



MACHAKOS UNIVERSITY

University examinations 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR
BACHELOR IN CIVIL ENGINEERING

ECV 405: THEORY OF STRUCTURES V

Date 7/3/2023

Time: 2:00 – 4:00 PM

INSTRUCTIONS

- This paper comprises of five questions. Answer **three** questions
 - Question one is **compulsory** and carry 30 marks
 - Answer any other **two** questions
1. (a) The system shown in figure 1 below but without the applied force F , has the following properties, $m=1\text{kg}$, $k= 10,000\text{N/m}$ and $c=40 \text{ N/m/s}$. Plot the time history of displacement for the initial conditions displacement = 0.1m, velocity=0 at time=0 (10mks)

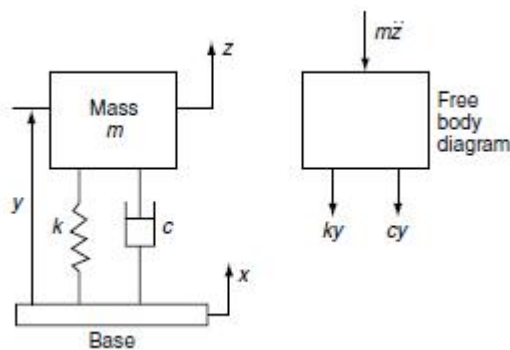


Figure 1

- (b) Briefly discuss three types of random dynamic forces (6mks)
 - (c) List seven simple design criteria considerations to be made to avoid earthquake loading failure in structures (7mks)
 - (d) Differentiate between stable, unstable and neutral equilibriums in structures (3mks)
 - (e) Derive the standard equation of motion for a two degree of freedom system (4mks)
2. A machine of mass 500kg is supported on spring mounts which deflect 3mm under its weight. It is found that the amplitude of free vertical vibrations is halved for each successive cycle. When the machine is operating there is a vertical harmonic force due to imbalance whose magnitude varies as the square of its frequency. The resulting amplitude of forced vibration is 2.25mm at 10Hz.
- a. Determine the magnitude of the imbalance force at 20Hz, which corresponds to the maximum machine speed.
 - b. Determine the greatest amplitude of vibration which may be experienced by the machine when running up to speed (20mks)
3. The two-storey building shown in figure 1 has very stiff floor slabs relative to the supporting columns. Calculate the natural frequencies and mode shapes. $EI_c = 4.5 \times 10^3 \text{ k Nm}^2$ (20mks)

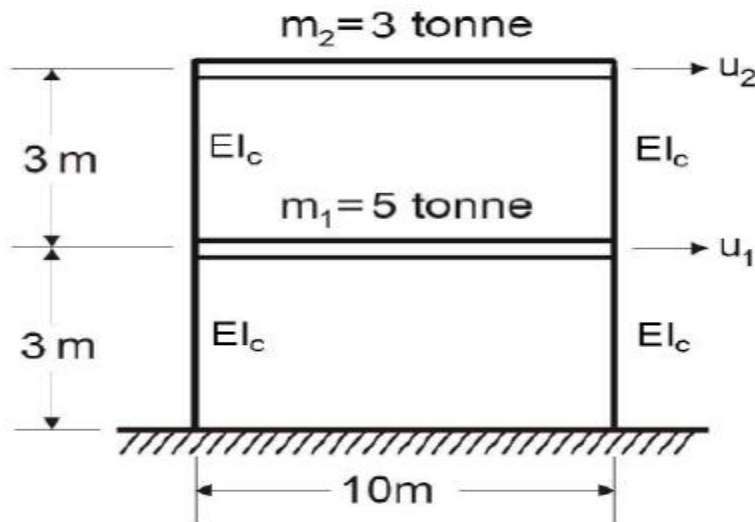


Figure 2.

- 4. Discuss FIVE effects of earthquake that cause damage (20mks)
- 5. A structure subjected to compressive forces can undergo either or both two types of failures, discuss giving relevant examples. (20mks)