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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Third Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2017/Jan - 2018

Mechanics of Materials

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitably missing data if any.
iii) Draw neat sketches whenever necessary and show detailed calculations.

UNIT - I

1 a. Define the following :
(i) Stress (ii) Strain (iii) Factor of safety
(iv) Hooke's law (v) Modulus of elasticity. 10

b. Draw stress-strain diagram for ductile material and explain. 10

2 a. A rectangular bar of c/s 30 mm × 60 mm and length 200 mm is restrained from expansion along its 30 mm × 200 mm sides by surrounding material. Find the change in dimension and volume when a compressive force of 180 kN acts in axial direction. Take $E = 2\times10^5$ N/mm^2 and $\mu = 0.3$. 14

b. Derive the relationship between modulus of elasticity, modulus of rigidity and bulk modulus. 6

UNIT - II

3 a. A composite bar made up of copper, steel and brass is rigidly attached to the end supports as shown in Fig.Q.3a. Determine the stresses in the three portions of the bar when the temperature of the composite system is raised by 70°C, if (i) the supports are rigid, (ii) the supports yield by 0.6 mm. Given $\alpha_S = 12\times10^{-6}$ /°C, $\alpha_C = 17\times10^{-6}$ /°C. 10

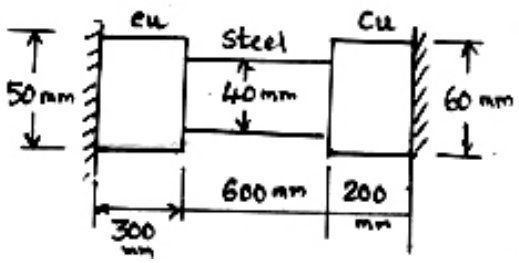

fig. Q.N.3.a.

b. Rails are laid such that there is no stress in them at 24°C. If the rails are 32 m long. Determine;
(i) The stress in the rails at 80°C, when there is no allowance for expansion
(ii) The stress in the rails at 80°C, when there is an expansion allowance of 8 mm per rail
(iii) The expansion allowance for no stress in the rails at 80°C
(iv) The maximum temperature for no stress in the rails when expansion allowance is 8 mm.
$\alpha = 11\times10^{-6}$/°C and E = 205 GPa. 10

4 a. Two pieces of wood of section 50 mm × 30 mm are joined together along a plane at 60° with *x*-axis. If the required strength of the joint is to be 7.5 MPa in tension and 4 MPa in shear, determine the maximum force which the member can sustain. 10

b. The state of stress in a two dimensionally stressed body is shown in Fig.Q.4b. Determine graphically the principal planes, principal stresses, maximum shear stress and their planes. 10

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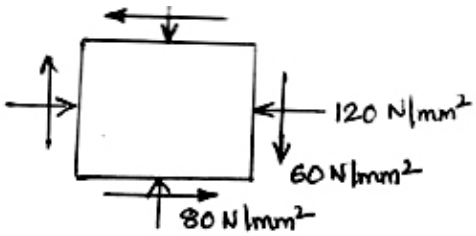

fig. Q.N. 4.b

UNIT - III

5 a. Derive a relation between load, shear force and bending moment. 6

b. A cantilever of 14 m span carries loads of 6 kN, 4 kN, 6 kN and 4 kN at 2 m, 4 m, 7 m and 14 m respectively from the fixed end. It also has a UDL of 2 kN/m run for the length between 4 m and 10 m from the fixed end. Draw the SFD and BMD. 14

6 a. Explain with neat sketches, the various types of supports and beams. 8

b. A simply supported beam of 7 m span with overhangs rests on supports which are 4 m apart. The left end overhanging is 2 m. The beam carries loads of 30 kN and 20 kN on the left and right ends respectively apart from a UDL of 25 kN/m between the supporting points. Draw the SF and BMD. 12

UNIT - IV

7 a. A circular pipe of external diameter 70 mm and thickness 8 mm is used as a simply supported beam over an effective span 2.5 m. Find the maximum concentrated load that can be applied at the centre of the span, if permissible stress in tube is 150 N/mm^2 and take I = 761195.33 mm^4. 10

b. The tension flange of a cast iron I-section beam is 240 mm wide and 50mm deep, the compression flange is 100 mm and 20 mm deep where as the web is 300 mm × 30 mm. Find the load per m run which can be carried over a 4 m span by a simply supported beam if the maximum permissible stresses are 90 MPa in compression and 24 MPa in tension. 10

Take I = 351.06×10^6 mm^4.

8. Find the maximum deflection and maximum slope for the beam loaded as shown in Fig.Q.8. 20

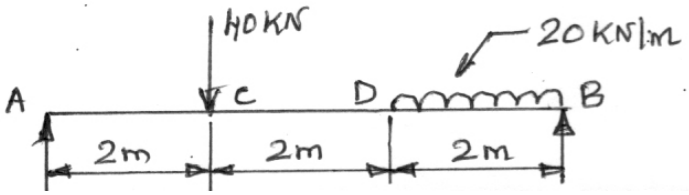

fig. Q.N. 8

UNIT - V

9 a. A thin cylinder of 200 mm inside diameter is 4 mm thick. The ends of the cylinder are closed by rigid plates and then it is filled with water under pressure. If an external axial pull of 75 kN is applied to the ends, the water pressure falls by 0.12 MPa. Find the value of the Poisson's ratio K = 2100 MPa and E = 150 GPa. 10

b. A shaft transmits 800 kW of power at 210 rpm. Determine the actual working stress and the diameter of the shaft if the shaft twists one degree on a length of 18 diameter and the shear stress is not to exceed 50 MPa. Take G = 81 GPa. 10

10 a. Determine column and list assumptions made in column analysis. 6

b. Obtain the expression for crippling load for a column for the following cases : 14

(i) One end fixed, other free (ii) Fixed at both ends.

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