1 Question 1

Statement 1

Modify the code to deal with a put option.

Put option

```
% Evaluation
r = 0.03;
S = 2;
E = 2;
T = 3;
tau = T;
sigma_true = 0.3;
[C_true, ~, P_true, ~] = bs_price(S, E, r,
    sigma_true, tau);

%% Newton's method
tol = 1e-8;
sigma = sqrt(2*abs((log(S/E)+r*T)/T));
sigmadiff = 1;
k = 1;
kmax = 100;
while sigmadiff>=tol && k<kmax
    [~, ~, ~, P, ~, Pvega] = geeks(S,E,r,sigma,tau);
    increment = (P-P_true) / Pvega;
    sigma = sigma - increment;
    k = k + 1;
    sigmadiff = abs(increment);
end

%% Black-Scholes implied volatility
disp("Implied volatility: " + blsimpv(S, E, r, tau,
    P_true));

% Evaluation
M = 100;
S = 3;
E = 1;
```

```
r = 0.05;
tau = 3;
sigma = linspace(0, 1.5, M);
[~, Pvalve] = blsprice(S, E, r, tau, sigma);
Pvega = zeros(M, 1);
for i = 1 : M
    Pvega(i) = blsvega(S, E, r, tau, sigma(i));
end

% Figure
figure;
subplot(2, 1, 1)
plot(sigma, Pvalve)
xlabel('\sigma');
ylabel('P(\sigma)')
subplot(2, 1, 2)
plot(sigma, Pvega)
xlabel('\sigma')
ylabel('\partial P/\partial \sigma')
```

Geeks

```
function [C, Cdelta, Cvega, P, Pdelta, Pvega] =
    geeks(S,E,r,sigma,tau)
    %{
    :Argument:
        - S: [str, float], asset price @ time t
        - E: [str, float], exercise price
        - r: [str, float], interest rate
        - σ: [str, float], volatility
        - τ: [str, float], time to expiry (T-t)
        - to_simple: bool, wheather to simplify
          result
        - to_str: bool, wheather to convert result
          to str
        - to_latex: bool, wheather to convert result
          to latex

```

```
    :Output:
        - C, call value
        - Cδ, δ value of call
        - Cν, ν value of call
        - Cθ, θ value of call
        - Cρ, ρ value of call
        - Cγ, γ value of call
        - P, put value
        - Cδ, δ value of put
        - Cν, ν value of put
        - Cθ, θ value of put
        - Cρ, ρ value of put
        - Cγ, γ value of put

    :Example:
        >>> S=1.0; E=1.5; r=0.05; σ=0.2; τ=1.0;
        >>> greeks(S, E, r, σ, τ)
    %}
    if tau > 0
        d1 = (log(S/E) + (r + sigma^2/2)*tau) / (
            sigma*sqrt(tau));
        d2 = d1 - sigma*sqrt(tau);
        Nd1 = (1+erf(d1/sqrt(2))) / 2;
        Nd2 = (1+erf(d2/sqrt(2))) / 2;
        C = S*Nd1-E*exp(-r*(tau))*Nd2;
        Cdelta = Nd1;
        Cvega = S*sqrt(tau)*exp(-d1^2/2) / sqrt(2*pi
            );
        P = C + E*exp(-r*tau) - S;
        Pdelta = Cdelta - 1;
        Pvega = Cvega;
    else
        C = max(S-E, 0);
        Cdelta = (sign(S-E) + 1) / 2;
        Cvega = 0;
        P = max(E-S, 0);
        Pdelta = Cdelta - 1;
        Pvega = 0;
    end
```

```
end
```

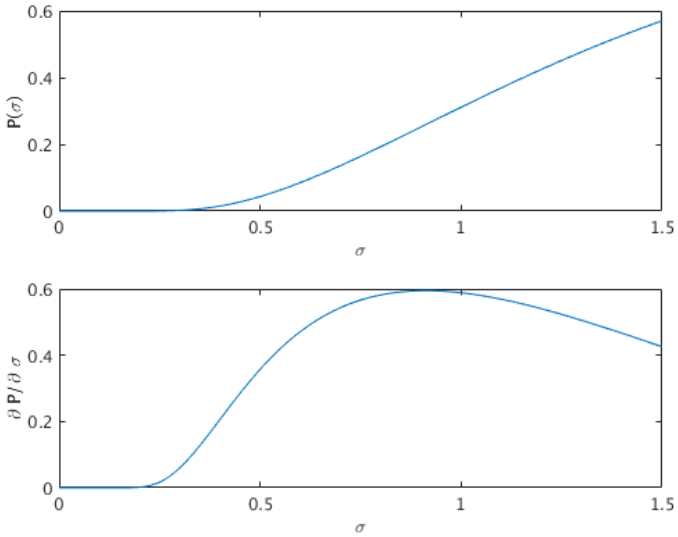

Figure 1: Put option

2 Question 2

Statement 2

Acquire some Geeks data, and create a figure as before. If possible, investigate the behavior of the implied volatility as the expiry time varies.

Option Price	Exercise Price	Implied Volatility
0.2536	2.2	0.281
0.2075	2.25	0.2643
0.1664	2.3	0.2646
0.1267	2.35	0.2524
0.0954	2.4	0.2563
0.0679	2.45	0.2533
0.0468	2.5	0.2531
0.0315	2.55	0.2533
0.02	2.6	0.2548
0.0122	2.65	0.2545
0.007	2.7	0.2545
0.0042	2.75	0.2566
0.0028	2.8	0.266
0.0019	2.85	0.2753
0.0014	2.9	0.2875
0.0015	2.95	0.315