



MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE

SMA496: SIMULATION AND MODELLING

DATE: 17/8/2021

TIME: 8:30 – 10:30 AM

INSTRUCTIONS

This paper consists of FIVE questions

*Answer **question one** and any **two other** questions in this paper*

QUESTION ONE(COMPULSORY) (30 MARKS)

- a) Differentiate the following sets of terminologies as applied in simulation and modelling (6 marks)
 - i) Stochastic v Deterministic Systems
 - ii) Discrete v Continuous simulation
 - iii) Random numbers v pseudo random numbers
- b) Outline FOUR roles of models in a Study (4 marks)
- c) There are several alternative algorithms for generating random variates from a given distribution. Highlight FIVE Factors to consider when choosing which algorithm to use in a particular simulation study. (5 marks)
- d) The use of simulated activities in education is widely becoming recognized as an important tool in schools. Describe the use of simulation in the education area. (4 marks)
- e) Explain TWO *statistical properties* of random numbers with example. (4 marks)
- f) Research has shown that it is very hard for computers to generate truly random numbers. Discuss TWO reasons why this is the case. (4 marks)
- g) Highlight THREE techniques for generating random variates (3 marks)

QUESTION TWO (20 MARKS)

- a) The average number of lost-time accidents at Saruji Cement Factory has been determined

from historical records to be Two (2) accidents per day. Moreover, it has been determined that this accident rate can be well approximated by a Poisson distribution. Historical data on breakdowns over the last 100 days are given in the following table:

Table Q2: Average number of lost-time accidents at Saruji Cement Factory

Number of Accidents	Frequency
0	135
1	271
2	271
3	180
4	90
5	36
6	12
7	4
8	1
Total	1000

- Develop a cumulative frequency probability and assign random number intervals corresponding to it; (4 marks)
- Simulate 5-days of accident experience for the factory (4 marks)
- What is the mean breakdown for the 5-day period (3 marks)
- Compare simulated mean to the *expected* number of breakdowns based on the historical data (3 marks)

NB: Use random numbers 182, 251, 735, 124, and 549.

- b) Discuss THREE methods of generating random numbers. (6 marks)

QUESTION THREE (20 MARKS)

- a) Given $a=67$, $m=31$, $c=17$ and seed $X_0 = 117$, use Linear congruential random number generator to generate the first FIVE random variates on $[0,1]$. (6 marks)
- b) Explain the main phases of simulation (6 marks)
- c) Highlight any FOUR elements/characteristics of a queueing system (4 marks)
- d) Outline FOUR Pitfalls to guard against in Simulation (4 marks)

QUESTION FOUR (20 MARKS)

- a) Kenya Airways has one reservation clerk on duty at the Jomo Kenyatta International Airport (JKIA) at any given time. The clerk handles information regarding passenger reservation and flight timings. Assume that the number of customers arriving during any given period is Poisson distribution with an arrival rate of eight (8) per hour and that the clerk can service one (1) customer in six (6) minutes on average, with an exponentially distributed service time. Simulate this system, hence determine:
 - i) The arrival rate and service rate (2 marks)
 - ii) What is the probability that the system is busy? (2 marks)
 - iii) What is the average time a customer spends in the system? (2 marks)
 - iv) What is the average length of the queue? (2 marks)
 - v) What is the average number of the customers in the system? (2 marks)
- b) Describe THREE factors that should be considered in selecting a simulation language. (6 marks)
- c) Outline any FOUR application areas of simulation. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Define discrete event simulation. (2 marks)
- b) Your friend has established a barber shop in Machakos town 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 identify the following components of the simulation model:

(8 marks)

- i) System state
 - ii) Resources
 - iii) Events
 - iv) Activities
- c) Explain the concept of Monte Carlo simulation, outlining its chronological steps. Hence explain the essential features of this type of simulation (6 marks)
- d) Briefly explain the *fixed increment time advance mechanism* giving the circumstances underwhich it is valid. (4 marks)