1. Consider an N×N VOQ switch where the arrival process into the queue (i, j) is Bernoulli with mean λ_{ij}. Assume that $\sum_i \lambda_i k < 1$ and $\sum_j \lambda_{lj}$ $\forall$ k,l . Compute an upper bound on the steady state mean of the sum of the queue lengths in the network assuming that the MaxWeight scheduling algorithm is used.

2. Consider a 2 × 2 VOQ switch. The arrival process into VOQ(i, j) is Bernoulli with mean λ_{ij}. The arrival processes are independent across queues and time slots. Consider a scheduling policy that gives priority to edges (1, 2) and (2, 1), i.e., these links are scheduled if they have any packets in their queues. Given λ_{12} and λ_{21}, compute the set of $(\lambda_{11}, \lambda_{22})$ that can be supported under the priority scheduling policy above and the set of $(\lambda_{11}, \lambda_{22})$ that can be supported by the MaxWeight scheduling algorithm. Assume that $q_{12}(0) = q_{21}(0) = 0$.

3. Consider the network shown in Figure 1. All links of this network are bi-directional links, i.e., $c_{ij} = c_{ji}$ for all i and j. The numbers in the figure are the link costs. Compute and summarize the result of Dijkstra's algorithm (at node a) at the end of each iteration

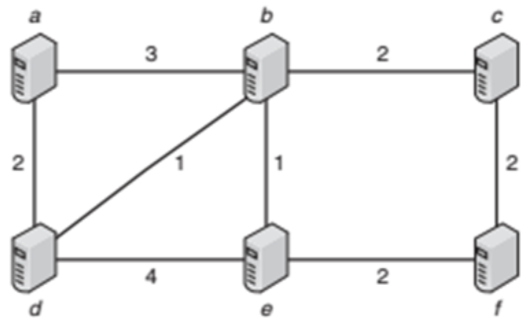

Figure 1: Network configuration

4. Consider a single wireless link, which can be in one of two states indexed by m = 0, 1. The transmitter has two power levels, indexed by j = 0, and 1, such that $p_0 = 1$ and $p_1 = 5$. The maximum number of packets that can be transmitted over the link under different channel states and transmit powers are summarized in Table-1. Assume that two-channel states occur equally likely, i.e., $\pi_0 = \pi_1 = 0.5$.

Table 1: The maximum number of packets that can be transmitted over the link under different channel states and transmit powers

	m = 0 (bad)	m=1 (good)
$P_0 = 1$	1	2
$P_1 = 5$	3	5

a. Let $\alpha_{m,j}$ denote the fraction of time that the transmitter transmits at power level j when the channel is in state m. Given $\alpha_{00} + 5\alpha_{01} = x$ for $0 \leq x \leq 5$, i.e., the average transmit power when the channel is in state 0 is x, calculate the maximum achievable throughput when the channel is in state 0, i.e., max $\alpha_{00} + 3\alpha_{01}$ subject to $\alpha_{00} + 5\alpha_{01} = x$.

b. Given $\alpha_{10} + 5\alpha_{11} = y$ for $0 \leq y \leq 5$, i.e., the average transmit power when the channel is in state 1 is y, calculate the maximum achievable throughput when the channel is in state 1, i.e., max $2\alpha_{10} + 5\alpha_{11}$ subject to $\alpha_{10} + 5\alpha_{11} = y$.