MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE, APPLIED AND HEALTH SCIENCES

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

FOURTH YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN APPLIED STATISTICS WITH PROGRAMMING

AMS 448 – SIMULATION AND MODELING

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a. Differentiate between
   i. Queue and a system (2marks)
   ii. Stochastic and deterministic simulation models (2marks)
   iii. Jockeying and Reneging (2marks)
   iv. Static and deterministic simulation models (2marks)

b. Describe a single-channel (server) queuing system (6marks)

c. Assume 100 numbers are distributed between [0,1] and the number of sample observed in each interval is given in the table below. Consider 10 intervals of equal length and the level of significance $\propto = 0.05$. Test whether these numbers are uniformly distributed. (6marks)

0i	10	9	5	6	16	13	10	7	10	14

d. Use the Linear congruential method to generate a sequence of random numbers with $x_o = 27$, a = 17, c = 43 and m = 100 with their corresponding random numbers (Ri) hence or otherwise determine the period or cycle length and random bits sequence. (6marks)

e. Give four reasons for not using simulation (4marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a. Explain three characteristics of a good random number generator (3marks)

b. The sequence of random numbers 0.54, 0.73, 0.93, 0.11 and 0.68 has been generated. Use Kolmogorov-Smirnov test at $\propto = 0.01$ to test whether the hypothesis that the numbers are uniformly distributed on the interval [0,1] can be rejected. Hence or otherwise compare F(x) and $S_N(X)$ on a graph. (10marks)

c. Describe the steps carried out in simulation of a given system. (7marks)

QUESTION THREE (20 MARKS)

What is the maximum possible period for a 32-bit computers by coming k = 2 generators with $M_1 =$ 2, 147, 483, 563, a_1 = 40,014, m_2 = 2, 147, 483, 399, a_2 = 20,692 by use of combined linear congruential method? (5marks)

a. With reference to a real system, describe the components of a system. (5marks)

b. Derive professor little's balance equation for estimating $p_{o,}\, p_n,\, L_s,\, L_q\; W_s$ and W_q Simplify each equation completely (ie write them in terms of $\lambda\; and\; \mu$ to get full credit. (10marks)

QUESTION FOUR (20 MARKS)

a. Discuss four instances when simulation is an appropriate tool. (4marks)

b. Vehicles pass through a toll gate at the rate of 90/h. The average time of passing through the gate is 36 seconds. The arrival rate and service rate follow Poisson distribution.
There is a complain that the vehicles wait for long duration. The authorities are willing to install one more gate to reduce the average time of passing through the toll gate to 30 seconds. If the idle time of the toll gate is less than 10% and the average queue length of the gate is more than 5 vehicles. Check whether the installation of the second gate is justified. (5marks)

c. A small grocery store has only one checkout counter. The customers arrive at this checkout counter at random from 1 to 8 minutes apart. Each has the same probability of occurrence. The service time varies from 1 to 6 minutes apart. Each possible value of service time has same probability of occurrence. Develop the simulation distribution table for 8 customers using the table below. (11marks)

Random digits for arrival time	913	727	15	948	309	922	753	235	302	
Random digits for service Time	84	10	74	53	17	79	91	67	89	38