Seat No ____________

GANPAT UNIVERSITY
M.TECH SEM.-II INFORMATION TECHNOLOGY
REGULAR MAY-JUNE 2012 EXAMINATION
3IT205: NETWORK MATHEMATICS

Max Time : 3 Hour] **[Total Marks : 70**

Instructions:
1. All questions are compulsory
2. Figures to the right indicate full marks.
3. Answer Both Sections in Separate Answer sheets

SECTION-I

Q-1 Answer the following questions.

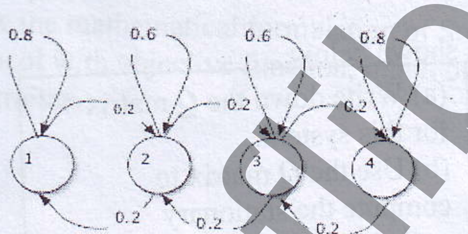
[A] Consider a link to which packets arrive as a Poisson process at a rate of 450 packets/sec such that the time taken to service a packet is exponentially distributed. Suppose that the mean packet length is 250 bytes, and that the link capacity is 1 Mbps. **[4]**

(a) What is the probability that the link's queue has 1, 2 and 10 packets respectively?

(b) What is the mean number of packets in the system? What is the mean number in the queue?

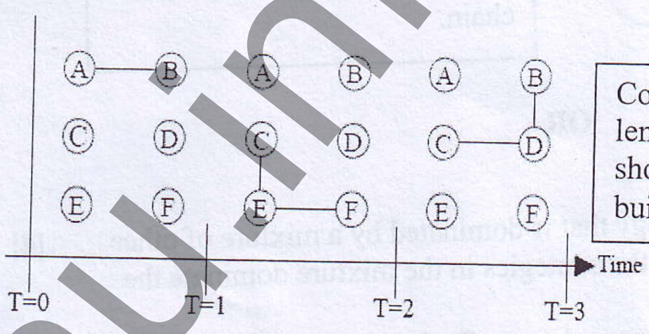
(c) What is the mean waiting time?

[B] **[4]**



For given Markov chain: 1.Compute Stationary probability 2. Compute Residence Time in each state of markov chain.

[C] **[4]**



Compute temporal path length for all nodes and show steps of matrix building.

OR

Q-1

[A] Consider that, a person is on an infinite staircase on stair number 10 at time 0 and potentially moves once every clock tick. Suppose that he moves from stair *I* to stair *i+1* with probability 0.2, and from stair *I* to stair *i-1* with probability 0.2 (the probability of staying on stair *I* is 0.6). **[4]**

Compute the probability that the person is on each stair at time 1 (after the first move), time 2, and time 3.

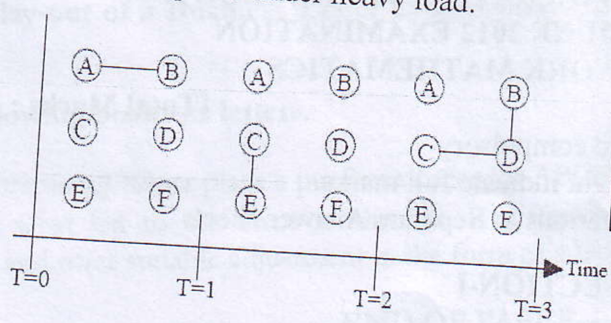
[B] Compute the mean number of customers in an M/D/1 system that has a utilization of 0.7 [4]

(a) How does this compare with a similarly loaded M/M/1 system?

(b) Compute the ratio of the mean number of customers as a function of ρ.

(c) Use this to compare the behavior of an M/D/1 queue with that of an M/M/1 queue under heavy load.

[C]



Compute temporal path length for all nodes and show steps of matrix building. [4]

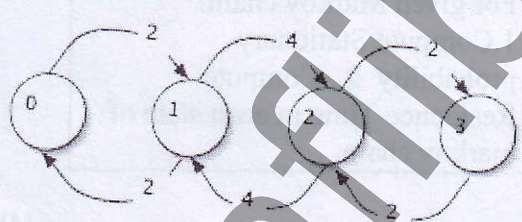
Q-2

[A] Prove that normal and extensive forms are equivalent if information sets are permitted. [4]

[B] In the 802.11 (WiFi) protocol, each station with data to send contends for airtime. For simplicity, assume that time is slotted and that each packet transmission takes exactly one time slot. If a station does not send data in a slot, airtime is wasted. If only one station sends data, it succeeds. If both send, both fail, and both must try again. [3]

Does the WiFi game of above example have a correlated equilibrium? If so, describe it.

[C] Consider the state-rate-transition diagram shown below. [4]



(a) Write down the Q matrix for this system.

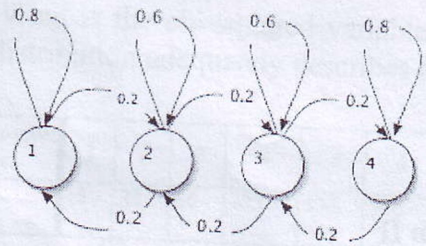
(b) Use the Q matrix to compute the stationary probability distribution of this chain.

OR

Q-2

[A] Show an example of a pure strategy that is dominated by a mixture of other pure strategies, although none of the strategies in the mixture dominate the pure strategy. [4]

[B] Suppose that you are not well prepared for a final, and you think you might fail it. If you miss the exam, you will certainly fail it. What is your dominant strategy: attend or miss? Why? [3]

[C] 

Is state 1 in the chain recurrent? Compute $f_1^{1}, f_1^{2}, f_1^{3}$ [4]

Q-3 Answer the following question.

[A] Compute the **delivery predictability [PROPHET]** new values for $P_{A,B}$ $P_{B,C}$,$P_{A,C}$ P_{init} =0.75 ,β =0.25 [4]

From/To	B	C
A	0.5	0.5
B	0.9	0.1

[B] Following table shows the current message vectors for Node A and Node B respectively. Show respective message vector's contents after encounter with each other for epidemic routing. [4]

Node A	
Dest Id	**Seq.No**
D	0
G	1
F	1

Node B	
Dest ID	**Seq No**
D	0
E	0
F	0
F	1

Write pseudo code for two hop routing protocol.

[C] Show the mathematical formulation of Socially Based Routing (SBR) protocol with objective function, input, output ,fixed parameters & set of constraints. [4]

Section II

Q.4 Answer the following:

[A] Suppose that you are using simulations to study the effect of buffer size at some network queue on packet loss rate. You would like to see if increasing the buffer size from 5 packets to 100 packets has a significant effect on loss rate. To do so, suppose that you run 10 simulations for each buffer size, resulting in loss rates shown below: **[4]**

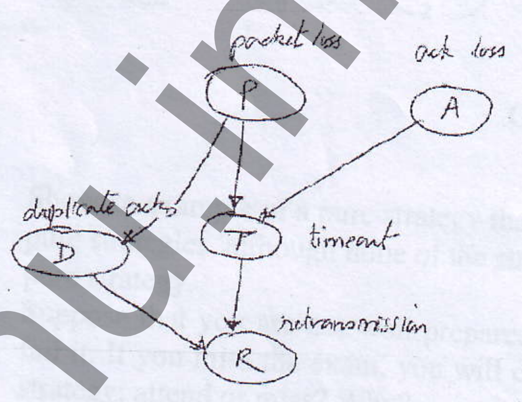
Loss rate with 5 buffers	1.20%	2.30%	1.90%	2.40%	3.00%	1.80%	2.10%	3.20%	4.50%	2.20%
Loss rate with 100 buffers	0.10%	0.60%	1.10%	0.80%	1.20%	0.30%	0.70%	1.90%	0.20%	1.20%

Does the buffer size have a significant effect on loss rate?

[B] Consider a company that has two network connections to the Internet through two providers (this is also called *multi-homing*). Suppose that the providers charge per-byte and provide different delays. For example, the lower-priced provider may guarantee that transit delays are under 50ms, and the higher-priced provider may guarantee a bound of 20ms. Suppose the company has two commonly used applications, A and B that have different sensitivities to delay. Application A is more tolerant of delay than application B. Moreover, the applications, on average, generate a certain amount of traffic every day, all of which has to be carried by one of the two links. The company wants to allocate *all* the traffic from the two applications on the two links, maximizing their benefit while minimizing its payments to the link providers. **[4]**

Represent the problem in standard form.

[C]



Consider the Bayesian network in Figure. It shows that when there is a packet loss (cause) there can be a timeout at TCP transmitter (effect). Similarly, on the loss of an acknowledgement, there can also be a timeout. A packet loss can lead to a duplicate acknowledgment being received at the transmitter. Packet and ack loss are mutually exclusive, as are duplicate acks and timeouts. And, finally, if there is either a duplicate ack or a timeout at the transmitter, it will retransmit a packet. **[4]**

Find P(packet loss | retransmission)

OR

Q.4

[A] In an experiment, a researcher counted the number of packet arriving to a switch in each 1ms time period. The table below shows the count of the number of time periods with a certain number of packet arrivals. For instance, there were 146 time periods that had 6 arrivals. The researcher expects the packet arrival process to be a Poisson process. Find the best Poisson fit for the sample. Use this to compute the expected count for each number of **[4]**

arrivals. What is the chi-squared variable value for this data set? Determine whether the Poisson distribution adequately describes the data.

Number of packet arrivals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Count	18	28	56	105	126	146	164	165	120	103	73	54	23	16	9	5

[B] Use Lagrangian optimization to find the optimal value of $z=x^3 + 2y$ subject to the condition that $x^2+y^2 = 1$ (i.e. the points (x,y) lie on the unit circle. [4]

[C] Use Bayesian network presented in Q.4[C] above[OR] and find P(ack loss | retransmission) [4]

Q-5 Answer the following

[A] Perform test to validate total unimodularity (TU) of given matrices. If it is TU then derive the partition matrices. [4]

$$A = \begin{matrix} 1 & -1 & -1 & 0 \\ -1 & 0 & 0 & 1 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & 0 \end{matrix}$$

[B] Prove that $X \sim N(\mu,\sigma^2)$ then $(X-\mu)/\sigma \sim N(0,1)$. [3]

[C] Consider the following probability mass function defined jointly over the random variables, *X, Y,* and *Z*: [4]
P(000) = 0.05; P(001) = 0.05; P(010) = 0.1; P(011)=0.3;P(100) = 0.05; P(101) = 0.05; P(110) = 0.1; P(111)=0.3.
(a) Write *down pX, pY,pZ,pXY,pXZ,pYZ.*
(b) Are *X* and *Y, X* and *Z*, or *Y* and *Z* independent? What is the probability that *X=0* given that *Z=1*?

OR

Q-5 Answer the following

[A] Two users, Alice and Bob, can schedule jobs on a machine in one of two time periods, Period 1 or Period 2. If Alice schedules a job during Period 1, she gains a benefit of 20 units, and incurs a cost of 10 units, and during Period 2, she gains a benefit of 10 units and incurs a cost of 20 units. If Bob schedules a job during Period 1, he gains a benefit of 100 units and incurs a cost of 10 units, and during Period 2, he gains a benefit of 10 units and incurs a cost of 200 units. Each user may schedule at most one job in one time unit and in each time period, at most one job can be scheduled. [4]

Generalize this to the case where *n* users can schedule jobs on one of *k* machines, such that each user incurs a specific cost and gains a specific benefit on each machine at each of *m* time periods. Write out the ILP for this problem.

[B] For the sample below, test the null hypothesis that the mean loss rate is 2% at the 95% confidence level. [3]

Loss rate with 5 buffers	1.20%	2.30%	1.90%	2.40%	3.00%	1.80%	2.10%	3.20%	4.50%	2.20%

[C] A hotel has 20 guest rooms. Assuming outgoing calls are independent and that a guest room makes 10 minutes worth of outgoing calls during the busiest hour of the day, what is the probability that 5 calls are simultaneously active during the busiest hour? What is the probability of 15 simultaneous calls? [4]

Q-6 Answer the following questions.

[A] What are the characteristics of Helper Nodes ? Write message deletion algorithm. [4]

[B] Show the classification chart of mobility models and list mobility metrics. [4]

[C] Write pseudo/algorithm code for : 1. Packet Drop Policy 2. Queuing Policy [4]

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