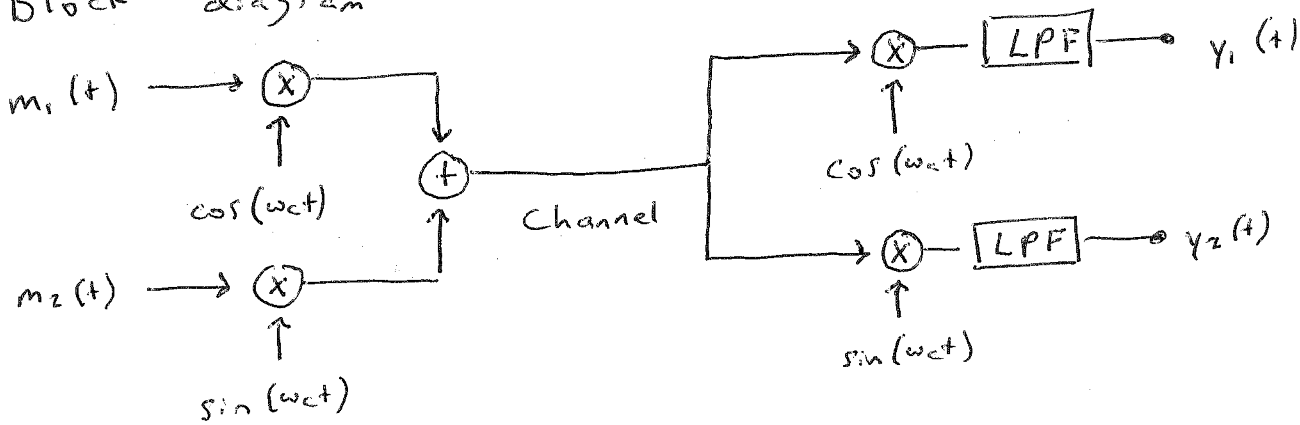
Lab 8: M-ary PSK

Block diagram



Question: what are $y_1(t)$, $y_2(t)$?

Answer: $y_1(t) = \frac{1}{2} m_1(t)$ $\quad y_2(t) = \frac{1}{2} m_2(t)$

Proof: use superposition, (System is linear)

① Turn $m_1(t)$ on, $m_2(t)$ off.

$$y_1(t) = LPF\{m_1(t)\cos(\omega_c t)\cos(\omega_c t)\}$$
$$= LPF\{\tfrac{1}{2}m_1(t) + \tfrac{1}{2}m_1(t)\cos(2\omega_c t)\}$$
$$= \tfrac{1}{2}m_1(t)$$

$$y_2(t) = LPF\{m_1(t)\cos(\omega_c t)\sin(\omega_c t)\}$$
$$= LPF\{\tfrac{1}{2}m_1(t)\sin(2\omega_c t)\}$$
$$= 0$$

So $m_1(t)$ survives only in upper branch.

② Turn $m_2(t)$ on, $m_1(t)$ off.

(Similar analysis...)

$$y_1(t) = 0$$
$$y_2(t) = \tfrac{1}{2}m_2(t)$$

③ Using superposition, turn both $m_1(t)$ and $m_2(t)$ on.

$$y_1(t) = \tfrac{1}{2}m_1(t) + 0 = \tfrac{1}{2}m_1(t)$$
$$y_2(t) = 0 + \tfrac{1}{2}m_2(t) = \tfrac{1}{2}m_2(t)$$

So we can modulate $\cos(\omega_c t)$ and $\sin(\omega_c t)$ independently!
(Send twice as many bits / second.)

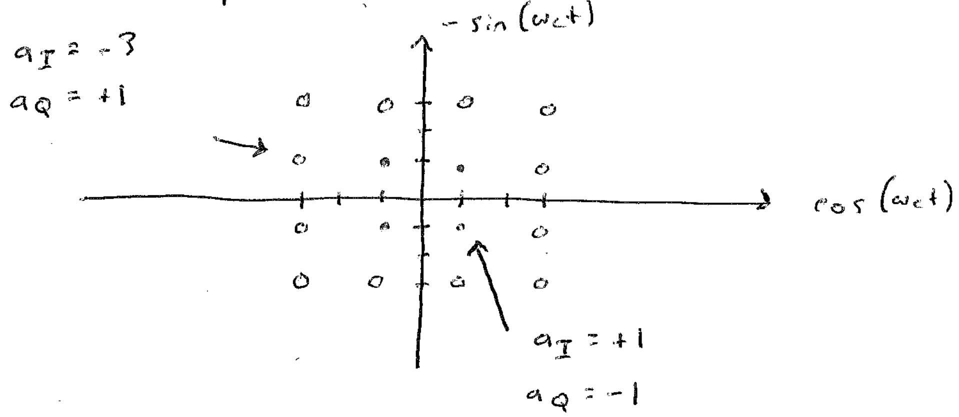
Method #1 : Amplitude shift keying (M-ASK)

Form of modulation:

$$s(t) = a_I \cos(\omega_c t) - a_Q \sin(\omega_c t)$$

Choose a_I a_Q from discrete set of amplitude levels, e.g. $\{-1, +1\}$ or $\{-3, -1, +1, +3\}$.

Constellation representation:



With 2^n points in constellation we can transmit n bits simultaneously. (Assign to each constellation point a binary string from 0 to $2^n - 1$.)

Method #2: Phase shift keying (M-PSK)

Form of modulation:

$$s(t) = \cos(\omega_c t + \phi)$$
$$= \cos\phi \cos(\omega_c t) - \sin\phi \sin(\omega_c t)$$

Constellation points lie on unit circle at locations $(\cos\phi, \sin\phi)$. Choose ϕ from discrete set of phase shifts between 0 and 2π