



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 420: SIMULATION AND MODELING

DATE: 22/5/2019

TIME: 2.00-4.00 PM

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 two bumps in a span of 40 seconds. Given that the total mass of the vehicle is 500 kg, the spring constant, $k = 100 \text{ N/m}$, damping coefficient, $c = 90 \text{ Ns/m}$ and the first and second bumps have a height of 0.2 m and 0.1 m respectively, use a software to model the response of the vehicle's mass (displacement and velocity) after hitting the two bumps. 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. (30 marks)

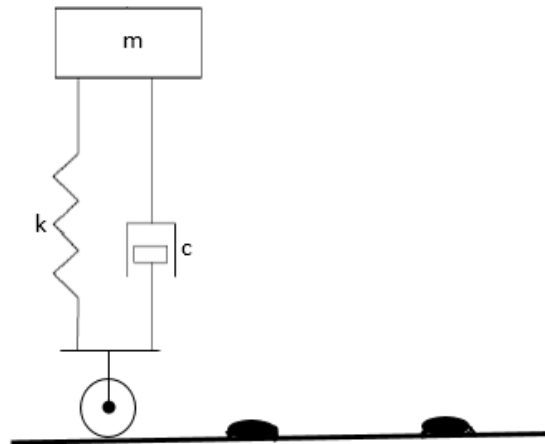


Figure Q1

QUESTION TWO (20 MARKS)

- What is an agent-based model? (1 mark)
- Briefly discuss FOUR (4) benefits of agent-based modelling. (4 marks)
- The concentrations of mass in reactors shown in Figure Q2 are denoted by the symbols C_1 , C_2 , C_3 and C_4 . Develop the mass-balance equation stating the laws used. Use a modelling software to solve for concentrations in each reactor. (15 marks)

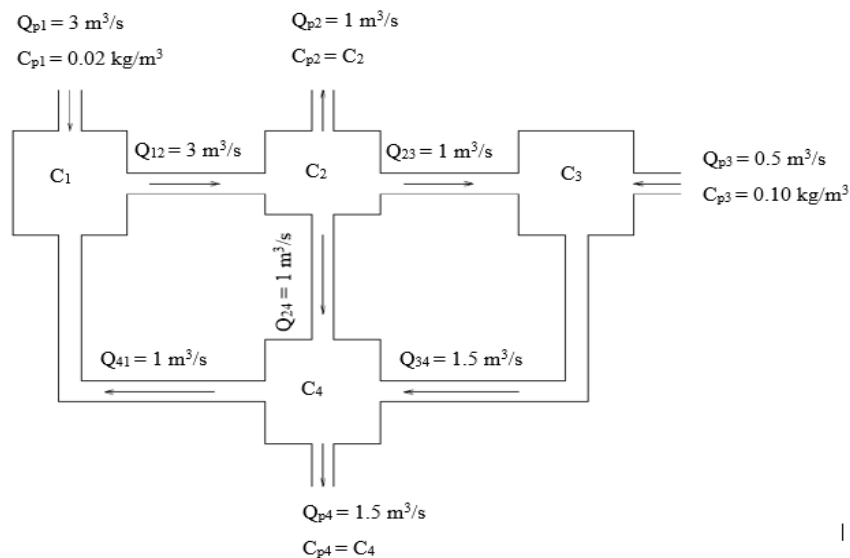


Figure Q 2 (c)

QUESTION THREE (20 MARKS)

- a) With the aid of a diagram, discuss three main categories of models. (7 marks)
- b) With the aid of examples, briefly discuss the main classes of simulations. (3 marks)
- c) What are the steps followed during modelling and simulations? Use a real life example to show how these steps are followed. (7 marks)
- d) Briefly discuss the attributes of a good model. (3 marks)

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)