TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECE 2416: THEORY OF STRUCTURES VI

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2013
TIME ALLOWED: 2 HOURS

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

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

Question One (Compulsory)

a) (i) Using clear sketches, explain the three classifications of dynamic loads. **(4 ½ marks)**
(ii) Using clear sketch, show the elements in a system with one degree of freedom system hence derive the equation for dynamic motion **(5 ½ marks)**

b) Figure Q1 (b) shows a structural frame with free vibration two degrees of freedom loaded as follows:

$$Mass\begin{Bmatrix} M_1 = & 6{,}000N \\ M_2 = & 7{,}000N \end{Bmatrix}$$

$$Stiffness\begin{Bmatrix} K_1 = 4.0\times 106N/m \\ K_2 = 8.0\times 106N/m \end{Bmatrix}$$

When the structure is subjected to lateral loading:

K2

Determine:

(i) Natural frequencies of the frames
(ii) Modes of vibrations (1st and 2nd mode) **(20 marks)**

Question Two

A platform of 6000N mass is supported by a five columns as shown in figure Q2, rigidly connected to the platform as well as at the bottom. When a static force of 4KN is applied horizontally to the platform, it produces a displacement of 3mm. If the estimated damping ratio of the structure is 5%, determine:

(i) The undamped and damped natural frequencies
(ii) Absolute and critical damping values
(iii) Logarithmic decreament of the system
(iv) Number of cycles and time required for the amplitude of motion to be reduced from initial value of 3mm to 0.3mm.
(v) Peak displacement of the 1st SIX cycles of vibrate if the frame is displaced 25mm and then released. **(20 marks)**

Mass = 6000N Platform

Question Three

Figure Q3 is a platform 5KN supported by two columns 3m rigidly fixed at the bottom. On top of the platform is a generator of 3KN mass.

a) If the generator is switched off:
   (i) Calculate the undamped and damped frequencies **(4 marks)**
   (ii) Peak displacement of the first SIX cycles of vibration if the frame is displaced 20mm horizontally and suddenly released. (Free vibration of SDOF damped system) **(6 marks)**

b) If the generator is switched on it exerts a periodic force of 10KN at a frequency of 2.0 hertz in the plane of the structure. Find:
   (i) Steady state amplitude of vibration **(8 marks)**
   (ii) Dynamic deflection at reasonance **(2 marks)**

Given that

$$\eta = 4\%$$

$$EI = 6.0 \times 10^6 \, N/m^2$$

Figure 3

Question Four

a) Outline THREE assumptions made when analyzing shear building **(3 marks)**

b) Figure Q4 shows a frame structure loaded with 10KN mass and stiffness are as shown. Compute the deflection at floor levels and hence draw SFD and BMD. Given EI = 10 x 10^6N/m^2 **(17 marks)**

F

Question Five

a) Using clear sketches, equilibrium and compatibility equations, show the effects of earthquake motion on a structure, hence show that the equation of motion dynamic equilibrium is applicable to building under earthquake motion. **(10 marks)**

b) For undamped system single degree of freedom, show that maximum displacement of $U = C\cos(w\alpha - \alpha)$

(10 marks)