Signals and Systems HW10
Deadline: 2019/06/14 before 18:30
(You should submit hand-writing paper to BL B1 EE student office.)

1. A signal modulated by PAM(Pulse-Amplitude Modulation) is expressed by

$$x(t) = (-1)^{s[n]}\sqrt{\frac{2E}{T}}\cos(w_c t), nT \le t \le (n+1)T$$

Where $s[n]$ is a binary (i.e., $s[n] \in \{0,1\}$) discrete-time signal, E is the energy per bit, and T is the time needed to transmit one bit. The demodulator is depicted in Figure 1. The demodulated signal is expressed by

$$\tilde{s}[n] = \int_{nT}^{(n+1)T} x(t)\phi(t)dt$$

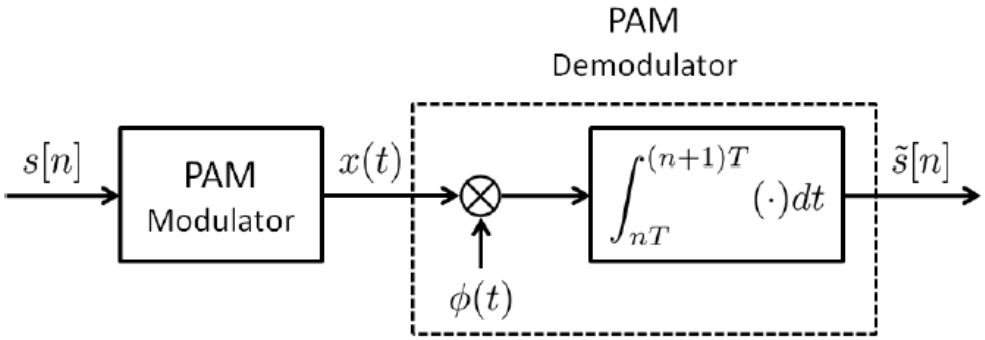

Figure 1:

(a) (20%) Find $\tilde{s}[n]$ in terms of $s[n]$, E and when $\phi(t) = \sqrt{\frac{2}{T}}\cos(w_c t)$.

(b) (20%) Suppose there is an unknown phase error θ between $x(t)$ and $\phi(t)$, i.e.,

$$\phi(t) = \sqrt{\frac{2}{T}}\cos(w_c t + \theta)$$

Find $\tilde{s}[n]$ in terms of $s[n]$, E, and θ.

(c) (20%) The modulated signal $x(t)$ is transmitted through a channel with an LTI impulse response $h(t)$. The block diagram is depicted in Figure 2. Assume $\theta = 0$ and $h(t) = \delta(t) + 2\delta(t-1) + \delta(t-2)$. Determine $g(t)$ such that $z[n] = \tilde{s}[n]$ in (a).

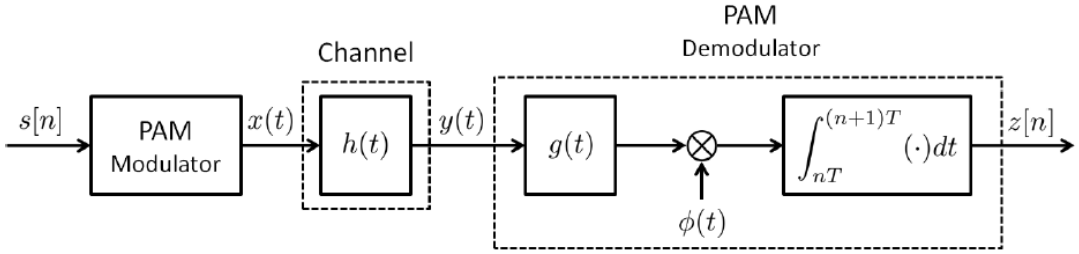

Figure 2:

2. A class of popularity used pulses in PAM are those which have a *raised cosine* frequency response. The generalized frequency response with *roll-off factor* α is

$$P_\alpha(jw) = \begin{cases} 1, 0 \le w < \pi(1-\alpha) \\ (1+\cos(\frac{w-\pi(1-\alpha)}{2\alpha}))/2, \pi(1-\alpha) \le w < \pi(1+\alpha) \\ 0, w \ge \pi(1+\alpha) \end{cases}$$

and for $w \le 0$, $P_\alpha(jw) = P_\alpha(-jw)$. Note that α is a parameter between 0 and 1.

(a) (20%) Determine $p_\alpha(0)$, where $p_\alpha(t)$ denotes the inverse Fourier transform of $P_\alpha(jw)$.

(b) (20%) Show that for $0 \le \alpha \le 1$, $P_\alpha(jw)$ satisfies

$$\sum_{k=-\infty}^{\infty} P_\alpha(j(w-2\pi k)) = 1$$