MACHAKOS UNIVERSITY

University Examination 2019/2020

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 405: THEORY OF STRUCTURES V

DATE: 10/12/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

a) Define the following terms as used in earthquake engineering (6 marks)

i. Response spectrum

ii. Fourier spectrum

iii. DVA spectrum

b) Derive the standard form of equation of motion (7 marks)

c) A 3m by 8m wide single bay storey frame is rigidly jointed with a beam of mass 5t and columns of negligible mass and stiffness of EI= 4. $5*10^3$KNm^2. Calculate the natural frequency in lateral vibration and its period. Find the force required to deflect the frame 25mm laterally (7 marks)

d) A water tower is idealized as a light prismatic cantilever forced at the base having a lamped mass m=w/g at the top where w=400KN and g=9.81m/s^2. The length of the cantilever is L=50m and its flexural rigidity EI=30*109 NM^2. Find the natural angular frequency ω_n and natural period T_n of vibration. If the motion is initiated by displacing the mass horizontally a distance Do then the system is left to vibrate, what is the displacement as t=T/8 and what are the values of T when L is reduced to 25m or increased to 75m (10 marks)

QUESTION TWO (20 MARKS)

Consider a heavy mass of weight w for the following damping ratio of the beam ε=10%. If displacement **u** corresponds to the displacement of the beam at the location of the attached weight and if the system is given an initial displacement of 0. 5cm and an initial velocity of 150m/s determine the following: EI= 10^6 N/cm^2

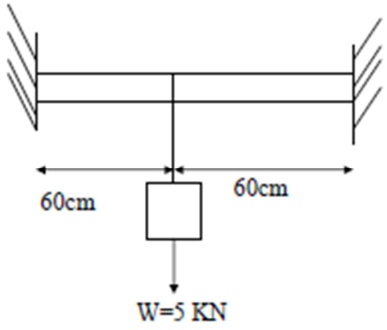

Fig: 1

i. Write the equation of motion of the system. What type of system is it?

ii. The undamped natural frequency ω_n and period T_n of the system.

iii. The damped natural frequency ω_d and period T_d of the system.

iv. The critical damping coefficient

v. Phase angle of the vibrating motion

vi. The peak displacement at $t = Td + \emptyset/\omega d$

vii. Peak displacement at $t = 2Td + \emptyset \frac{\emptyset}{\omega d}$

QUESTION THREE (20 MARKS)

a) Briefly discuss the response of structures due to blast loading (10 marks)

b) Briefly discuss blast effects on building structures (10 marks)

QUESTION FOUR (20 MARKS)

A two storey building is modeled as 2-DOF system and rigid floors as shown in figure 2. Determine the top floor maximum displacement and base shear due to El-centro 1940 earth quake ground motion. Take the inter-storey stiffenss k=197.392 $*10^3 N/m^2$, the floor mass m=2500kg and damping ratio as 2%

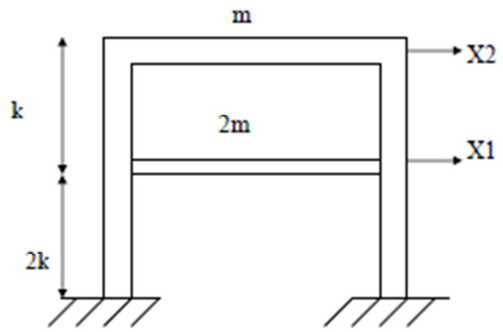

Fig:2

QUESTION FIVE (20 MARKS)

The storey building shown in figure 3 has very stiff floor slabs relative to the supporting columns. Calculate the natural frequencies. EI=4. $5*10^3 KNm^2$

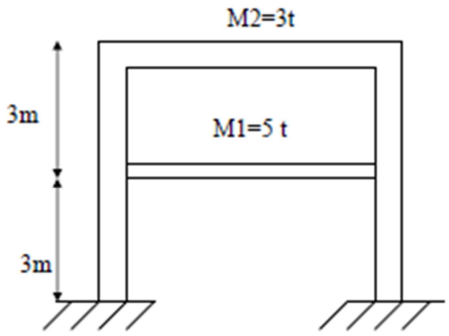

Fig :3