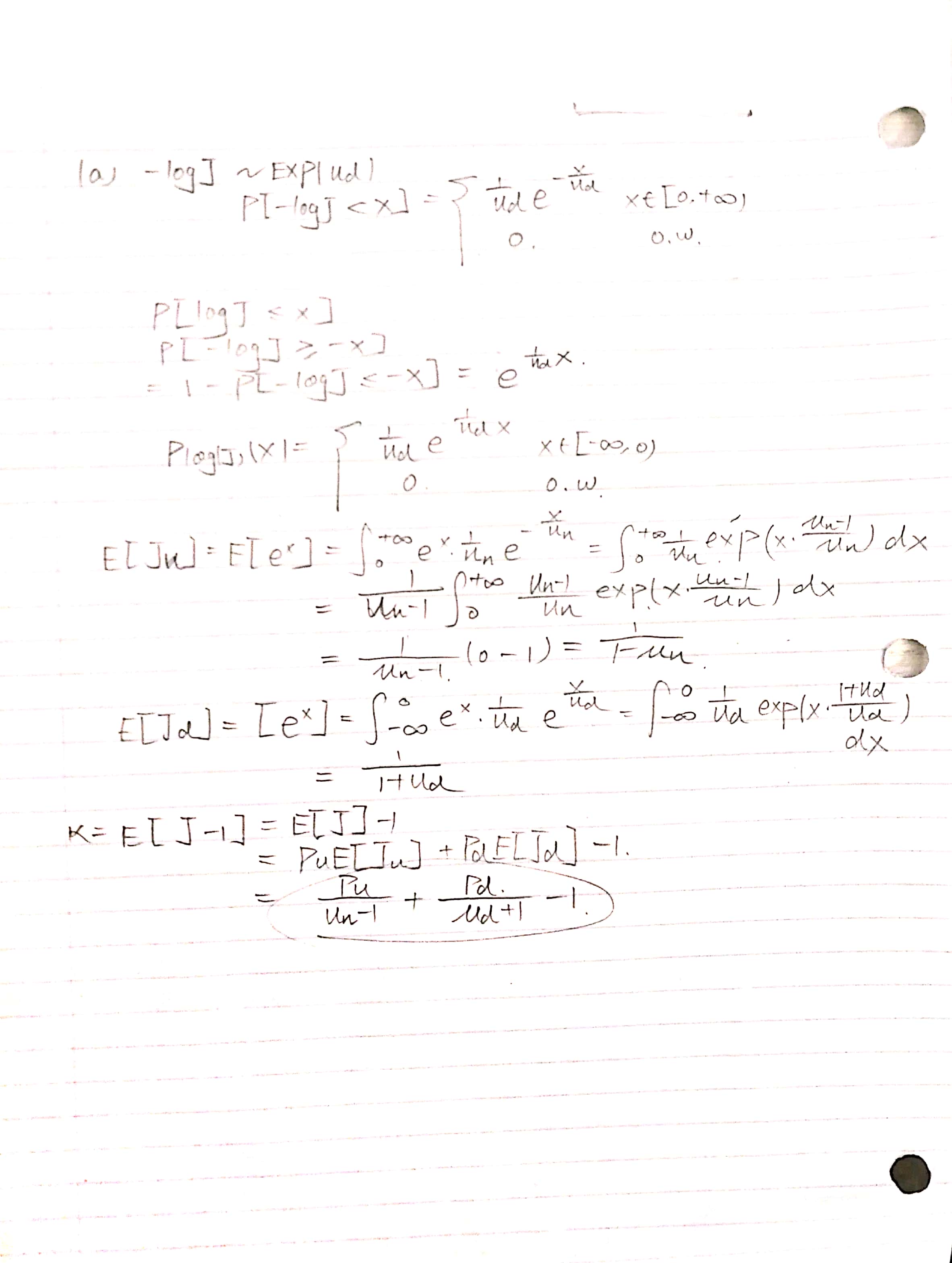
Question 5

(a)



（b）

T = 1.00; % time to expiry

sigma = 0.15; % volatility

r = 0.03; % risk free interest rate

S\_init = 90;

K = S\_init;

%jump size: log normal distribution

p\_u = 0.4; % probability of up jump

lambda = .1; % jump size arrival rate lambda = 0.1

u\_u = 0.32; % parameter for up movement

u\_d = 0.3; % parameter for down movement

N\_sim = 25000;

N=800;

delt = T/N; % delt = 1/1000

jump\_up\_mean = u\_u;

jump\_down\_mean = u\_d;

%

% compenstaed drift E[J-1]

%

%kappa value that we found int question 5 (a)

kappa = p\_u/(1-u\_u) + (1-p\_u)/(u\_d + 1) - 1;

%

% compensated drift for X = log(S)

drift = r - delt/2 - lambda\*kappa;

%

% X = log(S)

%

X\_old(1:N\_sim,1) = log(S\_init);

X\_new(1:N\_sim,1) = zeros(N\_sim,1);

jump\_chek = zeros(N\_sim,1);

jump\_size = zeros(N\_sim,1);

jump\_mask = zeros(N\_sim,1);

for i = 1:N %timestep loop

jump\_chek(:,1) = rand(N\_sim,1); % first check to determine lambda\*delt

jump\_chek2(:, 1) = rand(N\_sim, 1); % second check to determine p\_u

jump\_mask(:,1) = (jump\_chek(:,1) <= lambda\*delt);

jump\_mask2(:, 1) = (jump\_chek2(:, 1) <= p\_u);

jump\_mask3(:, 1) = (jump\_chek2(:, 1) > p\_u);

jump\_size = (jump\_mask2 .\* exprnd(u\_u, N\_sim, 1)) -... % determine the jump\_size

(jump\_mask3 .\* exprnd(u\_d, N\_sim, 1));

jump\_size = jump\_size .\* jump\_mask;

X\_new(:,1) = X\_old(:,1) + drift\*delt + sigma\*sqrt(delt)\*randn(N\_sim,1)+...

jump\_size(:,1);

X\_old(:,1) = X\_new(:,1);

end %timestpe loop

S(:,1) = exp(X\_new(:,1));

n\_bin = 200;

hist(S,n\_bin);

W(:,1) = max(K-S,0);

%European put option

Ep = exp(-r\*T)\*mean(W(:,1));

disp(sprintf('put option price is : %.5g\n', Ep));

|  |  |  |  |
| --- | --- | --- | --- |
|  | 800/25000 | 1600/100000 | 3200/400000 |
| European Put | 5.0515 | 5.0633 | 5.0722 |
|  |  |  |  |

Table: European Put Option price under different timesteps and simulation number

(c)

T = 1.00; % time to expiry

sigma = 0.15; % volatility

r = 0.03; % risk free interest rate

mu = 0.10;

S\_init = 90;

K=linspace(70, 120, 20);

%jump size: log normal distribution

p\_u = 0.4; % probability of up jump

lambda = .1; % jump size arrival rate lambda = 0.1

u\_u = 0.32; % parameter for up movement

u\_d = 0.3; % parameter for down movement

N\_sim = 25000;

N=800;

delt = T/N; % delt = 1/1000

jump\_up\_mean = u\_u;

jump\_down\_mean = u\_d;

jump\_up\_vol = u\_u^2;

jump\_down\_vol = u\_d^2;

%

% compenstaed drift E[J-1]

%

%kappa = exp(.5\*jump\_vol\*jump\_vol + jump\_mean) - 1.;

kappa = p\_u/(1-u\_u) + (1-p\_u)/(u\_d + 1) - 1;

%

% compensated drift for X = log(S)

drift = r - delt/2 - lambda\*kappa;

X\_old = zeros(N\_sim,20);

X\_new = zeros(N\_sim,20);

S = zeros(N\_sim,20);

W = zeros(N\_sim,20);

P = zeros(1,20);

%

% X = log(S)

%

for j = 1:20

X\_old(1:N\_sim,j) = log(S\_init);

X\_new(1:N\_sim,j) = zeros(N\_sim,1);

jump\_chek = zeros(N\_sim,1);

jump\_size = zeros(N\_sim,1);

jump\_mask = zeros(N\_sim,1);

for i = 1:N %timestep loop

jump\_chek(:,1) = rand(N\_sim,1);

jump\_chek2(:, 1) = rand(N\_sim, 1);

jump\_mask(:,1) = (jump\_chek(:,1) <= lambda\*delt);

jump\_mask2(:, 1) = (jump\_chek2(:, 1) <= p\_u);

jump\_mask3(:, 1) = (jump\_chek2(:, 1) > p\_u);

jump\_size = (jump\_mask2 .\* exprnd(u\_u, N\_sim, 1)) -...

(jump\_mask3 .\* exprnd(u\_d, N\_sim, 1));

jump\_size = jump\_size .\* jump\_mask;

jump\_size = jump\_size.\*jump\_mask;

X\_new(:,j) = X\_old(:,j) + drift\*delt + sigma\*sqrt(delt)\*randn(N\_sim,1)+...

jump\_size(:,1);

X\_old(:,j) = X\_new(:,j);

end %timestpe loop

S(:,j) = exp(X\_new(:,j));

n\_bin = 200;

hist(S,n\_bin);

W(:,j) = max(K(j)-S(:,j),0);

%European put option

P(j) = mean(W(:,j));

disp(sprintf('put option price is : %.5g\n', P(j)));

end

Volat = blsimpv(S\_init,linspace(70,120,20),r,T,P,[],[],[],false);

plot(linspace(70,120,20),Volat)

xlabel('Strike Price');

ylabel('Implied Volatility');

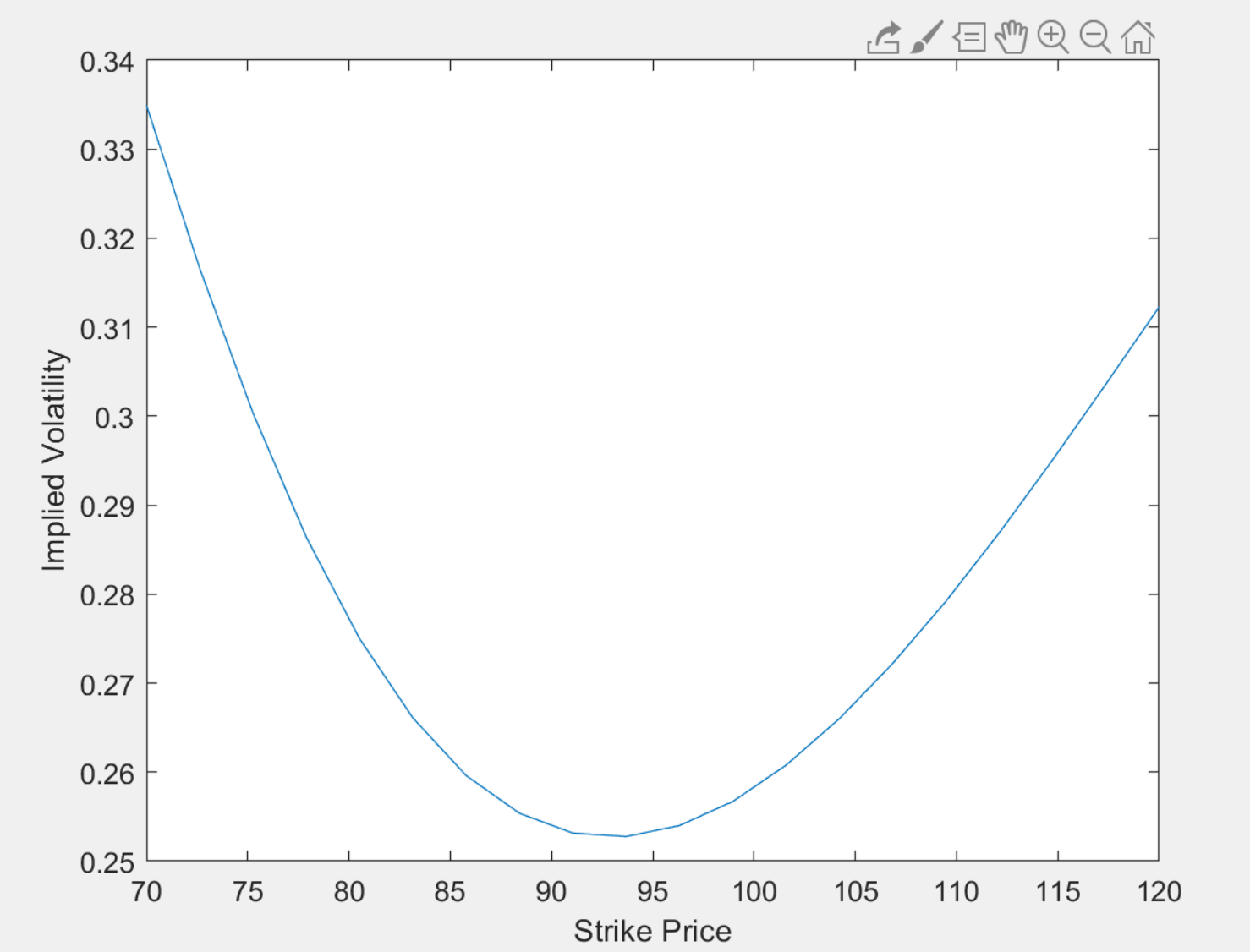


Figure. The Implied Volatility vs the Strike Price

It has shown in the graph, the observed volatility forms a volatility smile over the European Option price. The graph generated by the simulation is reasonable to the implied volatility decreases first and then increases with the increase of strike prices