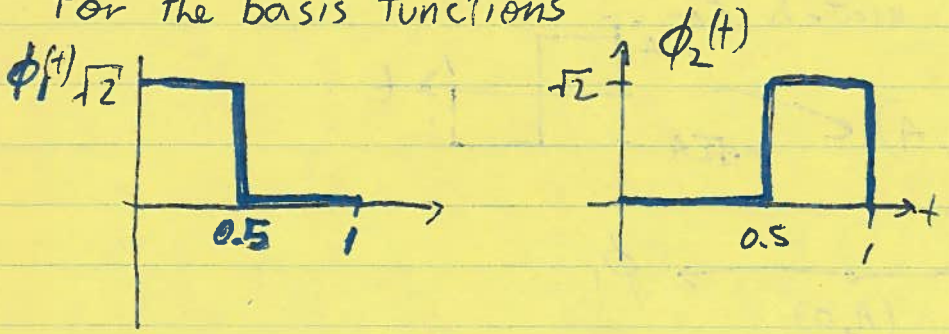
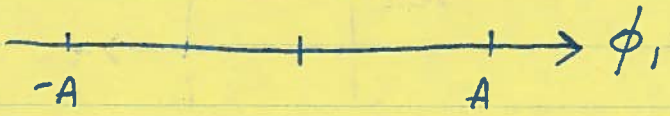
1)

For the basis functions

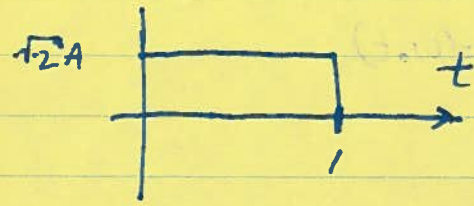


sketch the waveforms corresponding to the constellation



i.e. what waveforms map to A & $-A$ on the ϕ_1 basis's

$$\int_0^1 s(t)\,\phi_1(t)\,dt = A$$

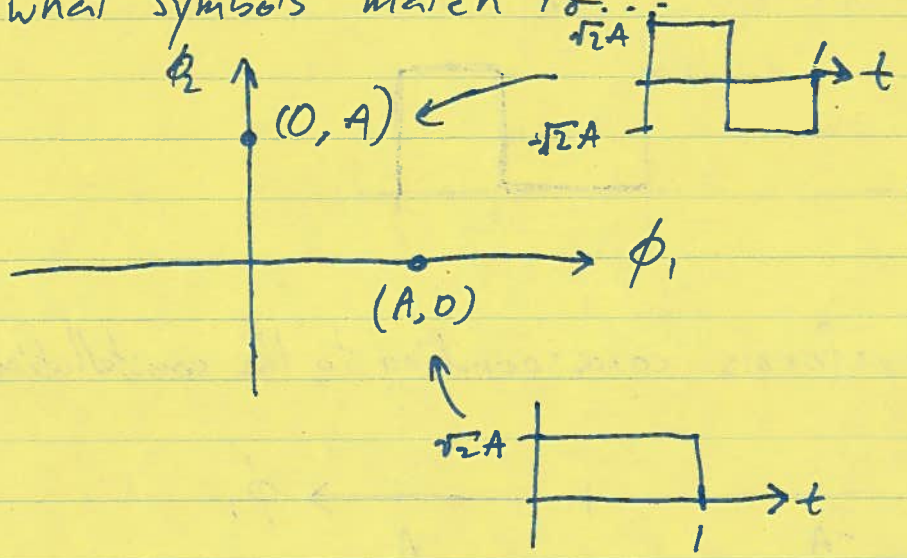


maps to A

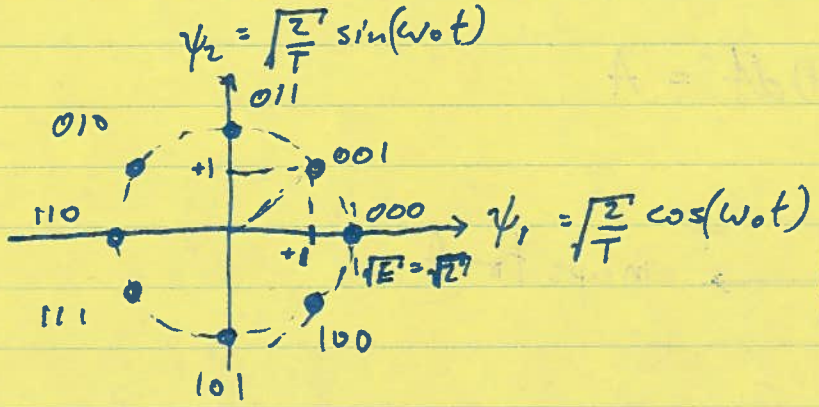
maps to $-A$

2)

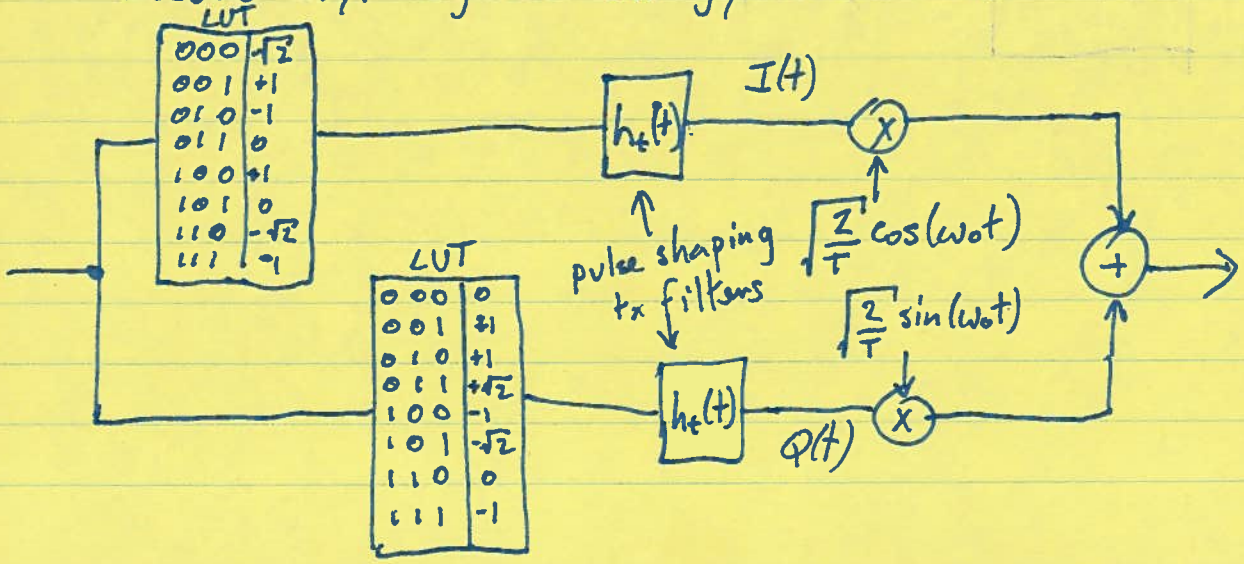
using the same basis functions as before what symbols match to...



3) Draw the modulator for an 8-PSK constellation



assume avg. symbol energy is 2J



4) BER of OOK?

$s_1(t) = A\cos\omega_0 t$

$s_2(t) = 0$

$P_B = Q\left(\sqrt{\frac{E_d}{2N_0}}\right)$ $\quad E_d = \int_0^T (s_1 - s_2)^2 dt$

$= \int_0^T A^2\cos^2\omega_0 t\, dt$

$P_B = Q\left(\frac{A^2T}{8N_0}\right)$ $\quad = \frac{A^2T}{4}$

avg. energy per bit is $E_b = \frac{1}{2}\int_0^T (s_1)^2 dt = \frac{A^2T}{8}$

$\therefore P_B = Q\left(\frac{E_b}{N_0}\right)$

5) 4.17 from Sklar

a) normally $a_1(T) = \frac{2\sqrt{E_b}}{T}\int_0^T \cos^2\omega_0 t\, dt$

if we have sych error with s_2 following s_1 we have

$a_1(T) = \frac{2\sqrt{E_b}}{T}\left[\int_{pT}^{T}\cos^2\omega_0 t\, dt + \int_{T}^{T+pT} -\cos^2\omega_0 t\, dt\right]$

$= 2\sqrt{E_b}(1-2p)$

similarly $a_2(T) = -\sqrt{E_b}(1-2p)$

assum 50% of the time a symbol is followed by its complement

$$\therefore P_B = \frac{1}{2} Q\left(\sqrt{\frac{2E_b}{N_0}}\right) + \frac{1}{2} Q\left[\sqrt{\frac{2E_b}{N_0}}(1-2p)\right]$$

b) $p=0$ $\frac{E_b}{N_0} = 9.6\ dB$

$$P_B = Q\left(\sqrt{\frac{2E_b}{N_0}}\right) = Q(4.27) \approx 10^{-5}$$

when $p=0.2$

$$P_B = \frac{1}{2} 10^{-5} + \frac{1}{2} Q(4.27 \times 0.6)$$

$$\approx 2.6 \times 10^{-3}$$

c) $$P_B = 10^{-5} = \frac{1}{2} Q\left(\sqrt{\frac{2E_b}{N_0}}\right) + \frac{1}{2} Q\left[\sqrt{\frac{2E_b}{N_0}}(1-2p)\right]$$

by trial & error can find $\frac{E_b}{N_0} = 13.7\ dB$

which represents an increase of 4.1 dB needed to restore $P_B = 10^{-5}$