TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR DECREE IN:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING (BSCE y4 s2)

ECE 2416: THEORY OF STRUCTURES VI

END OF SEMESTER EXAMINATION
SERIES: APRIL 2015
TIME ALLOWED: 3 HOURS

<u>Instructions to Candidates:</u>
You should have the following for this examination

- *Answer Booklet*
- *Pocket Calculator*

This paper consists of **FIVE** questions. Answer questions **ONE (Compulsory)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
Use neat, large and well labeled diagrams where required
This paper consists of **FOUR** printed pages

Question One (Compulsory)

a) Giving examples, define;
  (i) An impulses and
  (ii) Arbitrary forcing functions

b) Calculate the system equivalent stiffness, natural frequency and period

c) The un-damped SDOF system shown in figure Q.1 (a) is subjected to the loading shown in figure Q.1 (b). Calculate the displacement and force history for the time 0<t<0.6 seconds by numerical evaluation of the Duhamel's integral with $\Delta\zeta$ = 0.1 seconds using Simpson's rule.

Question Two

a) Compute the shear forces, bending moments and deflections at column ends for the frame loaded as shown in figure Q.2. Sketch the shear force and bending moment diagrams. The relative flexural rigidities for the columns are shown. The beams are assumed to be infinitely rigid.

b) Outline the mathematical models used in the analysis of the frame in Q.2 (a)

Question Three

a) Multi-storey shear buildings may be modeled as having multiple degrees of freedom when subjected to lateral loads. Briefly describe the properties of shear buildings and hence formulate the various model representations that may be used in such modeling and the resultant equations of motion.

b) Analyze the various natural frequencies and modes of vibration which are possible for the two-storey structure shown in figure Q.3

Question Four

a) Illustrate (i) the Newton's second law and (ii) the D'Alembert's principle as applied to the dynamic equilibrium of a mass.

b) Figure Q.4 (a) shows a structural system modeled as a simple single degree of freedom oscillator with viscous damping. Develop the general equilibrium equation of motion of the system under an external exciting dynamic load F(t).

c) The structural frame shown in figure Q.4 (b) has its platform rigidly fixed to the columns at column tops and the columns rigidly fixed to the floor system as shown. The mass of the structure (including the columns), m, is 5,000kg and is assumed to be concentrated at platform. The flexural rigidity of the columns, EI = 10 x 106Nm^{-2}. Two springs are attached to the structure at platform level as shown with elastic spring constants K1 = 5 x 10^6N/m and k^2 = 10 x 10^6N/m. The frame is assumed to have a viscous damping ratio of 10%. If the structure is initially displaced horizontally by 200mm and then suddenly released, determine:

- **(i)** The demand and un-damped natural frequencies
- **(ii)** The logarithmic decrement
- **(iii)** The peak displacements for the first three cycles or vibration

Question Five

a) The structural frame show in figure Q.5 has a mass, m of 10.000kg. assumed to be concentrated in the rigid platform. The frames is assumed to have a viscous damping ratio of 10% with the columns as the assumed to be weightless and each with flexural rigidity EI = 5 x 106N-m2. If the frame supports a reciprocating machine of mass m' = 5.000kg, which exerts a periodic force given by F(t) = 200 Sin (5.0t)kN, determine:

- **(i)** The frequency ratio
- **(ii)** The dynamic load factor
- **(iii)** The static deflection
- **(iv)** The steady state amplitude of vibration for the given damping ratio
- **(v)** The steady state amplitude if the forcing function was in resonance with the structure
- **(vi)** The maximum dynamic shear forces and bending moments at the column ends results from the amplitudes in (d) and (e) above