ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **WINTER SEMESTER, 2022-2023**

DURATION: 1 HOUR 30 MINUTES **FULL MARKS: 75**

CSE 4549: Simulation and Modeling

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding COs and POs are written within parentheses.

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1. A one-pump gas station is always open and has two types of customers. A police car arrives every 30 minutes (exactly), with the first police car arriving at time 15 minutes. Regular (non-police) cars have exponential inter-arrival times with mean 5.6 minutes, with the first regular car arriving at time 0. Service times at the pump for all cars are exponential with mean 4.8 minutes. A car arriving to find the pump idle goes right into service. A regular car arriving to find the pump busy joins the end of a single queue. A police car arriving to find the pump busy, however, goes to the front of the line, ahead of any cars in line.

   [If there are already other police cars at the front of the line, assume that an arriving police car gets in line ahead of them as well.]

   Initially the system is empty and idle, and the simulation is to run until exactly 500 cars (of any type) have completed their delays in queue. The simulation study is planned to estimate the expected average delay in queue for each type of car separately, the expected time-average number of cars (of either type or the sum of both) in queue, and the expected utilization of the pump.

   a) State the set of events and the set of state variables for the simulation model. Mention the relation between the events and the state variables, and how the events are changing the system states. Assume the simulation is terminated by an event. — 4 + 3 (CO1) (PO2)

   b) Write down the state equation(s) and the output equation(s) of the simulation model. [The state equation(s) is/are expected to reflect the change in each of the state variables with the occurrence of events] — 5 + 3 (CO1) (PO2)

   c) Draw separate flow charts of the event routines (i.e., the event handling functions) for each of the events of the simulation model mentioned in Question 1.(a). — 20 (CO1) (PO2)

   Note: From the event handling functions you can, in general, call other functions only, which may be shared by other event handling functions as well. Further, draw the flow charts of the functions that are called from the event handling functions.

2. Without actually computing any Z_i's, determine (and justify) which of the following mixed linear congruential generators (LCGs) have full period: — 5 + 5 (CO2) (PO1)

   i) $Z_i = (13 \times Z_{i-1} + 13) (\text{mod } 16)$

   ii) $Z_i = (4951 \times Z_{i-1} + 247) (\text{mod } 256)$

3. a) Use the Inverse-Transform method to generate random variates for the random variable X with the following PDF — 10 (CO2) (PO1)

$$f_X(x) = \begin{cases} x/2, & \text{for } 0 \le x \le 1; \\ 3/4, & \text{for } 1 \le x < 2; \\ 0, & \text{otherwise.} \end{cases}$$

   Generate 2 random variates for X by using the following random numbers: 0.11, 0.56, 0.91, 0.34.

b) Use the acceptance-rejection method to generate random variates for the following distribution function 10 (CO2) (PO1)

$$f_X(x) = \begin{cases} 3/4(1-x^2), & \text{for } -1 \le x \le 1; \\ 0, & \text{otherwise.} \end{cases}$$

Develop the mathematical formulation and write down the pseudocode. Generate 3 random values assuming necessary random numbers.

c) Let X denote the processing time for a particular drilling operation. There are three types of parts: A, B, and C. Thirty percent are type A, 65 percent at type B, and 5 percent are type C. The drill time for a type A part is exponential with mean 3.2 minutes. The drill time for a type B part is uniformly distributed between 1.2 and 2.0 minutes. The drill time for a type C part has a discrete distribution which is 0.5 Minutes 25% cases, 1.0 minute 50% cases and 1.5 minutes in the remaining 25% cases. 10 (CO2) (PO1)

Generate at least one processing time for each type of parts.