NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial and Manufacturing Engineering

2nd Semester Main Examination

COURSE : Dynamics II

CODE : TIE 2206

DATE : May 2014

DURATION : 3 Hours

INSTRUCTION AND INFORMATION FOR THE CANDIDATE

1. Answer any FIVE questions out of SEVEN.
2. Each question carries 20 marks.
3. Show all working
4. There are five (5) printed pages.

REQUIREMENTS

1. Scientific calculator

QUESTION 1

(a) Define the term mechanical vibration. [2]

(b) Differentiate between a periodic oscillation and aperiodic oscillation. [2]

(c) Derive the second order linear differential equation foe a horizontal spring-mass system. [8]

(d) The following equation represents the position of a particle in simple harmonic motion.$x(t) = 10Cos\,{}^{3\pi t}/_{4} - 24Cos\,{}^{3\pi t}/_{4}$

i. Write the equation for the particle motion in the form
$x(t) = ACos(\omega t - \emptyset)$ [2]

ii. Find the maximum velocity and the particle position when it occurs. [3]

iii. Find the maximum acceleration and the particle position when it occurs. [3]

QUESTION 2

(a) A system which is oscillating is related by the equation $x(t) = e^{-0.05t}(8cos3t - 6sin3t)mm$ which represent the position of a particle in damped vibratory motion. Classify the motion as underdamped, overdamped or critically damped and show on a graph. [8]

(b) A mass of 30kg is supported on a spring of stiffness 60000N/m. The system is damped and the damping ratio is 0.4.the mass is raised 5mm and then released. Calculate the following:

i. The damped frequency [4]

ii. The displacement, velocity and acceleration after 0.1s [8]

QUESTION 3

(a) A 4-kg block A is dropped from a height of 800 mm onto a 9-kg block B which is at rest as shown in ***Figure 3a***. Block B is supported by a spring of constant k = 1500 N/m and is attached to a dashpot of damping coefficient c = 230N s/m. Knowing that there is no rebound, determine the maximum distance the blocks will move after the impact. [10]

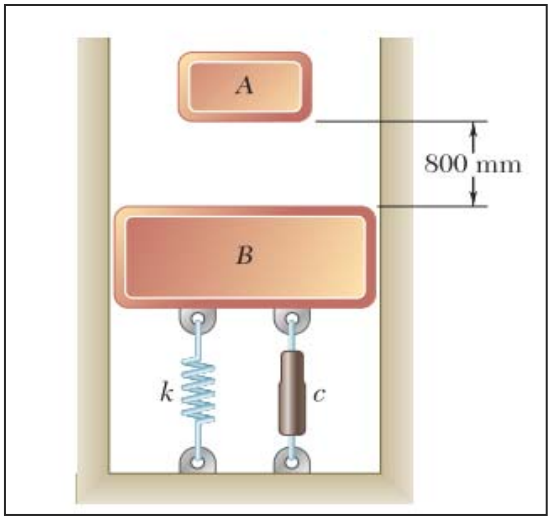

Figure 3a

(b) A machine element is supported by springs and is connected to a dashpot as shown in ***Figure 3b***. Show that if a periodic force of magnitude $P = P_m \sin \omega_f t$ is applied to the element, the amplitude of the fluctuating force transmitted to the foundation is: [10]

$$F_m = P_m \sqrt{\frac{1 + [2\left(\frac{c}{c_c}\right)\left(\frac{\omega_f}{\omega_n}\right)]^2}{[1 - \left(\frac{\omega_f}{\omega_n}\right)^2]^2 + [2\left(\frac{c}{c_c}\right)\left(\frac{\omega_f}{\omega_n}\right)]^2}}$$

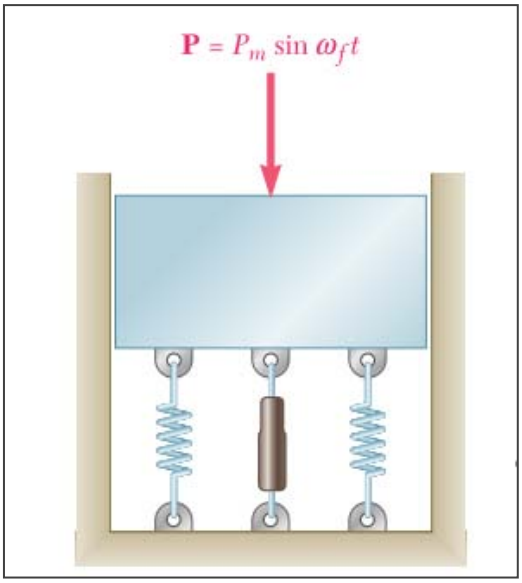

Figure 3b

QUESTION 4

(a) A machine of mass 100kg is supported on springs which deflect 20mm under the load. The machine vibrates in a vertical plane and a dashpot is fitted to reduce the amplitude of free vibration to one quarter of its initial value in two complete oscillations. Calculate the damping coefficient and compare the frequencies of damped and undamped vibrations of the system. [10]

(b) A single degree of freedom system, having a mass of 2.4 kg, is set into motion with viscous damping, and allowed to oscillate freely. The frequency of the oscillation is found to be 15 Hz and measurement of the amplitude of oscillation shows two successive amplitudes to be 5.5 mm and 5.1 mm. Determine the viscous damping coefficient, c. [10]

QUESTION 5

(a) A 15-kg motor is supported by four springs, each of constant 45 kN/m as shown in ***Figure 5a***. The unbalance of the motor is equivalent to a mass of 20 g located 125 mm from the axis of rotation. Knowing that the motor is constrained to move vertically, determine the amplitude of the steady-state vibration of the motor at a speed of 1500 rpm, assuming

i. that no damping is present, [6]

ii. that the damping factor c/cc is equal to 1.3. [8]

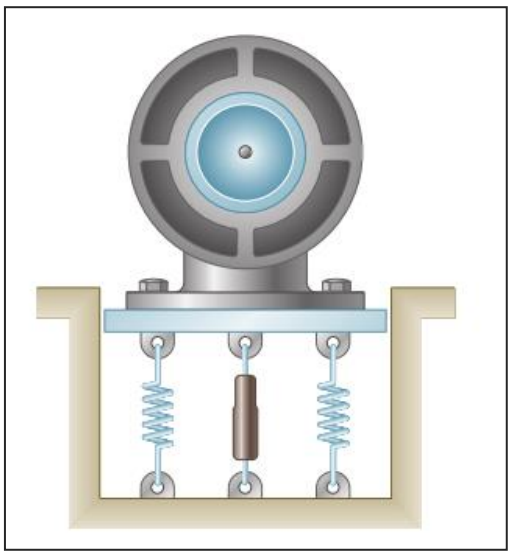

Figure 5a: Unbalanced motor-spring system

QUESTION 6

(a) What are forced oscillations? [2]

(b) The support of a spring mass system is vibrating with amplitude of 5 mm and a frequency of 1150 cpm. If the mass is 0.9 kg and the stiffness of springs is 1960 N/m,

i. Determine the amplitude of vibration of mass. [3]

ii. What amplitude will result if a damping factor of 0.2 is included in the system [5]

(c) The springs of an auto mobile trailer are compressed 0.1 m under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 0.08m and a wavelength of 14m. What will be the amplitude of vibration at 60k m/hr? [10]

QUESTION 7

(b) Define the following:

i. Static balance

ii. Dynamic balance

(c) **Figure 7b** shows on two rotor in planes B and C. Determine the masses to be added on the rotors in planes A and D at radius 40mm which will produce static and dynamic balance.

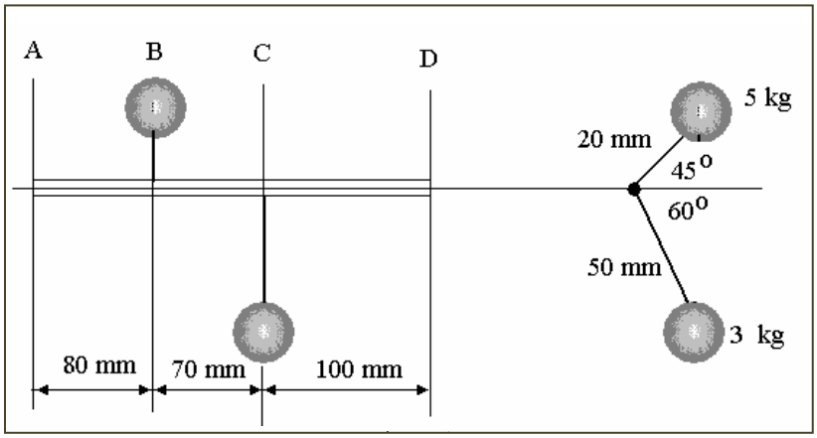

Figure 7b: Unbalanced Rotor

End of Exam