TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BSC IN CIVIL ENGINEERING

ECE 2416 : THEORY OF STRUCTURES VI

END OF SEMESTER EXAMINATION

SERIES:APRIL2016

TIME:2HOURS

DATE:18May2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, Drawing Instruments, Scientific calculator, examination pass and student ID

This paper consists of five questions.

Attemptquestion ONE (Compulsory) and any other TWO questions.

Question One (30 marks)

(a) (i) Discuss the design rules that have to be taken into account in order to avoid as much as possible damage in a building as a result of an earthquake.

(8 marks)

(ii) Describe the scales that can be used for the evaluation of the magnitude and intensity of an earthquake in a given region.

(4 marks)

(iii) Explain the Four virtues of earthquake-resistant buildings

(8 marks)

b) A machine of mass 2000 kg is supported on a vertical flexible mounting, modelled as a single degree-of-freedom system. The mounting has a total stiffness 60 kN/m but negligible damping. Any horizontal motion of the system should be ignored. In normal operation the machine is subjected to a vertical force $F = F_0 \sin\Omega t$ where the amplitude F_0 is 3000 N. Calculate the response amplitude and the force transmitted to the foundations when the driving frequency is (i) 130 rad/sec and (ii) 15 rad/sec

(10 marks)

Question Two (20 marks)

a) Define the following terms as applied in structural dynamics

- Free vibration
- Forced vibration
- Damped vibration
- Undamped vibration
- Linear vibration
- Non linear vibration
- Deterministic vibration
- Random vibration

(8 marks)

b) Derive the equation of motion for the undamped single degree of freedom system shown in figure 1 without the external forces and solve the response under the given conditions:

m=25 tons k=250kN/cm

x (0)=2cm $\dot{x}(\pi)$= -4cm/s

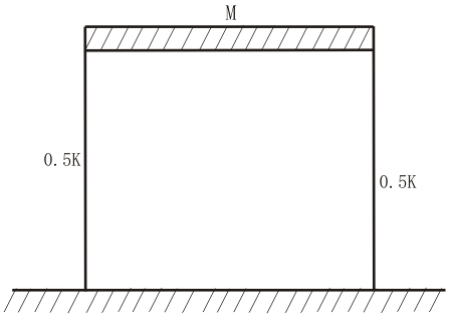

Figure 1 (8marks)

(14 ©Using sinusoidal graph illustrate the following types of damping

- Undamped
- Under damped
- Over damped
- Critically damped

(4 marks)

Question Three (20 marks)

a) Using undamped single degree of freedom system derive the equation of motion using D'Alembert's Principle

(6 marks)

b) Consider the transverse vibration of a bridge structure. For the fundamental frequency it can be considered as a single degree of freedom system. The bridge is deflected at midspan and suddenly released. After the initial disturbance the vibration was found to decay exponentially from amplitude of 8 mm to 4.2 mm in three cycles with a frequency of 1.5 Hz**.** The test was repeated with a vehicle of mass 30 000 kg at mid-span, and the frequency of free vibration was measured to be 1.4 Hz**.** Find the effective mass, the effective stiffness, and the damping ratio of the structure.

(14 marks)

Question Four (20 marks)

a) The vibration on the floor in a building is single harmonic motion at a frequency in the range 20-50 Hz. It is desired to install sensitive equipment in the building which must be insulated from floor vibration. The equipment is fastened to a small platform which is supported by three similar springs resting on the floor, each carrying an equal load. Only vertical motion occurs. The combined mass of the equipment and platform is 50 kg, and the equivalent viscous damping ratio of the suspension is 0.18. Find the maximum value for the spring stiffness, if the amplitude of transmitted vibration is to be less than 10% of the floor vibration over the given frequency range.

(8 marks)

b) A two-wheel trailer is drawn over an undulating surface in such a way that the vertical motion of the tyre may be regarded **as** sinusoidal, the pitch of the undulations being 8 m. The combined stiffness of the tyres is 180 kN/m and that of the main springs is 70 kN/m; the axle and attached parts have a mass of 500 kg, and the mass of the body is 600 kg is modeled as the figure 2. Find (i) the critical speeds of the trailer in km/h and (ii) the amplitude of the trailer body vibration if the trailer is drawn at 60 km/h and the amplitude of the undulations is 0.15 m.

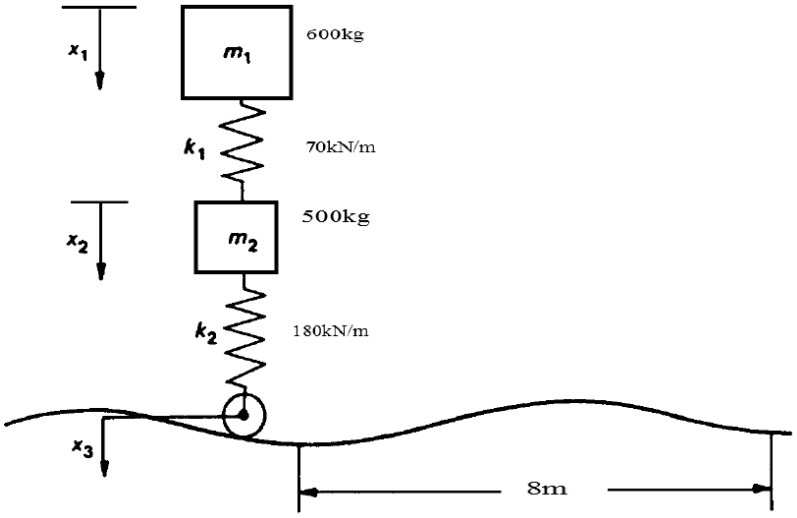

Figure 2

(12 marks)