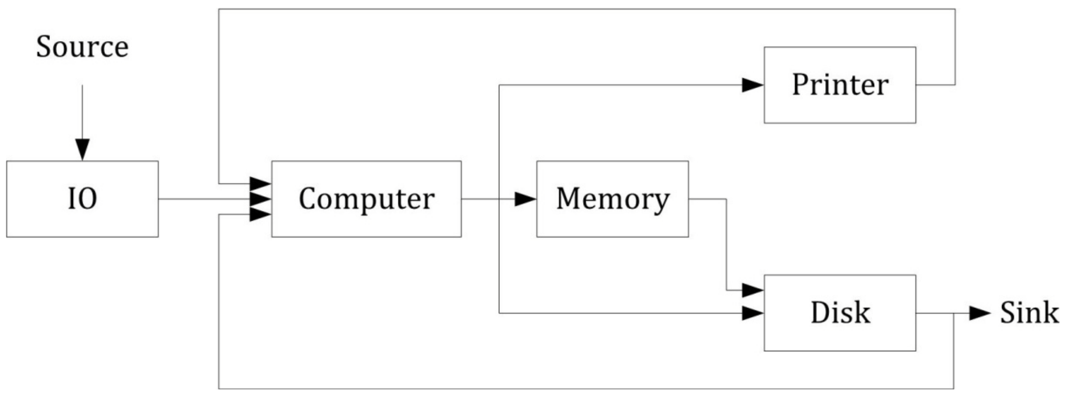
Problems

3.1 A communication line capable of transmitting at a rate of 50,000 bps can accommodate 10 sessions, each generating Poisson traffic at a rate of 2.5 packets/second, using time-division multiplexing (TDM). In each session, packet lengths are distributed such that 10% of the packets are 100 bits long and the rest are 1,500 bits long.

(a) Determine the average number of packets in queue, average delay per packet and the average number of packets in the system.
(b) Repeat part (a) for the case when short packets are given non-preemptive priority over the long packets.

3.2 Consider the queueing network given below, which consists of N = 5 single server first-come first-serve nodes.



States: Source-0, Computer-1, Printer-2, Memory-3, Disk-4, IO-5, Sink-6
The service times of the jobs at each node are exponentially distributed with respective means:

$$\frac{1}{\mu_1}=0.02 \text{ second},\ \frac{1}{\mu_2}=0.1 \text{ second},\ \frac{1}{\mu_3}=0.02 \text{ second},$$

$$\frac{1}{\mu_4}=0.04 \text{ second},\ \frac{1}{\mu_5}=0.02 \text{ second}.$$

The jobs enter the network from the source with the interarrival time exponentially distributed with the parameter:

$$\lambda = 10 \text{ jobs/second}.$$

Furthermore, the routing probabilities are given as follows:

$$p_{12} = 0.2,\ p_{13} = 0.4,\ p_{14} = 0.4,\ p_{34} = p_{21} = p_{51} = 1,$$
$$p_{41} = 0.5,\ p_{46} = 0.5.$$

(a) Express the number in states 1, 2, 3, 4, and 5 as $(k_1k_2k_3k_4k_5)$. What is the steady-state probability of state $(k_1k_2k_3k_4k_5) = (1,2,1,4,1)$?
(b) What is the total number of jobs in the network?