3) AM signal: \( x(t) = (1 + m(t)) \cos(2\pi 200t) \).

Matlab commands: spacing \( dt=0.001 \);

\[
m = \text{conv} \left( \text{randn}(1,9501), \text{ones}(1,500) \right) / 100;
\]

\[
x = (1+m) \cdot \cos(400\pi t);
\]

\( m \) is a baseband signal with bandwidth about 20Hz. \( x \) is AM signal.

Note impulse around 200Hz represents carrier sinusoid.
Here $m_1(t)$ represents output of envelope detector and $m_2(t)$ represents output of synchronous detector. Both detectors are fairly good approximations of $m(t)$, but drop some high frequency terms.
Here $x_2(t) = (1 + 5m(t)) \cos(2\pi 200 t)$. Phase reversals prevalent. $m_3(t)$ is output of envelope detector which is highly distorted version of $m(t)$. 

\begin{align*}
\text{Graph 1:} & \quad x(t) \\
\text{Graph 2:} & \quad m_3(t) \\
\text{Graph 3:} & \quad X_2(f) \\
\text{Graph 4:} & \quad M_3(f)
\end{align*}
4) Here message signal, $m(t)$ is the same as problem 3) $x(t)$ has phase reversals, but this does not matter as synchronous detector output is $m_1(t)$ which is a reasonable approximation of $m(t)$. Some high frequency content of $m(t)$ is lost.