PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Mid-Term Examination: Semester II — Academic Year: 2006
Date: 21 February 2007 — **Time: 09.00 – 11.00**
Subject: 240-542 Queueing and Computer Networks — Room: A203

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

== 2 Hours ==

- In this exam paper, there are FIVE questions. Answer ALL questions,
- All notes and books are **not** allowed,
- Answers could be either in Thai or English,
- Only un-programmable calculator is allowed,
- Each question has equal mark.

1. There are n+1 sessions each offering 1 unit/sec of traffic along a sequence of n links with capacity of 1 unit/sec. One session's traffic goes over all n links, while the rest of the traffic goes over only one link.
    a. What is the maximum throughput can be achieved? How does this one happen (what scenario is)?
    b. However, if our objective is to give equal rate to all session, what is the system throughput?
    c. Alternatively, if our objective is to give equal resources to all session, what is the system throughput?

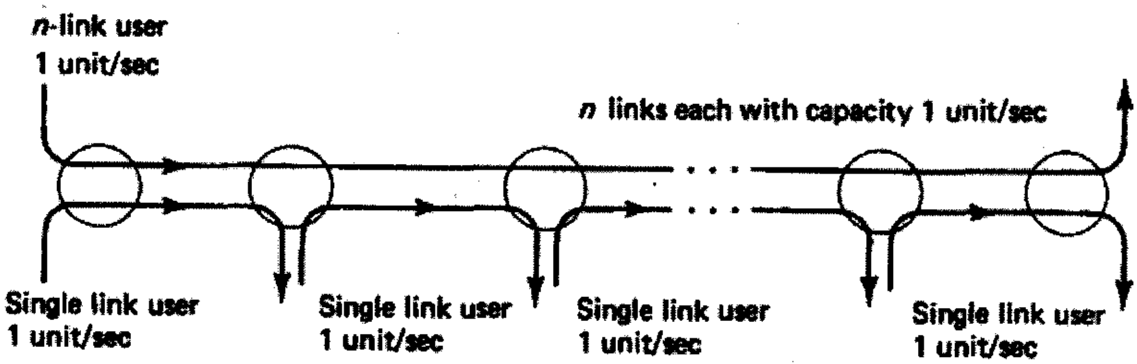

Figure 1 for question 1

2. A small router has only one output port with a large single FIFO queue. Packets arrive at this output port at random from 1 to 8 seconds apart. Each possible value of inter arrival time has the same probability of occurrence, as shown in **Table 1**. The service times vary from 1 to 6 second with the probability shown **in Table 2**. Table 3 and
3. Table **4** show a set of generated data for 20 packets of arrival and departure processes. The problem is to analyse the system by simulating the arrival and service of 20 packets. Please fill up an appropriated simulated data in. (20 Marks)

Table 1 Distribution of time between arrivals

Time between arrival (seconds)	Probability	Cumulative probability	Random digit assignment
1	0.125	0.125	001-125
2	0.125	0.125	126-250
3	0.125	0.125	251-375
4	0.125	0.125	376-500
5	0.125	0.125	501-625
6	0.125	0.125	626-750
7	0.125	0.125	751-875
8	0.125	0.125	876-000

Table 2 Service time distribution

Service time (seconds)	Probability	Cumulative probability	Random digit assignment
1	0.10	0.10	01-10
2	0.20	0.30	11-30
3	0.30	0.60	31-60
4	0.25	0.85	61-85
5	0.10	0.95	86-95
6	0.05	1.00	96-00

Table 3 Time-between-arrival determination

Packet No.	Random digits	Time between arrivals (seconds)	Packet No.	Random digits	Time between arrivals (seconds)
1	-	-	11	109	1
2	913	8	12	093	1
3	727	6	13	607	5
4	015	1	14	738	6
5	948	8	15	359	3
6	309	3	16	888	8
7	922	8	17	106	1
8	753	7	18	212	2
9	235	2	19	493	4
10	302	3	20	535	4

Table 4 Service time generated

Packet No.	Random digits	Service time (seconds)	Packet No.	Random digits	Service time (seconds)
1	84	4	11	32	3
2	10	1	12	94	5
3	74	4	13	78	4
4	53	3	14	05	1
5	17	2	15	79	5
6	79	4	16	84	4
7	91	5	17	52	3
8	67	4	18	55	3
9	89	5	19	30	2
10	38	3	20	50	3

Answer the following questions:

(a) What is the average waiting time for a packet? (3 Marks)
(b) What is the probability that a packet has to wait in the queue? (3 Marks)
(c) What is the system utilisation? (3 Marks)
(d) What is the average service time? (3 Marks)
(e) What is the average between arrivals? (3 Marks)
(f) What is the average time a packet spends in the system? (3 Marks)
(g) What is the average number of packets waiting in queue? (2 Marks).

4. One particular KFC restaurant in Hatyai City has an average customer arrival at 120 per hour. This restaurant has only one service counter which be able to server 120 customers per hour in average. Each customer takes 30 seconds (average) to be served at the counter?
   a. How much time each customer spend in the restaurant? (3 Marks)
   b. How much time each customer wait in line? (3 Marks)
   c. How many (an average) customers are in the restaurant (2 Marks)?
   d. How busy is the restaurant counter? (2 Marks)

5. (A) What are the limitations of end-to-end windows flow control on the following causes?
   - it cannot gurantee a minimum communication rate of a session
   - There is basic trade-off window size
   - There is delay-throughput trade-off
   - It fails to control packet delay of each session

   (B) A packet arrives at a transmission line every S seconds with the first packet arriving at time 0. All packets have equal length and require αS seconds for transmission where $\alpha < 1$. The processing and propagation delay per packet is Q seconds. The arrival rate here is λ. Because packets arrive at a regular rate, there is no delay for queueing.

   Proof that $N = \alpha + \frac{Q}{S}$, where N is the number of packets in the system (10 Marks)

6. Suppose that the rate of cars entering a parking lot is 5 cars per minutes with Poisson distribution. Further, suppose that the probability that a driver is female is 0.6. Find the probability that exactly 3 cars driven by females will enter the lot in the next 2 minutes. (10 Marks)

Name: .... Student ID: ....

(Used for Question 2)

Table 5 Simulation table

Packet No.	Time since last arrival (seconds)	Arrival time	Service time (seconds)	Time service begins	Time packet waits in queue (seconds)	Time service ends	Time packets spend in system (seconds)	Idle time of server
1	-	0						
2								
3								
4								
5								
6								
7								
8								
9								
10								
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