CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	PERFORMANCE MODELING OF COMMUNICATION NETWORK
COURSE CODE	:	BWB 43703
PROGRAMME CODE	:	BWQ
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

CONFIDENTIAL

Q1 (a) At one of the grocery checkout counters at Michael Mart, an analyst concluded that arrivals follow the Poisson probability distribution with an arrival rate of 24 customers per hour is 0.40 customers per minute. However, the analyst found that service times follow a normal probability distribution rather than an exponential probability distribution. The service rate was found to be 30 customers per hour is 0.50 customers per minute. A time study of actual customer waiting times showed that, on average, a customer spends 4.5 minutes in the system (waiting time plus checkout time). Using the waiting line relationships through Little's Flow Equation, compute the operating characteristics for this waiting line.

(6 marks)

(b) Given the joint probability density

$$f(x,y)=\begin{cases}\frac{2}{3}(x+2y), & 0<x<1, 0<y<1\\ 0 \quad , & \text{otherwise}\end{cases}$$

(i) Find the marginal density of X and Y.

(6 marks)

(ii) Compute the conditional density of X given $Y=y$ and use it to evaluate $P(X \leq \frac{1}{2} \mid Y = \frac{1}{2})$

(8 marks)

(c) A box of fuses contains 20 fuses of which 5 are defective. If 3 of the fuses are selected at random and removed from the box in succession without replacement, compute the probability that all 3 fuses are defective.

(2 marks)

(d) The completion of construction job may be delayed because of strike. The probabilities are 0.60 that there will a strike, 0.85 that the construction job will be completed on time if there is no strike and 0.35 that the construction job will be completed on time if there is a strike. Calculate the probability that the construction job will be completed on time.

(3 marks)

Q2 (a) The mean number of units that can be served per time period is called the service rate. Suppose that Daud Pizza studied the order-taking and order-filling process and found that the single food server can process an average of 60 customer orders per hour. On a one-minute basis, compute the probabilities such as the probability an order can be processed in 0.5 minute or less, 1 minute or less, and 2 minutes or less where $e = 2.71828$.

(3 marks)

(b) Discuss and illustrate the component of a basic queuing process.

(12 marks)

(c) Categorize **SIX (6)** mitigating approaches taken if there is a long queue.

(6 marks)

(d) A rare but serious disease, Q, has been found in 0.01 percent of a certain population. A test has been developed that will be positive, p, for 98 percent of those who have the disease and be positive for only 3 percent of those who do not have the disease. Calculate the probability that a person tested as positive does not have the disease.

(4 marks)

Q3 (a) Based on **Q2(a)** service rate of customer per minute, Daud Pizza had an arrival rate of 0.75 customers per minute. Therefore, to provide the operating characteristics for Daud Pizza single-channel waiting line, calculate the

(i) probability that no units are in the system.

(2 marks)

(ii) average number of units in the waiting line.

(2 marks)

(iii) average number of units in the system.

(2 marks)

(iv) average time a unit spends in the waiting line.

(2 marks)

(v) average time a unit spends in the system.

(2 marks)

(vi) probability that an arriving unit has to wait for service.

(2 marks)

(b) Suppose that the management wants to evaluate the desirability of opening a second order-processing station (two channel systems) so that two customers can be served simultaneously. Assume a single waiting line with the first customer in line moving to the first available server where the same service rate of customer per minute and arrival rate of customer per minutes for each channel are the same as in **Q3(a)**. Compute the

(i) probability that no units are in the system.

(2 marks)

(ii) average number of units in the waiting line.

(2 marks)

(iii) average number of units in the system.

(2 marks)

(iv) average time a unit spends in the waiting line.

(2 marks)

(v) average time a unit spends in the system.

(2 marks)

(vi) probability of 4 units in the system

(3 marks)

Q4 A shoes store consist only one checkout counter. Customers arrive at this checkout counter at random from 1 to 10 apart. Each possible value of inter-arrival time has the same probability of occurrence. The service times vary from 1 to 8 minutes with the probabilities shown in **Table Q4(a)**. The problem is to analyse the system by simulating the arrival and service of 8 customers.

Table Q4(a): Service time probability

Service time (min)	Probability
1	0.10
2	0.10
3	0.20
4	0.10
5	0.18
6	0.12
7	0.10
8	0.10

Use the following sequence of random number as shown in **Table Q4(b)**. Assume that the first customer arrives at time 0.

Table Q4(b): Random numbers

Random digits for arrival	899	655	25	940	303	799	931	700
Random digits for service time	83	17	63	51	17	78	23	53

Calculate,

(a) the average waiting time for a customer.

(13 marks)

(b) the probability that a customer has to wait in the queue.

(2 marks)

(c) the fraction of idle time of the server.

(2 marks)

(d) the average service time.

(2 marks)

(e) the average time between arrivals.

(2 marks)

(f) the average waiting time of those who wait.

(2 marks)

(g) the average time a customer spends in the system.

(2 marks)

-END OF QUESTIONS-

FINAL EXAMINATION

SEMESTER/ SESSION : SEM I 2019/2020 PROGRAMME CODE : BWQ
COURSE NAME : PERFORMANCE MODELING OF COMMUNICATION NETWORK COURSE CODE : BWB43703

Formulae

$$P[A \cap B] = P[A \mid B]P[B] @ P[B \mid A]P[A] @ P[A]P[B]$$

$$P[A \mid B] = \frac{P[A \cap B]}{P[B]}$$

$$P_0 = \left(1 - \frac{\lambda}{\mu}\right)$$

$$L = \frac{\lambda}{\mu - \lambda}$$

$$L_q = \frac{\lambda^2}{\mu^2 - \mu\lambda}$$

$$W = \frac{L}{\lambda}$$

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$U = \frac{\lambda}{\mu}$$

$$I = 1 - U$$