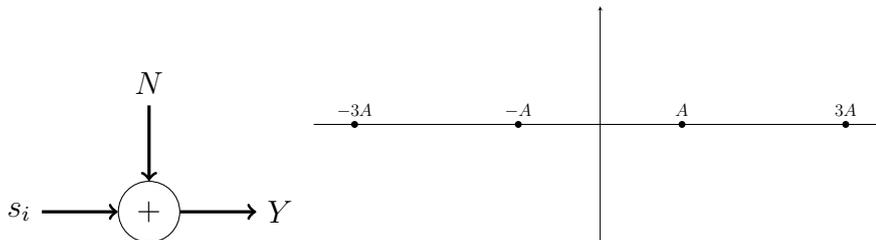


1. [5 points] Let $u_p(t)$ and $v_p(t)$ be passband signals centered at the same carrier frequency f_c . Let $u(t) = u_c(t) + ju_s(t)$ and $v(t) = v_c(t) + jv_s(t)$ be the complex baseband representations of $u_p(t)$ and $v_p(t)$ respectively. Prove that

$$\langle u_p, v_p \rangle = \text{Re}(\langle u, v \rangle).$$

2. [5 points] The constellation $s_0 = -3A, s_1 = -A, s_2 = A, s_3 = 3A$ is corrupted by noise N which is a zero mean Gaussian random variable having variance σ^2 . Assume all four 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.