MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 405: THEORY OF STRUCTURES V

DATE: 24/8/2022 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

- *This paper comprises of FIVE questions. Answer **THREE** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer any other **TWO** questions*

QUESTION ONE (30 MARKS)

a) A link AB in a mechanism is a rigid bar of uniform section 0.3m long. It has a mass of 10kg and a concentrated mass of 7kg is attached at B. The link is hinged at A and is supported in a horizontal position by a spring attached at the midpoint of the bar. The stiffness of the spring is 2 kN/m. Find the frequency of small free oscillations of the system. The system is as shown in figure 1. (6 marks)

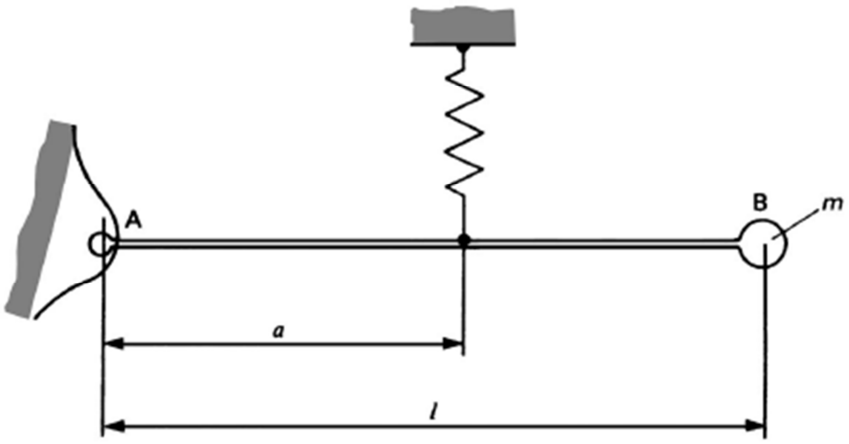

Figure 1

b) Briefly discuss THREE earthquake effects that cause damage (6 marks)

c) Applying the bifurcation method, analyse the structural stability of a rigid bar supported by rotational spring as shown in figure 2 (5 marks)

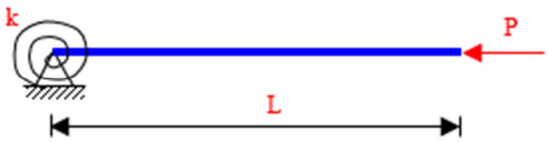

Figure 2

d) In a study of earthquakes, a building is idealized as a rigid body of mass M supported on two springs, one giving translational stiffness k and the other rotational stiffness Kt .Given that the IG is the mass moment of inertia of the building about its mass centre G, write down the equations of motion using coordinates x for the translation from the equilibrium position, and O for the rotation of the building. Determine the frequency equation of the motion (7 marks)

e) Derive the fundamental equation of motion (6 marks)

QUESTION TWO (2O MARKS)

The vibrations of a two-storey building is represented by the lumped mass system shown in figure 3. m1=1/2m2 and k1=1/2k2;(k1 and k2) represent the shear stiffness of the part of the building shown. Calculate the natural frequencies of the vibrations, and sketch the corresponding mode shapes for the building, showing the amplitude ratios. If a horizontal harmonic force F1sin vt is applied to the top floor, determine expressions for the amplitudes of the steady state vibration of each floor

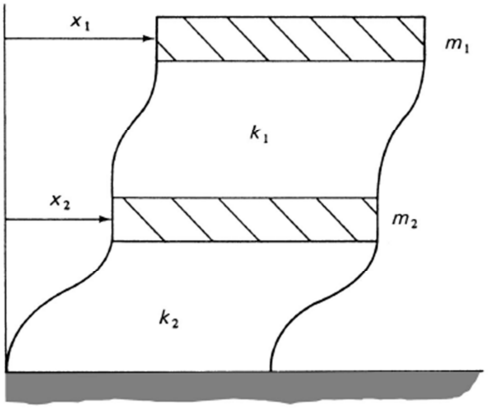

Figure 3

QUESTION THREE (20 MARKS)

The two-storey building shown in figure 4 has very stiff floor slabs relative to the supporting columns. Calculate the natural frequencies and mode shapes. EIC=4.5*10^3k Nm^2

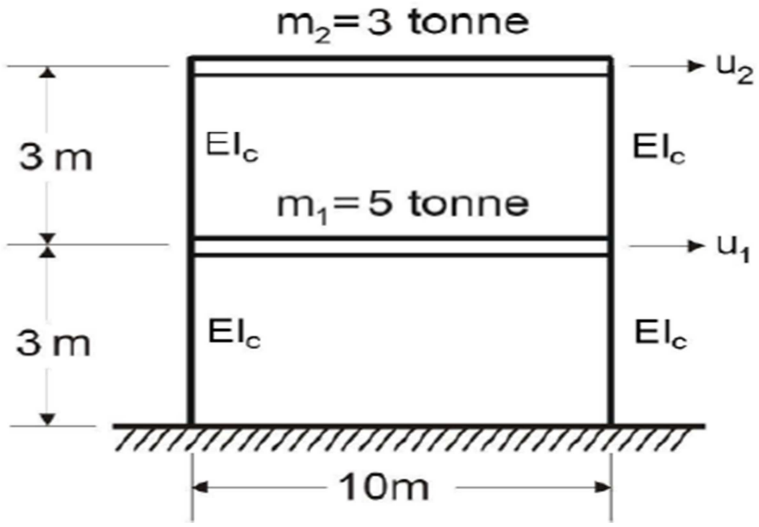

Figure 4.

QUESTION FOUR (20 MARKS)

Discuss FOUR classes of structural instability

QUESTION FIVE (20 MARKS)

Discuss the design criteria for buildings in areas prone to earthquakes