6.2. HW2

$\phi_1(t)=\sqrt{\frac{2}{T_b}}\cos(2\pi f_c t) \quad 0\le t\le T_b$

$s_1(t)=\sqrt{E_b}\,\phi_1(t)$

$s_2(t)=-\sqrt{E_b}\,\phi_1(t)$

$\phi_e(t)=\sqrt{\frac{2}{T_b}}\cos(2\pi f_c t+\varphi)$, local coherent reference signal

$X=\int_0^{T_b} x(t)\phi_e(t)\,dt=\int_0^{T_b}(s_i(t)+n(t))\cdot\left(\cos\varphi\,\phi_1(t)-\sqrt{\frac{2}{T_b}}\sin\varphi\sin(2\pi f_c t)\right)dt$

$=\cos\varphi\, s_{i1}+\sqrt{\frac{1}{2T_b}}\int_0^{T_b}\cos\varphi\, n_I(t)+\sin\varphi\, n_Q(t)\,dt$

$\Rightarrow X$ is a Gaussian distributed random variable with

mean μ: $\cos\varphi\, s_{i1}$

variance: $\sigma^2=\frac{N_0}{2}$

Because $n_I(t)$ and $n_Q(t)$ are independent zero-mean Gaussian process with PSD N_0 for $-\frac{B}{2}<f<\frac{B}{2}$

$\sigma^2=\frac{1}{2T_b}\times(\cos^2\varphi\, N_0B+\sin^2\varphi\, N_0B)=\frac{1}{2T_b}N_0B=\frac{N_0}{2}$,

$\Rightarrow P_{01}=\frac{1}{\sqrt{\pi N_0}}\int_{-\infty}^{0}e^{-\frac{1}{N_0}(x-\cos\varphi\sqrt{E_b})^2}dx$

$=\frac{1}{2}\operatorname{erfc}\left(\sqrt{\frac{\cos\varphi E_b}{N_0}}\right)$

Similarly, $P_{10}=\frac{1}{2}\operatorname{erfc}\left(\sqrt{\frac{\cos\varphi E_b}{N_0}}\right)$

Thus, the average error probability is $\frac{1}{2}\operatorname{erfc}\left(\sqrt{\frac{\cos\varphi E_b}{N_0}}\right)$

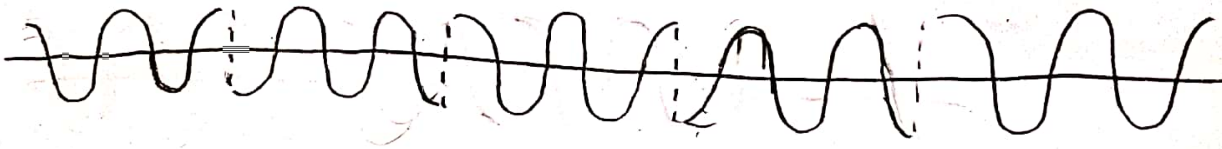
6.5.

$$s_i(t) = \sqrt{\frac{2E}{T}} \cos\left[(2i-1)\frac{\pi}{4}\right]\cos(2\pi f_c t) - \sqrt{\frac{2E}{T}} \sin\left[(2i-1)\frac{\pi}{4}\right]\sin(2\pi f_c t)$$

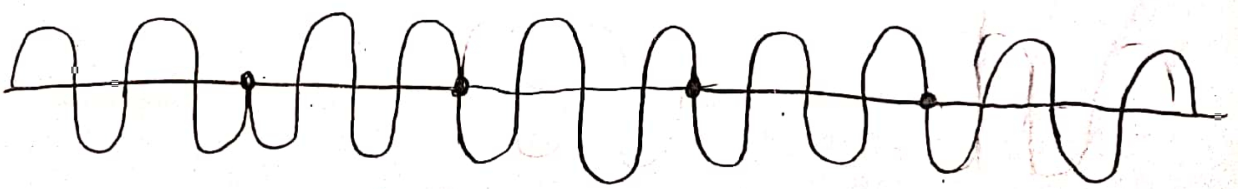
(a)

binary sequence : 11 00 10 00 10

in-phase (first bit)

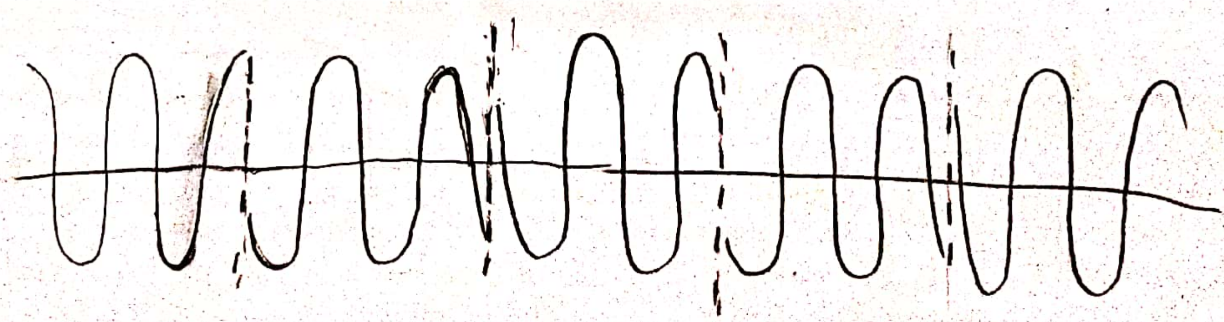


quadrature (second bit)



(b)

QPSK



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Q.6.

We knew that the outputs of in-phase and quadrature components are independent

Thus, the average probability of symbol correct overall system is

$$P_c = (1-P_{eI})(1-P_{eQ}) = 1 - P_{eI} - P_{eQ} + P_{eI}P_{eQ}$$

$$\Rightarrow P_e = 1 - P_c = P_{eI} + P_{eQ} - P_{eI}P_{eQ}$$

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6.10.

Step k	Phase θ_{k-1}	Input Dibit	Phase change $\Delta\theta_k$	Transmitted Phase θ_k
1	0	01	$3\pi/4$	$3\pi/4$
2	$3\pi/4$	10	$-\pi/4$	$\pi/2$
3	$\pi/2$	10	$-\pi/4$	$\pi/4$
4	$\pi/4$	00	$\pi/4$	$\pi/2$

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