



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

**BSME Y3S1**

**EMG 2304 : MECHANICS OF MACHINES II**

**END OF SEMESTER EXAMINATION**

**SERIES: APRIL 2016**

**TIME: 2 HOURS**

**DATE: 17 May 2016**

## **Instructions to Candidates**

You should have the following for this examination

-Answer Booklet, examination pass and student ID

-scientific calculator

-Drawing instruments

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

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

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## **Question ONE**

A three-cylinder compressor is arranged such as shown in figure 1, with the three pistons operated from a common crank and of  $60^\circ$  between the axes of the cylinders. The reciprocating masses are 9 kg for cylinder 1 and 3, and 6kg for cylinder 2. The crank radius is 40 mm; and the ratio of connecting rod to crank is 5 for each cylinder. Determine:

- the primary unbalanced force at a speed of 960 rev/min,
- the suitable balance mass at crank radius for vertical primary balance,
- the unbalanced secondary force

(20 marks)

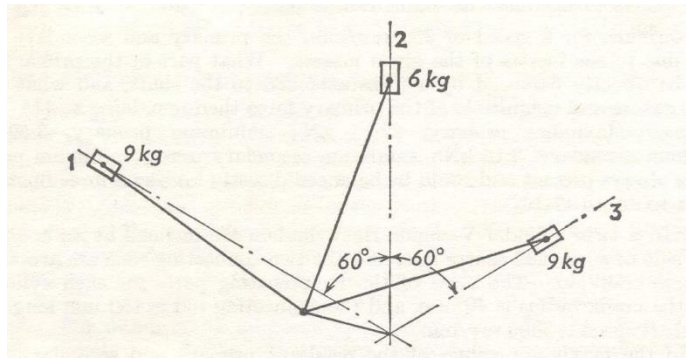


Figure 1

### Question TWO

A horizontal shaft, length  $l$  and diameter  $d$ , is simply supported at the bearings and carries a wheel of masses  $m$  at a distance  $a$ , from one bearing. The centre of the wheel is eccentric a distance  $e$ , to the centre-line of the shaft.

(a) show the expression for the whirling frequency is  $0.03456 \sqrt{\frac{E\pi d^4 l}{ma^2(l-a)^2}}$

(b) establish an expression for the maximum deflection of the shaft at the wheel from its unloaded position when the speed is 10% above the whirling speed.

(20 marks)

### Question THREE

(a) A beam carrying masses  $m_1, m_2, m_3, \dots$  at points along its length is deflected statically through distances  $y_1, y_2, y_3, \dots$  at these points if, when in transverse vibration, it is assumed that the form is similar, prove that the frequency is;

$$n = \frac{1}{2\pi} \sqrt{\frac{g\epsilon my}{\epsilon my^2}} \quad (10 \text{ marks})$$

(b) A shaft 50 mm diameter resting freely on supports  $l=0.8$  m apart carries three loads each of 35 kg, one at the centre and one 0.2m from each end. Assuming for the loaded shaft that the deflection under the

central load is  $\frac{19mgl^2}{384EI}$  and under each end load  $\frac{9mgl^2}{256EI}$  (10 marks)

### Question FOUR

The motion of a 10kg pendulum mass is controlled by a spring and dash-pot as shown in figure 2. The spring stiffness is 7kN/m and the dash-pot piston has a mass of 0.75kg. The bell-crank lever has a mass of 2.5kg and a radius of gyration of 50mm about its centre of gravity which is at the fulcrum. When the mass is displaced from its equilibrium position and released, the amplitude of the resulting vibration is reduced by one-half over three vibrations. Determine the damping coefficient at the dash-pot and the value required to give critical damping.

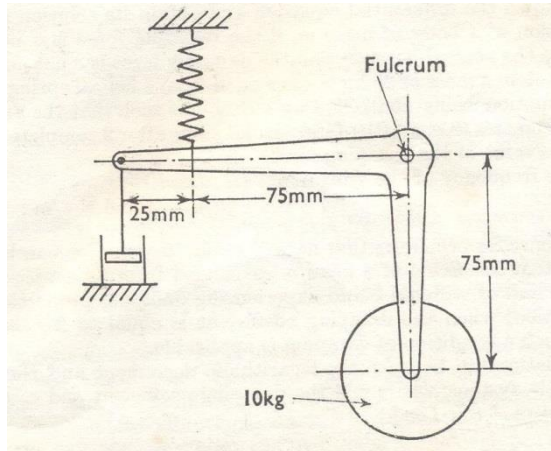


figure 2

(20 marks)

### Question FIVE

An unbalanced engine, mounted on elastic support, imposes a periodic vertical force on the support. An increase of engine speed from its normal value of 600 rev/min to 900 rev/min was observed to treble the amplitude of the resulting forced vibration. A damping device is required to reduce the amplitude at normal speed by 100%. Calculate the necessary damping coefficient expressed in terms of the mass of the engine.