



# **MACHAKOS UNIVERSITY**

**University Examinations for 2020/2021 Academic Year**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING**

**SECOND YEAR FIRST SEMESTER EXAMINATION FOR**

**BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)**

**EEE 212: MECHANICS OF MACHINES**

**DATE: 18/8/2021**

**TIME: 8.30-10.30 AM**

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## **INSTRUCTIONS**

**Answer question ONE and any other two questions.**

### **QUESTION ONE (30 MARKS) (COMPULSORY)**

- a) i With the aid of suitable sketches, distinguish between direct stresses and shear stress (2 marks)
- ii. Explain any two applications of Shearing in an engineering workshop (2 marks)
- iii. Factor of safety is an important aspect in engineering design. Discuss any two factors that influence the choice of a reasonable factor of safety. (3 marks)
- iv. A rubber pad for a machine mounting is to carry a load of 5kN and to compress 5mm. If the stress is not to exceed  $280 \text{ kN/m}^2$ , determine the diameter and thickness of the required pad of circular cross section. (4 marks)
- b) i An engine shaft is uniformly accelerated from 10 rpm to 20 rpm in 4 sec. The shaft continues to accelerate at this rate for the next 8 sec. Thereafter, the shaft rotates with uniform speed. Find the total time taken to complete 400 revolutions. (5 marks)
- ii. A body falling freely under gravity passes two points 10 metres apart vertically in 0.2 second. From what height, above the higher point, did it start to fall? (5 marks)

- c) A body of mass 10 kg moves over a smooth surface according to the equation:  
 $s = 5t + 2t^2$ , where (s) is the displacement in metres and (t) is the time in seconds. Determine the magnitude of force responsible for this motion. (3 marks)
- d) i. Distinguish between free and damped vibrations. (2 marks)
- ii. A vibrating system consists of a 200 kg mass, a spring of stiffness 80N/mm and a damper with a damping coefficient of 800N/m/s. Determine the frequency of vibration for this system (4 marks)

## QUESTION TWO (20MARKS)

- a) Draw the shear force and bending moment diagrams for the beam shown in Figure Q2 (a) and indicate on them the numerical values at all the critical points of the beam. (10 marks)

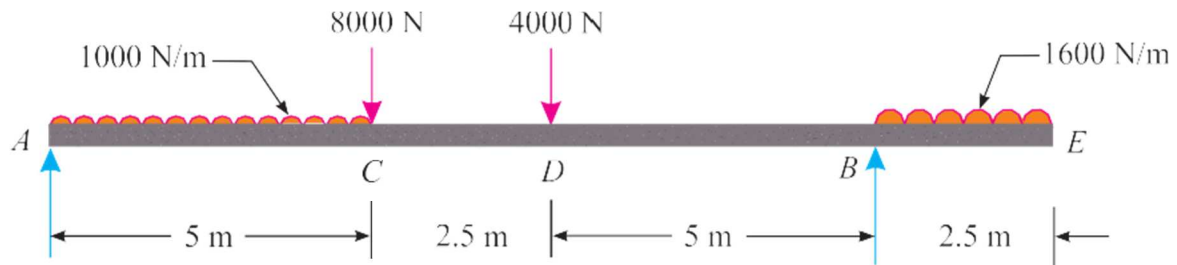


Fig. Q2 (a)

- b) Figure Qn 2 (b) shows the shear force diagram (in kN) for a beam ABCD of total length 7m.
- i. Draw the beam showing the loading on it. (5 marks)
- ii. Draw the Bending Moment Diagram for the beam. (5 marks)

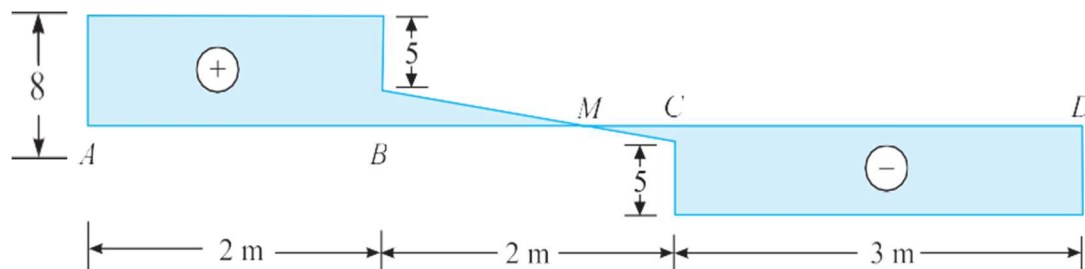


Figure Q2 (b)

### QUESTION THREE (20 MARKS)

- a) i. Distinguish between centre of gravity and centroid. (2 marks)
- ii. With reference to moments of inertia, state the parallel axis theorem. (2 marks)
- b) Determine the moment of inertia for the section shown in Figure Q3b:
- i. About the base AB. (4 marks)
- ii. About a centroidal axis x-x parallel to the base AB (3 marks)

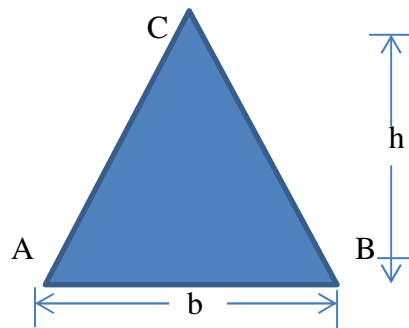


Figure Q3 (b)

- c) Determine the moment of inertia the hollow section shown in Figure Q3(c))about an horizontal axis passingthrough its centroid. (9 marks)

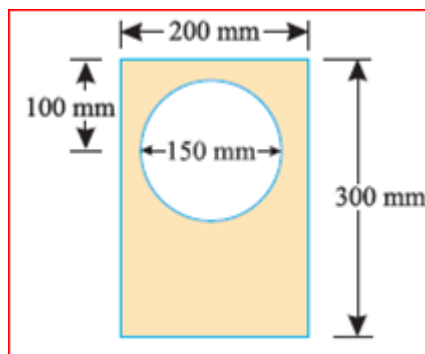


Figure Q3(c)

#### QUESTION FOUR (20 MARKS)

- a) i. State three assumptions made in the theory of pure bending. (3 marks)
- ii. Figure Q4 (a) shows a beam PQ before and after being subjected to pure bending where all the symbols have the usual meaning.

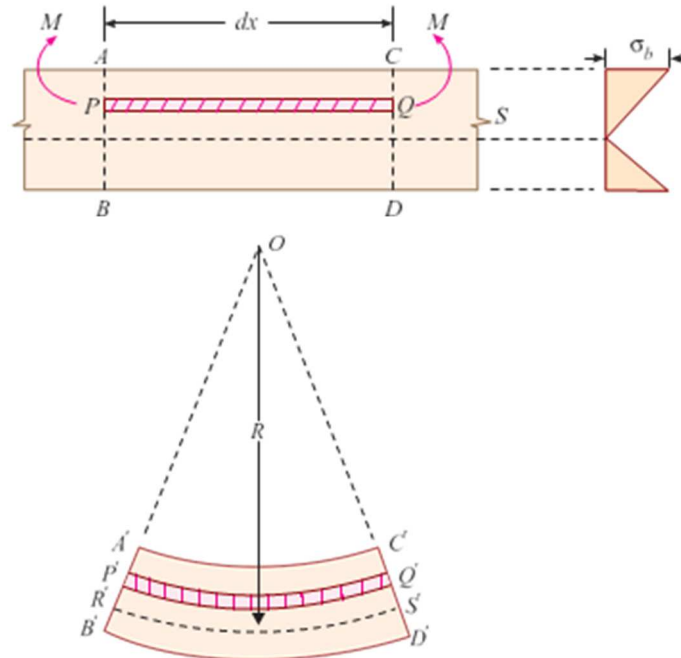


Figure Q4.(a)

Show that for this bending, the stress at any point is directly proportional to the distance of that point from the neutral axis. (6 marks)

- b) i A rectangular beam 300 mm deep is simply supported over a span of 4m. What uniformly distributed load can the beam carry, if the bending stress is not to exceed 120 MPa. Take  $I = 225 \times 10^6 \text{ mm}^4$ . (6 marks)
- ii) A cantilever has a rectangular section 80 mm width and 120mm depth. If the cantilever is subjected to a point load of 6 kN at the free end and the bending stress is not to exceed 40 MPa, find the span of the cantilever. (5 marks)

### QUESTION FIVE (20 MARKS)

- a) i. With the aid of suitable sketches, differentiate between a simple and a compound belt drive. (4 marks)
- ii) Find the difference in tensions in the two sides of a belt drive, when transmitting 120W at 30 m/sec (3 marks)
- iii) Two parallel shafts 6 m apart are provided with 900 mm and 300 mm diameter pulleys and are connected by means of a cross belt. The direction of rotation of the follower pulley is to be reversed by changing over to an open belt drive. By how much should the length of the belt be reduced? (4 marks)
- b) i. State two advantages and two disadvantages of using Gears in power transmission (4 marks)
- ii. Figure Q5C shows the gear transmission system of a workshop machine tool. The motor shaft for the machine tool rotates at 975 rpm and is connected to gear A. The final gear F is fixed on the output shaft G. The number of teeth on each wheel is as given below :

| Gear         | A  | B  | C  | D  | E  | F  |
|--------------|----|----|----|----|----|----|
| No. of teeth | 20 | 50 | 25 | 75 | 26 | 65 |

What is the speed of gear F ?

(5 marks)

