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)

   $$\begin{aligned} u(t) &= 5\cos(1800\pi t) + 20\cos(2000\pi t) + 5\cos(2200\pi t) \\ &= (20 + 10\cos(200\pi t))\cos(2000\pi t). \end{aligned}$$

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

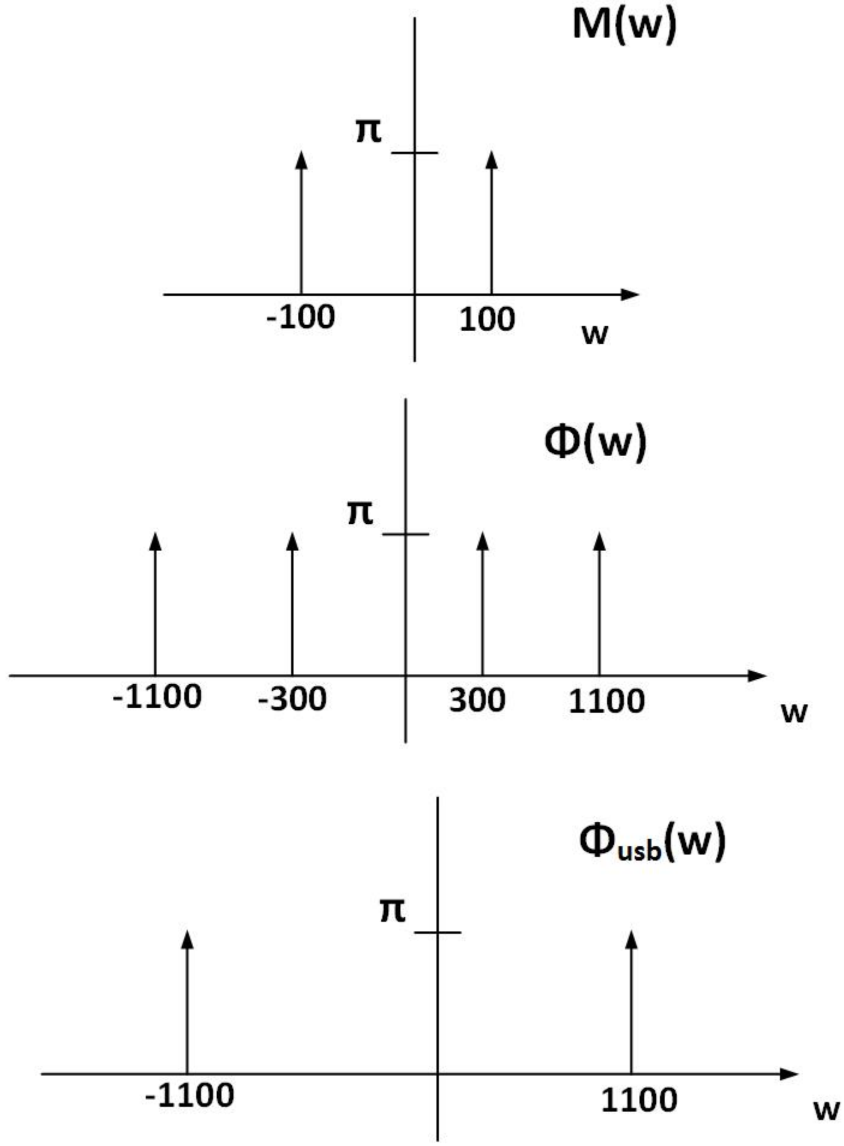
   (b) Since $-1 \leq cos(2000\pi t) \leq 1$, then $m_p = 10$ and the modulation index is $\mu = \frac{m_p}{A} = \frac{1}{2}$.

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

   Hence,

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

3.



$\Phi_{usb}(t) = \cos(1100t)$

Figure 1: