THE INSTITUTION OF ENGINEERS, SRI LANKA

PART I   EXAMINATION – AUGUST 2007

103 PROPERTIES & STRENGTH OF MATERIALS

Time Allowed: 3 hours

Answer **Five (5)** questions selecting at least two (02) from each of the two sections **A and B**.

Use Separate answer books for each section.

SECTION A

1)

a. Sketch the iron-carbon equilibrium phase diagram up to 6.67 weight percent of carbon.   [*12marks*]

b. Sketch the microstructure of the eutectoid alloy at 720^0 C and estimate the proportion of cementite in this alloy at this temperature.   [*06marks*]

c. Give the maximum amount of carbon that is dissolved in ferrite and austenite phases indicating the temperatures at which maximum solubility occurs.   [*02marks*]

2)

a. With the aid of suitable examples describe the process of nuclear fission.   [*03marks*]

b. Describe in detail how nuclear fission chain reactions are successfully used in power generation?   [*12marks*]

c. Calculate the amount of energy released by 1kg of deuterium due to the fusion of deuterium nuclei to form He-3 nuclei. Relative atomic masses of deuterium, neutron and helium are 2.015, 1.009, and 3.017 respectively. Assume that destruction of 1g of mass produces $931 \times 6.023 \times 10^{23}$ MeV of energy. Take $1eV = 1.6 \times 10^{-19}$ J   [*05marks*]

1

3)

    a. What is meant by the term 'close packed plane' in a crystal lattice?

                  [02marks]

    b. Sketch the atomic arrangements of the planes having the closest packing in BCC and FCC lattices. [04marks]

    c. Calculate the planar densities of each of the planes above in (b) taking the lattice constant as 2^0A. [04marks]

    d. Draw the engineering stress-strain diagrams usually obtained in a tensile test for mild steel and pure copper on the same axes. [04marks]

    e. Discuss the differences in the mechanical behavior of these two metals based on their crystal structures. [06marks]

4)   Give reasons for the following:

    a. Rotating shafts are usually prone to fail by fatigue. [05marks]

    b. Increased dislocation density can increase the strength of metals.

                  [05marks]

    c. Metals show steady rate of creep during the secondary stage.

                  [05marks]

    d. Addition of antimony (Sb) in small amounts to intrinsic silicon semiconductor increases its conductivity. [05marks]

SECTION B

(5) A simply supported beam is loaded as shown in Figure Q.5.

(i)   Find the support reactions.

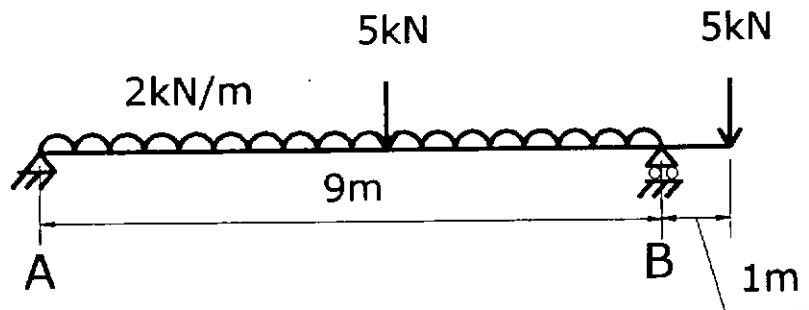(ii)   Draw the bending moment and shear force diagrams.

Figure Q5

(6) Cross section of a steel I beam, which is simply supported over span of 6 m is shown in Figure Q6. If the allowable stresses in tension and compression are limited to 150MPa, find the maximum weight of a point load that can be carried across the beam without exceeding the allowable stresses.
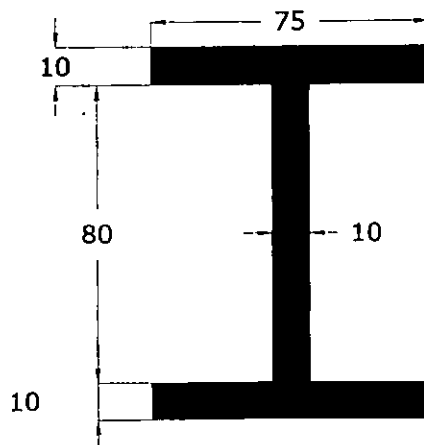

Figure Q6
(All dimensions are in millimetres)

3

(7) A propped cantilever, of length 9 m, is loaded by a uniformly distributed load of intensity 10kN/m over its central third, as shown in Figure Q7. Show that the maximum deflection occurs at 3.96 m from the simply supported end using Macaulay's method. Also calculate the magnitude of maximum deflection.

$E = 200$ kN/mm^2, $I = 8 \times 10^7$ mm^4.
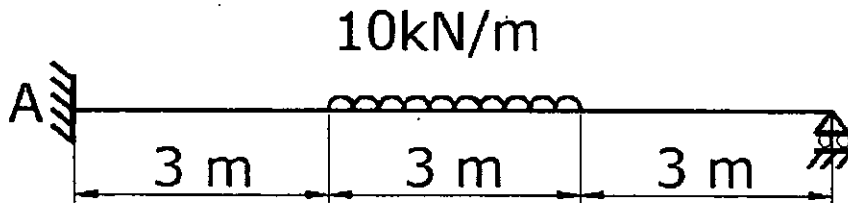
10kN/m

A

| 3 m | 3 m | 3 m |

Figure Q7

(8) A pin ended steel column has the cross section shown in Figure Q8. The yield stress of the strut material is 350 MPa and Young's modulus is 210 GPa. If the length of the strut column is 4 m find the maximum concentric axial load that can be carried by the strut without failing due to either yielding anywhere in the cross section or buckling in any lateral direction.
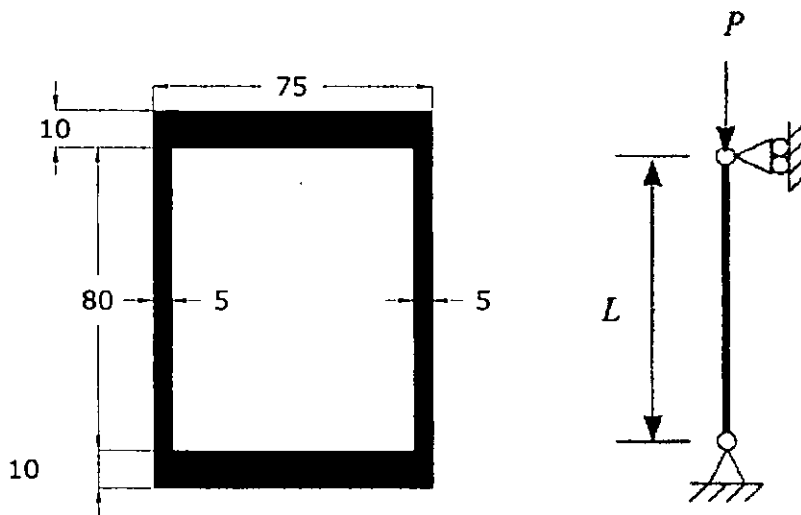
P

75

10

80 — 5   5

L

10

Figure Q8

(All dimensions are in millimetres)

4