



MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO 303: SIMULATION AND MODELLING

DATE: 17/4/2023

TIME: 2:00 – 4:00 PM

INSTRUCTIONS

*This paper consists of FIVE questions
Answer **question one** and **two** other questions.*

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define the following terms as used in simulation and modeling (6 marks)
 - i. Discrete event simulation
 - ii. Pseudo random number
 - iii. Black box modeling
- b) Examine THREE categories of software that can be used to perform modeling and simulation. (6 marks)
- c) Define the terms verification and validation in the context of modeling, giving a reason why they are important (4 marks)
- d) Explain TWO laws applicable in determining queue discipline in queuing systems (4 marks)
- e) Describe the Monte Carlo simulation and give TWO application areas where it would be most appropriate (4 marks)
- f) Explain THREE reasons why it is hard for computers to generate truly random number (6 marks)

QUESTION TWO (20 MARKS)

- a) Explain THREE statistical tests that can be carried out to test uniformity and independence of random numbers. (6 marks)
- b) Explain THREE circumstances under which simulation experiments would be preferred over experimentation (6 marks)
- c) Your friend has established a barber shop and is unsure about how many employees to hire to serve customers. He informs you that the queue in the shop is possibly infinite; Customers are served on a first-come, first-served basis and that there are currently two employees who, on average take the same time to serve a customer.

Required: Devise a simple model to help the barber shop determine how many employees to hire to serve customers and present the following components of the simulation model:

- i. System state (2 marks)
- ii. Resources (2 marks)
- iii. Events (2 marks)
- iv. Activities. (2 marks)

QUESTION THREE (20 MARKS)

- a) Explain THREE potential benefits of using simulation to investigate business problems compared to the use of mathematical formulae. (6 marks)
- b) At one of its stations, the Standard Gauge Railway (SGR) has a single ticket counter. During the rush hours, customers arrive at the rate of 10 per hour. The average number of customers that can be possibly served is 12 per hour. Determine:
 - i. Probability that the ticket counter is free. (3 marks)
 - ii. Average number of customers in the queue. (3 marks)
- c) In order to carry out a simulation using random inputs such as inter-arrival times, we have to specify their probability distributions. Discuss FOUR such distributions applicable in simulation. (8 marks)

QUESTION FOUR (20 MARKS)

- a) Briefly explain THREE types of models used in simulation and modelling (6 marks)
- b) Describe THREE methods of generating random numbers (6 marks)
- c) A dentist schedules all his patients for 30 minutes appointments. Some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities and the time actually needed to complete the work:

<u>Category</u>	<u>Time Required</u>	<u>Probability of category</u>
Filling	45 minutes	0.40
Crown	60 minutes	0.15
Cleaning	15 minutes	0.15
Extraction	45 minutes	0.10
Checkup	15 minutes	0.2

All patients are given appointments at half-an-hour intervals. Assume all the patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 a.m. Use the following random numbers for handling the above problem: 40, 82, 11, 34, 25, 66, 17, 79.

- i) Simulate the dentist's clinic for four (4) hours (3 marks)
- ii) Determine the average waiting time for the patients (3 marks)
- iii) Determine the idleness of the dentist (2 marks)

QUESTION FIVE (20 MARKS)

- a) Assess THREE algorithms for generating random variates (6 marks)
- b) Discuss THREE main steps of performing statistical analysis for terminating simulations. (6 marks)
- c) Using the linear congruential method, generate a sequence of three two-digit random numbers given $X_0=37$, $a=7$, $c=29$ and $m=100$ (8 marks)

