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| **: SIMULATION & MODELLING group cat one** |  |
| **DATE: March, 2024** | **TIME: I week** |
|  |  |
| **INSTRUCTIONS:** *Answer ALL Questions in Groups and one member submits* |  |
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**QUESTION ONE (30 MARKS)**

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| --- | --- | --- | --- |
| a) | List the circumstances under which simulation is the appropriate tool and circumstances | | |
|  | under which simulation is not the appropriate tool. | | (8 marks) |
| b) | Differentiate between the following | |  |
|  | (i) | Deterministic and stochastic model |  |
|  | (ii) | Static and dynamic simulation model | (4 marks) |
| c) | What do you mean by verification and validation of a simulation model? | | (2 marks) |
| d) | Draw a flow chart diagram of steps involved in a simulation study. | | (6 marks) |
| e) | Explain why optimization via simulation is difficult. | | (4 marks) |
| f) | State the properties of a good Arithmetic Number generator. | | (6 marks) |
| **QUESTION TWO (20 MARKS)** | | |  |
| a) | Define the following terms as used in simulation | |  |
|  | (i) | Discrete system | (2 marks) |
|  | (ii) | Continous system | (2 marks) |
|  | (iii) | Stochastic system | (2 marks) |
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1. Consider the grocery store with one checkout counter. Prepare a simulation table for eight customers and find out average waiting time of customer in queue, idle time of server and average service time. The inter-arrival time (IAT) and service time (ST) are given in minutes. Assume first customer arrives at time=0.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | IAT | 0 | 1 | 1 | 6 | 3 | 7 | 5 | 2 | 4 | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | ST(min) | 4 | 2 | 5 | 4 | 1 | 5 | 4 | 1 | 4 | 3 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| c) Use the linear congruential method to generate random numbers given that | | | | | | | | | |  |  |
|  | *X* 027, *a* 8, *c* 47 and *m* 100 | | | | |  |  |  |  | (6 marks) | |

**QUESTION THREE (20 MARKS)**

1. The time between arrivals at a drive through widow of a fast food restaurant follows the distribution below. The service time distribution is also given in the table. Use the random numbers provided to simulate the activities of the first four arrivals. Assume that the window opens at 11:00 am and that the first arrival is after this based on the first inter-arrival time.

|  |  |  |  |
| --- | --- | --- | --- |
| Time between Arrivals | Probability | Service Time | Probability |
|  |  |  |  |
| 1 | 0.2 | 1 | 0.3 |
|  |  |  |  |
| 2 | 0.3 | 2 | 0.5 |
|  |  |  |  |
| 3 | 0.3 | 3 | 0.2 |
|  |  |  |  |
| 4 | 0.2 |  |  |
|  |  |  |  |

|  |  |  |
| --- | --- | --- |
|  | Random numbers for arrivals: 14, 74, 27, 03 |  |
|  | Random numbers for service times: 88, 32, 36, 24 |  |
|  | What time does the fourth customer leave the system? | (7 marks) |
| b) | Explain with examples, the discrete and continuous systems. | (4 marks) |
| c) | Outline the state variables in a single server model. | (3 marks) |
| d) | Identify the events in a single server model | (2 marks) |
| e) | Define a simulation clock | (2 marks) |

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1. A recent survey indicated that 82% of single women aged 25 old will be married in their lifetime. Using the binomial distribution, find the probability that two or three women in

a sample of twenty will never get married. (2 marks)

**QUESTION FOUR (20 MARKS)**

1. A farmer has 10 acres of agricultural land and is cultivating tomatoes on the entire land. Due to fluctuations in water availability the yield per acre differs. The probability distribution yields are given below. The farmer is interested to know the yield for the

next 12 months if the same water availability exists. Generate 12 random numbers and

|  |  |
| --- | --- |
| simulate the average yield given in the following table. | (3 marks) |
|  |  |
| Yield of tomatoes per acre (kg) | Probability |
|  |  |
| 200 | 0.15 |
|  |  |
| 220 | 0.25 |
|  |  |
| 240 | 0.35 |
|  |  |
| 260 | 0.13 |
|  |  |
| 280 | 0.12 |
|  |  |

1. Due to fluctuating market price, the price per kg of tomatoes varies from Ksh 5.00 to Ksh 10 per kg. The probability of price variations is given in the table below. Simulate the price for next 12 months to determine the revenue per acre. Also find the average revenue per acre.

|  |  |
| --- | --- |
| Price per kg (Ksh) | Probability |
|  |  |
| 5.50 | 0.05 |
|  |  |
| 6.50 | 0.15 |
|  |  |
| 7.50 | 0.30 |
|  |  |
| 8.00 | 0.25 |
|  |  |
| 10.00 | 0.15 |
|  |  |

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