



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

**UNIVERSITY EXAMINATIONS FOR THE DEGREE IN SCIENCE IN
RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT**

2ND YEAR 1ST SEMESTER 2017/2018 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TET 3212

COURSE TITLE: SOLID MECHANICS

EXAM VENUE: WS

STREAM: BSc REN ENERGY TECH & MGT

DATE: 21/12/2017

EXAM SESSION: 2.00 – 4.00PM

DURATION: 2 HOURS

Instructions

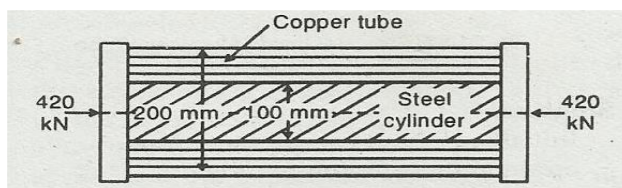
- 1. Answer question 1 (Compulsory) and ANY other two questions**
- 2. Candidates are advised not to write on question paper**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room**

QUESTION ONE

- i. Differentiate between a *deformable* body and a *rigid* body (4 Marks)
- ii. As a student undertaking a course in Renewable Energy, Technology and Management, explain how you will be able to apply the knowledge of this subject in future in the field (3 Marks)
- iii. In an experiment carried out in an engineering lab at JOOUST, students observed that when a heavy metallic block was gradually placed on a wooden seat made of plywood the chair was able to withstand the load. When the same load was brought very close to the seat (almost touching) and suddenly let go, the seat broke. Explain what could have caused the failure in the second case (5 Marks)
- iv. Briefly describe the following properties of structural materials (8 Marks)
 - a) Strength
 - b) Hardness
 - c) Elasticity
 - d) Ductility
- v. Differentiate between the following (6 Marks)
 - a) Load and stress
 - b) Strain and elongation
- vi. Briefly explain the following (4 Marks)
 - a) Torque
 - b) Torsion

QUESTION 2

- a) State Hooke's law (3 Marks)
- b) Explain what you understand by toughness as concerns properties of materials (3 Marks)
- c) Give any two examples of a working condition of a machine element that must rely on the property of toughness (4 Marks)
- d) A steel cylinder is enclosed in a copper tube as shown. The cylinder and the tube are compressed between rigid parallel plates. Find the stresses in steel and copper and the compressive strain under an axial thrust of 420kN. Internal diameter is 100mm and external diameter is 200mm. $E_s = 2.0 \times 10^5$ MPa and $E_c = 1.2 \times 10^5$ (5 Marks)



- e) A steel rod, 25mm diameter and 5m long, is subjected to an axial pull 65kN. If $E = 2 \times 10^5$ MN/m², determine the stress, strain and elongation (5 Marks)

QUESTION 3

- i. Briefly explain the following terminologies as used in solid mechanics (6 Marks)
 - a) Young's Modulus
 - b) Modulus of rigidity
 - c) Bulk Modulus
- ii. Explain what you understand by compressive load and compressive stress using also illustrative diagrams (6 Marks)
- iii. A square bar of 20mm side is held between two rigid plates and is loaded axially with a force of 150kN as shown in fig Q3.1. $E = 2 \times 10^8 \text{ kN/m}^2$. (4 Marks)
 - a) Develop free body diagrams for sections AB and BC
 - b) Determine the reactions at the ends A and C
 - c) Determine the extension of the portion AB.

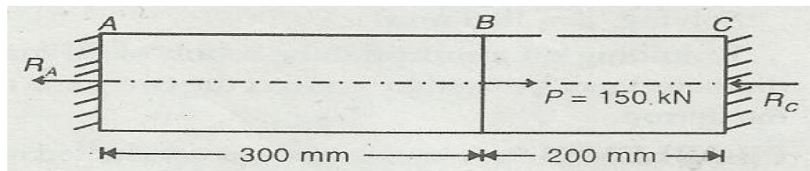


Fig Q3.1

- iv. A short hollow cast iron cylinder of wall thickness of 10 mm is to carry a compressive load of 600 kN. Assuming the ultimate strength of the material as 500 MN/m^2 and a factor of safety of 4, determine the size of the cross-section (4 marks).

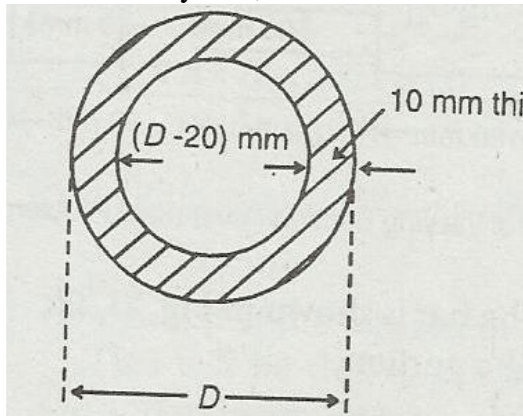


Fig Q 3.2

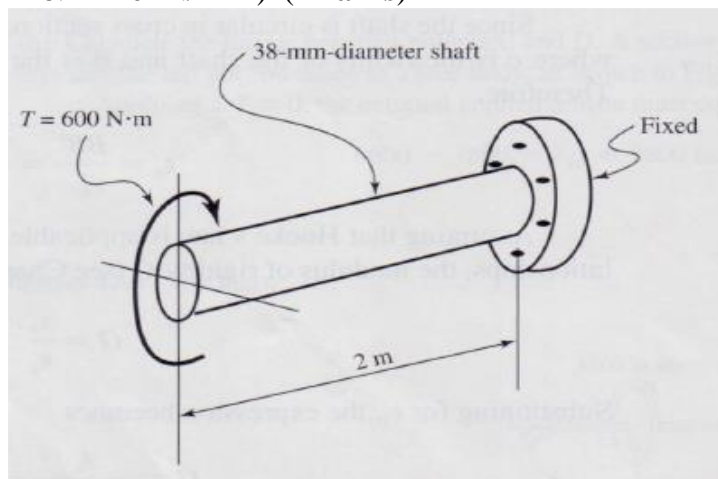
QUESTION 4

- i. Under what circumstance would a change in temperature in a member cause stress in the member? (2 marks)
- ii. Considering the deformation of a member subjected to some external load;
 - a) What do you understand by the term Poisson's ratio? (2 Marks)
 - b) Illustrate using a diagram the phenomenon in a) above (2 marks)

- iii. Draw a typical stress - strain curve for a ductile material (**6 Marks**)
- iv. Using the curve drawn in iii above, explain the behaviour of the material at or between the following points (**8 Marks**)
- Start to Limit of Proportionality (LP)
 - LP/EL to Yield Point (YP)
 - YP to Ultimate Strength (US)
 - US to Breaking Stress (BS)

QUESTION 5 (20 Marks)

- Briefly explain the meaning of the following (**3 Marks**)
 - Shaft
 - Torsional member
 - A couple
- In a power transmission system of a motor vehicle using gears, the arrangement is such that a driver gear is much smaller than the driven gear. Explain what happens to speed and torque from input to output shafts. You may use also diagrams to illustrate your answer (**3 Marks**)
- A 38mm solid steel shaft , 2m long is subjected to a torque of 600N.m. the shaft has one end completely restrained. The shaft is made of steel which is AISI hot rolled (take $G = 8.4 \times 10^4 \text{ N/mm}^2$) (**7marks**)



- A steel shaft of solid circular section has to transmit 300kW at 200 rpm. The maximum shear stress is not to exceed 50 MPa and the angle of twist not more than 1° in a length of 3 m. Select a suitable diameter if $G = 8.4 \times 10^4 \text{ N/mm}^2$. (**7 Marks**)