April 26, 2017

Final Exam

EE/TE 4367: Telecommunications Networks

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

First Name	
Last Name	
Student ID	
Assignment #	0

Exercise 1. Representing all the relevant intermediate steps, find a minimum weight spanning tree on the

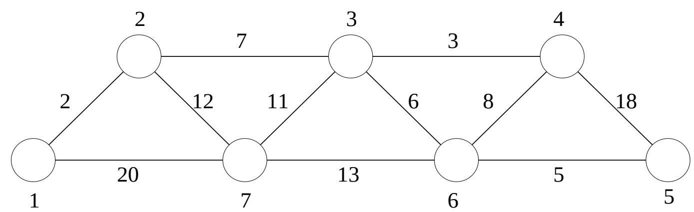

Figure 1: Undirected graph with 7 nodes and 8 edges.

graph shown in Fig. 1 using, respectively,

A) the Prim-Dijkstra algorithm choosing node 3 as the root vertex [pt. 10],

B) the Kruskal algorithm [pt. 10].

Exercise 2. Consider the graph shown in Fig. 2. Note that every arc in the figure represents two distinct

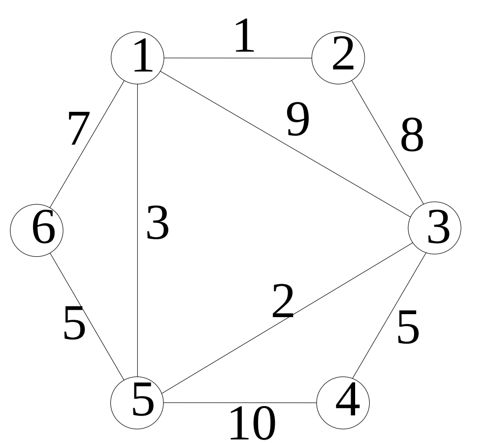

Figure 2: Undirected graph with 6 nodes and 9 edges.

directed arcs with opposite directions and same weight (shown next to the arc). Using a graphical or matrix based representation of each intermediate iteration, find the shortest path from every node to node 1 as indicated below.

A) Run the first two iterations of the Dijkstra algorithm and show the path costs at the end of the second iteration [pt. 15].

B) Identify the paths found at the end of the second iteration [pt. 10].

C) Continue to run iterations until a stop condition is reached, reporting the paths found and their respective costs [pt. 15].

Exercise 3. Consider the open network of two queues $Q1$ and $Q2$. Each queue has a single server. The service times at the queues are independent and exponentially distributed with mean $1/\mu_1$ and $1/\mu_2$, respectively. Customers (or jobs) entering the network form a Poisson arrival process with rate λ. Upon entering the network of queues, a job chooses to enter $Q1$ with probability p, or $Q2$ with probability $1-p$. Jobs leaving $Q1$ will choose to either re-enter $Q1$ (with probability q_1) or depart from the network for good (with probability $1-q_1$). Jobs leaving $Q2$ will choose to either re-enter $Q2$ (with probability q_2) or depart from the network for good (with probability $1-q_2$).

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

B) Find N, defined as the average number of jobs in the entire network of queues at steady state [pt. 15].

C) Find T, defined as the average time spent in the network of queues by a generic job [pt. 15].

D) Define $\hat{T}_1$ as the average total time spent in the network of queues by a job choosing to go through Q_1. Define $\hat{T}_2$ as the average total time spent in the network of queues by a job choosing to go through Q_2. Find p_T, defined as the value of p which guarantees a fair system, i.e., $\hat{T}_1 = \hat{T}_2$. Note that p_T must be a probability and there may be additional constraints on λ (beside those required for stability) for the solution to exist. Report any such additional constraint(s) on λ. [pt. 15].

E) Assuming now that $p = p_T$ and $q_1 = q_2 = q$, derive the stability conditions for the network of queues (answer must contain only q, λ, μ_1 and μ_2). Report any additional constraint(s) on λ for the solution to exist [hint: recall that p_T must be a probability] [pt. 15].