EE132B
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UCLA
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

EE132B - DATA COMMUNICATIONS AND TELECOMMUNICATIONS NETWORKS

Final Examination
Do all problems

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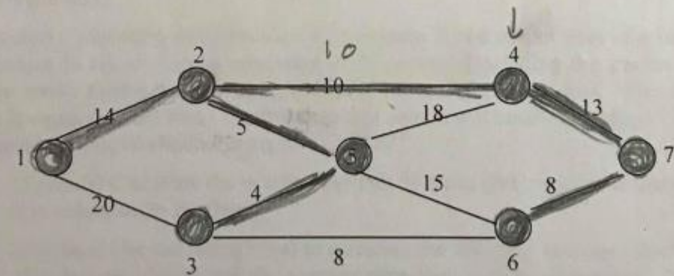
Problem 1 (25 points)

a. (10 points) State the principle of operation of link-state routing algorithms.
b. (15 points) Use Dijkstra's algorithm, showing all steps, to derive the shortest path tree (SPT) rooted at node 4 for the weighted network graph whose link weights are shown below.



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Problem 2 (Design Problem) (25 points)

(a) (10 points) Describe the operation of a sliding window flow control scheme as implemented at the transport layer. Also, illustrate it by discussing its implementation by TCP.

(b) (15 points) Consider a router at which packets arrive at an aggregate process that is modeled as a Poisson process at a rate of λ packets/sec. Arriving packets are queued in a single input buffer and are processed by a single header processor. The header processor operates at a rate of μ packets/sec. Assume that the processing of each packet takes a period of time that is exponentially distributed.

  a. (10 points) Determine what should be the packet arrival and service rates, λ and μ, respectively, so that the processor is kept idle for 20% of the time and so that the packet's delay time (including the sum total of its wait and service times) is shorter than 5 msec for 75% of the time.

  b. (5 points) For the system designed in (a), calculate the probability that there are 5 or more packets in the system (including waiting and in-service packets).

Problem 3 (25 points)

(a) (5 points) Describe the operation of a Demand-Assigned joint TDMA/FDMA multiple-access algorithm.

(b) (20 points) Consider a radio transmission module at the output port of a packet router. The system is set to store a maximum of N packets (including the packet in service). Packets arrive to the module in accordance with a Poisson process. The mean packet length is equal to 2000 bits. The transmission data rate is equal to 1 Mbps. The bit error rate across the output channel is equal to 2.5×10^{-4}.

  a. (5 points) Calculate the average number of times that a packet is transmitted until it is successfully received.

  b. (5 points) Use the result in (a) to calculate the effective average transmission time of a packet, identifying the average time that it takes to successfully transmit a packet. Assume subsequently the transmission time of a packet to be exponentially distributed with its average value set equal to the calculated effective average transmission time. Using the latter computed extended service time, incurred by possible retransmissions of packets, the system is determined to incur an offered loading service rate of 0.9 Erlangs.

  c. (5 points) Using the extended service time calculated in (b), incurred by possible retransmissions of packets, the system is determined to incur an offered loading service rate of 0.9 Erlangs. It is required to design the system storage capacity N so that it is selected as the lowest (integral) value that will induce a packet blocking probability that is not higher than 20%. Calculate the value of N that the system engineer should set.

d. (5 points) Using the result obtained in (c), calculate the realized packet blocking probability and then the ensuing packet throughput rate (expressed in packets/sec and in bits/sec).

Problem 4 (25 points)

(a) (5 points) Describe the function of a network layer protocol entity.

(b) (20 points) Consider a station that transmits packets across a wireless link by using two output channels. When one of the two channels becomes available, a queued packet is assigned for transmission across it (either one of the channels is assigned if both channels are currently available).

The packet transmission time across a channel is exponentially distributed. The channel's transmission rate is equal to 500 packets/sec when the system contains a total of 1 packet (which is being transmitted by one of the channels). In turn, the service rate of each channel is set to 1000 packets/sec and kept at this level for as long as the system size state is equal to or higher than 2.

Packets arrive to the system in accordance with a Poisson process. The packet arrival offered rate is equal to 3800 packets/sec when the system contains a total of less than 2 packets. In turn, when the system contains a total of at least two packets, the packet arrival rate is set to 1900 packets/sec and kept at this level for as long as the system size state is at least 2.

a. (8 points) Determine the probability that the service facility is saturated (i.e., that the two service channels are occupied).
b. (6 points) Calculate an estimate for the average number of messages residing in the system (in-service and in the queueing facility).
c. (6 points) Use the above results to calculate the average delay time of a message in the system (including its waiting time and service time).