



# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

## *Faculty of Engineering and Technology*

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

### **DIPLOMA IN TECHNOLOGY**

Mathematics and Robotics Engineering (DMRE 4)

**UNIT CODE:** \_\_\_\_\_

## **VIBRATIONS, STRENGTH OF MATERIALS AND MACHINE DESIGN**

SEMESTER III EXAMINATIONS

**SERIES:** FEBRUARY 2011 SERIES

**TIME:** 2 HOURS

### **Instructions to Candidates:**

1. You are required to have the following for this examination;
  - Answer booklet
  - A non-programmable calculator
2. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions.
3. Take the value of acceleration due to gravity ( $g$ ) to be  $8.81 \text{ m/s}^2$ .
4. Question ONE carries 30 marks, Questions TWO, THREE, FOUR and FIVE carry 20 marks each.

**(COMPULSORY)**

### **Question ONE**

- a) i) Define the following terms:  
I) Simple Harmonic Motion  
II) Vibrations  
III) Frequency  
IV) Oscillation  
V) Amplitude (5 marks)
- ii) A body is moving with S.H.M. at a frequency of 2 Hz and an amplitude of 200mm. Calculate the displacement of the body after 2 seconds from the mid-position. (5 marks)
- b) State and explain the TWO types of vibrations. (4 marks)
- c) i) Show that the frequency in vertical motion is given by:  
$$\eta = \frac{1}{2\pi} \sqrt{\frac{g}{d}}$$
  
Where  $\eta$  = Frequency  
g = Gravitational force  
d = Static deflection. (6 marks)
- d) State and explain the THREE types of vibration damping. (6 marks)

**(ANSWER ANY OTHER TWO QUESTIONS)**

### **Question TWO**

- a) i) The beam shown below has a bending stress of 80MN/m<sup>2</sup>. What is the value of the load W. (8 marks)
- ii) State the FIVE main parameters that affect the amount of deflection of a beam.

(5marks)

- b) A robotic arm is carrying a 500g load and is rotating at 15 yards/s with a periodic time of 1.2 seconds. Calculate.
- The length of the arm.
  - The tension the arm is experiencing. (7 marks)

### **Question THREE**

- a) The triangular section solid shaft in Fig Q. 3 (a) can withstand a maximum shear stress of  $20\text{KN/m}^2$  with a deflection of 0.80mm. If the value of E for the shaft is  $60\text{KN/m}^2$ , calculate its maximum length (L). (19marks)
- b)
  - State any FOUR factors that determine the choice of a damping system for a vibrating body.
  - A 2 tonne vehicle is fitted with a suspension system of a co-efficient of 0.87. Determine:
    - The damping co-efficient of the system if the springs used have a stiffness of 470N/m.
    - The type of vibration damping. (7 marks)

### **Question FOUR**

- a) The figure below shows a beam undergoing combined loading.

Calculate:

- The reaction forces L and R.
  - If the beam is of circular cross-section with a radius of 0.4m, calculate the radius of circular of the beam portion A – B at point B. Given  $E = 50\text{KN/m}^2$ . (10marks)
- b) A shaft of 5m long and 200mm diameter is rotated by a 10KW power rated motor at 40 rpm. Calculate:
- The shear stress experienced by the shaft.
  - The angle of twist in degrees, given  $G = 84\text{GN/m}^2$ .
  - If the shaft weighs 0.5 tonnes, calculate its frequency and periodic time of the vibrations due to its rotation. (10marks)

### **Question FIVE**

- a) A 2m long square section beam of 75mm by 75mm is subjected to a bending moment of 2.5KN/m due to a circular motion at 20 rad/s.

Calculate:

- i) The maximum stress the beam experiences.
  - ii) The amount of power the beam develops. (10marks)
- b) The beam elongates to a total length of 10.54m after deflection. If the beam is of a square section with a width and breadth of 0.7m, calculate the total deflection of the shaft. (10marks)