1. (a) Differentiate between the following terms:

(i) modulus of elasticity and bulk modulus;

(ii) modular ratio and Poisson's ratio.

(4 marks)

(b) (i) Sketch and label a stress-strain graph for typical results obtained from a test on a mild steel rod tested under tension to destruction.

(ii) From the graph in (i), define **three** ranges of stress.

$(7\frac{1}{2}$ marks)

(c) A mild steel specimen was tested under tension to destruction from which the following data was collected:

Gauge length	195 mm
Original diameter	18 mm
Final length	205 mm
Diameter at fracture	16.5 mm
Extension at an early load of 48 kN	0.05 mm
Yield load	56 kN
Maximum load	190 kN

Determine:

(i) modulus of elasticity for the material;
(ii) yield stress;
(iii) ultimate stress;
(iv) percentage elongation;
(v) percentage area reduction;
(vi) working stress with a factor of safety of 1.75 applied on maximum stress.

($8\frac{1}{2}$ marks)

2014 simple stress

(b) A hollow steel tube 100 mm external diameter, 80 mm internal diameter and length 3.2 m is subjected to a tensile load of 40 kN. Calculate:

(i) the stress in the material;
(ii) extension of the tube, if the Young's modulus of elasticity is 210 kN/mm^2

2018

(7 marks)

(c) A mild steel specimen was tested in tension and the following results were obtained:

Diameter of specimen	-	20 mm
Length of specimen	-	200 mm
Extension under load of 10 kN	-	0.032 mm
Load at yield point	-	82 kN
Maximum load	-	133 kN
Length of specimen after fracture	-	252 mm
Diameter at the neck	-	12.6 mm

Calculate:

2018 (i) Young's modulus E; (4 marks)

(ii) ultimate stress ; (3 marks)

(iii) percentage elongation. (3 marks)

2. (a) A tension member 4 m long is made of timber and steel firmly fixed together side by side. The cross sectional area of the steel if 1300 mm^2 and that of timber is 4000 mm^2. If the maximum permissible stresses for the steel and timber used separately are 140 N/mm^2 and 8 N/mm^2 respectively.

Calculate:

(i) The safe load that the member can carry;

(ii) The elongation due to the load given that $E_{steel} = 205\ kN/mm^2$ and $E_{timber} = 8.2\ KN/mm^2$.

(8 marks)

2013 composite

3. (a) The diagram in figure 3 shows a bimetallic tube of 200 mm length. The tube carries a point load of 10 KN.

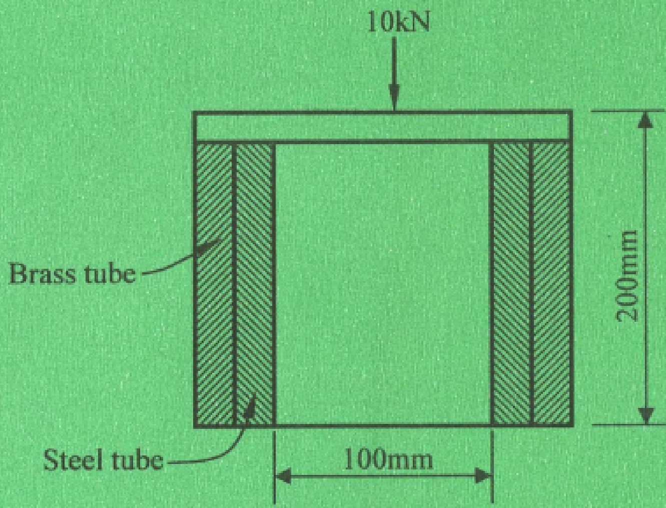

Fig. 3

Calculate:

(i) The load carried by each tube;

(ii) Change in the length of the tube.

Take:- $E_s = 2.1 \times 10^5$ N/mm^2
$E_b = 1.0 \times 10^5$ N/mm^2

(16 marks)

(b) Define the following terms:

(i) Bulk modulus;

(ii) Working stress;

(iii) Poison ratio;

(iv) Elasticity.

2015 composite materials

(4 marks)

3. (a) Define the following terms:

(i) Poisson's ratio;
(ii) Modulus of elasticity;
(iii) Modulus of rigidity;
(iv) Bulk modulus;

166. 2<

(4 marks)

(b) A short reinforced concrete column of section 250 mm diameter is to be reinforced with six steel bars and is required to carry an axial load of 450 kN. The stresses in concrete and steel must not exceed 7 N/mm^2 and 145 N/mm^2 respectively. Calculate:

(i) the diameter of steel bars required;
(ii) stresses in concrete and steel under this loading.

2016 Take $E_{concrete} = 14$ kN/mm^2 and $E_{steel} = 210$ kN/mm^2.

(12 marks)

2. (a) Define the following terms in relation to properties of materials:

(i) modulus of elasticity;

(ii) bulk modulus;

(iii) elastic limit;

(iv) strain. (4 marks)

(b) A solid steel bar, 500 mm long and 70 mm diameter is placed inside an aluminium tube having 75 mm inside diameter and 100 mm outside diameter. The aluminium cylinder is 0.15 mm longer than the steel bar. An axial load of 600 kN is applied to the bar and cylinder through rigid cover plates as shown in **figure 2**. Find the stresses developed in the steel bar and the aluminium tube.

2017 Take $E_s = 220$ kN/mm^2, $E_A = 70$ kN/mm^2. (10 marks

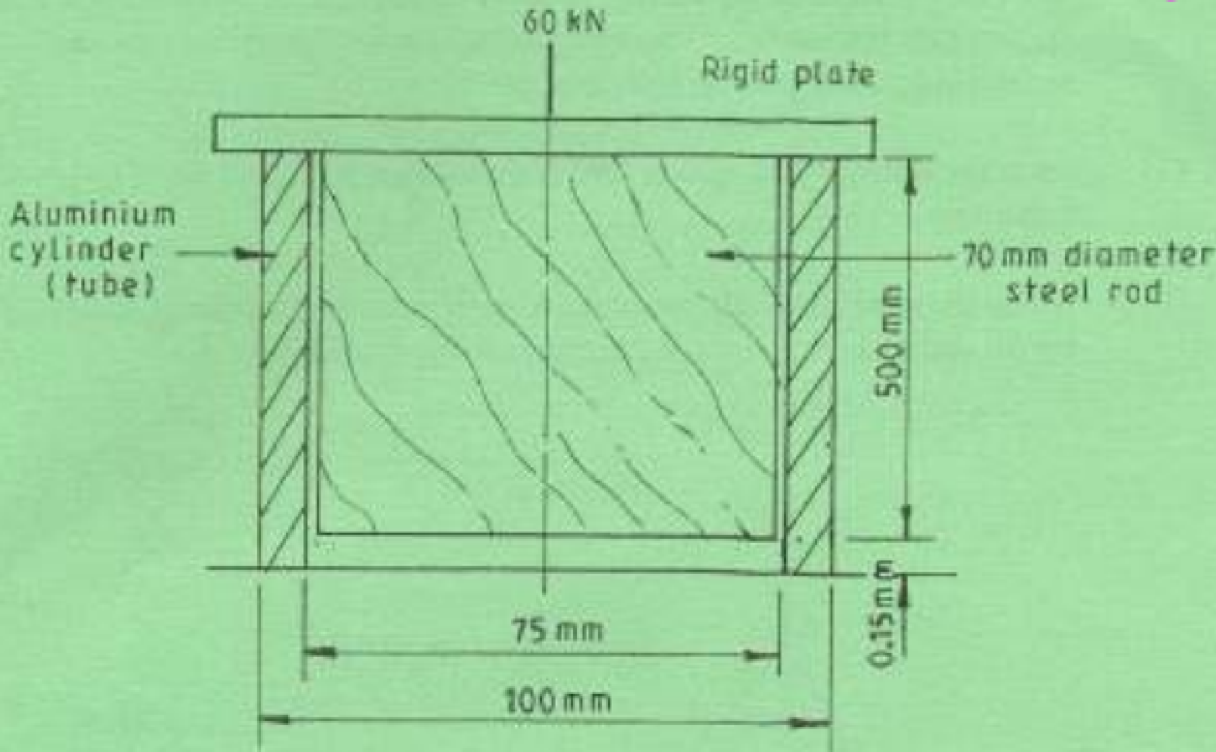

Figure 2

(c) A metal bar 50 mm x 50 mm section, is subjected to an axial load (compressive) of 500 kN. The contraction of a 200 mm gauge length is found to be 0.5 mm. Find the value of Young's modulus for the metal bar in kN/mm^2. (6 marks)

2017

3. (a) A composite timber and steel section is as shown in **figure 4**. Calculate the maximum safe uniformly distributed load that the section can carry when simply supported over a span of 3.5 m, given the following information:

Permissible stress in steel	=	150 N/mm^2
Permissible stress in timber	=	7 N/mm^2
m	=	20

(9 marks)

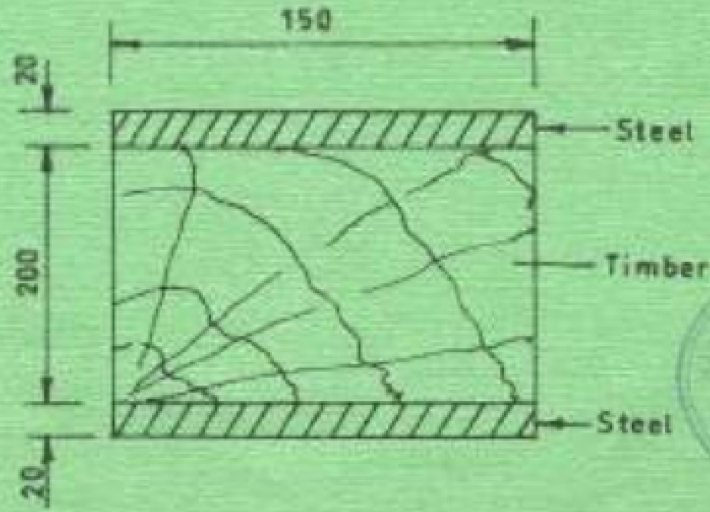

Fig. 4

1. (a) **Figure 1** shows a longitudinal section through a steel bar of varying sections. If a compressive force of 300 kN is applied to the bar, calculate:

(i) stress in each section;

(ii) total change in length of the section.

Take $E_{steel} = 210\,kN/mm^2$.

$\frac{P}{A}\left[\frac{L_1}{A_1} + \frac{L_2}{A_2} + \frac{L_3}{A_3}\right.$

(9 marks)

1.42 + 0.42 + 0.198 +

Fig. 1

(b) A concrete column 4 m high and 400 mm × 200 mm in section is reinforced with six No. 20 mm diameter steel bars. Calculate:

(i) safe axial load that can be applied to the column if the permissible stresses are limited to $7\,N/mm^2$ for concrete and 140 N/mm^2 for steel;

(ii) change in length that will take place in the column under this load.

Young's modulus: steel = 210 kN/mm^2
concrete = 14 kN/mm^2.

2019 composite materials

(11 marks)

(a) (i) Derive the temperature stress equation and state its main limitation.

(ii) A hollow circular copper section of external diameter 225 mm and thickness 4 mm is to be used as a strut. It is initially subjected to a pre-compressive force of 175 kN axially. Determine the stress and hence the thrust against the supports at the ends if it undergoes a change in temperature from 20°C to 125°C. Take the coefficient of thermal expansion for the material as 11×10^{-6} per °C and $E = 105 kN/mm^2$

(11 marks)

2014 Temperature stress and strain

(c) A steel rod 30 mm in diameter and 750 mm long is heated from 25°C to 95°C. Calculate the changes in diameter and length. Take coefficient of linear expansion of steel = 0.0000162 per °C.

(4 marks)

2016 Temperature stress and strain

1. (a) Define the following terms used in properties of materials:

   (i) thermal stress;

   (ii) thermal strain. (3 marks)

(b) A metal rod 20 mm diameter screwed at the ends passes through an aluminium tube of 25 mm and 30 mm internal and external diameters respectively. The nuts on the rods are screwed tightly on the ends of the tube. Find:

   (i) the intensity of stress in each metal when the common temperature rises by 150° C; (14 marks)

   (ii) load in each material. $\alpha \cdot \Delta T \cdot E$ (3 marks)

Take:

Coefficient of expansion per °C for steel $= 10 \times 10^{-6}$.
Coefficient of expansion per °C for aluminium $= 23 \times 10^{-6}$.
Modulus of elasticity for steel $= 200\ \text{kN/mm}^2$.
Modulus of elasticity for aluminium $= 90\ \text{kN/mm}^2$.

$\frac{\sigma_s}{E_s} = \frac{\sigma_a}{E_a}$

2018

1. A bar is 500 mm long and is stretched to 505 mm with a force of 50 kN. The bar is 10 mm diameter. Calculate the stress and strain.

   The material has remained within the elastic limit. Determine the modulus of elasticity.
   (Answers 636.6 MPa, 0.01 and 63.66 GPa.

2. A steel bar is stressed to 280 MPa. The modulus of elasticity is 205 GPa. The bar is 80 mm diameter and 240 mm long.

   Determine the following.

   i. The strain. (0.00136)
   ii. The force. (1.407 MN)

3. A circular metal column is to support a load of 500 Tonne and it must not compress more than 0.1 mm. The modulus of elasticity is 210 GPa. the column is 2 m long.

   Calculate the cross sectional area and the diameter. (0.467 m^2 and 0.771 m)

   Note 1 Tonne is 1000 kg.