



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Master of Engineering in Manufacturing Systems and Operations Management

Modelling and Simulation

TIE 6210

Special Supplementary Examination Paper

August 2024

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Statistical Tables and Graph Paper

Examiner's Name: S Mhlanga

INSTRUCTIONS

1. Answer any four **(4)** questions
2. Each carries 25 marks.
3. Use of calculators is permissible

Question 1

- a) Describe briefly two classification of modelling methods. [6]
- b) Describe briefly the first three methods to discrete event simulation [4]
- c) Test for independence using the runs up and runs down method for numbers give in Table 1.1. (Using $\alpha=0.05$). [15]

Table 1.1: Random Numbers

0.35	0.15	0.55	0.84	0.85	0.47	0.21	0.3	0.86	0.22
0.15	0.61	0.32	0.81	0.29	0.09	0.26	0.3	0.67	0.85
0.3	0.87	0.96	0.83	0.95	0.27	0.21	0.75	0.32	0.01
0.76	0.8	0.09	0.14	0.9	0.79	0.68	0.07	0.97	0.29
0.92	0.34	0.49	0.74	0.15	0.26	0.65	0.92	0.22	0.02

Question 2

- a) Explain briefly two methods of verification. [8]
- b) Using the 50 two digit random numbers shown in Table 1.1 apply the Chi-square test with $\alpha=0.05$ to determine if the hypothesis that the numbers are uniformly distributed on the interval $[0, 1]$ can be rejected. [17]

Question 3

- a) Briefly discuss one method of identifying input model distribution. [6]
- b) Explain the term sensitivity estimation. [4]
- b) The time (in minutes) between requests for mechanical service was accurately maintained at ABC Company with the following results for the last 9 requests shown in Table 3.1. How are the times between requests for service distributed? Develop a suitable input model. [15]

Table 3.1: Time (in minutes) between requests

9
23
35
60
75
55
43
33
17

Question 4

a) Explain the difference between multivariate and time-series input models with the use of examples. [10]

b) Using the 10 two digit random numbers shown in Table 4.1 apply the Kolmogorov Smirnov test with $\alpha=0.05$ to determine if the hypothesis that the numbers are uniformly distributed on the interval [0, 1] can be rejected. [15]

Table 4.1: Random Numbers

0.49	0.87	0.27	0.32	0.14	0.16	0.09	0.94	0.86	0.79
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Question 5

a) Consider a typical hospital operation which includes three activities Accident and Emergency (A&E), Outpatients and In-patients. Patients arrive in the system through A&E and Outpatients. Depending on the condition, a patient can be admitted to hospital (in-patient) or discharged. Develop a conceptual model of the systems described above which will need to find the utilization and number in the queues at different points and concluded by the number that passed through the system. [15]

b) Discuss briefly seven (7) advantages and three (3) disadvantages of discrete event systems simulation. [10]

Question 6

a) Discuss four aspects of the three areas of concern which one must consider when purchasing simulation software. [12]

b) Test whether the 4th, 9th, 14th, and so on numbers in the sequence shown in Table 6.1 are autocorrelated (Using $\alpha=0.05$.) [13]

Table 6.1: Random Numbers

0.95	0.68	0.05	0.49	0.43	0.58	0.36	0.87	0.19	0.69
0.89	0.12	0.23	0.01	0.28	0.31	0.28	0.93	0.64	0.83
0.91	0.99	0.33	0.15	0.35	0.41	0.27	0.88	0.60	0.75

END OF EXAM