



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 420: SIMULATION AND MODELING

DATE: 26/7/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

A vehicle modelled as a spring mass damper system shown in Fig. Q1 is travelling on a smooth road. Suddenly, the vehicle hits a bump. Given that the total mass of the vehicle is 700 kg, the spring constant, $k = 100 \text{ N/m}$, damping coefficient, $c = 90 \text{ Ns/m}$ and the bump has a height of 0.3 m, use a software to model the response of the vehicle mass (displacement, velocity and acceleration) after hitting the bump. Take the sampling interval, $\Delta t = 0.1 \text{ s}$ for a period of 120 s.

NB: Show all the mathematical modelling, write your code on the script, and sketch the response on the answer booklet clearly indicating the important parameters.

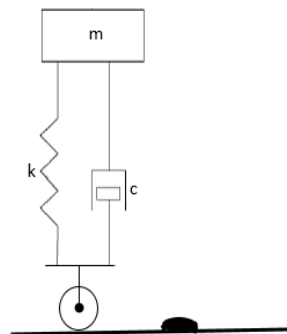


Figure Q1

QUESTION TWO (20 MARKS)

- a) Systems can be classified according to the nature and type of components. Briefly discuss FIVE (5) types of systems under this classification. (10 marks)
- b) In the design of bridge structures and crane structures, engineers are often required to compute the member forces and support reactions in planar truss structures. Figure Q2(b) shows a six-bar cantilever truss carrying 10 kN loads at joints B and C. Obtain an expression for forces at each joint and reactions in support member AE in x and y directions (10 marks)

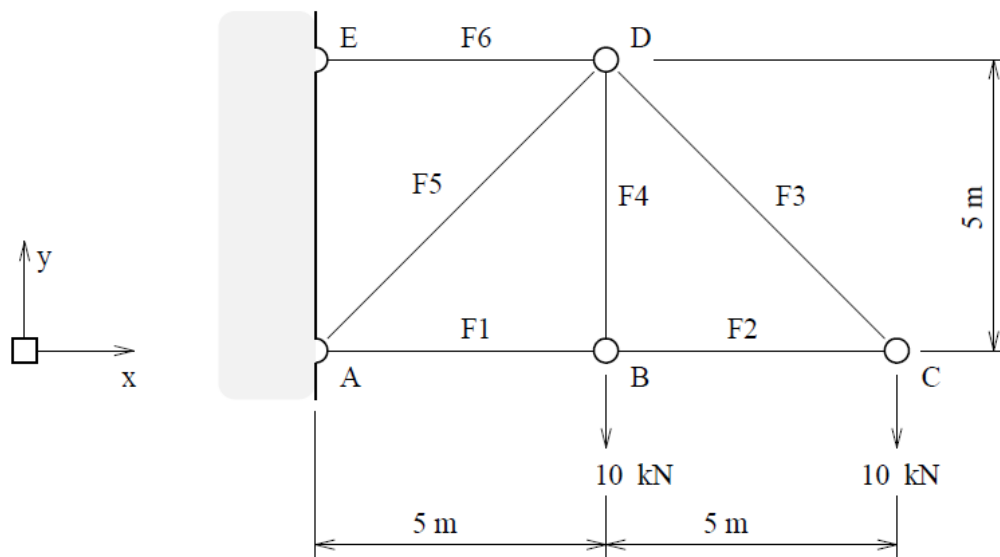


Figure Q2(b)

QUESTION THREE (20 MARKS)

- a) With the aid of examples, briefly discuss the main classes of simulations.(3 marks)
- b) What are the steps followed during modelling and simulations? Use a real life example to show how these steps are followed. (7 marks)
- c) Figure Q3(c) shows an electrical circuit consisting of two inductors, two resistors, and a capacitor. A voltage V_a is applied to the circuit. Derive an expression for the mathematical model for the circuit. (10 marks)

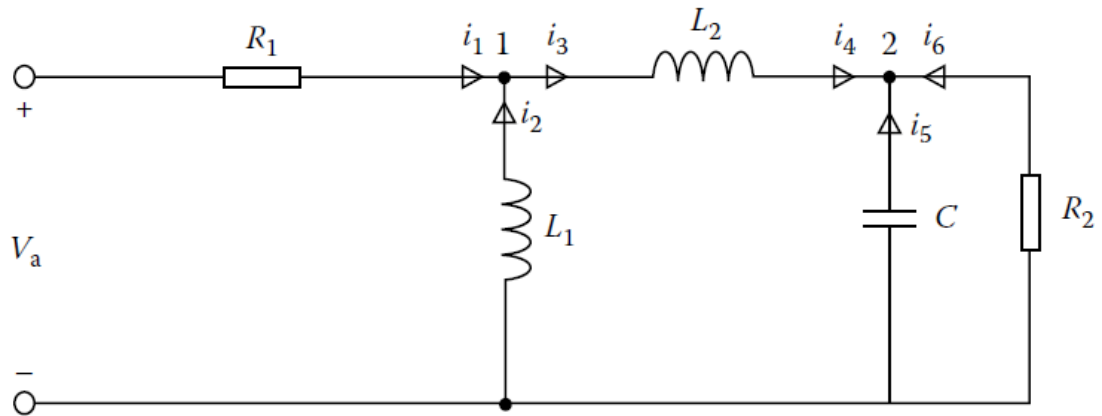


Figure Q 3(c)

QUESTION FOUR (20 MARKS)

- a) Define the following terms, and give a suitable example.
 - i. System (1 mark)
 - ii. Entity (1 mark)
 - iii. state (1 mark)
- b) Discuss five reasons why simulations are important in engineering. (10 marks)
- c) What is the difference between discrete and continuous dynamical system? (4 marks)
- d) A swinging pendulum has a nonlinear second order dynamic equation given as $\frac{d^2\theta}{dt^2} = -\frac{g}{L} \sin \theta$. Convert this equation to a first order. (3 marks)

QUESTION FIVE (20 MARKS)

- a) Define the following terms, and give two examples each.
 - i) Aleatoric uncertainty (2 marks)
 - ii) epistemic uncertainty (2 marks)
- b) What is stochastic modelling? Give an example. (6 marks)
- c) Briefly discuss why Monte Carlo technique is popular in simulating uncertain events. (8 marks)