UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
MAY 2012 SEMESTER

COURSE : TBB4363 MODELING AND SIMULATION FOR COMPUTER BASED SYSTEMS

DATE : 6th SEPTEMBER 2012 (THURSDAY)

TIME : 9.00 AM – 12.00 NOON (3 HOURS)

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions from the Questions Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions.
5. Do not open this Question Booklet until instructed.

Note : There are **NINE (9)** pages in this Question Booklet including the cover page.

1. A simulation of traffic intersections between Ipoh and Lumut is to be conducted with the objective of improving the current traffic flow.

   a. Generate **THREE (3)** iterations, in increasing order of complexity during the problem formulation.

   [3 marks]

   b. Generate **THREE (3)** iterations, in increasing order of complexity during setting up of objectives and overall project plan.

   [6 marks]

   c. Propose **FOUR (4)** possible types of data required in this study in order to meet the objective.

   [4 marks]

   d. Data collection process is always challenging. Propose **THREE (3)** possible ways to enhance and facilitate the above data collection process.

   [3 marks]

   e. Can the above systems be categorised as continuous systems? Justify your answer.

   [2 marks]

   f. Can the above systems be modelled as deterministic? Justify your answer.

   [2 marks]

2. A computer engineer is on-called between 8 AM to 5 PM to provide a support for a number of servers at a data centre. A simulation study has shown that the number of calls per hour is known to occur in accordance with a Poisson distribution with parameter $\alpha = 2$ per hour.

   a. Calculate the mean number of calls per hour.

   [2 marks]

   b. Calculate the variance number of calls per hour.

   [2 marks]

   c. Calculate the probability of three calls in the next hour.

   [2 marks]

   d. Calculate the probability of two or more calls in the next hour.

   . [2 marks]

   e. Calculate the probability of zero call between 3 PM to 5 PM.

   [2 marks]

   f. Suppose there is no call between 1 PM to 3 PM, calculate the probability of zero call between 3 PM to 5 PM.

   [2 marks]

   g. What can you conclude to your answer in **part 2(e)** and **part 2(f)**?

   [2 marks]

   h. Can the above systems be categorised as continuous systems? Justify your answer.

   [2 marks]

   i. Propose an alternative distribution function that can possibly be used to handle the above problem other than Poisson distribution. Justify your answer.

   [4 marks]

3. It has been claimed that CPU life expectancy is in the region of 10 – 20 years. To verify this statement, a study was conducted with a sample size of 10000 CPUs and it has been found that 0.01% of all computers of a certain type experienced a CPU failure during the warranty period of 3 years.

a. Propose the random variable for the above scenario.

[1 marks]

b. What is the probability that exactly one of the computers having the defect during the warranty period of three years?

[3 marks]

c. Suppose you use the Poisson approximation to solve **part 3(a)**.

i. Calculate the expected value.

[2 marks]

ii. Calculate the standard deviation.

[2 marks]

iii. Use your answer in **part 3(c)(i)** and/or **part 3(c)(ii)** to calculate the probability that exactly one of the computers having the defect during the warranty period of three years.

[2 marks]

iv. How do you compare your answer in **part 3(c)(iii)** to **part 3(b)**? Justify your answer.

[3 marks]

d. Suppose you want to use exponential distribution to approximate the problem in **part 3(a)**.

i. Calculate the value of λ.

[2 marks]

ii. Use your answer in **part 3(d)(i)** to calculate the probability that exactly one of the computers having the defect during the warranty period of three years.

[2 marks]

iii. How do you compare your answer in **part 3(d)(ii)** to **part 3(b)**? Justify your answer.

[3 marks]

4. A small low calories cafe has one cashier who provides counter services to walk-in customers between 8 AM to 4 PM. After picking up the buffet style of servings, the customers queue in a single line to be served by the cashier. The customers arrive randomly throughout the day and the time to serve each customer is also random.

   a. Suppose the arrivals of customers occur according to a Poisson process with $\lambda = 2$ per minute during peak hours, 8 AM – 12 PM, and $\lambda = 1$ per minute during the off-peak hour 12 PM – 4 PM. Let time $t = 0$ correspond to 8 AM.

      i. Write an appropriate model to represent the above situation using Kendall notation.

         [2 marks]

      ii. Calculate the arrival rate for both off-peak and peak.

         [2 marks]

      iii. Propose the entities in this service system.

         [2 marks]

      iv. Propose the attributes in this service system.

         [2 marks]

      v. Propose the activities in this service system.

         [2 marks]

      vi. Propose the events in this service system.

         [2 marks]

      vii. Propose the variables in this service system.

         [2 marks]

b. Suppose there are 5 arrivals, $N = 5$, in $T = 20$ minutes during the peak hours.

i. Calculate the observed arrival rate λ.

[2 marks]

ii. Suppose the average time customer spent in the systems, w, is 4.6 minutes. Calculate conservation equation, L.

[2 marks]

iii. Explain the conservation equation in **part 4(b)(ii)**

[2 marks]

5. a. Why verification is important in modelling and simulation?

[2 Marks]

b. Propose **FOUR (4)** relevant steps in verifying a model.

[4 Marks]

c. Suppose a Poisson distribution was used to model the number of arrivals per minute at a bank located in the central business district of a city. Suppose that the actual arrivals per minute were observed in 200 one-minute periods over the course of a week. The results are summarized in **TABLE Q5**.

TABLE Q5

ARRIVALS(mi)	Frequency(fi)	Mifi	Probability P(x) for poisson distribution with $\lambda = 2.9$	Theoretical Frequency
0	14	0	0.0550	11.00
1	31	31	0.1596	31.92
2	47	94	0.2314	46.28
3	41	123	0.2237	44.74
4	29	116	0.1622	32.44
5	21	105	0.0940	18.80
6	10	60	0.0455	9.10
7	5	35	0.0188	3.76
8	2	16	0.0068	1.36
9 or more	0	0	0.0030	0.60
Total	**200**	**580**	**1**	**200**

i. Propose the random variable for the above scenario.

[2 Marks]

ii. Propose the appropriate null and alternative hypothesis.

[2 Marks]

iii. Calculate the mean arrival per minute.

[2 Marks]

iv. Calculate the number of degree of freedom.

[2 Marks]

v. Suppose the calculated chi-square statistic is 2.28954. Test whether these data fit Poisson distribution. Use level of significant of $\alpha=0.05$.

[4 Marks]

vi. What can you conclude from the overall test?

[2 Marks]

-END OF PAPER-