**ENEL102, fall term 2018**

**Assignment 4**

**Solving nonlinear functions and optimization, Chapter 9**

**Due date: Oct 29**

Assignment is based on material in the Gilat textbook from section 9.1 and 9.2. Suggest you review this material before answering these questions. Fill in the following template with your answers using Matlab plots and screen shots as necessary. Then submit your Word document on D2L.

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**Q1.** Consider the single variable equation of



Generate a plot of this function over the range of -10<x<8. Use fzero() to find the two zeros of the function and on the plot, indicate the location of the zero crossing with a suitable marker. Complete your plot with a legend.

**(Matlab input)**

fplot('exp(0.45\*x)-2\*x+1', [-10 8])

x1 = fzero('exp(0.45\*x)-2\*x+1', 2)

F = @(x)exp(0.45\*x)-2\*x+1

fzero(F,7)

hold on

plot(x1,0,'xr')

plot((fzero(F,7)), 0, '\*r')

legend()

**(Matlab Response)**

x1 =

1.4680

ans =

4.7619



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**Q2** Consider the single variable equation of



Generate a plot of this function over the range of -10<x<8 as in Q1. Now determine the minimum using **fminbnd()** and mark the minimum point on the plot.

**(Matlab input)**

F = @(x)exp(0.45\*x)-2\*x+1

fplot(F, [-10 8])

[x fval] = fminbnd(F, 0, 5)

hold on

plot(x,fval,'xr')

**(Matlab Response)**

x =

3.3148

fval =

-1.1851

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**Q3.** Consider the single variable equation of



Generate a plot of this function over the range of -10<x<12. As observed, this function has two stationary points (zero slope points) in this region. Use fzero() to find these points and place them on your plot with suitable markers.

**(Matlab input)**

fplot('exp(0.45\*x)-x^2+4', [-10 12])

x1 = fzero('exp(0.45\*x)-x^2+4', 1)

F = @(x)exp(0.45\*x)-x^2+4

fzero(F, 9)

hold on;

plot(x1, 0, 'or');

plot((fzero(F,9)), 0, 'xr');

**(Matlab Response)**



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**Q5** Consider a series circuit of a battery connected to a series circuit consisting of a diode with a current-voltage relation of



and a resistor of 150 ohms. The diode is connected such that it is forward biased. Plot the current through the diode (i) as a function of the voltage across it (v).

**(Matlab input)**

i = @(v)0.001\*(exp(7\*v)-1)

fplot(i, [0,1.25])

**(Matlab Response)**



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**Q6** Consider the series diode and resistor circuit of Q5. Find the voltage across the diode (denoted as v) and the current in the series circuit (denoted by C). Generate a plot of v and C as the supply battery voltage, denoted as , is varied between -10 volts to 10 volts. Note that the overall equation is



where R=150 and is the current through the diode as given by the diode equation in Q5.

**(Matlab input)**

Vb = -10:0.5:10;

R = 150;

I = @(v) 0.001\*(exp(7\*v)-1) - (Vb-v)./R

v = linspace(0,0.7,41);

C = I(v);

plot(v,C);

xlabel('v');ylabel('C')

**(Matlab Response)**

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**Q7** Consider two trajectories in the two dimensional x-y plane. One trajectory is a circle of unit radius given as



and the other trajectory is a parabola given by



First generate a plot out these two trajectories superimposed in a figure.

**(Matlab Input)**

ezplot('x^2+y^2=1')

axis equal;

hold on;

ezplot('y=x^2')

**(Matlab Response)**



**Q8** In the previous question use fzero() to determine the intersection points of the parabola and the circle then regenerate the plot of Q7 with the two points of intersection indicated.

**(Matlab input)**

syms x y

ezplot('x^2+y^2=1')

axis equal;

hold on;

ezplot('y=x^2');

[xs ys] = solve('x^2+y^2=1', 'y=x^2')

**(Matlab Response)**

xs = -(-5^(1/2)/2 – 1/2)^(1/2)

-(5^(1/2)/2 – 1/2)^(1/2)

(-5^(1/2)/2 – 1/2)^(1/2)

(5^(1/2)/2 – 1/2)^(1/2)

ys = -5^(1/2)/2 – 1/2

5^(1/2)/2 – 1/2

-5^(1/2)/2 – 1/2

5^(1/2)/2 – 1/2

Intersection points: (-0.78615133778, 0.6180339887) and (0.7861513778 , 0.6180339887)



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**Q9** Consider a matrix with unknown coefficients of a,b,c that is given by the model of



Lab measurements show that A has the values of



Find the values of  using fsolve().

**(Matlab input)**

A = @(x) [x(1)\*x(2)-2; x(1)\*x(3)-3; x(1)\*sin(x(4))-.4794; x(1)\*x(2)+x(3)-5]

fsolve(A,[0;0;0;0])

**(Matlab Response)**

ans =

1.0000

2.0000

3.0000

0.5000

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**Q10** Given a polynomial  we can determine the local maximums by taking the derivative and then finding the roots. Hence in this case we have  such that the root is at 0 indicating a maximum or minimum at that point. We can determine if it is a minimum or a maximum by determining the curvature. In this case the curvature at x=0 is negative so this implies that f(0) is a maximum point.

Consider the polynomial function . Find the real valued extremum of this function and determine if is a maximum or minimum at that point.

**(Matlab input)**

syms x

f = 5\*x^4+4\*x^3+3\*x^2+2\*x+1

g = diff(f,x)

solve(g == 0, x,'MaxDegree',4);

extrema = vpa(ans,4)

**(Matlab Response)**

extrema =

-0.4371 (local minimum)

- 0.08146 - 0.4713i

- 0.08146 + 0.4713i