```
%  Simulation of digital M-QAM modulation schemes over an AWGN channel
%  November 2004. Robert Morelos-Zaragoza. San Jose State University.
%  Needs the Communications toolbox.

clear
Fd = 1; Fs = 1;
N= 70000   ;                                    % Number of simulated points
method='qask';                                  % Quadrature amplitude
modulation
set(1) = 4; set(2) = 16; set(3) = 64;           % Sizes of constellations
for j=1:1:3
    M = set(j);                                 % Size of M-QAM constellation
    l=1:1:M;
    aux = sum(abs(modmap(l-1,Fd,Fs,method,M)).^2)/M;
    energy(j) = aux(1)+aux(2);
    i=1;
    for esno=0:2:26;
        sigma = sqrt(10^(-esno/10)/2)*sqrt(energy(j));
        x = randint(N,1,M);                     % Random information symbols
(integers)
        y = modmap(x,Fd,Fs,method,M);           % Mapped signal
        ynoisy = y + sigma*randn(N*Fs,2);       % Gaussian noise added
        z = demodmap(ynoisy,Fd,Fs,method,M);    % Demapped noisy signal
        s = symerr(x,z);                        % Number of symbol errors
after demapping
        ber(j,i) = (s/N)/log2(M);               % Bit error rate (BER) with
Gray mapping
        snr(i) = esno;
        i=i+1;
    end
    j
end
semilogy(snr,ber(1,:),'-b^',snr,ber(2,:),'-bo',snr,ber(3,:),'-bs');
grid on;
ylabel('BER');
xlabel('E/N_0 (dB)');
legend('QPSK', '16-QAM', '64-QAM',1);
title('Error performance of M-QAM. SJSU - Fall 2004.');
```