TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
SCHOOL BASED
BSc. Mechanical Engineering
EMG 2304 : MECHANICS OF MACHINES II
END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2016
TIME: 2 HOURS
DATE: Pick Date **Apr 2017**

Instruction to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt question **ONE** and any other **TWO** questions.

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

Do not write on the question paper.

Question ONE

a)State TWO conditions for simple harmonic motion (4 marks)

b)The uniform thin rod, AB, shown in Fig 1 has a mass of 1kg and carries a concentrated mass of 2.5 kg at B. The rod is hinged at A and is maintained in the horizontal position by a spring of stiffness 1.8 kN/m at C. Find the frequency of oscillation, neglecting the effect of the mass of the spring. (8 marks)

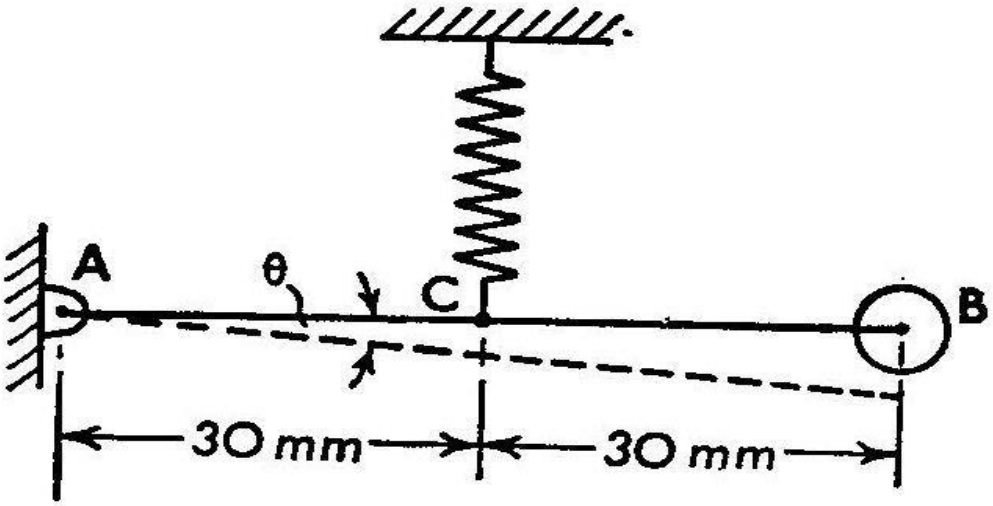

Fig . 1

c)On a packaging machine mechanism a crosshead moves in a straight guide with a simple harmonic motion. At distances 125 mm and 200 mm from the mean position the crosshead has velocities of 6 and 3 m/s respectively. Determine:

i)The amplitude of the motion
ii)The maximum velocity
iii)The periodic time
iv)The maximum inertia force if crosshead mass is 0.2 kg. (8 marks)

Question TWO

A small three-throw crankshaft has cranks of radii 125 mm, set at 120^o to each other and equally spaced with a pitch of 250 mm. the revolving masses at crank radii are the same for each line and of amount 15 kg. The shaft is supported in two bearings symmetrically arranged with respect to the cranks and 850 mm apart. Determine the dynamical loads on the bearings for a speed of 500 rev/min.
The shaft is to be balanced by means of a mass at a radius of 187.5 mm in the plane of No. 1 crank, and a mass at radius 250 mm attached to the flywheel situated 225 mm beyond the bearing adjacent to No. 3 crank. Determine the magnitude of these balance masses and their angular positions relative to No. 1 crank. (20 marks)

Question THREE

In a Hartnell governor the length of the ball arm is 190 mm, that of the sleeve arm is 140 mm, and the mass of each ball is 2.7 kg. The distance of the pivot of each bell-crank lever from the axis of rotation is 170 mm, and the speed, when the bell arm is vertical, is 300 rev/min. The speed is to increase 0.6 per cent for a lift of 12 mm of the sleeve.

a) Neglecting the dead load on the sleeve, find the necessary stiffness of the spring and the required initial compression
b) What spring stiffness and initial compression would be required if the speed is to remain the same for the changed position of the sleeve (i.e. the governor is to be isochronous). (20 marks)

Question FOUR

A gyrowheel D of mass 0.5 kg, with a radius of gyration of 20 mm, is mounted in a pivoted frame C as shown in Fig.Q4. The axis AB of the pivots passes through the centre of rotation O of the wheel, but the centre of gravity G of the frame C is10 mm below O. The frame has a mass of 0.30 kg and the speed of rotation of the wheel is 3000 r.p.m. in the anticlockwise direction as shown. The entire unit is mounted on a vehicle so that the axis AB is parallel to the direction of motion of the vehicle. If the vehicle travels at 15 m/s in a curve of 50 metres radius, find the inclination of the gyrowheel from the vertical, when:

a) The vehicle moves in the direction of the arrow 'X' taking a left hand turn along the curve, and
b) The vehicle reverse at the same speed in the direction of arrow 'Y' along the same path.(20 marks)

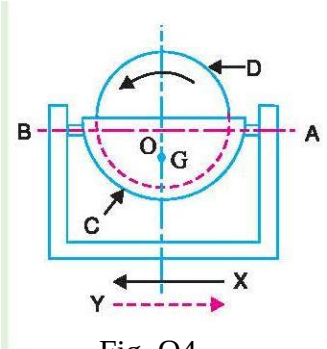

Fig. Q4

Question FIVE

A 4-cylinder engine and flywheel coupled to a propeller are approximated to a 3-rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kg-m^2, the flywheel to a second rotor of 320 kg-m^2 and the propeller to a third rotor of 20 kg-m^2. The first and second rotors are connected by a 50 mm diameter and 2 m long shaft and the second and third rotors are connected by a 25 mm diameter and 2 m long shaft. Neglecting the inertia of the shaft and taking its modulus of rigidity as 80 GN/m^2, determine:

a) Natural frequencies of torsional oscillations
b) The positions of the nodes (20 marks)