Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	QUEUING SYSTEM
COURSE CODE	:	BWA 40503
PROGRAMME	:	4 BWA
EXAMINATION DATE	:	DECEMBER 2015 / JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Babies are born in a populated state at the rate of one birth every 12 minutes. The time between births follows an exponential distribution. Calculate the following.

(i) The probability that no births will occur in any day.

(4 marks)

(ii) The probability of issuing 50 birth certificates in 3 hours, given that 40 certificates were issued during the first 2 hours of the 3-hour period.

(5 marks)

(iii) Suppose that a clerk who enters the information from birth certificates into the computer normally waits until at least 5 certificates have accumulated. What is the probability that the clerk will be entering a new batch every one hour?

(13 marks)

(b) The time between arrivals at R&S Restaurant is exponential with mean 5 minutes. The restaurant opens for business at 11:00 a.m. Determine the probability of having 10 arrivals in the restaurant at 11:12 a.m., given that there were 8 arrivals at 11:05 a.m.

(3 marks)

Q2 (a) Avaz Corporation is holding a car wash as a fundraiser to a handicapped society. The average time to wash a car is 4 minutes and the time is exponentially distributed. Cars arrive at a rate of two every 12 minutes, and the number of arrivals per time period is described by Poisson distribution.

Find the following.

(i) The average number of cars in the line.

(2 marks)

(ii) The average number of cars in the system.

(1 mark)

(iii) The probability the service is busy.

(1 mark)

(iv) The probability the service is idle.

(1 mark)

(v) The average time in the system.

(1 mark)

(vi) The average time for cars waiting in the line.

(1 mark)

(vii) The probability that there are four cars in the system.

(2 marks)

(b) Mechanics in a maintanence company can service 2 drilling machines for a steel plate manufacturer. Machines break down on an average of once every 10 hours of use. The breakdowns tend to follow Poisson distribution. Mechanic X with level 2 expertise on duty can handle an average of 4 hours of repair job, following an exponential distribution. Meanwhile Mechanic Y with level 1 expertise can service the machine in an average of 5 hours. The drilling machine downtime costs about RM 600 per hour. Mechanics in the maintanence company are paid RM 100 per hour (level 1 expertise) and RM 200 per hour (level 2 expertise). The objective function is to minimize the total hourly cost. What prediction can the company make from this situation?

(16 marks)

Q3 (a) Sentosa Island is a famous tourist attraction in Singapore. During peak hours, tourists arrive at the island at a mean rate of 35 per hour and thus can be approximated by a Poisson process. As tourists complete their sightseeing on the island, they queue at the exit point to purchase tickets for one of the following modes of transportation to returm to the mainland: cable car, ferry or mini-bus. The average service time at the ticket counters is 5 minutes per tourist. Past records show that a tourist usually spends an average of 8 hours sightseeing. If we assume that the sightseeing times and ticket-purchasing times are exponentially distributed, identify the following.

(i) The minimum number of ticket counters required to be in operation during peak periods.

(3 marks)

(ii) The average tourists at the Sentosa Island, if it is decided to add one more than the minimum number of counters required in operation.

(15 marks)

(b) In a point-to-point setup, data packets generated by device A are sent over a half-duplex transmission channel operating at 64 kbits/sec. using stop-and-wait protocol. Data packets are assumed to be generated by the device A according to a Poisson process and are of fixed length of 4096 bits. The probability of a packet being in error is 0.01.

(i) What is the average time required to transmit a packet till it is correctly received by device B?

(5 marks)

(ii) At what packet arrival rate will the transmission channel be saturated?

(2 marks)

Q4 Friendly's Departmental Store maintains a successful catalog sales department in which a clerk takes orders by telephone. If the clerk is occupied on one line, incoming phone calls to the catalog department are answered automatically by a recording machine and asked to wait. As soon as the clerk is free, the party that has waited the longest is transferred and answered first. Call come in at a rate of about 12 per hour. The clerk is capable of taking an order in an average of 4 minutes. Calls tend to follow a Poisson distribution and service times tend to be exponential. The clerk is paid RM 10 per hour, but because of lost goodwill and sales, Friendly's loses about RM 50 per hour of customer time spent waiting for the clerk to take an order. The management is considering adding a second clerk to take calls. The store would pay that person the same RM 10 per hour. Propose the low-cost employment to the management.

(25 marks)

- END OF QUESTION -

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FORMULA

Pure birth model: $P_n(t) = \dfrac{(\lambda t)^n \, e^{-\lambda t}}{n!}$

M/M/1	M/M/m
$L = \dfrac{\lambda}{\mu - \lambda} = L_q + \dfrac{\lambda}{\mu}$	$P_0 = \dfrac{1}{\left[\sum_{n=0}^{n=m-1} \dfrac{1}{n!}\left(\dfrac{\lambda}{\mu}\right)^n\right] + \dfrac{1}{m!}\left(\dfrac{\lambda}{\mu}\right)^m \left(\dfrac{m\mu}{m\mu - \lambda}\right)}$
$W = \dfrac{1}{\mu - \lambda} = \dfrac{L}{\lambda}$	$L = \dfrac{\lambda \mu \left(\dfrac{\lambda}{\mu}\right)^m}{(m-1)!\,(m\mu - \lambda)^2} P_0 + \dfrac{\lambda}{\mu}$
$L_q = \dfrac{\lambda^2}{\mu(\mu - \lambda)}$	$W = \dfrac{\mu \left(\dfrac{\lambda}{\mu}\right)^m}{(m-1)!\,(m\mu - \lambda)^2} P_0 + \dfrac{1}{\mu} = \dfrac{L}{\lambda}$
$W_q = \dfrac{\lambda}{\mu(\mu - \lambda)}$	$L_q = L - \dfrac{\lambda}{\mu}$
$\rho = \dfrac{\lambda}{\mu}$	$W_q = W - \dfrac{1}{\mu} = \dfrac{L_q}{\lambda}$
$P_0 = 1 - \rho = 1 - \dfrac{\lambda}{\mu}$	
$P_n = \left(\dfrac{\lambda}{\mu}\right)^n P_0 = \left(\dfrac{\lambda}{\mu}\right)^n \left(1 - \dfrac{\lambda}{\mu}\right)$	

M/M/1 with finite source: $P_0 = \dfrac{1}{\sum_{n=0}^{N} \dfrac{N!}{(N-n)!}\left(\dfrac{\lambda}{\mu}\right)^n}$

$L_q = N - \left(\dfrac{\lambda + \mu}{\lambda}\right)(1 - P_0)$, $L = L_q + (1 - P_0)$

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