Assignment 2
## CS232/NetSys201/EECS248 Fall 2021

November 9, 2021

Deadline: November 18 on Canvas (upload your answers in PDF under Assignment 2 and please mark each problem accordingly).

Turn in: A *pdf* file of your answers to each question.

Note: You must fully compute fractions/equations in your answers when possible. Also show all steps taken to reach the final answer.

1 Problem 1:

Consider the queuing system in the figure, where packets whose service is completed by Server 1 and 2 go to Server 3. The service time of Server 1, 2, and 3 is exponential with rate $\mu_1 = 1$ pks/s, $\mu_2 = 2$ pkt/s and $\mu_3 = 3$ pkt/s, respectively. At time $t=0$, packet A arrives in the buffer of Server 1 (which was empty), and Server 2 has two packets in its buffer (Packet B and C).
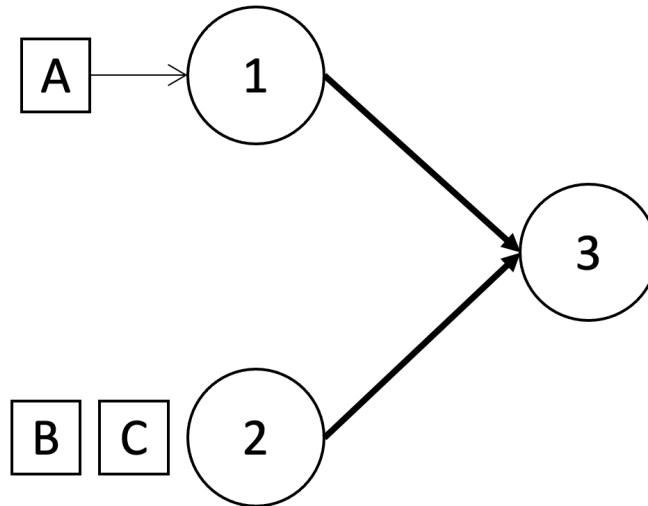
(a) Compute the probability that A exits the system before any other packets move to server 3.

(b) Compute the probability that C exits the system before any other packets move to server 3.

(c) Suppose b) is the next chain of events that happened (packet C exited the system while packets A and B are being served at server 1 and 2 respectively), compute the expected time T needed by Packet A to exist the system.

2 Problem 2:

Consider a router receiving packets according to a Poisson process $\{N(t), t \geq 0\}$ with rate $\lambda=3$ packets/second.

a) Compute the probability that $N(2)=1$.

b) Compute the expectation of $E[N(2)]$.

c) Assume that 5 packets arrived in the time interval from 0 to 2s, compute the probability that between the second 5 and the second 3 there are exactly 4 packets in the router (Hint: $P(N(5) - N(3)=4)$).

3   Problem 3:

A router sends out 60 packets every 3 seconds on average. Suppose that the time in between two packets sent out can be modeled as an exponential r.v.
a) What is the probability that a packet will be sent out in less than 4 seconds?
b) What is the probability that exactly 1 packet will leave in the next second?
c) What is the probability that less than 2 packets will leave in the next second?
d) What is the probability that exactly 2 packets will leave in the next 3 second?

4   Problem 4:

A router is receiving packets from two different clients. Assume the time between the generation of two consecutive packets at each client is exponentially distributed with parameters $\lambda_1=1$ packets/second for node 1, and at $\lambda_2=2$ packets/second for node 2.
a) What is the probability that the next packet will come from node 2?
b) What is the probability that the router will receive exactly 3 packets in the next 2 second?
c) Assume that at time $t=2$, two packets have arrived at the router. What is the probability that at least one packet will arrive by $t=4$?