EGR 103L – Fall 2017

Laboratory 7 - Roots and Extrema

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Lab Section 1B, Tuesday 8:30-11:20 AM

October 29th, 2017 I understand and have adhered to all the tenets of the Duke Community Standard in completing every part of this assignment. I understand that a violation of any part of the Standard on any part of this assignment can result in failure of this assignment, failure of this course, and/or suspension from Duke University.

Contents

List of Figures

1 Basic Root-Finding Problems

Function	Real Roots	Roots
$f(x) = 20e^{-4x} - 36e^{-2x} + 18e^{-x} - 1$	3	4.5651e-02, 6.3358e-01, 2.7546e+00
$f(x) = x^5 + 100\cos(2x)$	3	-7.8392e-01, 7.8691e-01, 2.1295e+00
$f(x) = \frac{10}{x-2} - 90e^{-(x/2)}, x \neq 2$	2	2.3619e+00, 7.9669e+00

2 Basic Min/Max-Finding Problems

Function	Counts	Extrema
$f(x) = 20e^{-4x} - 36e^{-2x} + 18e^{-x} - 1$	1 min, 1 max	min:$f(2.4510e-01) = -1.4596e+00$ max:$f(1.3002e+00) = 1.3421e+00$
$f(x) = x^5 + 100\cos(2x)$	2 min, 2 max	min 1:$f(-1.6682e+00) = -1.1103e+02$ min 2:$f(1.5063e+00) = -9.1415e+01$ max 1:$f(-2.4916e+00) = -6.9275e+01$ max 2:$f(8.7055e-06) = 1.0000e+02$

3 Chapra 6.16

V, m^3	10	20	30	40	50	60
h, m	8.6492e-01	1.4210e+00	1.9292e+00	2.4326e+00	2.9685e+00	3.6373e+00

4 Chapra 6.20

The value of d when h is 0.43 is 1.6672e-01. Numerical evidence that this graph is that by plugging two values of h into the formula (h=0.25,h=0.5). Plugging these values of h into the formula $\frac{2*40d^{5/2}}{5}+\frac{1}{2}40,000*d^2-95*9.81*d-95*9.81*h$ the output for h = 0.25 is d = 0.133693 and the output for h = 0.5 is d = 0.177671. These appear to be points on the graph, giving numerical evidence that the graph is correct.

5 Chapra 6.21

The two angles that achieve the desired velocity at the desired distance are $3.7959e+01^{\circ}$ and $5.1532e+01^{\circ}$.

6 Chapra 7.25, 7.26, and 7.27(b/c)

The minimum value for the equation in Chapra 7.25 was -6.5165e-01 at the coordinates (5.5233e-01,7.4472e-01).
The maximum value for the equation in Chapra 7.26 was 4.3440e+00 at the coordinates (9.6756e-01,6.5585e-01).
The minimum value for the equation in Chapra 7.27 was -1.7333e+01 at the coordinates (3.3333e+00,-6.6665e-01).

A Codes

A.1 Problem741.m

```
1   % I have adhered to all the tenets of the
2   % Duke Community Standard in creating this code.
3   % Signed: [ih52]
4  %% Initialize workspace
5  clear; format short e
6  %% Establish functions
7  f1 = @(x) 20.*exp(-4*x)-36.*exp(-2*x)+18.*exp(-x)-1;
8  f2 = @(x) x.^5 + 100.*cos(2*x);
9  f3 = @(x) 10./(x-2)-90.*exp(-(x/2));
10 %% Function one plot
11 figure(1); clf
12 x = linspace(-10,10,1000);
13 subplot(2,1,1)
14 plot(x, f1(x),'k-')
15 xlabel('x')
16 ylabel('f(x)')
17 title('Plot of f(x)= 20e^{-4x}-36e^{-2x}+18e^{-x}-1 (ih52)')
18 subplot(2,1,2)
19 plot(x, sign(f1(x)), 'k-')
20 xlabel('x')
21 ylabel('sign(f(x))')
22 title('Plot of sign(f(x))')
23 axis([-10 10 -1.2 1.2])
24 print -depsc F1Plot
25 %% Function one roots
26 [Root11,ValueRoot11] = fzero(@(xdummy) f1(xdummy), [-1 0.2])
27 [Root12,ValueRoot12] = fzero(@(xdummy) f1(xdummy), [0.2 1])
28 [Root13,ValueRoot13] = fzero(@(xdummy) f1(xdummy), [2.5 3])
29 %% Function two plot
30 figure(2);clf
31 x = linspace(-10,10,10000);
32 subplot(2,1,1)
33 plot(x, f2(x),'k-')
34 xlabel('x')
35 ylabel('f(x)')
36 title('Plot of f(x)=x^5+100cos(2x) (ih52)')
37 subplot(2,1,2)
38 plot(x, sign(f2(x)), 'k-')
39 xlabel('x')
40 ylabel('sign(f(x))')
41 title('Plot of sign(f(x))')
42 axis([-10 10 -1.2 1.2])
43 print -depsc F2Plot
44 %% Function two roots
45 [Root21,ValueRoot21] = fzero(@(xdummy) f2(xdummy), [-2 0])
46 [Root22,ValueRoot22] = fzero(@(xdummy) f2(xdummy), [0 1.5])
47 [Root23,ValueRoot23] = fzero(@(xdummy) f2(xdummy), [1.5 3])
48 %% Function three plot
49 figure(3);clf
50 x = linspace(-10,10,10000);
51 subplot(2,1,1)
52 plot(x, f3(x),'k-')
53 xlabel('x')
```

```
ylabel('f(x)')
title('Plot of f(x)=10/(x-2)-90e^{-(x/2)},x~=2 (ih52)')
subplot(2,1,2)
plot(x, sign(f3(x)), 'k-')
xlabel('x')
ylabel('sign(f(x))')
title('Plot of sign(f(x))')
axis([-10 10 -1.2 1.2])
print -depsc F3Plot
%% Function Three Roots
[Root31,ValueRoot31] = fzero(@(xdummy) f3(xdummy), [2.1 3])
[Root32,ValueRoot32] = fzero(@(xdummy) f3(xdummy), [7 9])
```

A.2 Problem742.m

```
 % I have adhered to all the tenets of the
 % Duke Community Standard in creating this code.
 % Signed: [ih52]
%% Initialize workspace
clear; format short e
%% Establish functions
f1 = @(x) 20.*exp(-4*x)-36.*exp(-2*x)+18.*exp(-x)-1;
f2 = @(x) x.^5 + 100.*cos(2*x);
%% Find local minima
[F1MinX,F1MinY] = fminbnd(@(dummyx) f1(dummyx),-1,1)
[F2Min1X,F2Min1Y] = fminbnd(@(dummyx) f2(dummyx),-2,-1)
[F2Min2X,F2Min2Y] = fminbnd(@(dummyx) f2(dummyx),1,2)
%% Find local maxima
[x1,y1] = fminbnd(@(dummyx) -f1(dummyx),1,3);
[x21,y21] = fminbnd(@(dummyx) -f2(dummyx),-3,-2);
[x22,y22] = fminbnd(@(dummyx) -f2(dummyx),-1,1);
F1MaxX = x1
F1MaxY = -1*y1
F2Max1X = x21
F2Max1Y = -1*y21
F2Max2X = x22
F2Max2Y = -1*y22
```

A.3 Chapra616.m

```
 % I have adhered to all the tenets of the
 % Duke Community Standard in creating this code.
 % Signed: [ih52]
%% Initialize workspace
clear; format short e
%% Establish functions
V = @(r,h,L) (r.^2.*acos((r-h)/r)-(r-h).*sqrt(2.*r.*h-h.^2)).*L;
Height = zeros(1,6);
x = linspace(10,60,6)
for k = 1:numel(x)
    [Height(k)] = fzero(@(dummyv) V(2,dummyv,5)-x(k),[0 4]);
end
Height = Height
```

A.4 Chapra620.m

```
 % I have adhered to all the tenets of the
 % Duke Community Standard in creating this code.
 % Signed: [ih52]
%% Initialize workspace
clear; format short e
%% Establish function & solve Chapra equation
MyFun = @(d,h) (2.*40.*d.^(5/2))./5+1/2.*40000.*d.^2-95.*9.81.*d-95.*9.81.*h;
ChapraFunZeros = fzero(@(ddummy) MyFun(ddummy,0.43), [0 1])
%% Graph of d for 50 values of h
h = linspace(0.0001,1,50);
dvals = zeros(1,50);
for k = 1:numel(h)
    dvals(k) = fzero(@(ddummy) MyFun(ddummy,h(k)),[0.00001 10]);
end
figure(1); clf
plot(h,dvals,'k-')
grid on
title('Plot of Chapra Problem 6.20')
xlabel('h (m)')
ylabel('d (m)')
print -depsc Chapra620Fig


```

A.5 Chapra621Bball.m

```
 % I have adhered to all the tenets of the
 % Duke Community Standard in creating this code.
 % Signed: [ih52]
%% Initialize workspace
clear; format short e
%% Establish functions
MyFun = @(x,v,theta) tan(theta).*x-9.81/(2.*v.^2.*(cos(theta).^2)).*x.^2+1.8;
%% Get angle in radians
FunZero1 = fzero(@(dummytheta) MyFun(90,30,dummytheta)-1,[0.1]);
FunZero2 = fzero(@(dummytheta) MyFun(90,30,dummytheta)-1,[1]);
%% Plot trajectories
x = linspace(0,90,1000);
y1 = MyFun(x,30,FunZero1);
y2 = MyFun(x,30,FunZero2);
figure(1); clf
plot(x,y1,'k-',x,y2,'c-')
legend('37.959 Degrees','51.532 Degrees')
axis([0 90 0 50])
xlabel('x (m)')
ylabel('y (m)')
print -depsc Chapra621BballPlot
%% Convert angle to degrees
Angle1 = radtodeg(FunZero1)
Angle2 = radtodeg(FunZero2)


```

A.6 Chapra725.m

```
 % I have adhered to all the tenets of the
 % Duke Community Standard in creating this code.
 % Signed: [ih52]
%% Initialize workspace
clear; format short e
%% Chapra 7.25 minimum
MyFun1 = @(x,y) 2.*y.^2-2.225.*x.*y-1.75.*y+1.5.*x.^2;
[MinX1, MinY1] = fminsearch(@(dummyv) MyFun1(dummyv(1),dummyv(2)),[0 0])
%% Chapra 7.25 surface plot
figure(1);clf
x = linspace(-4,4,20);
[X,Y] = meshgrid(x);
surfc(X,Y,MyFun1(X,Y))
colormap jet
title('Surface Plot w/ Contours of Chapra 7.25')
xlabel('x')
ylabel('y')
zlabel('f(x,y)')
print -depsc Chapra725Plot
%% Chapra 7.26 maximum
MyFun2 = @(x,y) 4.*x+2.*y+x.^2-2.*x.^4+2.*x.*y-3.*y.^2;
[MaxX2,NegMaxY2] = fminsearch(@(dummyv) -MyFun2(dummyv(1),dummyv(2)),[0 0]);
MaxX2 = MaxX2
MaxY2 = -1.*NegMaxY2
%% Chapra 7.26 surface plot
figure(2);clf
surfc(X,Y,MyFun2(X,Y))
colormap jet
title('Surface Plot w/ Contours of Chapra 7.26')
xlabel('x')
ylabel('y')
zlabel('f(x,y)')
print -depsc Chapra726Plot
%% Chapra 7.27 minimum
MyFun3 = @(x,y) -8.*x+x.^2+12.*y+4.*y.^2-2.*x.*y;
[MinX3,MinY3] = fminsearch(@(dummyv) MyFun3(dummyv(1),dummyv(2)),[0,0])
%% Chapra 7.27 surface plot
figure(3);clf
surfc(X,Y,MyFun3(X,Y))
colormap jet
title('Surface Plot w/ Contours of Chapra 7.27')
xlabel('x')
ylabel('y')
zlabel('f(x,y)')
print -depsc Chapra727Plot
```

B Figures

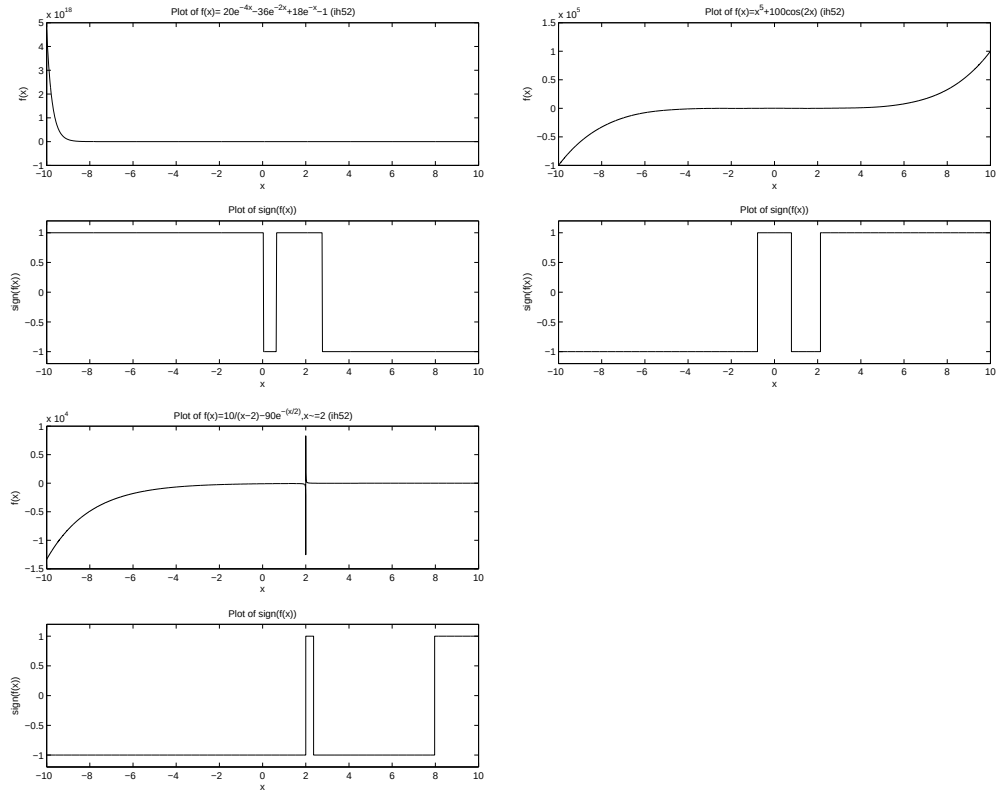

Figure 1: Basic Roots Problems

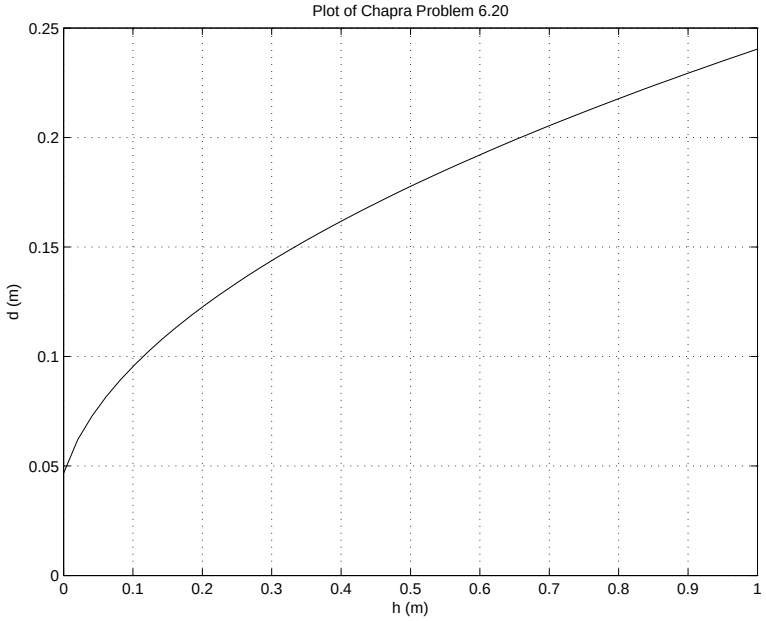

Figure 2: Plot of d vs. h from Chapra 6.20

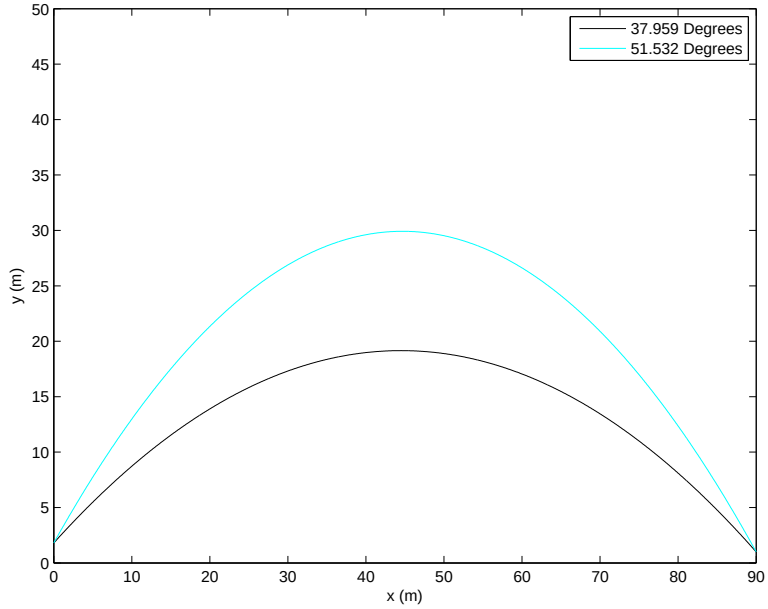

Figure 3: Plot of trajectories from Chapra 6.21

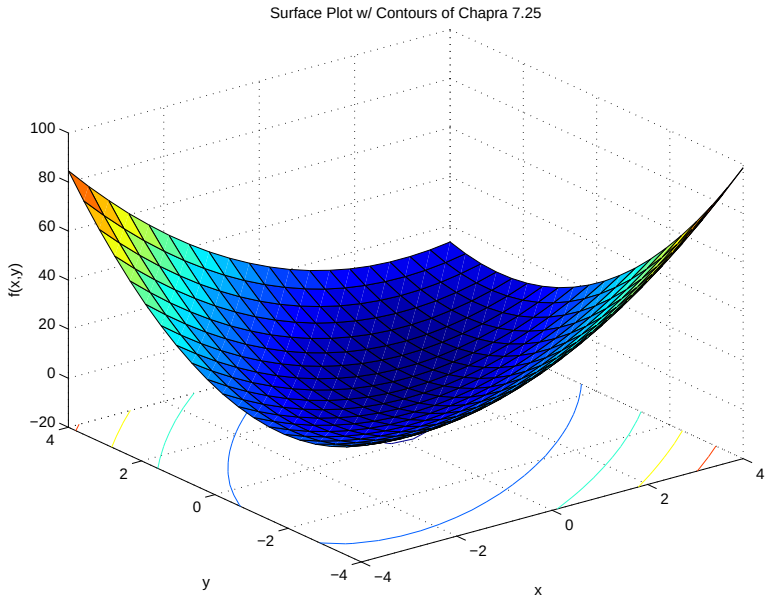

Figure 4: Surface plot with contours of Chapra 7.25

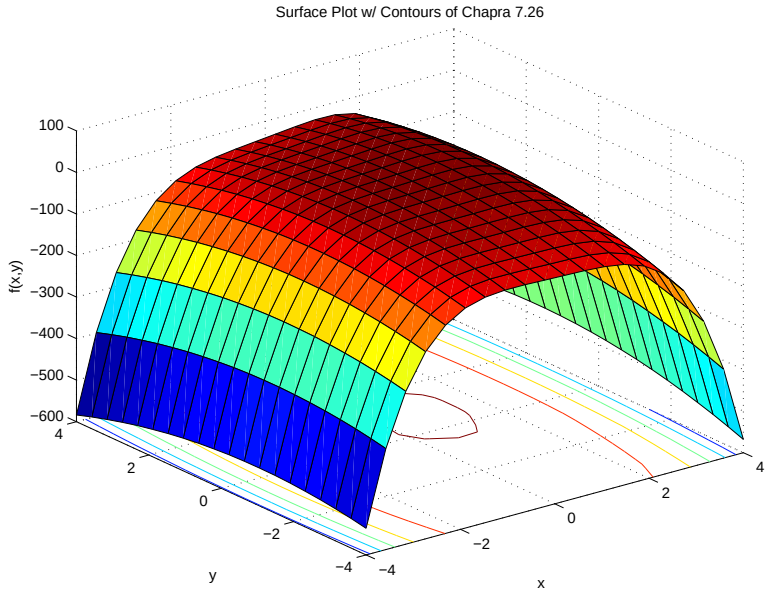

Figure 5: Surface plot with contours of Chapra 7.26

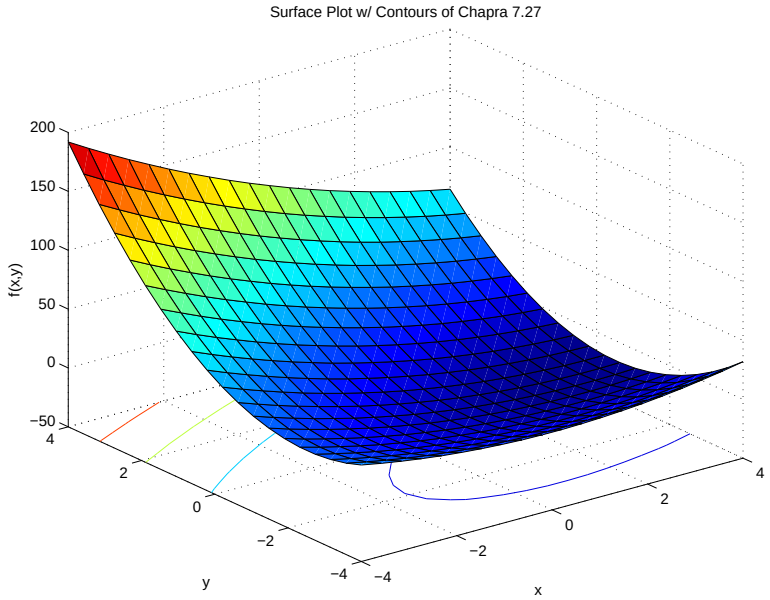

Figure 6: Surface plot with contours of Chapra 7.27