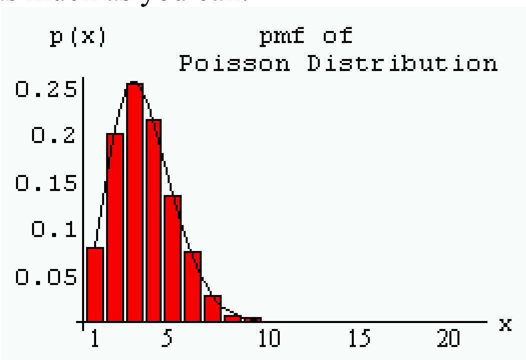
PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

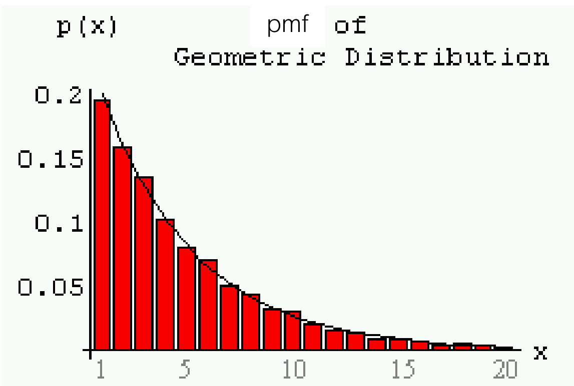
Mid-Term Examination: Semester II　　Academic Year: 2002
Date: 27 December 2002　　Time: 09.00-12.00 A.M.
Subject: 240-542 Queueing and Computer Networks　　Room:

- In this exam paper, there are FOUR 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.

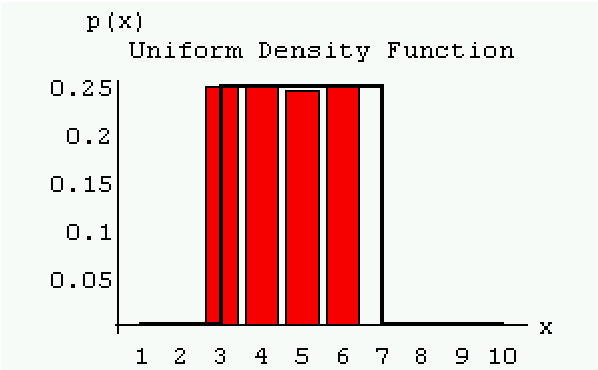
1. Explain the following terms clearly
   1.1 What are the properties of Poisson Distribution?
   1.2 What are the differences between Poisson and Exponential Distributions?
   1.3 In probability function, we know Probability Mass Functions (pmf.). Why do we need to know Cumulative Distribution Function (cdf.)?
   1.4 Queue delay, service delay, time delay in a system, packet delay of arrivals,
   1.5 From the graphs shown below, use your knowledge to explain, interpret, and/or compare as much as you can:



(a)



(b)



(c)

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 **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.

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?
(b) What is the probability that a packet has to wait in the queue?
(c) What is the system utilisation?
(d) What is the average service time?
(e) What is the average between arrivals?
(f) What is the average time a packet spends in the system?

3. A communication line capable of transmitting at a rate of 50 Kbit/sec will be used to accommodate 10 sessions each generating Poisson traffic at a rate 150 packets/min. Packet lengths are exponentially distribution with mean 1,000 bits.
   (a) For each session, find the average number of packets in queue, the average number in the system, and the average delay per packet when the line is allocated to the sessions by using:
      1. 10 equal-capacity time-division multiplexed channels,
      2. Statistical multiplexing.
   (b) Repeat part (a) when case (a).1 has queue length of 50 packets, case (a).2 uses queue length of 9 packets. What is blocking probability of each case?
   (c) Repeat part (a) for the case where five of the sessions transmit at a rate of 270 packets/min while the other five transmit at a rate of 30 packets/min.

4. (a) Consider queue with finite buffer N, FIFO service discipline and single server. If the system requires dropped packets not more than one packet every 1,000,000 packets when traffic intensity is 0.6. Determine N, system throughput, and probability that queue is not empty.

   (b) A packet arrives at a transmission line every *K* seconds with the first packet arriving at time 0. All packets have equal length and require αK seconds for transmission where $\alpha < 1$. The processing and propagation delay per packet is *P* seconds. The arrival rate here is $\lambda = 1/K$. Because packets arrive at a regular rate, there is no delay for queueing. Proof that $N = \alpha + \frac{P}{K}$

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

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								
11								
12								
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