Homework Problems for Lecture # 01

Assigned Date: September 19, 2022

1. The signal constellation for M-ary PSK has $s_{i1} = A\cos\left[\frac{2\pi(i-1)}{M}\right]$ and $s_{i2} = A\sin\left[\frac{2\pi(i-1)}{M}\right]$ for $i = 1, \ldots, M$. The symbol energy is $E_s = A^2$, so $\gamma_s = A^2/N_0$. For the received vector $x = re^{j\theta}$ represented in polar, find the probability of symbol error for this constellation.

2. Using the result $y^2 \geq (y-x)^2 + x^2$, prove the following inequality for the Gaussian $\mathcal{Q}$ function, where $\mathcal{Q}(x) \triangleq \frac{1}{\sqrt{2\pi}} \int_x^\infty \exp\{-\frac{t^2}{2}\}\mathrm{d}t$

$$\mathcal{Q}(x) \leq e^{-x^2/2}, \text{ for } x > 0$$

3. **Matlab Assignment:** Perform simulation and plot the error probability performance, i.e., bit error rate vs E_b/N_0 (dB) and symbol error rate vs E_b/N_0 (dB), of a M-ary PSK communication system ($M = 2, 4, 8, 16$) over AWGN channel. In your figure, you should show 2 curves: (i) The results by simulation. (ii) The results by analysis (if available)

4. **Matlab Assignment:** Perform simulation and plot the error probability performance, i.e., bit error rate vs E_b/N_0 (dB) and symbol error rate vs E_b/N_0 (dB), of a M-ary QAM communication system ($M = 4, 16, 64$) over AWGN channel. In your figure, you should show 2 curves: (i) The results by simulation. (ii) The results by analysis (if available).