

Communications I

Solutions to problem sheet six

1. (a) The modulating signal $m(t)$ can be written as $m(t) = \sqrt{2} \cos(100t - \pi/4)$.
Therefore, $m_p = \sqrt{2}$.
- (b) The modulating index is

$$\mu = \frac{m_p}{A} = \frac{1}{\sqrt{2}} < 1.$$

This means that it is possible to use an envelope detector to demodulate $s(t)$.

(c)

$$P_c = \frac{A^2}{2} = 2$$

$$P_s = \frac{1}{2} P_m = \frac{1}{2}$$

$$\eta = \frac{P_s}{P_c + P_s} = \frac{1}{5} = 0.2$$

2. The general expression of the AM signal is

$$\phi_{AM} = (A + m(t)) \cos \omega_c t.$$

(a)

$$u(t) = 5 \cos(1800\pi t) + 20 \cos(2000\pi t) + 5 \cos(2200\pi t)$$

$$= (20 + 10 \cos(200\pi t)) \cos(2000\pi t).$$

The modulation signal is $m(t) = 10 \cos(200\pi t)$ whereas the carrier signal is $c(t) = 20 \cos(2000\pi t)$.

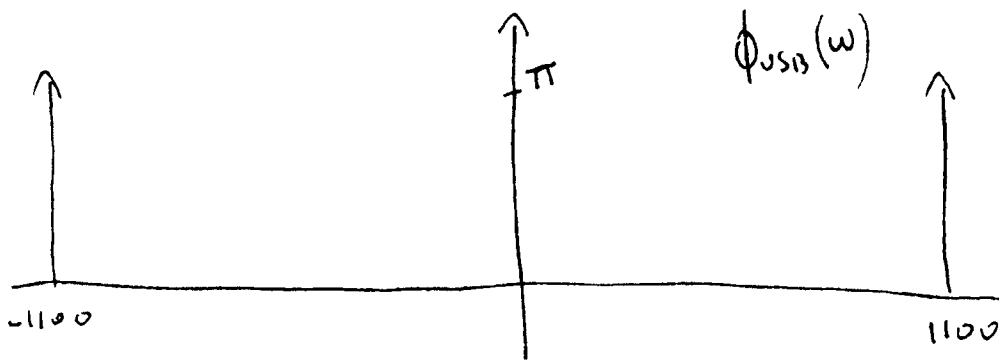
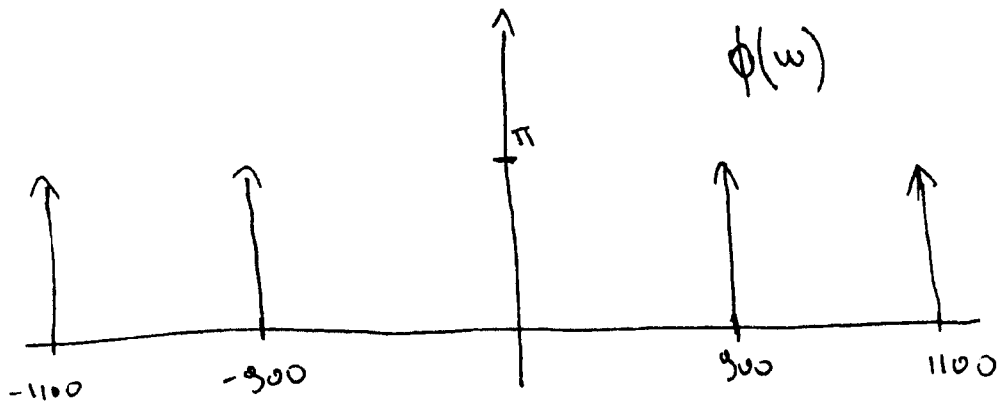
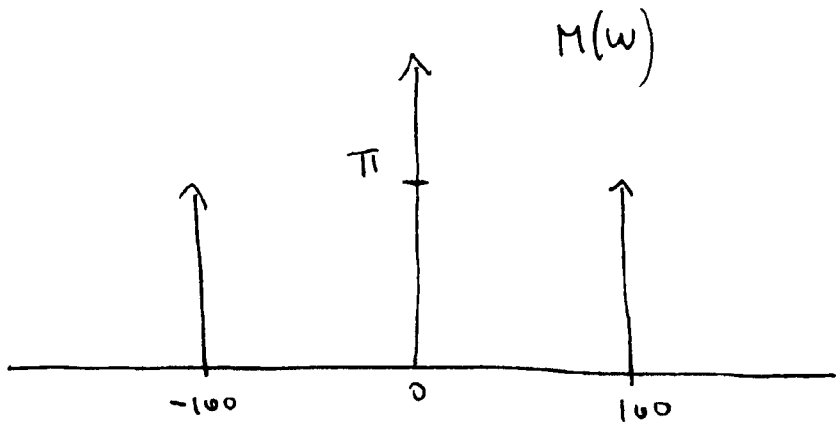
- (b) Since $-1 \leq \cos(200\pi t) \leq 1$, then $m_p = 10$ and the modulation index is $\mu = \frac{m_p}{A} = \frac{1}{2}$.

- (c) $P_{carrier} = \frac{A^2}{2} = 200$, $P_{sidebands} = \frac{P_m}{2} = 25$.

Hence,

$$\frac{P_{sidebands}}{P_{carrier}} = \frac{1}{8}.$$

3.



$$\psi_{USB}(t) = \cos 1100t$$