```
% MECH 6318 - Homework 6
% Jonas Wagner
% 2021-10-06

close all
clear
```

Problem 12.4

```
f = @(x) -3 .* x.^3 + 12*(x.^(-2)) + 2*exp(x.^2);
df = matlabFunction(diff(f(sym('x'))));
ddf = matlabFunction(diff(diff(f(sym('x')))));

f_x = f(sym('x'))
```

f_x =

$$2\,\mathrm{e}^{x^2}+\frac{12}{x^2}-3\,x^3$$

```
df_x = df(sym('x'))
```

df_x =

$$4\,x\,\mathrm{e}^{x^2}-9\,x^2-\frac{24}{x^3}$$

```
ddf_x = ddf(sym('x'))
```

ddf_x =

$$4\,\mathrm{e}^{x^2}-18\,x+8\,x^2\,\mathrm{e}^{x^2}+\frac{72}{x^4}$$

```


x_min = 0.5;
x_max = 2;
```

Part 1b: Newton-Raphson Method By Hand

```
p = @(x) df(x)/ddf(x);
p_x = p(sym('x'))
```

p_x =

$$-\frac{9\,x^2-4\,x\,\mathrm{e}^{x^2}+\frac{24}{x^3}}{4\,\mathrm{e}^{x^2}-18\,x+8\,x^2\,\mathrm{e}^{x^2}+\frac{72}{x^4}}$$

```


x_0 = 1
```

x_0 = 1

```
f_1 = f(x_0)
```

```
f_1 = 14.4366
```

```
df_1 = df(x_0)
```

```
df_1 = -22.1269
```

```
ddf_1 = ddf(x_0)
```

```
ddf_1 = 86.6194
```

```
p_1 = p(x_0)
```

```
p_1 = -0.2554
```

```
x_1 = x_0 - p_1
```

```
x_1 = 1.2554
```

```
f_2 = f(x_1)
```

```
f_2 = 11.3498
```

```
df_2 = df(x_1)
```

```
df_2 = -2.0271
```

```
ddf_2 = ddf(x_1)
```

```
ddf_2 = 86.7119
```

```
p_2 = p(x_1)
```

```
p_2 = -0.0234
```

```
x_2 = x_1 - p_2
```

```
x_2 = 1.2788
```

```
f_3 = f(x_2)
```

```
f_3 = 11.3265
```

```
df_3 = df(x_2)
```

```
df_3 = 0.0550
```

```
ddf_3 = ddf(x_2)
```

```
ddf_3 = 91.5640
```

```
p_3 = p(x_2)
```

```
p_3 = 6.0025e-04
```

```
x_3 = x_2 - p_3
```

```
x_3 = 1.2782
```

```
f_4 = f(x_3)
```

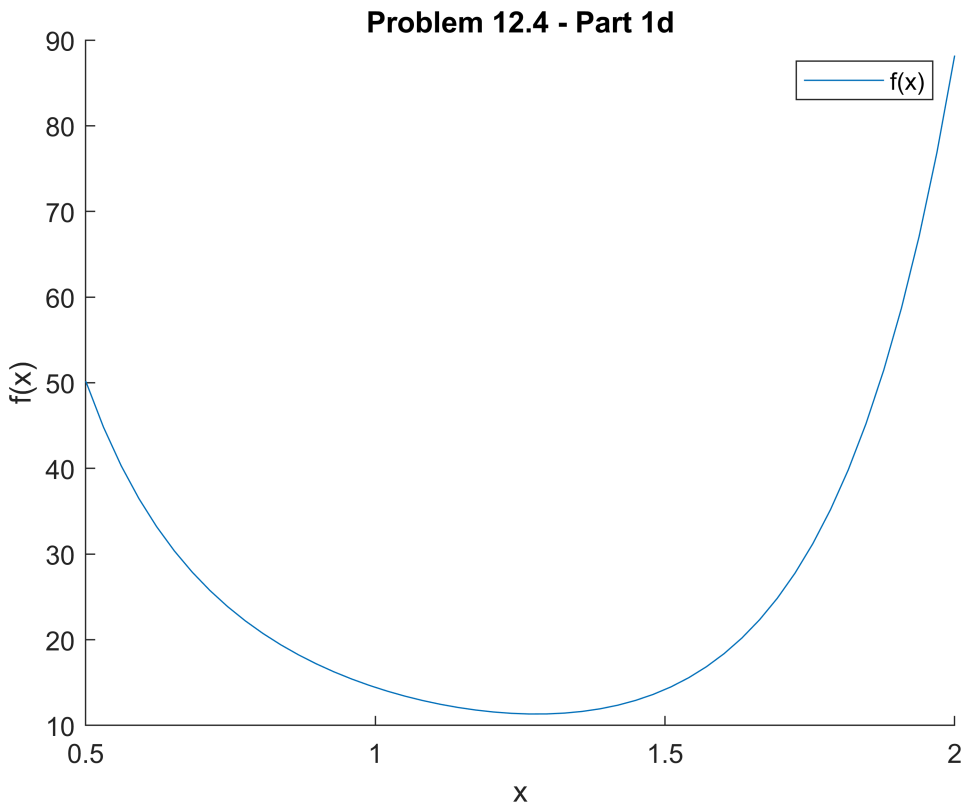
```
f_4 = 11.3265
```

```
df_4 = df(x_3)
```

```
df_4 = 4.0833e-05
```

Part 1d: Plot f(x)

```
X_all = linspace(x_min,x_max,50);
F_all = f(X_all);
figure()
hold on
plot(X_all,F_all, 'DisplayName', 'f(x)')
% scatter([x_0,x_1,x_2,x_3],...
%         [f_1,f_2,f_3,f_4],...
%         'DisplayName', 'Newton-Raphson Method')
% hold off
legend()
xlabel('x')
ylabel('f(x)')
title('Problem 12.4 - Part 1d')
```



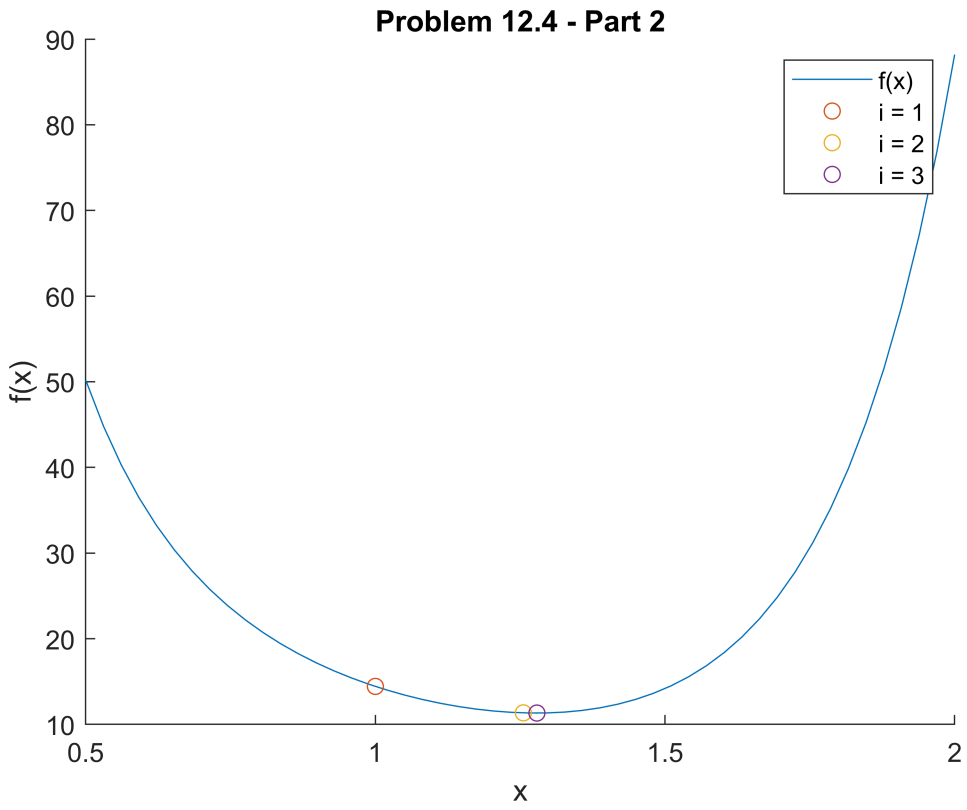
Part 2: Newton-Raphson in MATLAB

```
disp('Part 2 - Coded Newto-Raphson ------------------------------------')
```

```
Part 2 - Coded Newto-Raphson ----------------------------------
```

```
figure()
hold on
plot(X_all,F_all, 'DisplayName', 'f(x)')
legend()
xlabel('x')
ylabel('f(x)')
title('Problem 12.4 - Part 2')

x_0 = 1;
epsilon = 0.01;
max_itr = 10;
X(1) = x_0;
for i = 1:max_itr
    F(i) = f(X(i));
    DF(i) = df(X(i));
    DDF(i) = ddf(X(i));
    P(i) = p(X(i));
    X(i+1) = X(i) - P(i);
    scatter([X(i)],[F(i)],'DisplayName',['i = ',num2str(i)])
    if (abs(df(X(i+1))) < epsilon)
        disp(['Number of iterations: ', num2str(i)])
        disp(['Optimal Variable: ', num2str(X(i+1))])
        disp(['Optimal Value: ', num2str(f(X(i+1)))])
        break
    end
end
```




```
Number of iterations: 3
Optimal Variable: 1.2782
Optimal Value: 11.3265
```

Part 3 : fmincon validation

```
disp('Part 3 - fmincon validation -------------------------------------')
```

```
Part 3 - fmincon validation ----------------------------------
```

```
[x_star, f_star, exitflag, output] = fmincon(f,x_0,[],[],[],[],x_min,x_max)
```

```
Local minimum found that satisfies the constraints.

Optimization completed because the objective function is non-decreasing in
feasible directions, to within the value of the optimality tolerance,
and constraints are satisfied to within the value of the constraint tolerance.

<stopping criteria details>
x_star = 1.2782
f_star = 11.3265
exitflag = 1
output = struct with fields:
         iterations: 8
          funcCount: 19
    constrviolation: 0
           stepsize: 2.0168e-09
          algorithm: 'interior-point'
      firstorderopt: 2.7777e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.Optimization completed because the objective
```

```
        bestfeasible: [1×1 struct]
```

Part 4: final notes

The cold I wrote goes through 3 iterations but fmincon goes through 8. fmincon is using the interior-point method, so more iterations makes sense.