Additional Problem:
The purpose of this problem is to examine issues in modulation.

a) Consider the following signal to be transmitted by amplitude modulation with no carrier ("suppressed carrier": DSB-SC-AM). The signal is modulated at $\omega_c = 2000 \pi$, and transmitted as $x(t) = m(t) \cos(\omega_c t)$.

(i.) Draw $x(t)$.
(ii.) Consider the effect of putting $x(t)$ through an envelope detector circuit, as shown below and as discussed in class.
(iii.) Compare $y(t)$ as drawn above to $m(t)$, and comment on the effectiveness of using an envelope detector for this signal without a carrier.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{envelope_detector.png}
\caption{Envelope detector circuit diagram}
\end{figure}

(b) Let us now consider the transmission of a signal by DSB-WC-AM ("with carrier", the method used in commercial AM radio), where the message signal is offset by a DC constant before transmission. If $m(t)$ is the message signal (shown above), then a DSB-WC-AM signal is $x(t) = (1 + \mu m(t)) \cos(\omega_c t)$, where $\cos(\omega_c t)$ is the modulation signal and $\mu$ is called the modulation index. $\mu$ is selected such that $(1 + \mu m(t)) \geq 0$ for all $t$.

(i.) Determine the maximum value of $\mu$ for the message signal in part (a) above.
(ii.) For the value you determined, draw $x(t)$.
(iii.) Consider the effect of putting $x(t)$ through an envelope detector. Draw a sketch of the output $y(t)$.
(iv.) What must be done to reconstruct $m(t)$ from $y(t)$?
(v.) Determine the Fourier transform of the original m(t). (easily done using tables).
(vi.) Draw the magnitude spectrum of the Fourier transform of m(t), and x(t). (find a sketch of M(w) using sample values or matlab, then use the properties of Fourier transform to find X(w).)