Prince of Songkla University
Faculty of Engineering

Final Examination: Semester 2 **Academic Year**: 2005

Date: 2 March 2006 **Time**: 13.30 – 16.30

Subject Code: 240-361 **Room**: R300

Subject Name: Introduction to Queueing Theory

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียนหนึ่งภาคการศึกษา

Students must read exam instructions carefully before starting the exam

Permitted: writing instrumentals such as pens, pencil, and one A4 paper in hand-writing (to be submitted together with exam papers) are permitted

Not permitted: books, dictionaries, notes and calculators are not permitted

Exam Duration: 3 hours (180 minutes)

Instructions to students:

- This paper has 8 pages (including the cover), 5 questions, 40 marks
- Attempt all questions
- Write answers in this exam paper only
- Any unreadable parts will be considered wrong
- **Write student name and student ID on every page**
- Cheating will result in failing this subject and academic halt for 1 semester. Maximum penalty is to be expelled from the university.

Student ID :_____ Name :_____ Section : ____

Question	1	2	3	4	5	Total
Marks						

Student ID : _____ Name : _____ Section : _____

1. The arrivals of new telephone calls at a telephone switching office is a Poisson process $N(t)$ with an arrival rate of 2 calls per second for local calls, an arrival rate of 2 calls per second for long distance calls and with an arrival rate of 1 call per second for international calls. An experiment consists of monitoring the switching office and recording $N(t)$ between 5 P.M. and 7 P.M.

   a) *What is the PMF of N(t), the number of calls that arrive during the observation period?* (4 marks)

Answer _____

_____

_____

_____

_____

_____

   b) *What is $P_{N(10)}(2)$, the probability of exactly 2 calls arriving in the first ten seconds?* (2 marks)

Answer _____

_____

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_____

2. A small drive-it-through-yourself car wash, in which the next car cannot go through the washing procedure until the car in front is completely finished, has a capacity to hold a maximum of 3 cars (including the one in wash). The company has found that cars arrive at rate 5 cars / hour, and its service times to be exponential with a mean of 6 minutes.

(a) *What is the probability that the car wash is empty?* (8 marks)

Answer

(b) *What is the probability that the car wash is full?* (2 marks)

Answer

3. In a packet switching network, assume arrival rate is 2 packets per second and the average occupancy of the system is 6 packets.

(a) *What is the average delay of packets in the system?* (3 marks)

Answer

(b) *Sketch a diagram showing the flow of packets in the system.* Show times (seconds) on the horizontal axis and draw each packet as it arrives at the system for the first 6 seconds. *What is the average number of packets in the system at time = 3 seconds?* (4 marks)

Answer

4. A printer is attached to the LAN of the department. Printing jobs are assumed to arrive with a Poissonian intensity(arrival rate 0.5 job/sec) and the actual printing times are assumed to obey the distribution Exp(μ) with mean 2 seconds. The capacity of the printer has become insufficient with regard to the increased load. In order to improve the printing service, there are two alternatives:

   Case I Replace the old printer by a new one twice as fast, i.e. with service rate 2μ.

   Case II Add another similar printer (service rate μ) and there is a common printer queue where all jobs are taken and the job at the head of the queue is sent to which ever printer becomes free first. Answer the following question

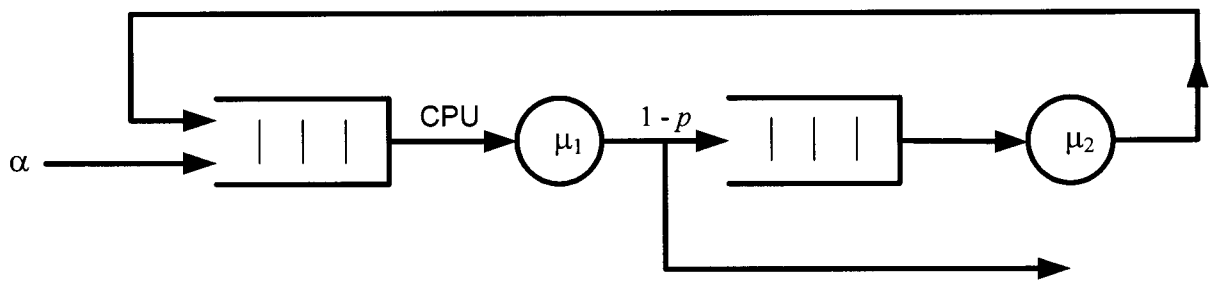
Compare the mean delay and mean waiting time performance of the two systems. (9 marks)

Answer

Student ID : Name : Section :

5. New programs arrive at a CPU according to a Poisson process of rate α as shown in Figure below. A program spends an exponentially distributed executing time of mean $1/\mu_1$ in the CPU. At the end of this service time, the program execution is complete with probability p or it requires retrieving addition information from secondary storage with probability 1-*p*. Suppose that the retrieval of information from secondary storage requires an exponentially distributed amount of time with mean $1/\mu_2$. *Find the mean time that each program spends in the system (in terms of* α, *p*, μ_1, μ_2).

(8 marks)



Answer