BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH208

Department of Engineering and Physics

Bachelor of Science (Honours) Degree in Agricultural Engineering

Strength of Materials

3 HOURS (100 Marks)

INSTRUCTIONS

Answer any **FOUR** questions. Each carries **25 marks**

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1. A cylinder of diameter 230 mm has walls 5 mm thick and 1000 mm long. It is found to change in internal volume by $12\times10^{-6}\ m^3$ when filled with a liquid at a pressure of P. if E = 200G N/m^2 and $v = 0.25$ and assuming rigid end plates, determine:
   a) The value of the hoop and longitudinal stress. **[12 marks]**
   b) The modification to these values if joint efficiencies of 45 % for hoop and 85% for longitudinal are assumed. **[13 marks]**
2. A four meter long beam with rectangular section of 100 mm width and 200 mm depth is simply supported at the ends. If it is loaded with a uniformly distributed load of 4000 N/m throughout the span and a concentrated load P = 200 N placed at a distance of 1500 mm from the end. Determine the maximum bending stress in the beam. **[25 marks]**
3. A short column of I - section 200 mm × 160 mm has a cross - section as shown in Fig. Q3. A vertical load W acts through the centroid of the section together with parallel load of $\frac{W}{4}$ acting through a point on the center line of the web, distance 60 mm from the centroid measured towards the longer flange. Calculate:
   i) The greatest allowable value of W if the maximum compressive

stress is not to exceed 80 MN/m^2. **[13 marks]**

ii) The minimum stress in the section? **[12 marks]**

4. a) A solid shaft, 100 mm diameter, transmit 75 kW at 150 rev/min. determine the value of the maximum shear stress set up in the shaft and the angle of twist per meter of the shaft length if E = 80 GN/m^2. **[12 marks]**

b) If the shaft were now bored in order to reduce weight to produce a tube of 100 mm outside diameter and 60 mm inside diameter, what torque could be carried if the same maximum shear stress is not to be exceeded? What is the percentage/weight ratio effected by this modification. **[13 marks]**

5. a) State any five modes of failure of an engineering material in use. **[5 marks]**

b) A steel tube has a mean diameter of 100 mm and a thickness of 3 mm. Calculate the torque which can be transmitted by the tube with a factor of safety of 2.25 if the criterion of failure is:

i. Maximum shear stress. **[7 marks]**

ii. Maximum strain energy. **[6 marks]**

iii. Maximum shear strain energy. **[7 marks]**

The elastic limit of the steel in torsion is 225 M/m^2 and poison's ratio v = 0.3.

6. The results of a tensile test are: Diameter of specimen 15mm; gauge length 40 mm; load at limit of proportionality 85 kN; extension at limit of proportionality 0.075 mm; maximum load 120 kN; final length at point of fracture 55mm. Determine:

i. a) Young's Modulus of elasticity. **[10 marks]**

ii. b) The ultimate tensile strength. **[5 marks]**

iii. c) The stress at the limit of proportionality and **[5 marks]**

iv. d) The percentage elongation. **[5 marks]**

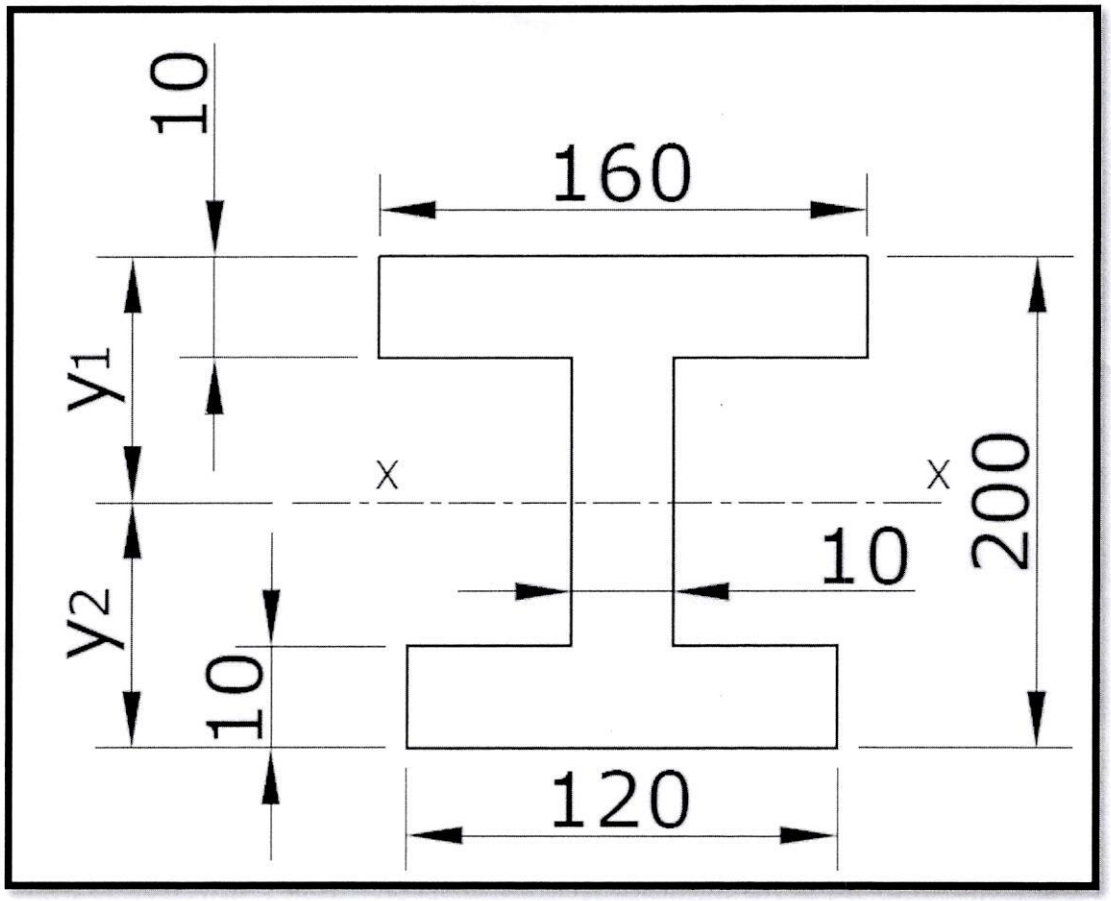

Fig. Q3: I - Section

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