CRAWFORD UNIVERSITY, FAITH CITY IGBESA
COLLEGE OF NATURAL AND APPLIED SCIENCES
RAIN SEMESTER, 2022/2023 SESSION
COURSE CODE: CSC 304 TITLE: QUEUEING SYSTEM 3 UNITS 2.5 HOURS
Instruction: Answer Any Four (4) Questions (Each Question Carries 15 marks)

QUESTION ONE (15marks)

(A) (i) What is a queue and why do we study queues? (2mrks)
(ii) Describe the general structure of a queuing model (3mrks)
(ii) Discuss the general characteristics of the components of a queuing system (3mrks)

(B) The Arctic Flyers minor league hockey team has one box office clerk. On average, each customer that comes to see a game can be sold a ticket at the rate of 8 per minute. For normal games, customers arrive at the rate of 5 per minute. Assume arrivals follow the Poisson distribution and service times follow the exponential distribution.

a. What is the average number of customers waiting in line?
b. What is the average time a customer spends in the waiting line?
c. What is the average number of customers in the system?
d. What is a customer's average time in the system?
e. What is the probability that someone will be buying tickets when an arrival occurs?

The Flyers are playing in the league playoffs and anticipate more fans, estimating that the arrival rate will increase to 12 per minute. Output is supplied for a two-cashier and a three-cashier system.

Number of Channels	2	3
Arrival Rate	10	10
Service Rate	6	6
Probability of No Units in System	.0909	.1727
Average Waiting Time	.3788	.0375
Average Time in System	.5455	.2041
Average Number Waiting	3.7879	.3747
Average Number in System	5.4545	2.0414
Probability of Waiting	.7576	.2998
Probability of 11 in System	.0245	less than .0088

f. The rink has space for six customers to wait indoors to buy tickets. Which system will be better?
g. Do you think it is more sensible for them to continue the one cashier system? (7mrks)

QUESTION TWO (15marks)

(A) (i) Discuss the assumptions for the M/M/1 queuing system model (3mrks)

(ii) Assuming that a M/M/1 system is in a steady-state condition (at a given time t), discuss briefly five (5) system performance measures that can be evaluated, obtaining expressions for each of them. (5mrks)

(B) (i) Define Traffic Intensity and explain the implications of its different possibilities (3mrks)
(ii) On average, it was been observed at a call center that during a 10 minutes period, 75 calls arrive every minute. Find the mean number of arrivals per second. Evaluate the probability that every second: a) no calls arrive b) 5 calls arrive c) less than 5 calls arrive (4mrks)

QUESTION THREE (15marks)

(A) (i) In a M/M/1 queue, express the probability of having n jobs in the system, P_n, as a function of the probability of the system being empty, P_0. Show how the expression is derived (3mrks)
(ii) If people arrive to purchase cinema tickets at the average rate of 6 per minute, it takes an average of 7.5 seconds to purchase a ticket. If a person arrives 2 minutes before the picture starts and if it takes exactly 1.5 minutes to reach the correct seat after purchasing the ticket. Can he expect to be seated for the start of the picture? (3mrks)

(B) (i)Three students arrive per minute at a coffee machine that dispenses exactly four cups per minute at a constant rate. Describe the system parameters. (4mrks)

(ii) Consider a disk drive that can complete an average request in 10ms. The time to complete a request is exponentially distributed. Over a period of 30 minutes, 117,000 requests were made to the disk. How long will it take to complete the average request and what is the average number of queued requests? (5mrks)

QUESTION FOUR (15marks)

(A) A new shopping mall is considering setting up an information desk manned by one employee. Based upon information obtained from similar information desks, it is believed that people will arrive at the desk at a rate of 20 per hour. It takes an average of 2 minutes to answer a question. It is assumed that the arrivals follow a Poisson distribution and answer times are exponentially distributed.

(i) Find the probability that the employee is idle.
(ii) Find the proportion of the time that the employee is busy.
(iii) Find the average number of people receiving and waiting to receive some information.
(iv) Find the average number of people waiting in line to get some information.
(v) Find the average time a person seeking information spends in the system.
(vi) Find the expected time a person spends just waiting in line to have a question answered. (6mrks)

(B) (i) The shopping mall (in Question 4A) above has decided to investigate the use of two employees on the information desk. Find the probability of having no people in the system, the average number of people waiting in this system and the expected time a person spends waiting in this system. (6mrks)
(ii) Assume that the information desk employee in Question 4A (above) earns $10 per hour. The cost of waiting time, in terms of customer dissatisfaction with the mall, is $12 per hour of time spent **waiting** in line. Find the total expected costs over an 8-hour day. (3mrks)

QUESTION FIVE (15marks)

(A) UBA is considering opening a drive-in window for customer service. Management estimates that customers will arrive at the rate of 15 per hour. The teller whom it is being considered to staff the window can service customers at the rate of one every three minutes. (5mrks)
Assuming Poisson arrivals and exponential service find:
(i) Average number in the waiting line.
(ii) Average number in the system.
(ii) Average waiting time in line.
(iii) Average waiting time in the system.

(B) In a health clinic, the average rate of arrival of patients is 12 patients per hour. On an average, a doctor can serve patients at the rate of one patient every four minutes. Assume, the arrival of patients follows a Poisson distribution and service to patients follows an exponential distribution.
(i) Find the average number of patients in the waiting line and in the clinic. (2mrks)
(ii) Find the average waiting time in the waiting line or in the queue and also the average waiting time in the clinic. (2mrks)
(iii) Differentiate clearly between the following queue configurations: Single server, Multi-server and Multiple single servers (6mrks)

QUESTION SIX (15marks)

(A) (i)If an M/M/1 queue model was used for the computer system with an arrivalrate λ=20 tasks/sec and one processor with a service rate μ= 40 tasks/sec. Decide if the M/M/1 queue model will provide a faster **response time** or not as compared to a M/M/2 queue model (5mrks)
(ii) New Delhi Railway Station has a single ticket counter. During the rush hours, customers arrive at the rate of 10 per hour. The average number of customers that can be served is 12 per hour. Find the probability that the ticket counter is free and the average number of customers in the queue. (4mrks)

(B) At a bank's ATM location with a single machine, customers arrive at the rate of one every other minute. This can be modeled using a Poisson distribution. Each customer spends an average of 90 seconds completing his/her transactions. Transaction time is exponentially distributed. Determine (i) the average time customers spend from arriving to leaving,
(ii) the chance that the customer will not have to wait,
(iii) the average number waiting to use the machine. (6mrks)