

12/5



**MASINDE MULIRO UNIVERSITY OF  
SCIENCE AND TECHNOLOGY  
(MMUST)  
MAIN CAMPUS**

**UNIVERSITY EXAMINATIONS  
2022/2023 ACADEMIC YEAR**

**THIRD YEAR FIRST SEMESTER EXAMINATIONS  
FOR THE DEGREE  
OF**

**BACHELOR OF SCIENCE IN INFORMATION SYSTEMS AND  
KNOWLEDGE MANAGEMENT**

**COURSE CODE: BIK 310**

**COURSE TITLE: SIMULATION AND MODELING**

**DATE: 13/12/2022**

**TIME: 08:00-10:00AM**

---

---

**INSTRUCTIONS TO CANDIDATES**

- Answer Questions ONE and ANY OTHER TWO.

**TIME: 2 Hours**

### QUESTION ONE 30 MARKS (COMPULSORY)

- a. MMUST has decided to increase the number of computer assignments in its curriculum and is concerned about the impact on the help desk. Instead of a single person working at the help desk, the university is considering a plan to have three identical service providers. It expects that students will arrive at a rate of 45 per hour, according to a Poisson distribution. The service rate for each of the three servers is 18 students per hour, with exponential service times. Calculate the following operating characteristics of the service system:
- i. The average utilization of the help desk **2 Marks**
  - ii. The probability that there are no students in the system **4 Marks**
  - iii. The average number of students waiting in line **3 Marks**
  - iv. The average time a student spends waiting in line **2 Mark**
  - v. The average time a student spends in the system **2 Marks**
  - vi. The average number of students in the system **2 Marks**
- b. Define the following terms and concepts as used in simulation and modelling: **5 Marks**
- i. System
  - ii. Event
  - iii. Simulation
  - iv. Delay
  - v. Modelling
- c. What is the difference between:
- i. A discrete and a continuous system **2 Marks**
  - ii. Analytical models and numerical models. **2 Marks**
- d. Briefly explain the steps followed in the simulation process. **6 Marks**

### QUESTION TWO 20 MARKS

- a. The local Division of Motor Vehicles (DMV) is concerned with its waiting line system. Currently, the DMV uses a single-server, single-line, single-phase system when processing license renewals. Based on historical evidence, the average number of customers arriving per hour is 9 and is described by a Poisson distribution. The service rate is 12 customers per hour with the service times following an exponential distribution. The customers are patient and come from an infinite population. The manager of the DMV would like you to calculate the operational characteristics of the waiting line system.

- i. What is the average system utilization? **2 Marks**
  - ii. What is the average number of customers in the system? **2 Marks**
  - iii. What is the average number of customers waiting in line? **2 Marks**
  - iv. What is the average time a customer spends in the system? **2 Marks**
  - v. What is the average time a customer spends waiting in line? **2 Marks**
- b. Sample Queue discipline: the logical ordering of customers in a queue that determines which customer is chosen for service when a server becomes free, is for example:
- i. First in first out (FIFO)
  - ii. Last in first out (LIFO)
  - iii. Service in random order (SIRO)
  - iv. Shortest processing time first (SPT)
  - v. Service according to priority (PR)
- Clearly outline using appropriate examples in modeling when you would employ any of the models listed above. **10 Marks**

### QUESTION THREE 20 MARKS

- a. The average response time for http requests at a web server is 2 minutes. The system busy time was measured to be 50 seconds during a one minute observation interval. Use an M/M/1 model for the system to determine the following.
- i. What is the average service time per transaction **4 Marks**
  - ii. What is the probability there are more than one http request in the system. **2 Marks**
  - iii. On average, how many requests are in the system **2 Marks**
  - iv. What is the average time a request spends in the queue? **2 Marks**
- b. Queueing models provide the analyst with a powerful tool for designing and evaluating the performance of queueing systems. Identify at least **TWO** typical measures of system performance **2 Marks**
- c. Briefly explain the following terms and identify at least **THREE** examples of each.
- i. Queue behavior, **4 Marks**
  - ii. Queue discipline **4 Marks**

### QUESTION FOUR 20 MARKS

- a. Explain briefly any **THREE** Pitfalls in simulation and modeling. **3 Marks**
- b. Explain Montel Carlo simulation pointing out the important characteristics of this method. **3 Marks**

- c. What are major simulation software in manufacturing applications? Also discuss model system randomness. **5 Marks**
- d. Discuss in detail, why validating a model of a computer system might be easier than validating a military combat model. Assume that the computer system of interest is similar to an existing one. **5 Marks**
- e. Briefly describe each of the following and their respective application in real life:
- i. Manufacturing and material handling system **2 Marks**
  - ii. Acceptance-rejection techniques **2 Marks**

### QUESTION FIVE 20 MARKS

- a. Consider a simple queuing network where customers enter the system with Exponential inter-arrival times with expectation 1 minute. One server then serves the incoming people with a service time uniform between 0.3 and 0.5 minutes. After that service people leave the system with probability 80% whereas with probability 20% they have to join the queue again to wait for another service. The simulation should start with an empty system and last for 4 hours.
- i. Identify the entities, the resources and the events for this simple network. **6 Marks**
  - ii. What are two variables you can use as state variable for that system? **2 Marks**
  - iii. Is the system transient or steady state? Explain **2 Marks**
- b. The average response time for http requests at a web server is 2 minutes. The system busy time was measured to be 50 seconds during a one minute observation interval. Use an M/M/1 model for the system to determine the following.
- i. What is the average service time per transaction **4 Marks**
  - ii. What is the probability there are more than one http request in the system. **2 Marks**
  - iii. On average, how many requests are in the system **2 Marks**
  - iv. What is the average time a request spends in the queue? **2 Marks**