Problems for the 3rd quiz

Name:________________ Student ID:________________ Score:____________

1. Consider two binary FSK formulations respectively defined by

$$s(t) = \sum_{k=-\infty}^{\infty} g(t - kT_b) \cos\left(2\pi f_c t + I_k \frac{\pi h}{T_b} t\right), \tag{1}$$

and

$$s(t) = \sum_{n=-\infty}^{\infty} g(t - nT_b) \cos\left(2\pi f_c t + \sum_{k=-\infty}^{n-1} I_k \pi h + I_n \pi h \left(\frac{t - nT_b}{T_b}\right)\right), \tag{2}$$

where $I_k \in \{\pm 1\}$ and $g(t) = \begin{cases} 1, & 0 \le t < T_b; \\ 0, & \text{otherwsie.} \end{cases}$

(a) (25%) Which FSK formulation guarantees memorylessness, regardless of h and $f_c T_b$?

(b) (25%) Which FSK formulation guarantees phase continuity, regardless of h and $f_c T_b$?

(c) (50%) Both FSK formulations give $f_1 = f_c + \frac{h}{2T_b}$ and $f_2 = f_c - \frac{h}{2T_b}$. In bluetooth standard, the *frequency deviation* range $f_d \triangleq (f_1 - f_2)/2 = f_1 - f_c = f_c - f_2$ is between 140 KHz and 175 KHz. Given the data rate of 1 Mbps, what is the range of the modulation index h for the Bluetooth standard?

Solution.

(a) (1) is memoryless.

(b) (2) guarantees phase continuity.

(c) The *modulation index* h is between

$$h_{\min} = \frac{2f_{d,\min}}{1/T_b} = \frac{2 \times 140 \text{ KHz}}{1 \text{ Mbps}} = 0.28 \quad \text{and} \quad h_{\max} = \frac{2f_{d,\max}}{1/T_b} = \frac{2 \times 175 \text{ KHz}}{1 \text{ Mbps}} = 0.35.$$