Homework 3, ME3215 Spring 2022

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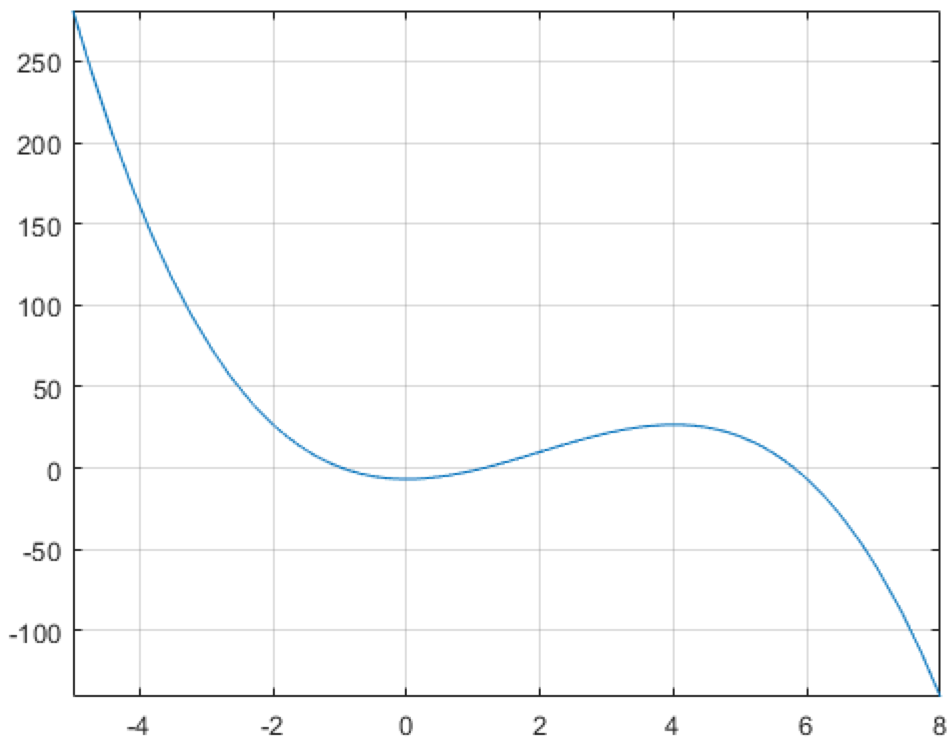
Root finding- open methods

HW3_2 Submerged depth of floating cork ball

```
clc; clear; close all

r=2;                %radius of cork, cm
rho_w=1;            %density of water
rho_c=1/5*rho_w;    %density of the liquid
Vc=4*pi*r^3/3;      %volume of cork sphere

%define function & 1st derivative
f=@(x) rho_w*(pi*x.^2*r-pi*x.^3/3)-rho_c*Vc;
df=@(x) rho_w*(2* pi*x*r- 3*pi*x.^2/3);

fplot(f,[-5 8]); grid on
% NOTE: There are 3 possible roots. But only one of them makes
 physical
% sense. The depth at which the ball floats cannot be a negative
 number or
% be greater than 4 cm (diameter of ball). Therefore, the first guess
 should be
% selected so that it is close to the root that satisfies 0<root<4.
 Thus,
% first guess is selected to be 2

xi = 2; %first guess
ea=100; es = 0.5; i=0; %initialize error, goal, and counter
while ea>es && i<25
    i=i+1;      %increment counter
    %calc next value
    xip1=xi-f(xi)/df(xi);      %i + 1 guess (the "current" guess)
    ea=abs((xip1-xi)/xip1)*100; %error between previous and current
    xi=xip1;    %move the i + 1 guess into the ith guess (now is the
 "previous" guess)
end
if i==25
    warning('maximum # of iterations reached')
else
    root=xip1;
    fprintf('The cork floats at a depth of %.2f cm\n', root)
end
```

The cork floats at a depth of 1.15 cm



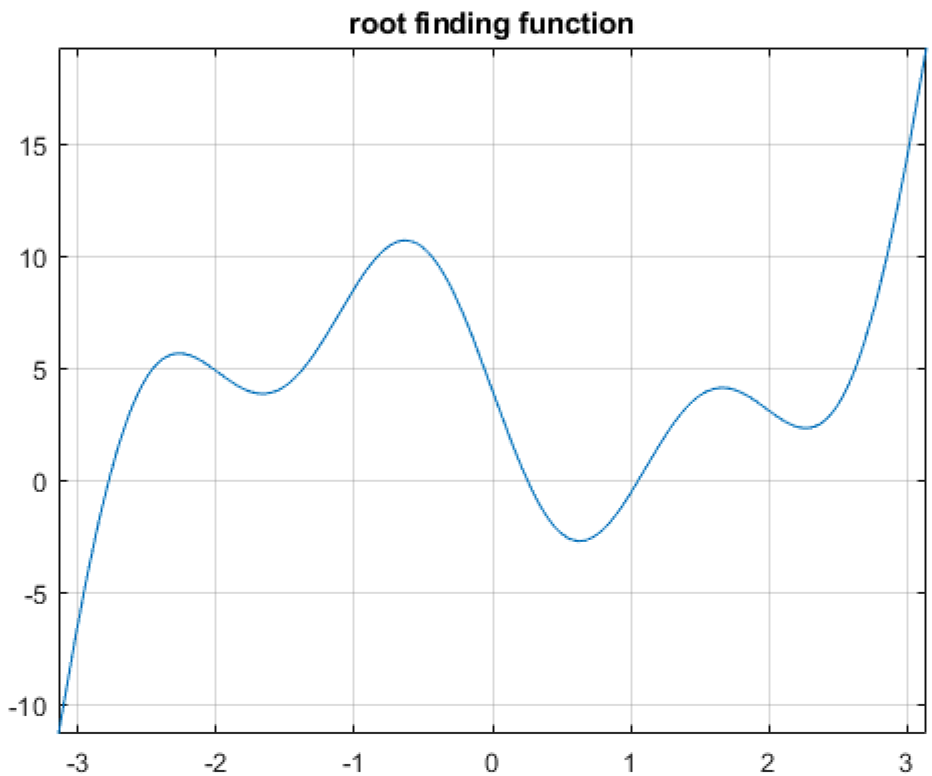
HW3_3: Applications of built-in functions

```
%(a) Roots of a polynomial

clear;clc;close all
%g=@(x)x^4+65*x^3+198*x^2+86*x+128;
r=roots([1 65 0 86 128]);
%'roots' finds real and complex roots
fprintf('The roots of x^4+65x^3+86x+128 are:\n
 %5.4f,\n %5.4f %+5.4fi,\n %5.4f -%5.4fi,\n %5.4f
\n',real(r(1)),real(r(2)),imag(r(2)),real(r(2)),imag(r(2)),
 real(r(4)))
```

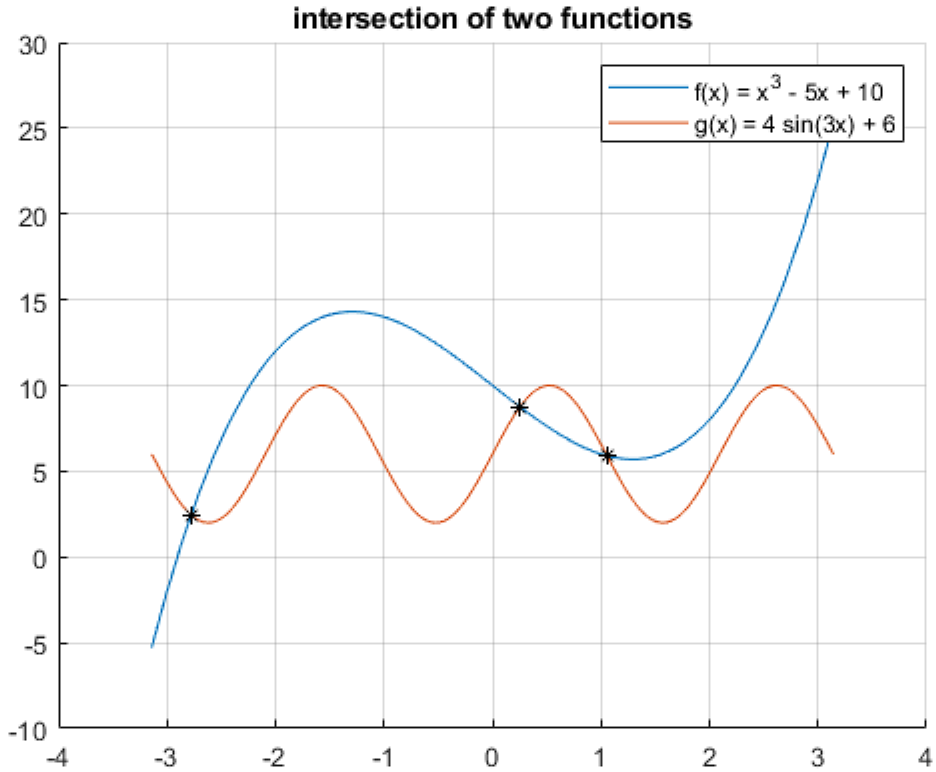
```
The roots of x^4+65x^3+86x+128 are:
 -65.0199,
 0.4679 +1.3894i,
 0.4679 -1.3894i,
 -0.9159
```

```
%(b) Intersections of equations
close all;clc;clear
%find the intersections of f(x) & g(x)
f=@(x) x.^3 -5*x + 10;
g=@(x) 4*sin(3*x)+6;
```

```
%plot the root finding func
h = @(x) f(x)-g(x);
fplot(h,[-pi pi])
title('root finding function')
grid on
```

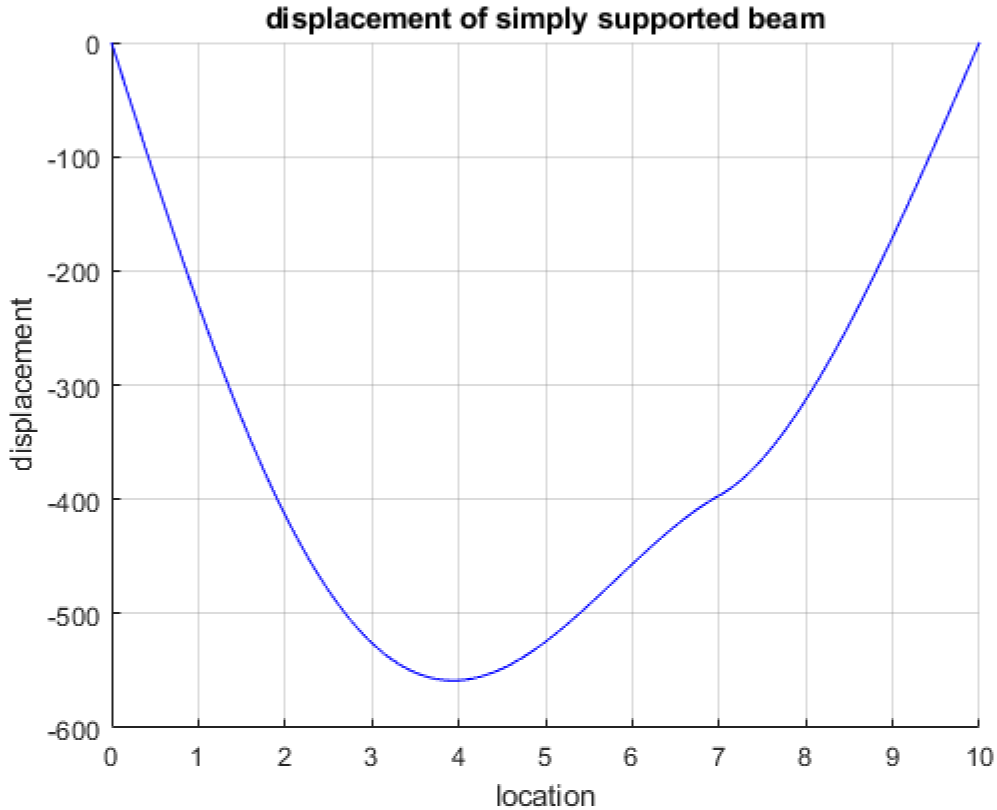



```
%there are three roots
r1 = fzero(h,[-3 -2]);
r2 = fzero(h,[0 1]);
r3 = fzero(h,[1 2]);

%plot
figure; hold on; grid on
fplot(f,[-pi pi])
fplot(g,[-pi pi])
plot([r1, r2,r3],[f(r1), f(r2), f(r3)], 'k*')
title('intersection of two functions')
legend('f(x) = x^3 - 5x + 10','g(x) = 4 sin(3x) + 6')
```



HW3_4:Beam displacement

```
clear;clc;close all
%plot the piecewise function (one version)
term=@(x) 57/6*x.^3-238.25*x; %common to all
f1=@(x) -5/6*x.^4+term(x);
f2=@(x) -5/6*(x.^4-(x-5).^4)+term(x);
f3=@(x) -5/6*(x.^4-(x-5).^4)+75*(x-7).^2+term(x);
f4=@(x)  -5/6*(x.^4-(x-5).^4)+75*(x-7).^2+15/6*(x-8).^3+term(x);
hold on
fplot(f1,[0,5],'b')
fplot(f2,[5,7],'b')
fplot(f3,[7,8],'b')
fplot(f4,[8,10],'b')
grid on
title('displacement of simply supported beam')
xlabel('location')
ylabel('displacement')
```




```
%observe that the max displacement occurs in the 0<x<5 range
%take 1st derivative of this eq (f1) & solve
f=@(x)-5/6*4*x.^3 + 57/6*3*x.^2-238.25;
df=@(x) -5/6*4*3*x.^2 + 57/6*3*2*x;
ea=100; es = 0.05; i=0; %initialize error, goal, and counter
xi = 3; % select first guess from plot
while ea>es && i<25
    i=i+1;                                          %increment counter
    %calc next value
    xip1=xi-f(xi)/df(xi);                      %(i +1)-th guess
    ea=abs((xip1-xi)/xip1)*100; %error
    xi=xip1;    %move the (i +1)-th guess into the i-th guess
end
if i==25
    warning('maximum # of iterations reached')
else
    maxdisp=xip1;
    fprintf('This max displacement occurs at location x=%.2f ft on the
 beam\n',floor(100*maxdisp)/100)
end
```

This max displacement occurs at location x=3.93 ft on the beam

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