5. (a) Define Principal Stress. 2

(b) An element in a stressed material has tensile stress of 500 MN/m^2 and a compressive stress of 350 MN/m^2 acting on two mutually perpendicular planes and equal shear stresses of 100 MN/m^2 on these planes. Find principal stresses and position of the principal plane. Find also maximum shearing stress. Solve by both graphical and analytical method. 14

(c) At a point in a material under stress, the intensity of the resultant stress on a certain plane is 50 MN/m^2 (tensile) inclined at 30° to the normal of that plane. The stress on a plane at right angles to this has a normal tensile component of intensity of 30 MN/m^2. Find :

(i) the resultant stress on the second plane,

(ii) the principal planes and stresses,

(iii) the plane of maximum shear and its intensity.

Solve by both Graphical and Analytical method. 14

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B. E. (Third Semester) Examination, Nov.-Dec. 2015

(New Scheme)

(Mech. Engg. Branch)

MECHANICS of SOLIDS-I

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. From each question part (a) is compulsory & attempt questions of 14 marks from the remaining parts. Assume suitable data if missing.*

1. (a) Write relation between : 2

(i) E & K

(ii) E & G

(b) Derive relation between E and G.

(c) A rigid bar is supported by three rods in the same vertical plane and equidistant. The outer rods are of brass and of length 600 mm and diameter 30 mm. The central rod is of steel of 900 mm length and of 37.5 mm diameter. Calculate the forces in the bars due to an applied force P, if the bar remains horizontal after the load has been applied. 7

Take $E_s/E_b = 2$.

(d) A steel rod 15 m long is at a temperature of 15°C. Find the free expansion of the length when the temperature is raised to 65°C. Find the temperature stress produced when:

(i) the expansion of the rod is prevented.

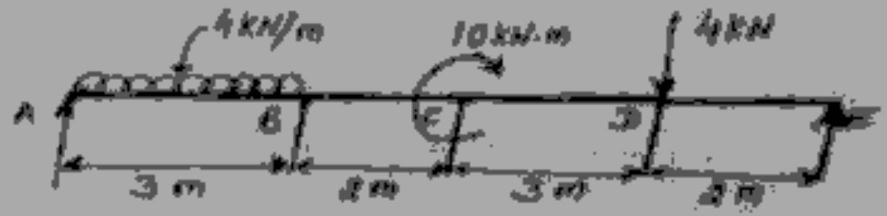
(ii) the rod is permitted to expand by 6 mm. 7

Take:

$\alpha = 12 \times 10^{-6}$ per °C and $E = 200$ GN/m^2.

2. (a) Define Point of Contraflexure. 2

(b) Draw SFD and BMD for given loading condition. 7



(c) Two wooden planks 150 mm × 50 mm each are connected to form a T-section of a beam. If a moment of 3.4 kNm is applied around the horizontal neutral axis, inducing tension below the neutral axis, find the stresses at the extreme fibres of the cross-section. Also calculate the total tensile force on the cross-section. 7

(d) Derive the variation of shear stress for rectangular cross-section is parabolic and also prove that:

$$\tau_{max} = 3/2\ \tau_{mean}.$$ 7

3. (a) Write down the formula for maximum deflection of a cantilever beam carrying a point load at the free end. 2

(b) Derive the expression for slope and maximum deflection for a simply supported beam carrying a UDL over the whole span. 14

A beam AB of 4 metres span is simply supported at the ends and is loaded as shown in figure. Determine:

(i) deflection at C,

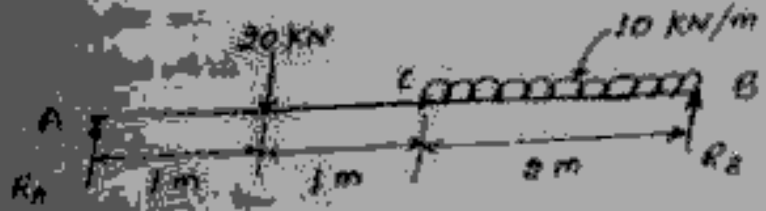
(ii) maximum deflection

and

(iii) slope at the end A. 14

Take $E = 200 \times 10^6$ kN/m^2 and $I = 20 \times 10^{-6}$ m^4

by Macaulay's method.



4\. (a) Define Torsional Rigidity.

(b) A solid alloy shaft 50 mm diameter is to be coupled in series with a hollow steel shaft of the same external diameter. If the angle of twist per unit length of the steel shaft is to be 70 percent of that of the alloy shaft find the internal diameter of the steel shaft. Also find the speed at which the shafts should be driven to transmit 20 kW if allowable shearing stresses in alloy and steel are 56 MN/m^2 and 80 MN/m^2 respectively. Take :

$$C_{steel} = 2.25\,C_{alloy}.$$ 14

(c) For a close-coiled helical spring subjected to an axial load of 300 N having 12 coils of wire diameter of 16 mm and made with coil diameter of 250 mm. Find

(i) axial deflection;

(ii) strain energy stored

(iii) maximum torsional shear stress in the wire

(iv) maximum shear stress using Wahl's correction factor.

Take $C = 80$ GN/m^2. 14