TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR THE BACHELOR OF SCIENCE IN CIVIL ENGINEERING
[Institutional Based Programmes]

ECE 2416: THEORY OF STRUCTURES VI

END OF SEMESTER EXAMIANTION
SERIES: APRIL 2013
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer Booklet*
- *Scientific Calculator (Non Programmable)*

This paper consists of **FIVE** questions. Answer question **ONE** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One (Compulsory)

a) Figure 1 below is a two storey frame structure supported by columns rigidly fixed at its ends. The first floor weighs 5.0KN and the upper floor slab weighs 7KN with stiffness of 4.0×10^6N/m and 8.0×10^6N/m respectively. Determine the natural frequencies and modes of vibration for the given structure.

K2 = 8.0 X 10^6 N/m

(27 marks)

b) Outline **THREE** assumptions made when analyzing shear buildings. **(3 marks)**

Question Two

a) Figure 2 shows a platform supported by columns. The column end A is pinned while E and G are rigidly fixed. Calculate the column deformations hence sketch the shear force diagram**. (17 marks)**

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b) Using a well sketched diagrams, briefly explain the following terms as used in:

(i) Degree of freedom **(1 ½ marks)**

(ii) Logarithmic decreament **(1 ½ marks)**

Question Three

Figure 3 shows a platform of 4000kg mass supported by four columns rigidly connected to the platform as well as the foundation.

It has been found that, a static force of 2KN applied horizontally to the platform produces a displacement of 2mm. If the estimated damping ratio of the structure is 4%, determine:

(i) The undamped and damped natural frequencies. **(3 ½ marks)**

(ii) Absolute and critical damping values **(3 marks)**

(iii) Logarithmic decreament **(1 ½ marks)**

(iv) Number of cycles and the time required for the amplitude of motion to be reduced from the initial value of 2mm to 0.2mm **(5 ½ marks)**

(v) Peak displacement for the first five cycles of vibration if the frame is displaced horizontally by 20mm and suddenly released. **(6 ½ marks)**

Figure 3

Question Four

The platform on figure 4 weighs 6000N supporting a machine weighing 4000N is supported by 3m columns rigidly fixed at the ends.
The following two cases were observed

Case 1: If the Machine is switched off:

(i) Find the undamped and damped natural frequencies. **(3 ½ marks)**
(ii) Find the peak displacement of the first five cycles of vibration if the frame is displaced horizontally and then released. **(5 ½ marks)**

Case 2: If the Machine is switched on

In this case it exerts a periodic force of 8.5KN at a frequency of 1.75 hertz.

(i) Find the steady state amplitude of the system
[Hint: $Ft = Fo \sin \Omega t$] **(7 marks)**

(ii) Find the deflection (dynamic) at resonance. **(4 marks)**
$EI = 4.5 \times 10^6 N/m$

Question Five

a) With the aid of well defined sketches, explain the effects of earthquake motion on structures and in relation to this clearly describe the parameters in the equation for dynamic equilibrium. **(8 ½ marks)**

b) Explain clearly (using sketches) the natural period of building subjected to earthquake motion and explain the following terminologies associated with it.
   (i) Building flexibility
   (ii) Rigid buildings
   (iii) Semi-rigid buildings
   (iv) Flexible buildings **(8 ½ marks)**

c) Using clear sketches, briefly explain **THREE** classifications of dynamic loads. **(3 marks)**