Problem 17.1

Assume a CSMA/CA MAC protocol, similar to problem 12.4, but where nodes in backlogged state transmit continuously a *backlogged-tone* (in a non interfering channel). When a thinking node wants to transmit a packet and sense the backlogged-tone, it defers the transmission and enters in backlogged state. When a backlogged node wants to transmit a packet, it does the transmission if the medium is idle (even if the backlogged-tone is sensed). Assume 2 nodes and parameters $\mu = 1$, $\lambda = 1/4$ and $\alpha = 3/4$.

17.1.A Let X be the random variable equal to the time since a node enters backlogged state upon listening the backlogged-tone, until it transmits the packet. Derive an absorbing DTMC that allows computing $\mathrm{E}[X]$.

17.1.B Compute the fundamental matrix $\mathbf{N} = -\mathbf{T}^{-1}$ using the cofactors formula.

17.1.C Compute $\mathrm{E}[X]$ using $\mathbf{N}$.

17.1.D Let Y be the random variable equal to the time since a node enters backlogged state upon listening the medium busy, until it transmits the packet. Using $\mathbf{N}$ of item 17.1.B compute $\mathrm{E}[Y]$.

17.1.E Let Z be the random variable equal to the time since a node enters backlogged state until it transmits the packet. Using the previous items and the results of problem 14.3, compute the expected value of Z. Compare the result with the expected value obtained in item 13.2.B.

Problem 17.2

Assume the CSMA/CA protocol of problem 12.4 with 2 nodes and parameters $\mu = 1$, $\lambda = 1/2$ and $\alpha = 1/4$. Suppose that node n_1 enters in backlogged state. Build an absorbing CTMC and use the fundamental matrix to answer the following questions:

17.2.A How many packets will transmit node n_2 before node n_1 transmits the backlogged packet?

17.2.B How long will be node n_1 backlogged before transmitting the packet?

17.2.C What is the probability that n_2 transmits 2 or more packets before n_1 transmits the backlogged packet?