ECSE-4670: Computer Communications Netwoks Exam 2: Solutions

Time: **75 min (strictly enforced)**

Points: **50**

YOUR NAME:

Be brief, but DO NOT omit necessary detail

{Note: Simply copying text directly from the slides or notes will not earn (partial) credit. Brief, clear and consistent explanation will.}

I. Below, you are given a true or false statement and asked a follow up question.

1. **[5 pts]** ***False statement:*** The multiplicative increase/additive decrease (MIAD) algorithm converges to the optimum point of fairness and efficiency.

Qn: Explain why MIAD algorithm does not converge to the optimum point.

Each increase using MI will take the system away from the origin along the line joining its current point to the origin.

Each decrease using AD will bring the system down on a 45 degree line.

The net result is that the system has moved away from the optimum point (intersection of y = x; and x+y = C).

Hence the system diverges from the optimum point.

2**. (5 pts) *True statement:*** The formula for TCP latency with slow start is:

$$Latency = 2RTT + \frac{O}{R} + P\left[RTT + \frac{S}{R}\right] - (2^P - 1)\frac{S}{R}$$

What part of the latency do the sub-terms denote?

$$2RTT + \frac{O}{R}$$

Latency without slow start, fixed windows.

$$P\left[RTT + \frac{S}{R}\right]$$

P round trip times, where P is the number of stalls

$$(2^P - 1)\frac{S}{R}$$

Sum of the times taken to transmit the window as the system proceeded through slow start

II. [10 pts] Assume that you are the address administrator at an ISP. You have a 128.20.224.0/20 address block. You have two customers with networks of size 1000 nodes each; two customers whose networks have 500 nodes each; and three customers whose networks have 250 nodes each. What are the address blocks you will assign to these customers? Use notation similar to 128.20.224.0/20 to denote the address blocks you allocate. Suppose that all your remaining customers have networks of size 50 nodes each. For how many customers can you allocate address blocks with the remaining addresses you have ?

1000 nodes need 10 bits => 32 –10 =22 bit prefixes needed

128.20.1110 00 00. 0000 0000/22 = 128.20.224.0/22

128.20.1110 01 00. 0000 0000/22 = 128.20.228.0/22

500 nodes need 9 bits => 32 –9 =23 bit prefixes needed

128.20.1110100 0. 0000 0000/23 = 128.20.232.0/23

128.20.1110101 0. 0000 0000/23 = 128.20.234.0/23

250 nodes need 8 bits => 32 –8 =24 bit prefixes needed

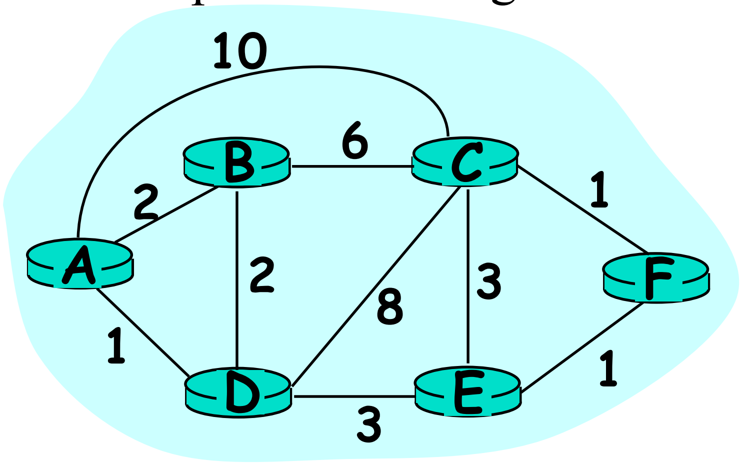
128.20.11101100. 0000 0000/24 = 128.20.236.0/24

128.20.11101101. 0000 0000/24 = 128.20.237.0/24

128.20.11101110. 0000 0000/24 = 128.20.238.0/24

Four more customer networks of size 50 each can be supported (because remaining space = 256 addresses, and minimum granularity = 64 nodes)

III. [10 pts] In the network below, compute the shortest paths from node A to all other nodes using the Dijkstra algorithm. Fill up the following table to show your work. What is the final forwarding table at node A? (fill up table in next page)



Step	Start N	D(B),P(B)	D(C),P(C)	D(D),P(D)	D(E),P(E)	D(F),P(F)
0	A	2,A	10,A	1,A	infinity	infinity
1	AD	2,A	9,D		4,D	infinity
2	ADB		8,B		4,D	infinity
3	ADBE		7,E			5,E
4	ADBEF		6,F			
5	ADBEFC					

Forwarding Table at Node A

Destination	Next Hop
B	B
C	D
D	D
E	D
F	D

IV. [10 pts] Supposes buses arrive at the RPI student union according to a Poisson process with rate $\lambda = 0.05$ arrivals per minute.

(a) (2 pts) What is the average inter-arrival time?

20 minutes = 1/0.05

Now assume that a student reaches the student union at a random point in time.

(b) (2 pts) What is the average amount of time the student has to wait till the next bus?

E(T) = 20 minutes. Because of independence.

(c) (2 pts) What is the average amount of time that has passed since the last bus departure when the student arrives at the student union?

E(T) = 20 minutes. No matter when you look at an exponential distribution, it always has the same distribution and parameters.

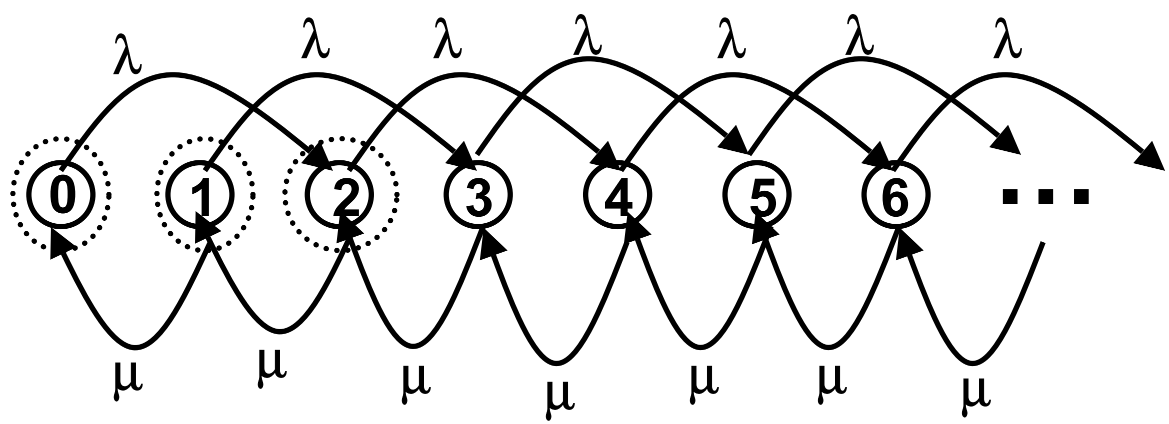
(d) (4 pts) Add the average times from part (a) and (b). One would naively think that this sum should also be the "average" time between two arrivals. Is this sum different from the answer in part (a) and if so, why?

Sum = 40 minutes. It is different.

Explanation: more likely to arrive during a period of longer inter-arrival time.

V. [10 pts] Consider a M/M/1 queuing system with infinite buffers, arrivals according to a Poisson process with rate λ and packet sizes exponentially distributed with parameter μ. We now introduce the change that each arrival implies two packets arriving at the queue (also called batch arrivals). The server still serves only one packet at a time at a rate μ. The state transition diagram for this system is given below.

(a) **(5 pts)** Write the balance equations for the three circular dotted boundaries shown in the diagram (at states 0, 1 and 2 respectively). Write the equations in terms of $\rho = \lambda/\mu$, and p_0, the steady state probability of state 0.



$p0\ \lambda = p1\ \mu$ => $p1 = \rho\ p0$

$p1\ (\lambda + \mu) = p2\ \mu$ => $p2 = \rho\ (1+\rho)\ p0$

$p2\ (\lambda + \mu) = p0\ \lambda + p3\ \mu$ => $p3 = \rho\ ((1+\rho)^2 - 1)\ p0$

(b) (3 pts) Generalize the balance equations for any given state n >= 2; in terms of $\rho = \lambda/\mu$, and p_{n-1} and p_{n-3}

$$\mathbf{pn = p(n\text{-}1)(1+ \rho) - p(n\text{-}3)\, \rho}$$

(c) (2 pts) What is the condition on λ for the system to be stable?

$$\lambda < \mu/2$$