Assume internal diameter 0.75 times the external diameter for hollow shaft. [8]

(*b*) Compare the crippling load given by Euler's and Rankine's formula for a tubular steel strut 2.3 m long having external diameter 38 mm and internal diameter 33 mm. Strut is fixed at one end and hinged at other end. Yield stress for steel 335 MPa, E = 205 GPa, $a$ = 1/7500. [8]

*Or*

**10.** (*a*) Derive Euler's formula for buckling load for column with hinged ends. Also state the limitations of Euler's formula. [8]

(*b*) A hollow shaft has 60 mm external diameter and 50 mm internal diameter : [8]

(*i*) Determine the twisting moment it can resist if permissible shear stress is 100 MPa.

(*ii*) Determine the diameter of solid circular shaft made of the same material which can transmit same twisting moment.

(*iii*) Compare their weights per meter length.

Take G = 80 GPa.

**11.** (*a*) Explain the various steps in the process of designing machine components. [6]

(*b*) A knuckle joint is subjected to an axial load of 70 kN. It is made of plain carbon steel with ultimate strength in tension 420 $N/mm^2$. The shearing strength of material is 396 $N/mm^2$. Take FOS as 6. [12]

*Or*

**12.** (*a*) Explain briefly the requisites of Design Engineer. [4]

(*b*) Explain the term 'Design for Environment'. [4]

(*c*) Design a cotter joint to transmit a load of 90 kN in tension or compression. Assume the following stress for socket, spigot and cotter : [10]

Allowable tensile stress = 90 MPa

Allowable crushing stress = 120 MPa

Allowable shear stress = 60 MPa.