```
% generate message
Ts = 1/1000; %1 millisecond sampling period = 1KHz sampling rate
t_max = 1.0; %1 sec signal
t = 0:Ts:t_max; %make sampling instances into list, t
W = 25; %signal bandwidth (one sided)
to = 50e-3; %filter delay
h = fir2(2*to/Ts,[0,0.25*W*2*Ts,W*2*Ts,1],[1,1,0,0])/Ts; %build LPF
mI = filter(h,1,randn(1,t_max/Ts+1))*Ts; %make inphase signal using random
draw
mQ = filter(h,1,randn(1,t_max/Ts+1))*Ts; %quadrature signal

% QAM modulate without pilot
fc = 200; %carrier frequency
s = mI.*cos(2*pi*fc*t) - mQ.*sin(2*pi*fc*t);

% QAM demodulate coherently
% first build the LPF to remove double frequency term
Bp = W;
Bs = 2*fc-W;
to = 10e-3;
b = fir2(2*to/Ts,[0,Bp*2*Ts,Bs*2*Ts,1],[1,1,0,0])/Ts;
po = 0; %phase offset...to see what happens when not =0
vI = filter(b,1, s.*cos(2*pi*fc*t+po)*2 )*Ts; %do the QAM demod diagram
vQ = filter(b,1, -s.*sin(2*pi*fc*t+po)*2 )*Ts;

% plot results
figure(1)
plottf(s,Ts);
title('QAM')
figure(2)
subplot(211);
plottf(vI,Ts,'t');
%overlay the original....
hold on; hh = plottf(mI,Ts,'t'); hold off;
set(hh,'LineStyle','--','Color','Red');
title('recovered I signal')
subplot(212);
plottf(vQ,Ts,'t');
hold on; hh = plottf(mQ,Ts,'t'); hold off;
set(hh,'LineStyle','--','Color','Red');
title('recovered Q signal')
```