Registration No. : | | | | | | | | | | |

Total number of printed pages – 4

B. Tech

PCME 4202

Third Semester Examination – 2013

MECHANICS OF SOLIDS

BRANCH : AUTO, MINING, MINERAL, MECH, CIVIL

QUESTION CODE : C- 500

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

Draw neat sketches wherever necessary. Assume any missing data suitably.

1. Answer the following questions : 2×10

(a) Briefly explain with an example what do you mean by Statically Indeterminate problems.

(b) State and briefly explain Saint Venant's principle.

(c) What is the purpose of wire winding of thin cylinders ?

(d) Explain the following terms :

(i) Resilience and

(ii) Poisson's ratio

(e) Sketch the Bending Moment Diagram of a simply supported beam subjected to a moment M at its mid-span.

(f) What do you mean by Section modulus and what is its significance ?

(g) What do you mean by Composite Beams ? Give an example.

(h) Write the expression for maximum deflection of a simple supported beam of span length 'l' carrying a concentrated load 'W' at the center of the beam.

(i) Differentiate between a column and strut and define slenderness ratio of a column.

(j) Give two mechanical components where you can use close-coiled helical spring.

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2. The state of plane stress at a point with respect to the xy-axes is shown in Figure Q. 2. Determine graphically

(i) the principal stresses and principal planes

(ii) the maximum in-plane shear stress iii) the equivalent state of stress with respect to the x′y′- axis. Show all results on sketches of properly oriented elements. 10

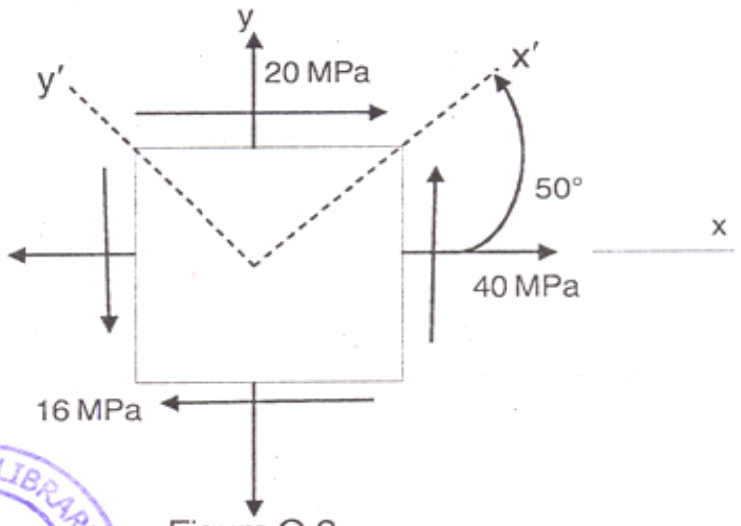

Figure Q.2

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3. (a) A cylindrical shell 2 meter long which is closed at its ends has an internal diameter of 1 meter and a wall thickness of 12 mm. Calculate the circumferential and longitudinal stresses induced and also the change in dimensions of the shell if it is subjected to an internal pressure of 2 MN/m^2.

Take E = 200 GN/m^2 and Poisson's ratio (μ) = 0.25 5

(b) A steel tube of 40 mm outer diameter and 30 mm inner diameter encloses a gun metal rod of 25 mm diameter and is rigidly joined at each end. If at a temperature of 40°C there is no longitudinal stress, determine the stresses developed in the rod and the tube when the temperature of the assembly is raised to 240°C. Take :

$\alpha_{steel} = 11 \times 10^{-6}$ /°C, $\alpha_{gun\ metal} = 18 \times 10^{-6}$ /°C ,

E_{steel} = 205 GPa, $E_{gun\ metal}$ = 91.5 GPa.

Also find the increase in length if the original length of the assembly is 1 meter. 5

4. Draw the shear force and bending moment diagrams for a 15-meter long beam simply supported at the positions shown in Figure Q.4. Find the point of contraflexture if any. 10

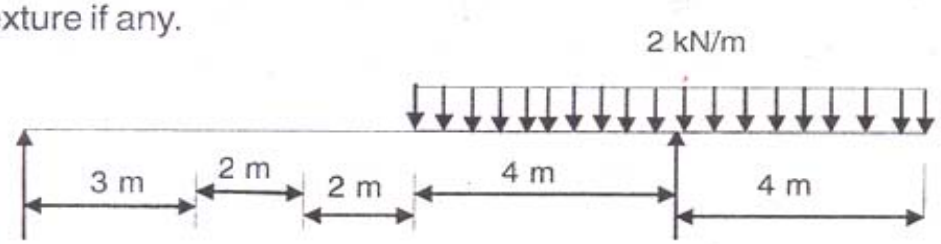

Figure Q.4

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5. In order to reinforce the steel beam, a wood is placed between its flanges as shown in the figure Q. 5. If the allowable normal stress for the steel is $(\sigma_{allow})_{st} = 168$ Mpa, and for wood $(\sigma_{allow})_{w} = 21$ Mpa, determine the maximum bending moment the beam can support, with and without the wood reinforcement. $E_{st} = 200$ Gpa, $E_w = 12$ GPa. The moment of inertia of the steel beam is $I_x = 7.93 \times 10^6$ mm^4, and its cross-sectional area (only steel beam) is $A = 5493.75$ mm^2. Without the wood the neutral axis coincide with the x-axis. 10

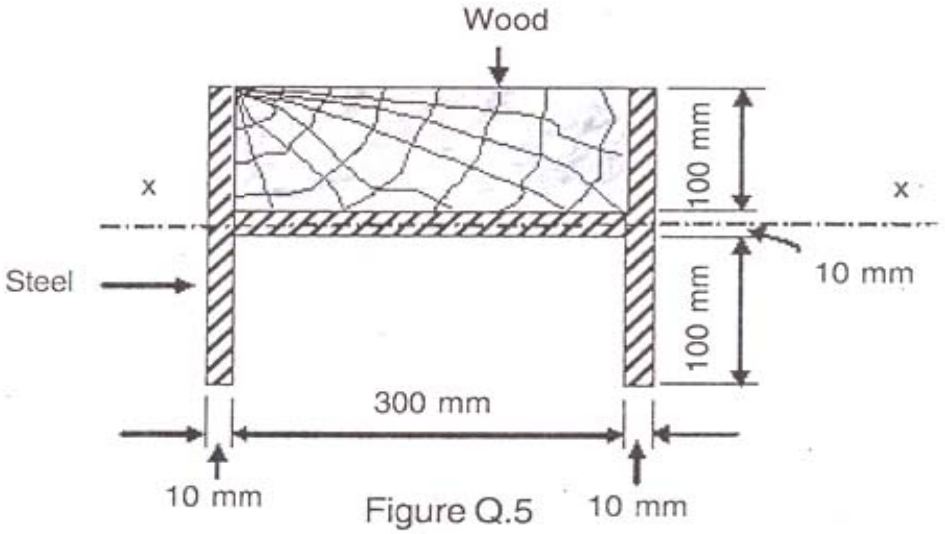

Figure Q.5

6. (a) A simply supported beam of 10 m length carries a point load of 100 kN and a pure moment of 100 kNm at 3 m and 7 m respectively from the left end. Find the slopes at the simply supported ends and the deflection under the point load. Also find the position and magnitude of maximum deflection. Take $E = 210$ GPa and $I = 180 \times 10^6$ mm^4. 5

(b) A steel bar of rectangular cross-section 2.5 cm × 5 cm is to be used as a column with pinned ends. What is the shortest length 'l' for which Euler's equation applies if E = 210 GPa and the proportional limit $\sigma_{p.l.}$ = 210 MPa. Also calculate the critical compressive stress for the column, if it is 120 meter long. 5

7. (a) A solid circular shaft and a thin-walled circular tube made of the same material and having the same weight are stressed in torsion to the maximum shear stress τ. What is the ratio of the amounts of strain energy stored in the two shafts ? 5

(b) A close coiled helical spring absorbs 70 Nm of energy, when compressed through 60 mm. There are 08 coils in the spring. The coil diameter is 10 times the wire diameter. Find the diameters of the coil and the wire and the maximum shear stress. Take G = 82 GPa. 5

8. (a) Two shafts having same length and material are joined in series. If the ratio of their diameters is 2, then what is the ratio of their angles of twist and shear stresses ? 5

(b) Prove the relation $\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$ for simple bending clearly stating the assumptions made while deriving the relation. 5

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