Digital Communication I

Homework 3: due 2:20pm, Nov. 19

1. Problem 5.16
2. Problem 5.30
3. Problem 5.42
4. Problem 5.43
5. In a binary phase-shift keying (PSK) modulation, the two signal waveforms are

$$\begin{aligned} s_1(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t], \quad 0 \le t \le T \\ s_2(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t + \pi], \quad 0 \le t \le T \end{aligned}$$

   However, due to an imperfect phase modulator, the two signal waveforms are

$$\begin{aligned} s_1(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t], \quad 0 \le t \le T \\ s_2(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t + \pi - \theta_e], \quad 0 \le t \le T \end{aligned}$$

   where θ_e is a small phase error. Assume that the two signals occur with equal probability, for the imperfect PSK modulation with coherent detection, please find

   (a) The error probability in the presence of additive white Gaussian noise of zero mean and spectra density of $N_0/2$.

   (b) Compare with a conventional binary PSK signal, the signal-to-noise ratio (SNR) penalty as a function of phase error.

6. In a differential phase-shift keying (DPSK) modulation, information is encoded in the phase difference of the following two signal waveforms in consecutive time intervals

$$\begin{aligned} s_1(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t], \quad 0 \le t \le T \\ s_2(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t + \pi], \quad 0 \le t \le T \end{aligned}$$

   However, due to an imperfect phase modulator, the two signal waveforms are

$$\begin{aligned} s_1(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t], \quad 0 \le t \le T \\ s_2(t) &= \sqrt{\frac{2E}{T}}\cos[2\pi f_c t + \pi - \theta_e], \quad 0 \le t \le T \end{aligned}$$

   where θ_e is a small phase error. Please find the error probability of the DPSK signal with phase error in the presence of additive white Gaussian noise of zero mean and spectra density of $N_0/2$.