NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH

SORS2205: SIMULATION

BSc. OPERATIONS RESEARCH AND STATISTICS: Part II

MARCH 2025 EXAMINATION

Time : 3 hours

Total Marks: 100

Candidates should attempt **ALL** questions from Section A and **ANY THREE** questions from Section B. Each question should start on a fresh page.

SECTION A: Attempt all questions in this section (40 marks).

A1. (a) When is simulation an appropriate tool? [4]

(b) Distinguish between:

(i) Static simulation model and dynamic simulation model, [2]

(ii) Deterministic simulation model and stochastic simulation model, [2]

(iii) Discrete simulation and continuous simulation. [2]

A2. Explain the 10 major steps in simulation with the aid of a flow chart. [10]

A3. The following 5 random digits were generated;

$$0.44 \quad 0.81 \quad 0.14 \quad 0.05 \quad 0.93.$$

Perform a test for uniformity using Kolmogorov-Smirnov test with $\alpha = 0.05$ level of significance. [10]

A4. A Linear Congruential random number generator has $m = 100, X_0 = 117$, $a = 8, c = 47$, Find the first 5 random numbers from this generator and comment on the sequence. [10]

SECTION B: Attempt any three questions in this section (60 marks).

B5. (a) Using a banking system, state and give examples of any four objects of the system. [8]

(b) Consider the 40 two digit values shown below:

```
0.30  0.48  0.36  0.01  0.54  0.34  0.96  0.06  0.61  0.85
0.48  0.86  0.14  0.86  0.89  0.37  0.49  0.60  0.04  0.83
0.42  0.83  0.37  0.21  0.90  0.89  0.91  0.79  0.57  0.99
0.95  0.27  0.41  0.81  0.96  0.31  0.09  0.06  0.23  0.77
```

Test whether the 2nd, 9th, 16th, ...numbers in the sequence are autocorrelated. [12]

B6. Table 1 contains a set of inter-arrival and service times of customers at a NUST staff canteen generated from rolling a die and recording the up face.

Table 1: Inter-arrival and service times.

Customer	1	2	3	4	5	6	7	8	9	10
Inter-arrival time	-	3	1	2	4	2	6	1	5	3
Service time	2	1	3	2	1	4	1	5	6	2

(a) Compute the arrival times of the customers at the queuing system. [5]

(b) Construct a simulation table, emphasising clock times. [5]

(c) Arrange the events in a chronological order. [5]

(d) Construct a diagram that depicts the number of customers in the system at the various clock times. [5]

B7. Consider a generator that provided the following set of 40 random numbers:

```
0.37  0.97  0.41  0.84  0.85  0.30  0.31  0.71  0.41  0.17
0.87  0.88  0.35  0.67  0.10  0.61  0.42  0.75  0.77  0.42
0.69  0.61  0.05  0.43  0.25  0.54  0.46  0.35  0.68  0.19
0.02  0.02  0.30  0.19  0.52  0.58  0.32  0.20  0.07  0.22
```

(a) Stating the necessary null and alternative hypothesis, perform a runs up and runs down test to test for independence of the data. [9]

(b) Stating the necessary null and alternative hypothesis, perform a runs above and runs below test to test for independence of the data. [9]

(c) Compare and contrast your conclusion in (a) and (b) above. [2]

B8. (a) One hundred random numbers have been generated as given below.

0.79	0.71	0.23	0.19	0.82	0.93	0.65	0.37	0.39	0.42
0.99	0.17	0.99	0.46	0.05	0.66	0.10	0.42	0.18	0.49
0.37	0.51	0.54	0.01	0.81	0.28	0.69	0.34	0.75	0.49
0.72	0.43	0.56	0.97	0.30	0.94	0.96	0.58	0.73	0.05
0.06	0.39	0.84	0.24	0.40	0.64	0.40	0.19	0.79	0.62
0.18	0.26	0.97	0.88	0.64	0.47	0.60	0.11	0.29	0.78
0.34	0.90	0.25	0.89	0.87	0.44	0.12	0.21	0.46	0.67
0.83	0.76	0.79	0.64	0.70	0.81	0.94	0.74	0.22	0.74
0.96	0.99	0.77	0.67	0.56	0.41	0.52	0.73	0.99	0.02
0.47	0.30	0.17	0.82	0.56	0.05	0.45	0.31	0.78	0.05

Test the generator for uniformity. [14]

(b) For an exponential distribution with probability mass function given by $f(x, \lambda) = \lambda e^{-\lambda x}$, where the parameter λ is a positive real quantity.

(i) Derive the mean and variance of the exponential distribution. [6]

END OF QUESTION PAPER