Name of the Program: B.Sc. in CSE
Semester: Winter 2020-2021

16 June 2021
Time: 2:30 pm – 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

Mid Semester Examination — **Winter Semester: 2020-2021**
Course Number: CSE 4549 — **Full Marks: 75**
Course Title: Simulation and Modeling — **Time: 1.5 Hours**

There are **3 (three)** questions. Answer all of them. Figures in the right margin indicate marks. The examination is **Online** and **Closed Book**. Course outcome (**CO**) and associated programme outcome (**PO**) are written below/above the marks.

Write down your **Student ID** and **Name** on top of the **first page** and **student ID** and **page no** on the top of every other pages. Submit the bundled pdf of the scanned pages with the file name **Student_ID-Course_No.pdf.**

Answer all the sub-questions of a question together in successive pages.

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1. Coal trains arrive to an unloading facility with independent exponential interarrival times having mean 10 hours. If a train arrives and finds the system idle, the train is unloaded immediately. Unloading times for the trains are independent and distributed uniformly between 3.5 and 4.5 hours. If a train arrives to a busy system, it joins a FIFO queue.

   The situation is complicated by what the railroad calls "hogging out." In particular, a train crew can work for only 12 hours, and a train cannot be unloaded without a crew present. When a train arrives, the remaining crew time (out of 12 hours) is independent and distributed uniformly between 6 and 11 hours. When a crew's 12 hours expire, it leaves immediately and a replacement crew is called. The amount of time between when a replacement crew is called and when it actually arrives is independent and distributed uniformly between 2.5 and 3.5 hours.

   If a train is being unloaded when its crew hogs out, unloading is suspended until a replacement crew arrives. If a train is in queue when its crew hogs out, the train cannot leave the queue until its replacement crew arrives. Thus, the unloading equipment can be idle with one or more trains in queue.

   You need to develop simulation for the above scenario. The simulation program will run for 720 hours (30 days) and gather statistics on:
   - Average and maximum time a train spends in the system
   - Proportion of time unloading equipment is busy, idle, and hogged out
   - Average and maximum number of trains in queue

   Note that if a train is in queue when its crew hogs out, the record for this train must be accessed. (This train may be anywhere in the queue.)

   a) Write down the goals and objectives of the simulation. — 3 (CO1, PO1)

   b) What is/are the state variable(s) and output variable(s) for the simulation model? — 6 (CO1, PO1)

   c) Identify the set of events for the simulation model. Assume that the simulation terminates by a terminating event. — 3 (CO1, PO1)

   d) Write down the state space for the simulation model. — 3 (CO1, PO1)

   e) Write down the state equation(s) and output equation(s) for the simulation model. — 8 (CO2, PO2)

   f) Draw separate flow charts of the event routines (i.e., the event handler functions) for each of the events of the simulation model. — 12 (CO2, PO3)

2. Without actually computing the generated random numbers, determine (and justify) which of the following mixed linear congruential generators (LCGs) have full period: (CO3) (PO1, PO2)

a) $Z_i = 13 \times Z_{i-1} + 13)(mod\ 16)$ 7

b) $Z_i = (4951 \times Z_{i-1} + 247)(mod\ 256)$ 8

3. a) Develop a random variate generator for a random variable with the following probability density function: (CO3) (PO1, PO2)

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$$f(x) = \begin{cases} \frac{1}{3}, & 0 \leq x \leq 2 \\ \frac{1}{24}, & 2 < x \leq 10 \\ 0, & \text{otherwise.} \end{cases}$$

Find the random values for the following random numbers.
0.665, 0.225, 0.125, 0.965, 0.115, 0.445 and 0.555.

b) Use the acceptance-rejection method to generate random values for the following density function: (CO3) (PO1, PO2)

$$f(x) = \begin{cases} \frac{1}{2}(x-2), & 2 \leq x \leq 3 \\ \frac{1}{2}\left(2 - \frac{x}{3}\right), & 3 \leq x \leq 6 \\ 0, & \text{otherwise.} \end{cases}$$

i. Derive the mathematical formulation for the method and write the algorithm for generating the random values. 10

ii. With the example of a few generated numbers (assume arbitrary numbers), justify that the generated numbers follow the mentioned distribution. 5

Good Luck !!!