KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWBLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: **REN 211**

COURSE TITLE: **SOLID MECHANICS**

DURATION: 2 HOURS

DATE: 13/12/202 **TIME: 2:00-4:00PM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **4** printed pages. Please Turn Over

QUESTION 1 (30 marks)

a. Define the following terms:
   i. Load (1 mark)
   ii. Stress (1 mark)
   iii. Strain (1 mark)
   iv. Poisson's Ratio (1 mark)
   v. Moment (1 mark)

b. A specimen of cross section 50 mm x 50 mm was initially 200 mm long parallel to the grain. After an axial compressive load of 40 kN was applied, the specimen shortened by 0.29 mm. Calculate the Young's Modulus of the specimen. (5 marks)

c. A strip of cross section 20 mm x 30 mm and length 1 metre is subjected to an axial push of 6 kN. It shortens by 0.05 mm. Taking μ =0.3, calculate:
   i. the stress induced in the bar (1 mark)
   ii. strain in the bar (1 mark)
   iii. Young's modulus (1 mark)
   iv. The new breadth and depth. (2 marks)

d. A hollow circular shaft is required to transmit a torque of 6 kNm and is 5 m long. If the maximum permissible angle of twist is 2 degrees over the whole length, determine the diameters required when in a ratio of 2: 1. Take G = 70 kN/mm^2 (5 marks)

e. With the aid of sketches, describe any five types of beams depending on how they are supported. (5 marks)

f. Find R_A and R_B in Fig. 1. (5 marks)

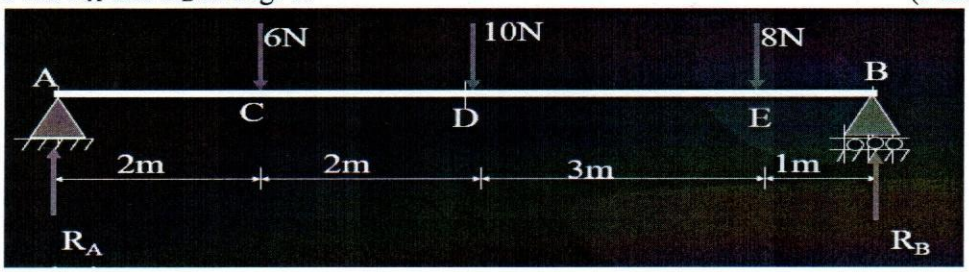

Fig. 1

QUESTION 2 (20 marks)

a. State Hooke's Law. (2 marks)

b. Draw the stress strain curve showing all the important points. (3 marks)

c. State any five (5) assumptions made in the theory of simple bending. (5 marks)

d. The section shown in Fig. 2 below is that of a cantilever 8 m long carrying a uniform load of 6 kN/m, which is applied perpendicular to the x–x axis. Calculate:
   i. The maximum bending stress in the beam under this loading. (5 marks)
   ii. The maximum concentrated load that may be carried at the free end of the cantilever in addition to the uniform load, if the permissible bending stress is 120 N/mm^2. (5 marks)

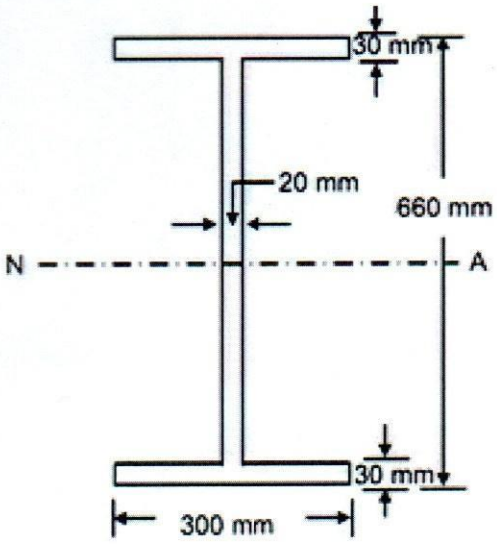

Fig. 2

QUESTION 3 (20 marks)

Fig. 3 is a single side overhanging beam subjected to loading as shown below. Calculate:

i. The reactions at A and B. (5 Marks)
ii. Draw the shearing force diagram. (5 marks)
iii. Draw the bending moment diagram. (5 marks)
iv. Determine the point of contra flexure. (5 marks)

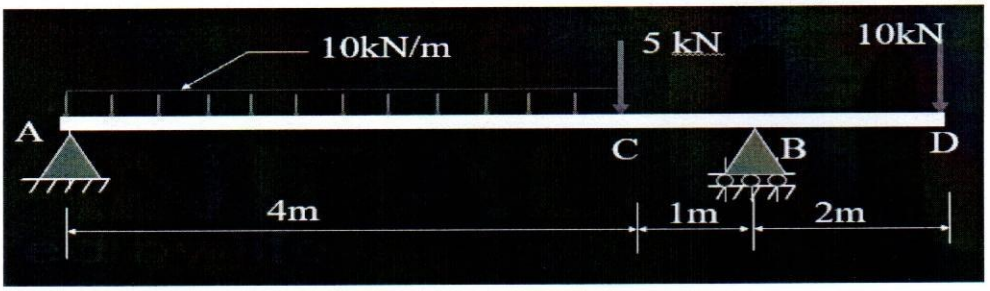

Fig. 3

QUESTION 4 (20 marks)

a. Determine the increase in length of a steel tie-rod 3 m long and 30 mm diameter when subjected to a tensile load of 120 kN. Take E = 205 kN/mm^2 (5 marks)
b. A short hollow, cast iron cylinder with wall thickness of 15 mm is to carry compressive load of 200 kN. Compute the required outside diameter 'D', if the working stress in compression is 80 N/mm^2. (5 marks)
c. Calculate the maximum torque that may be transmitted by a solid circular steel shaft of diameter 150 mm and length 2.5 m if the shearing stress is not to exceed 75 N/mm^2. Take shear modulus = 82 kN/mm^2. (5 marks)

d. A cantilever of length 2 m fails when a load of 4 kN is applied at the free end. If the section of the beam is 50 mm x 80 mm, find the stress at the failure. (5 marks)

QUESTION 5 (20 marks)

a. Derive the Euler-Bernoulli equation of simple bending. (10 marks)

b. A truck with axle loads of 40 kN and 60 kN on a wheel base of 5 m rolls across a 10 m span. Compute:

i. The maximum bending moment. (7 marks)

ii. The maximum shearing force. (3 marks)