MACHAKOS UNIVERSITY

University Examinations for 2020/2021Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR SPECIAL/ SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 405 THEORY OF STRUCTURES V

DATE: 23/3/2021 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

Answer question one and any other two questions

1. a) Define the concept of dynamic degree of freedom. (3 marks)

   b) Discuss the following degrees of freedom.

      i. single degree of freedom systems and (2 marks)

      ii. multi degree of freedom systems. (2 marks)

   c) A vibrating system consisting of a mass of 50 kg and a spring of stiffness 4×40^4 N/m is viscously damped. The ratio of two consecutive amplitudes is 20:18. Determine

      i. the natural frequency of undamped system. (6 marks)

      ii. the damping ratio and (6 marks)

      iii. damped natural frequency. (6 marks)

2. a) Discuss the various types of dynamic loads. (3 marks)

   b) State some of the characteristics of seismic loads. (2 marks)

   c) An SDOF system consists of a mass with weight of 175 kg and a spring constant, k = 530 kN/m. While testing the system a relative velocity of 30 cm/s was observed on application of a force of 450N.

      i. Determine the damping ratio, (5 marks)

ii. damped frequency of vibration, (5 marks)

iii. logarithmic decrement, and (5 marks)

iv. the ratio of two consecutive amplitudes. (5 marks)

3. a) Name the various modelling techniques of structures. (2 marks)

b) Discuss lumped mass approach in detail. (3 marks)

c) The properties mass m, stiffness k, and natural frequency ω of an undamped SDOF system are to be determined by a harmonic excitation test. At an excitation frequency of 4 Hz the response tends to increase without bound. Then, a weight W of 22 N is attached to the mass m, the resonance occurred at 3 Hz. Determine the dynamic properties of the system-(mass m, stiffness k, and natural frequency ω of an undamped). (20 marks)

4. a) Write short notes on the following:

i. d′Alembert's principle (2 marks)

ii. Inertia force (2 marks)

iii. Hamilton's principle (2 marks)

iv. Uncertainties of dynamic analysis (2 marks)

b) An empty elevated water tank is pulled by a steel cable by applying a 30 kN force. The tank is pulled horizontally by 5 cm. The cable is suddenly cut and the resulting free vibration is recorded. At the end of five complete cycles, the time is 2.0 s and the amplitude is 2 cm.

Determine :

i. the damping ratio (3 marks)

ii. natural period of undamped vibration (4 marks)

iii. effective stiffness (4 marks)

iv. effective weight (4 marks)

v. damping coefficient for the given data. (4 marks)