



## TECHNICAL UNIVERSITY OF MOMBASA

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**Faculty of Engineering and Technology**  
**Department of Mechanical & Automotive Engineering**  
**UNIVERSITY EXAMINATION FOR:**  
**Diploma in Mechanical Engineering**  
**EME 2206 : Solid & Structural Mechanics II**  
**END OF SEMESTER EXAMINATION**  
**SERIES: AUGUST 2019**  
**TIME: 2 HOURS**  
**DATE: Pick Date Aug 2019**

### **Instruction to Candidates:**

You should have the following for this examination

- *Student I.D. Card & Examination Pass*
- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt any **THREE** questions.

Maximum marks for each part of a question are as shown.

**Do not write on the question paper.**

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### **Question ONE**

- a) Derive the torsion equation and state the assumptions made in the analysis. **(10 marks)**
- b) A hollow steel shaft 400 mm external diameter transmits 9 MW at 120 rev/min. If the angle of twist measured over a length of 2 m is  $0.45^\circ$  and  $G$  is  $80 \text{ GN/m}^2$ , estimate the internal diameter of the shaft, the maximum shearing stress and the strain energy per metre length of the shaft. **(10 marks)**

### **Question TWO**

A steel shaft 3 m long is transmitting 1 MW at 240 rev/min. The working conditions to be satisfied by the shaft are:

- that the shaft must not twist more than 0.02 radian on a length of 10 diameters;
- that the working stress must not exceed  $60 \text{ MN/m}^2$ .

If the modulus of rigidity of steel is  $80 \text{ GN/m}^2$  what is

- a) the diameter of the shaft required
- b) the actual working stress;
- c) the angle of twist of the 3 m length?

(20 marks)

**Question THREE**

A close-coiled helical spring is required to absorb  $2.25 \times 10^3$  joules of energy. Determine the diameter of the wire, the mean diameter of the spring and the number of coils necessary if:

- (a) the maximum stress is not to exceed  $400 \text{ MN/m}^2$ ;
- (b) the maximum compression of the spring is limited to 250 mm;
- (c) the mean diameter of the spring can be assumed to be eight times that of the wire.

For the spring material  $G = 70 \text{ GN/m}^2$ .

(20 marks)

**Question FOUR**

Calculate the thickness and number of leaves of a semi-elliptic carriage spring which is required to support a central load of 2 kN on a span of 1 m if the maximum stress is limited to  $225 \text{ MN/m}^2$  and the central deflection to 75 mm. The breadth of each leaf can be assumed to be 100 mm.

For the spring material  $E = 210 \text{ GN/m}^2$ .

(20 marks)

**Question FIVE**

Determine by the method of either *unit load* or *Castigliano's first theorem*;

- a) The vertical deflection of point A of the bent cantilever shown in Fig. below when loaded at A with a vertical load of 600N.
- b) What will then be the horizontal movement of A?

The cantilever is constructed from 50 mm diameter bar throughout, with  $E = 200 \text{ GN/m}^2$ .

