April 30, 2003

Final Exam

# EE 6340: Introduction to Telecommunications Networks

NOTE: **Please, complete the following table and keep record of your assignment number.**

| | |
|---|---|
| First Name | |
| Last Name | |
| Assignment # | |

## Final Exam: Second Half of the Course

**Exercise 1.** Assume for simplicity that each transmitted packet in a slotted Aloha system is successful with some fixed probability $p$. New packets are assumed to arrive at the beginning of a slot and are transmitted *with a probability* $q_r$. If a packet is unsuccessful, it is retransmitted with a probability $q_r$ in each successive slot until received.

**A)** Given that a packet has not been transmitted successfully before, what is the probability that it is both transmitted and successful in the $i^{th}$ slot ($i > 1$) after arrival [pt. 5]?

**B)** What is the expected delay $T$ from the arrival of a packet until the completion of its successful transmission [pt. 10]?

**Exercise 2.** Assume for simplicity that each transmitted packet in a slotted Aloha system is successful with some fixed probability $p$. New packets are assumed to arrive at the beginning of a slot and are transmitted *immediately.* If a packet is unsuccessful, it is retransmitted with a probability $q_r$ in each successive slot until received.

**A)** Given that a packet has not been transmitted successfully before, what is the probability that it is both transmitted and successful in the $i^{th}$ slot ($i > 1$) after arrival [pt. 5]?

**B)** What is the expected delay $T$ from the arrival of a packet until the completion of its successful transmission [pt. 10]?

**Exercise 3.** Find a minimum weight spanning tree of the graph in Fig. 1 (representing all necessary

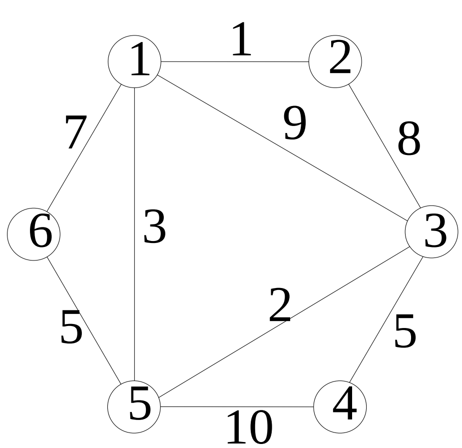


Figure 1: Undirected graph with 6 nodes and 9 edges.

intermediate steps) using, respectively,

**A)** the Prim-Dijkstra algorithm using vertex 1 as the root vertex [pt. 10],

**B)** the Kruskal algorithm [pt. 10].

**Exercise 4.** Consider the graph shown in Fig. 1. Using a graphical or matrix based representation of each intermediate iteration, find the shortest path from any node to node 4 by applying:

**A)** the Dijkstra algorithm [pt. 15].

**B)** the Bellman-Ford algorithm [pt. 15].

# Final Exam: First Half of the Course

**Exercise 5.** Consider the open queueing network in Figure 2, consisting of three M/M/1 queues. The

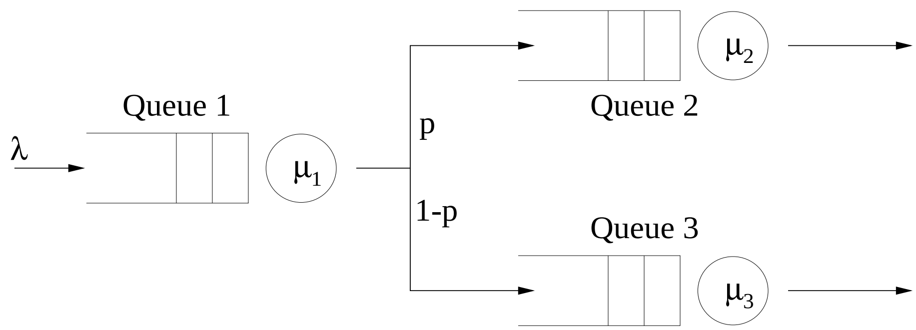


Figure 2: Open queueing network.

arrival rate at queue 1 is $\lambda = 4$ arrivals per minute. Customers exiting from queue 1 will choose queue 2 with probability $p = 0.25$ and queue 3 with probability $(1-p) = 0.75$. The service time of the queues are independent and exponentially distributed with mean $\frac{1}{8}$, $\frac{1}{2}$, and $\frac{1}{4}$ minutes.

**A)** Find the stability conditions of the network of queues [pt. 10].

**B)** Find the steady state probability $P(n)$, where $n = (n_1, n_2, n_3)$ is the vector denoting the number of customers at queue 1, 2, and 3 [pt. 10].

**C)** Find the average queue length of each queue [pt. 10].

**D)** Find the average time spent in the system by a customer [pt. 10].

**Exercise 6.** Consider the closed queueing network in Figure 3, consisting of two M/M/1 queues. There is

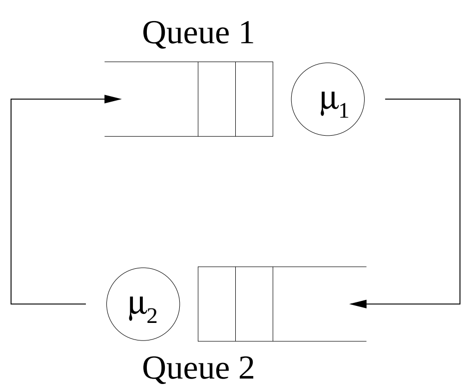


Figure 3: Closed queue network.

only one customer that cycle continuously through queue 1 and queue 2. The service time of the queues are independent and exponentially distributed with mean $\mu_1$ and $\mu_2$.

**A)** Represent the system with a Markov chain and find the transition rates of the chain [pt. 5].

**B)** Find the stability conditions [pt. 5].

**C)** Find the steady states probabilities of the states [pt. 10].

**D)** Find the customer departure rate at queue 1 [pt. 10].

**E)** Find the average time required to complete a cycle in the system [pt. 10].