NETAJI SUBHAS UNIVERSITY OF TECHNOLOGY

DATA COMMUNICATION (CAECC12)

NAME- SNEHA GUPTA

ROLL NO-2021UCA1859

SEMESTER- IV

BRANCH-CSAI

SECTION-1 (GROUP-2)

INDEX

1. To plot the spectrum of a pulse of width 10.

2. To verify following properties of Fourier Transform:

i. Time Shifting, ii.

Frequency shifting,

iii. Convolutional

3. To generate Uniform random number and plot its density function. Find its mean and variance.

4. To generate Gaussian distributed random number and plot its density function. Find its mean and variance.

5. Compute the Signal to quantization Noise ratio of Uniform Quantization. Plot SNQR versus Quantization levels.

6. Compute the Signal to quantization Noise ratio of Non-Uniform Quantization. Plot SNQR versus Quantization levels.

7. Study of passband digital communication technique BPSK. Calculate the BER of BPSK modulated signal.

8. Given is a linear block code with the generator matrix G G = 1 1 0 0 1 0 1 0 1 1 1 1 0 0 1 1 1 0 0 1 1 a. Calculate the number of valid code words N and the code rate RC. Specify the complete Code set C.

b. Determine the generator matrix G′ of the appropriate systematic (separable) code C′.

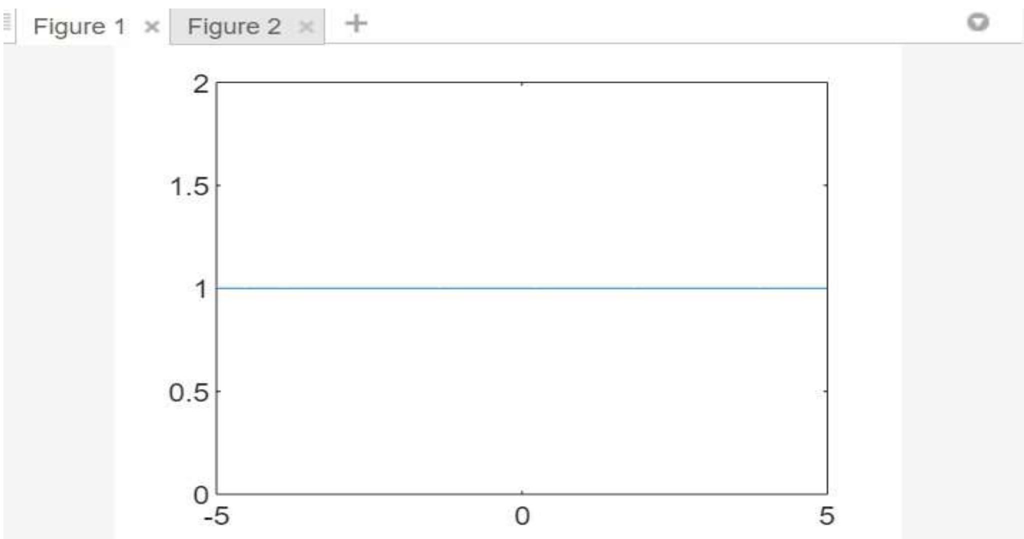
9.To generate a M/M/1 Queue having infinite buffer space with parameters (·, ·) and plot the average delay per packet vs ·/·.

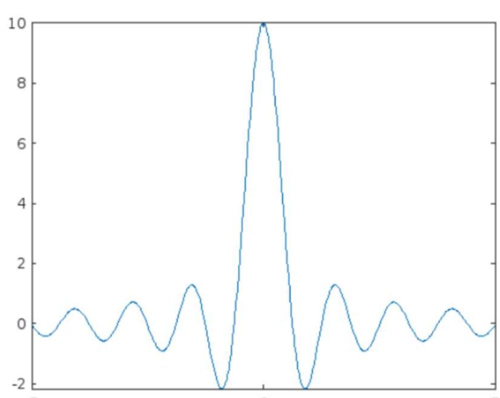
10.To generate a M/M/1 Queue having finite buffer space with parameters (·, ·) and plot blocking probability with respect to variation with buffer space.

1. To plot the spectrum of a pulse of width 10.

/MATLAB Drive/exp1.m

```
clc;
clear all;
close all;
syms t w
x=1;
expw=exp(-1*1i*w*t);
z=int(x*expw,t,-5,5);
xlabel('t')
ylabel('x(t)')
figure(1);
fplot('1',[-5 5])
figure(2);
fplot(z)
```





2. To verify following properties of Fourier Transform:

i. Time Shifting

/MATLAB Drive/exp2.m

```
clc;
clear all;
close all;

syms t w;
x = cos(t);
t0=2;
xt0=cos(t-t0);

Left = fourier(xt0,w)
X= fourier(x,w)
Right= exp(-j*w*t0)*X
```

Command Window

```
Left =

pi*(dirac(w - 1)*exp(-2i) + dirac(w + 1)*exp(2i))


X =

pi*(dirac(w - 1) + dirac(w + 1))


Right =

pi*exp(-w*2i)*(dirac(w - 1) + dirac(w + 1))

>>
```

ii. Frequency shifting

/MATLAB Drive/exp21.m

```
clc;
clear all;
close all;

syms t w
x=t^3;

w0=3;
to_output=exp(j*w0*t)*x;
Left=fourier(to_output,w)
```

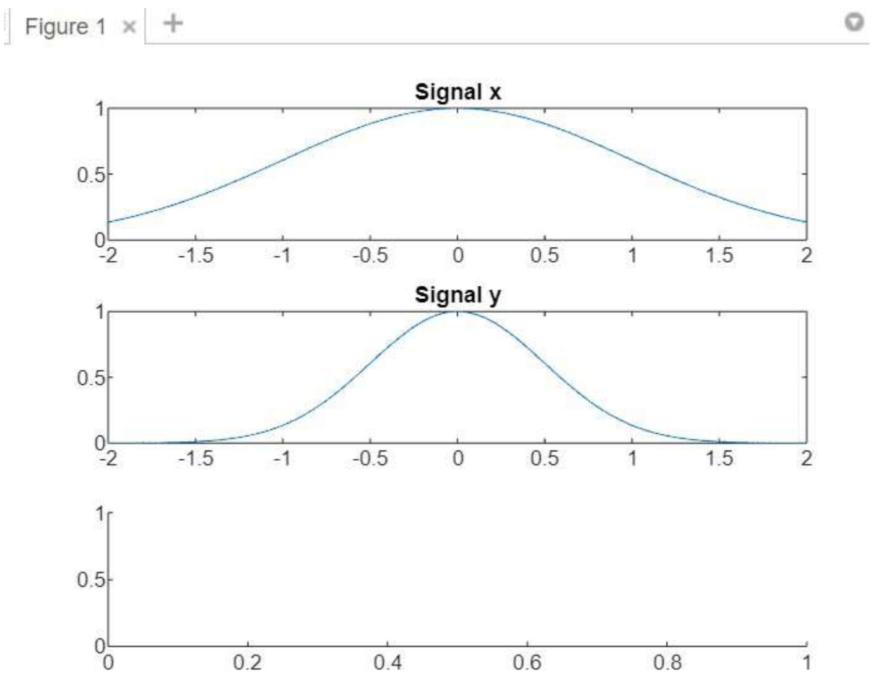
Command Window

```
Left =

-pi*dirac(3, w - 3)*2i

>>
```

iii. Convolutional

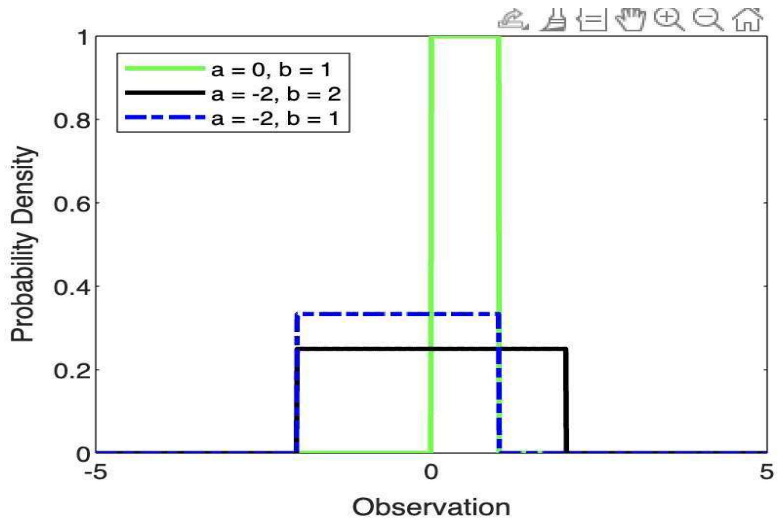
```
clc;
clear all;
close all;
% Define two signals
x = [1 2 3 4];
h = [1 1 1 1];

% Compute the convolution
y = conv(x,h);

% Compute the Fourier transform of each signal
X = fft(x);
H = fft(h);

% Compute the Fourier transform of the convolution
Y = X .* H;

% Compute the inverse Fourier transform to obtain the convolution in time
 domain
y_verify = ifft(Y);

% Compare the result
disp(y);
disp(y_verify);
```

```
     1     3     6    10     9     7     4

    10    10    10    10
```



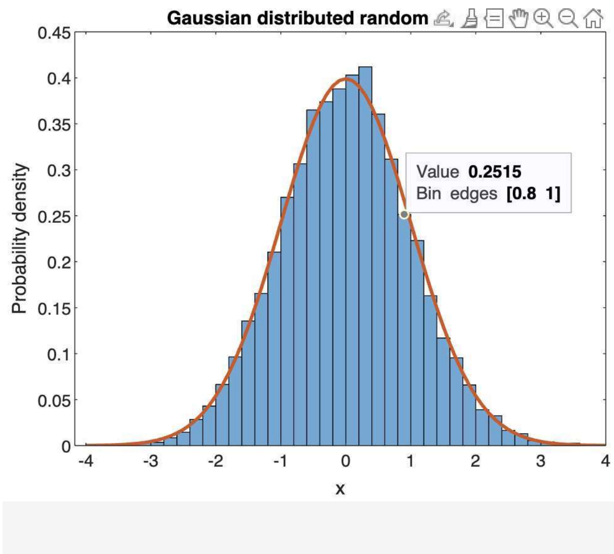
3. To generate Uniform random number and plot its density function. Find its mean and variance.

```
%generating uniform random number & find mean, variance
clear all;
 close all;
pd1 = makedist('Uniform');
pd2 = makedist('Uniform','lower',-2,'upper',2);
pd3 = makedist('Uniform','lower',-2,'upper',1);
 x = -5:.01:5;
pdf1 = pdf(pd1,x);
pdf2 = pdf(pd2,x);
pdf3 = pdf(pd3,x);
 figure;
plot(x,pdf1,'g','LineWidth',2);
hold on;
plot(x,pdf2,'k-','LineWidth',2);
plot(x,pdf3,'b-.','LineWidth',2);
legend({'a = 0, b = 1','a = -2, b = 2','a = -2, b = 1'},'Location','northwest');
xlabel('Observation')
ylabel('Probability Density')

hold off;
```



4. To generate Gaussian distributed random number and plot its density function. Find its mean and variance

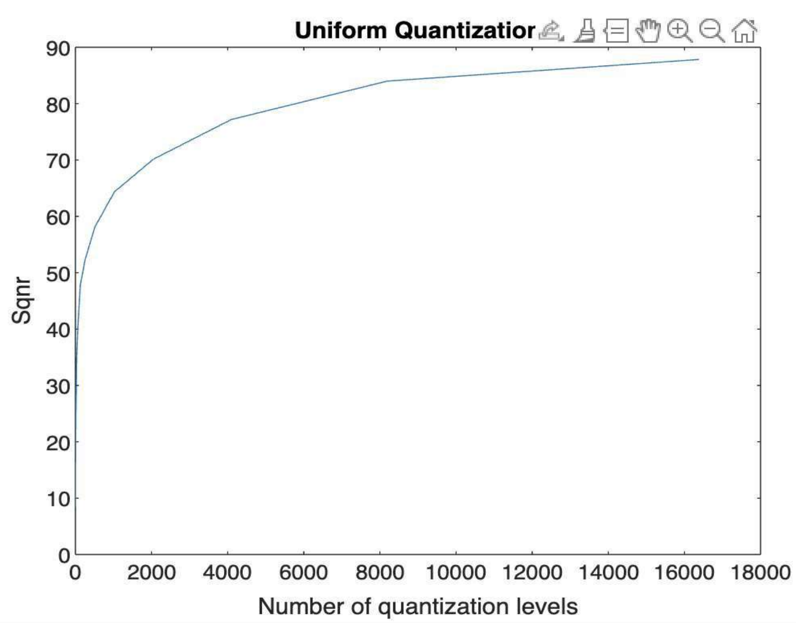
```
% Set the parameters for the Gaussian distribution
mu = 0;     % Mean of the distribution
sigma = 1;  % Standard deviation of the distribution

% Generate 10000 random numbers from the Gaussian distribution using randn
N = 10000;
X = mu + sigma * randn(N, 1);

% Plot the histogram of the generated random numbers
histogram(X, 'Normalization', 'pdf')

% Overlay the Gaussian density function on the histogram
hold on
x_range = -4:0.1:4;
y = normpdf(x_range, mu, sigma);
plot(x_range, y, 'LineWidth', 2)
hold off

% Add axis labels and title
xlabel('x')
ylabel('Probability density')
title('Gaussian distributed random numbers')
```



5. Compute the Signal to quantization Noise ratio of Uniform Quantization.Plot SNQR versus Quantization levels

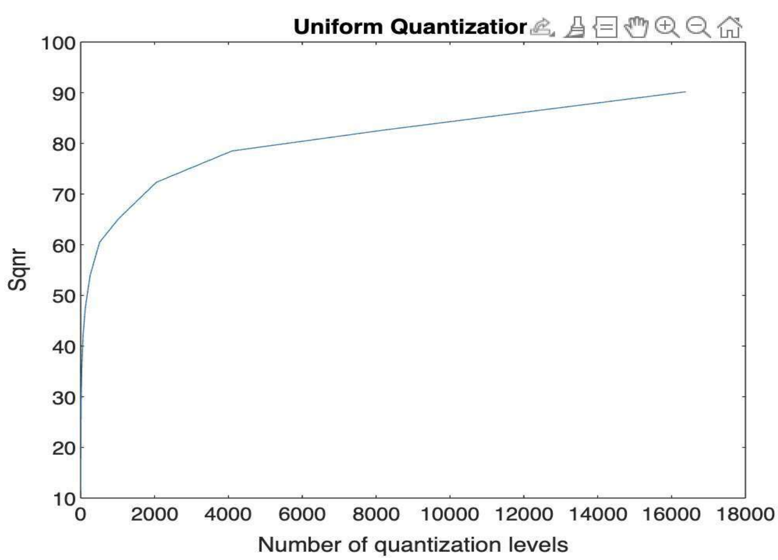
```
clc;clear all;close all;
n = 10; x = rand(1,n);vmin = min(x);vmax = max(x);xpow = sum(x.^2)/n;
for i=1:1:14
    L(i)=2^i;
    d=(vmax-vmin)/L(i);
    for j=1:length(x)
        start = min(x);
        while(start < x(j))
            start=start+d;
        end
        xq(j)=start-d;
        if(start == x(j))
            xq(j)=start;
        end
    end
    err=x-xq;
    noisepow(i)=sum(err.^2)/n;
end
sqnr=xpow./noisepow;
sqnrdb=10.*log10(sqnr);
plot(L,sqnrdb)
xlabel('Number of quantization levels');
ylabel('Sqnr');
title('Uniform Quantization')
```

```
clc;clear all;close all;
n = 10; x = rand(1,n);vmin = min(x);vmax = max(x);xpow = sum(x.^2)/n;
for i=1:1:14
    L(i)=2^i;
    d=(vmax-vmin)/L(i);
    for j=1:length(x)
        start = min(x);
        while(start < x(j))
            start=start+d;
        end
        xq(j)=start-d;
        if(start == x(j))
            xq(j)=start;
        end
    end
    err=x-xq;
    noisepow(i)=sum(err.^2)/n;
end
sqnr=xpow./noisepow;
sqnrdb=10.*log10(sqnr);
plot(L,sqnrdb)
xlabel('Number of quantization levels');
ylabel('Sqnr');
title('Uniform Quantization')
```



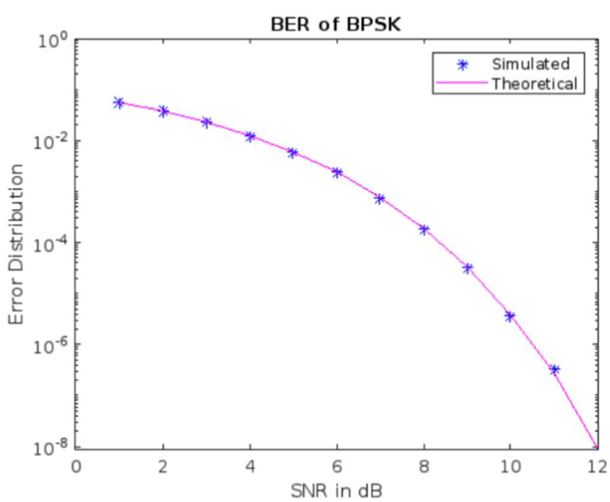
6. Compute the Signal to quantization Noise ratio of Non-Uniform Quantization. Plot SNQR versus Quantization levels.

```
clc;clear all;close all;
n = 10; x = rand(1,n);
u = 255;
xcomp = ((log(1+(abs(x)./max(x)).*u))./log(1+u)); %compressed sample
vmin = min(xcomp);vmax = max(xcomp);xpow = sum(xcomp.^2)/n;
for i=1:1:14
    L(i)=2^i;
    d=(vmax-vmin)/L(i);
    for j=1:length(xcomp)
        start = min(xcomp);
        while(start < xcomp(j))
            start=start+d;
        end
        xq(j)=start-d;
        if(start == x(j))
            xq(j)=start;
        end
    end
    err=xcomp-xq;
    noisepow(i)=sum(err.^2)/n;
end
sqnr=xpow./noisepow;
sqnrdb=10.*log10(sqnr);
plot(L,sqnrdb)
xlabel('Number of quantization levels');
ylabel('Sqnr');
title('Uniform Quantization')
```



7.Study of passband digital communication technique BPSK. Calculate the BER of BPSK modulated signal

```
clc;
clear all;
close all;

N = 10^8;
a =rand(1,N) > 0.5;
s = 2.*a-1;
n = (1/sqrt(2))*(randn(1,N) + 1i* rand(1,N));
snr_dB = 1:1:12;
snr_ratio = 10.^(0.1.*snr_dB);
for i=1:length(snr_dB)
    y = 10.^(0.05.*snr_dB(i)).*s + n;
    adec = real(y)>0;
    err(i) = size(find(a-adec),2);
end
sim_avg_err = err/N;
th_avg_err = 0.5 * erfc(sqrt(snr_ratio));

figure(1);
semilogy(snr_dB,sim_avg_err,'b*'); hold on
semilogy(snr_dB,th_avg_err,'m-');

title("BER of BPSK");
legend('Simulated','Theoretical');
xlabel('SNR in dB');
ylabel('Error Distribution');
```



8. Given is a linear block code with the generator matrix G G = 1 1 0 0 1 0 1 0 1 1 1 1 0 0 1 1 1 0 0 1 1 a. Calculate the number of valid code words N and the code rate RC. Specify the complete Code set C. b. Determine the generator matrix G′ of the appropriate systematic (separable) code C'.

```
clc;
clear all;
close all;
G = [1,1,0,0,1,0,1; 0,1,1,1,1,0,0;1,1,1,0,0,1,1];
m = [0,0,0;0,0,1;0,1,0;0,1,1;1,0,0;1,0,1;1,1,0;1,1,1;];
C = mod(m*G, 2);

disp('The Complete code set C is:');
disp(C);


G(3,:)=mod(G(3,:)+G(1,:),2);
G(2,:)=mod(G(2,:)+G(3,:),2);
G(1,:)=mod(G(1,:)+G(2,:),2);

disp('The sysytem matrix matrix S is');
disp(G);
m = [0,0,0;0,0,1;0,1,0;0,1,1;1,0,0;1,0,1;1,1,0;1,1,1;];
T= mod(m*G, 2);

disp('The Complete code set T is:');
disp(T);
```

```
The Complete code set C is:
     0     0     0     0     0     0     0
     1     1     1     0     0     1     1
     0     1     1     1     1     0     0
     1     0     0     1     1     1     1
     1     1     0     0     1     0     1
     0     0     1     0     1     1     0
     1     0     1     1     0     0     1
     0     1     0     1     0     1     0

The sysytem matrix matrix S is
     1     0     0     1     1     1     1
     0     1     0     1     0     1     0
     0     0     1     0     1     1     0

The Complete code set T is:
     0     0     0     0     0     0     0
     0     0     1     0     1     1     0
     0     1     0     1     0     1     0
     0     1     1     1     1     0     0
     1     0     0     1     1     1     1
     1     0     1     1     0     0     1
     1     1     0     0     1     0     1
     1     1     1     0     0     1     1

>>
```

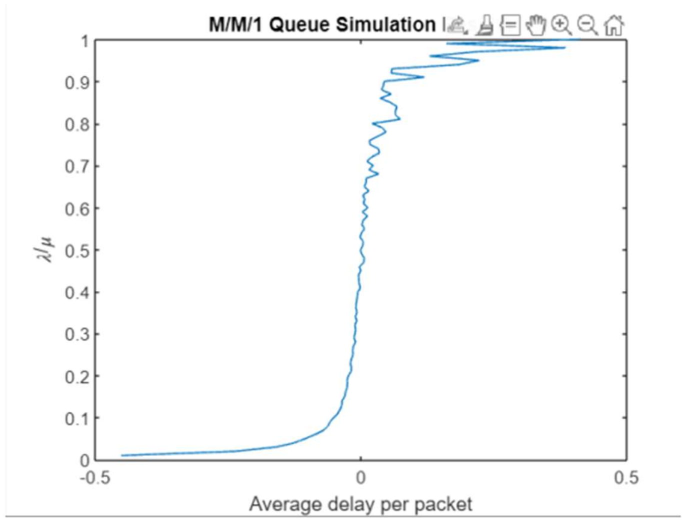
9. To generate a M/M/1 Queue having infinite buffer space with parameters (,) and plot the average delay per packet vs /.

```
clc;
clear all;
close all;

% Define simulation parameters
queue_lim = 200000;                 % system limit
sim_packets = 750;                  % number of clients to be simulated
mu = 100;                           % service rate

% Define range of arrival rates to simulate
lambda_min = 1;
lambda_max = 100;
lambda_step = 1;

% Initialize results arrays
lambda_vals = lambda_min:lambda_step:lambda_max;
avg_delay = zeros(size(lambda_vals));

% Simulate M/M/1 queue for each value of lambda
for i = 1:length(lambda_vals)

    % Define arrival rate for this simulation
    lambda = lambda_vals(i);

    % Initialize simulation variables
    server_busy = false;
    queue_size = 0;
    total_delay = 0;
    last_event_time = 0;

    % Initialize event calendar
```

```
% Initialize event calendar
next_arrival_time = exprnd(1/lambda);
next_departure_time = Inf;

% Run simulation until target number of packets are serviced
packets_serviced = 0;
while packets_serviced < sim_packets

    % Determine next event time and type
    [event_time, event_type] = min([next_arrival_time, next_departure_time]);

    % Update queue statistics based on time since last event
    queue_size = queue_size + server_busy*(event_time-last_event_time);
    total_delay = total_delay + queue_size*(event_time-last_event_time);
    last_event_time = event_time;

    % Handle next event
    if event_type == 1 % arrival event
```

```
        % Schedule next arrival event
        next_arrival_time = event_time + exprnd(1/lambda);

        % If server is busy, add packet to queue
        if server_busy
            queue_size = queue_size + 1;
            if queue_size > queue_lim
                error('Queue overflow!');
            end
        else % Otherwise, start service immediately
            server_busy = true;
            next_departure_time = event_time + exprnd(1/mu);
        end

    else % departure event

            % Update statistics
            packets_serviced = packets_serviced + 1;
            server_busy = false;
            total_delay = total_delay + (event_time - next_departure_time);

            % Check if there are packets in the queue
            if queue_size > 0
                queue_size = queue_size - 1;
                server_busy = true;
                next_departure_time = event_time + exprnd(1/mu);
            else
                next_departure_time = Inf;
            end

        end

    end

    % Compute average delay for this simulation
    avg_delay(i) = total_delay/sim_packets;

end
```

```
% Plot results
figure;
plot(avg_delay,lambda_vals/mu);
ylabel('\lambda/\mu');
xlabel('Average delay per packet');
title('M/M/1 Queue Simulation Results');
```



10. To generate a M/M/1 Queue having finite buffer space with parameters (,) and plot blocking probability with respect to variation with buffer space.

```
lambda = 2; % arrival rate
mu = 3; % service rate
buffer_sizes = 0:20; % vary buffer size from 0 to 20

blocking_probabilities = zeros(size(buffer_sizes)); % preallocate for efficiency

for i = 1:length(buffer_sizes)
    buffer_size = buffer_sizes(i);
    if buffer_size == 0
        blocking_probabilities(i) = 1 - lambda/mu; % no buffer
    else
        rho = lambda/mu;
        p0 = 1 - rho;
        summation = 0;
        for j = 0:buffer_size
            summation = summation + (rho^j)/factorial(j);
        end
        blocking_probabilities(i) = (rho^buffer_size)/(factorial(buffer_size)*p0*summation); % compute blocking probability
    end
end

plot(buffer_sizes, blocking_probabilities, 'o-'); % plot blocking probability vs. buffer size
xlabel('Buffer Size');
ylabel('Blocking Probability');
title(['M/M/1 Queue with Finite Buffer, \lambda = ', num2str(lambda), ', \mu = ', num2str(mu)]);
```