GX497

Ollscoil na hÉireann, Gaillimh

National University of Ireland, Galway

SECOND SEMESTER EXAMINATIONS, 1999

Third Civil Engineering Examination

Mechanics of Solids

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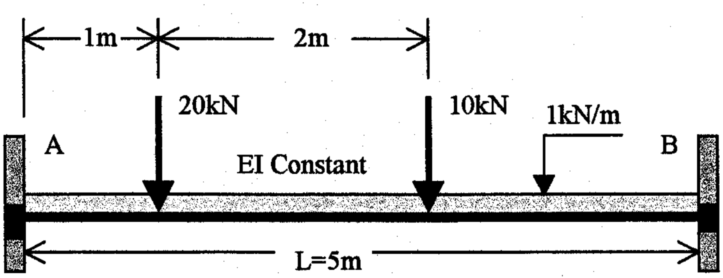
Time allowed: Three hours

Attempt *five* questions

1. At a point in a linear elastic material the strains in the x and y directions are $\varepsilon_{xx} = +350\mu\varepsilon$, $\varepsilon_{yy} = +50\mu\varepsilon$ and an unknown shear strain γ_{xy}. The axes x and y are perpendicular to each other. If a principal strain at this point is $+420\mu\varepsilon$, determine:
   a) The magnitude of the shear strain γ_{xy},
   b) The magnitude of the other principal strain and
   c) The principal stresses at the point.
   $E = 200\text{x}10^3$ MPa and $\nu = 0.3$

2. a) The beam in Fig. Q2 is fixed at A and B, it has constant section and its span is L = 5m. It has a uniform load of 1kN/m and point loads of 20kN and 10kN applied as shown. The self-weight of the beam may be ignored and the beam behaves in a linear elastic manner. Evaluate the end moments M_A and M_B.
   [The fixed-end moments M_A and M_B for the beam shown with a point load P at a distance x from support A are given by: $M_A = -\{Px(L-x)^2\}/L^2$, $M_B = -\{Px^2(L-x)\}/L^2$]
   b) Plot, to scale, the bending moment diagram for the beam. (Use graph paper).

Fig. Q2



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3. a) Derive the differential equations governing the behaviour of the following viscoelastic materials:

i) Linear Maxwell, (spring and dashpot in series) and

ii) Linear Kelvin, (spring and dashpot in parallel).

b) Evaluate and plot on graph paper the strain versus time for each of the above viscoelastic materials when subject to the following stress history:

$-\infty < t < 0, \quad \sigma = 0$ and $t \geq 0, \quad \sigma = \sigma_0$

4. A hollow steel shaft 100mm external diameter and 50 mm internal diameter transmits 750kW at 600 rev./min. The material of the shaft is linear elastic and the Shear Modulus G is 80×10^3 MPa.

a) Find the torque applied to the shaft.

b) Evaluate the maximum shear stress in the shaft.

c) Find the angular twist per meter length of shaft.

5. The I-section shown is made from a material that behaves in an ideal elastic-plastic manner. The yield stress is 300MPa. The I-section is used as a beam and when subject to certain loads the stress distribution at a particular section is as shown.

a) Evaluate the moment applied at the cross-section in question and

b) If the loads are removed determine the residual stress distribution at the cross-section.

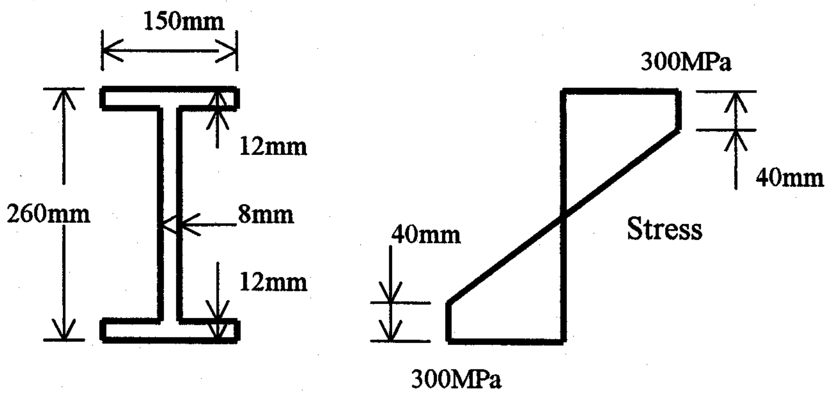

Fig. Q5

6. Determine the deflection curve and critical buckling load for the long column shown in Fig. Q6. The column is fixed at A and free at B. The column is subject to an axial load P and a lateral load F at the point B. EI is constant throughout the length of the column.

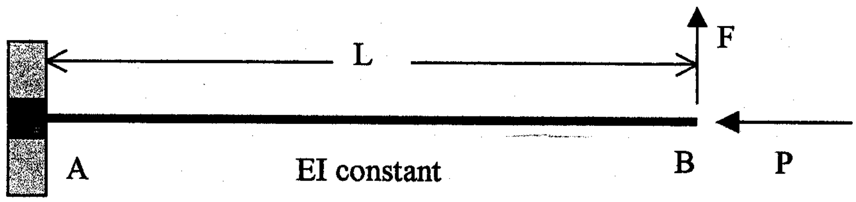

Fig. Q6

7. Find the principal axes and the principal second moments of area of the unequal leg angle section shown in Fig. Q7. Calculations should be made for centroidal axes.

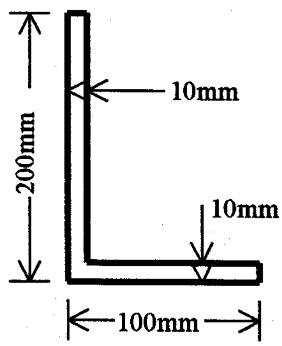

Fig. Q7

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