



# UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, APRIL/MAY 2019

**COURSE NO:** GL 124

**COURSE NAME:** STRENGTH OF MATERIALS

**CLASS:** GL I [Unihubgh.com](http://Unihubgh.com)

**TIME:** 3 HOURS

Name: \_\_\_\_\_ Index Number: \_\_\_\_\_

## ANSWER ALL QUESTIONS IN YOUR ANSWER BOOKLET

### SECTION A

*Choose the correct answer from the list of options given for each question. Indicate the correct answer in your answer booklet. The question paper must be tied loosely into the answer booklet and therefore not leaving the Examination Room.*

- A steel bar of rectangular cross-section 25 mm x 20 mm carries an axial tensile load of 5 kN. What is the average tensile stress in the cross-section?
  - 10 MPa
  - 200 Pa
  - 500 Pa
  - 1000 N/m<sup>2</sup>
- A steel bar of length 200 mm is at a temperature of 10 °C. If the material properties are; E = 210 GPa and  $\alpha = 12 \times 10^{-6}/K$ . Find: The new length of the bar when it is heated to 23 °C.
  - 198.35 mm
  - 200.69 mm
  - 300.48 mm
  - 100.05 mm
- The deformation per unit length is called \_\_\_\_\_.
  - Tensile stress
  - Strain
  - Compressive stress
  - Shear stress
- All of the following are basic deformation of forces acting on a body **except**
  - Tension
  - Displacement
  - Bending
  - Torsion
- The torque transmitted by a solid shaft of diameter (D) is \_\_\_\_\_  
(where  $\tau$  = Maximum allowable shear stress)
  - $\frac{\pi\tau d^3}{4}$
  - $\frac{\pi\tau d^3}{64}$
  - $\frac{\pi\tau d^3}{16}$
  - $\frac{\pi\tau d^3}{32}$
- A beam which is completely supported at one end by being framed in a solid wall and free at the other end is called \_\_\_\_\_.
  - Simply supported beam
  - Overhang Beam



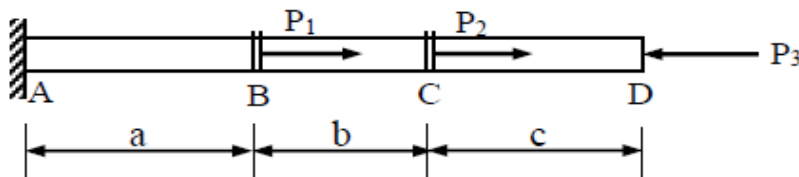
- a.  $T\omega$  watts
- b.  $2\pi T\omega$  watts
- c.  $\frac{2\pi T\omega}{75}$  watts
- d.  $\frac{2\pi T\omega}{4500}$  watts
16. If all the support reactions in a beam cannot be determined by the laws of static equilibrium, then the beam is said to be \_\_\_\_\_
- a. Determinate
- b. Indeterminate
- c. Equilibrium
- d. Perfectly rigid
17. The product of the tangential force acting on the shaft and its distance from the axis of the shaft (i.e. radius of shaft) is known as \_\_\_\_\_
- a. Twisting moment
- b. Flexural rigidity
- c. Torsional rigidity
- d. Bending moment
18. Which of the following statement is correct?
- a. Stress is the pressure per unit area.
- b. Strain is expressed in mm
- c. Hook's law holds good up to the breaking point
- d. Stress is directly proportional to strain within elastic limit
19. The ratio of the largest load in a test to the original cross-sectional area of the test piece is called \_\_\_\_\_
- a. Elastic limit
- b. Ultimate stress
- c. Breaking stress
- d. Yield stress
20. \_\_\_\_\_ tends to deform element by causing the right-hand phase to move downward with respect to the left-hand phase
- a. Negative shear stress
- b. Positive shear stress
- c. Bending Moment
- d. Shear force

**SECTION B**  
**INSTRUCTIONS**

- Answer **all** questions
- Full credits will be given to clear logical and logical presentation of solution rather than mere writing of final ANSWERS.
- Begin each question on a **FRESH PAGE**.

**QUESTION 1**

- a) A steel bar AD (see figure) has a cross-sectional area of  $260 \text{ mm}^2$  and is loaded by forces  $P_1 = 12 \text{ kN}$ ,  $P_2 = 8 \text{ kN}$ , and  $P_3 = 6 \text{ kN}$ . The lengths of the segments of the bar are  $a = 1.5 \text{ m}$ ,  $b = 0.6 \text{ m}$ , and  $c = 0.9 \text{ m}$ .
- i. Assuming that the modulus of elasticity  $E = 210 \text{ GPa}$ , calculate the change in length  $\delta$  of the bar. Does the bar elongate or shorten? **(8 marks)**
  - ii. By what amount  $P$  should the load  $P_3$  be increased so that end D of the bar does not move when the loads are applied? **(2 marks)**



**Figure 1**

- b) A 150 mm diameter steam pipe is laid in a trench at a temperature of  $13^\circ\text{C}$ . When steam passes through the pipe, its temperature rises to  $130^\circ\text{C}$ ;
- i. What is the increase  $\Delta d$  in the diameter of the pipe if the pipe is free to expand in all directions? **(3 marks)**
  - ii. What is the axial stress  $\sigma$  in the pipe if the trench restrains the pipe so that it lengthens only two-third as much as it would if it could expand freely? (Note: The pipe is made of steel with modulus of elasticity  $E = 200 \text{ GPa}$  and coefficient of thermal expansion  $\alpha = 12 \times 10^{-6} /^\circ\text{C}$ ). **(2 marks)**

**QUESTION 2**

- a) A steel pipe of length  $L = 1.2 \text{ m}$ , outside diameter  $d_2 = 150 \text{ mm}$ , and inside diameter  $d_1 = 110 \text{ mm}$  is compressed by an axial force  $P = 620 \text{ kN}$ . The material has modulus of elasticity  $E = 200 \text{ GPa}$  and Poisson's ratio  $\nu = 0.3$ . Determine the following quantities for the pipe:
- i. the shortening  $\delta$  **(2 marks)**
  - ii. the lateral strain **(2 marks)**

- iii. the increase  $\Delta d_2$  in the outer diameter and the increase  $\Delta d_1$  in the inner diameter **(2 marks)**
  - iv. the increase  $\Delta t$  in the wall thickness **(2 marks)**
  - v. the increase  $\Delta V$  in the volume of the material **(2 marks)**
- b) A solid shaft has diameter 20 mm, length 1 m and shear modulus of elasticity  $G = 70$  GPa. The bar is subjected to torques  $T$  acting at the ends.
- i. If the torque  $T = 300$  Nm, what is the maximum shear stress in the bar? **(3 marks)**
  - ii. What is the angle of twist between the ends? **(2 marks)**

***QUESTION 3***

- a) A tensile test is carried out on a bar of mild steel of diameter 25 mm. The bar yields under a load of 12 kN. It attains a maximum load of 18 kN and breaks finally at a load of 10 kN. Estimate:
- i. the tensile stress at the yield point. **(2 marks)**
  - ii. the ultimate stress. **(2 marks)**
  - iii. the average stress at the breaking point if the diameter of the neck is 14 mm. **(2 marks)**
  - iv. Determine the lateral strain at the breaking point. **(2 marks)**
  - v. If the initial length of the bar is 100 mm and the change in length of the bar at breaking point is 50 mm, determine the poisson's ratio. **(2 marks)**

**Examiner: Mr I. Osei/ Mr D. Yellezuome**