EE 703: Digital Message Transmission (Autumn 2022)
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Quiz 1: 10 points   Date: September 8, 2022

1. Consider

$$s(t) = \sum_{n=-\infty}^{\infty} a_n p(t - nT)$$

   where $p(t) = I_{[0,T)}(t)$. Recall that $I_A(t)$ is the indicator function of the set A.

   (a) [2½ points] Prove that $s(t)$ is a cyclostationary random process with respect to period T if $\{a_n\}$ is a discrete-time stationary random process.

   (b) [2½ points] Prove that $s(t)$ is a wide-sense cyclostationary random process with respect to period T if $\{a_n\}$ is a discrete-time wide-sense stationary random process.

2. [5 points] The constellation $s_1 = -A, s_2 = A, s_3 = 3A$ is corrupted by noise $N \sim \mathcal{N}(1, \sigma^2)$. Note that the noise N has mean 1. Assume all three constellation points are equally likely to be transmitted.
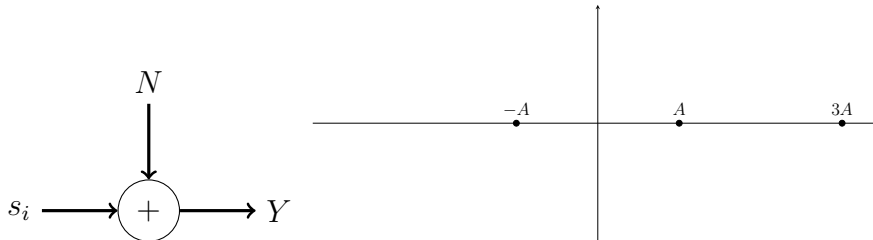
   (a) Find the optimal decision rule based on the observation Y. Show your steps.

   (b) Find the average probability of decision error for the optimal decision rule. Express your final answer in terms of the Q function. Show your steps.