Homework # 6

Due: Tuesday, August 1st

Question 1. (10 points) Explain how power system equipment and buildings are protected against lightning strokes.

Question 2. (10 points) Why the power flow analysis involves with non-linear equations?

Question 3. (40 points) Using Gauss-Seidel method, find the root of the following equation. Use initial guess of the root as 0. Stop iterations, if the solution does not seem to converge in 5 iterations.

$$f(x) = 2x^3 - 3x^2 + 5x - 2 = 0$$

Question 4. (40point) Use Newton-Raphson method and hand calculations to find the solution of the following equations.

$$x_1^2 - 2x_1 - x_2 = 3$$

$$x_1^2 + x_2^2 = 41$$

Start with the initial estimates of $x_1^{(0)} = 2$ and $x_2^{(0)} = 3$. Perform three iterations

1)
Transmission lines are often protected by a grounded shield wire. Buildings are often protected by lightning arresters. Power stations can be protected with a "net" of shield wires, arresters, or both.

2)
Because P=V1V2/X12 sin(th1-th2) and Q=V1V2/X12 cos(th1-th2)-V2^2/X12 cos(phi), and because of the trig functions, we know YV=(P+jQ)/V* is a nonlinear function. Power depends on sin and cos of voltage angle and shunts depend on Vi^2. These are extremely difficult to solve purely analytically, so we instead use iterative methods.

3) 2x^3-3x^2+5x-2 = 0
-5x = 2x^3-3x^2-2
x = -2/5x^3+3/5x^2+2/5
x = -.4x^3+.6x^2+.4
x(0)=0
x(1) = -.4x(0)^3+.6x(0)^2+.4 = .4
x(2) = -.4x(1)^3+.6x(1)^2+.4 = .4704
x(3) = -.4x(2)^3+.6x(2)^2+.4 = .4911
x(4) = -.4x(3)^3+.6x(3)^2+.4 = .4973
x(5) = -.4x(4)^3+.6x(4)^2+.4 = .4992
x(6) = -.4x(5)^3+.6x(5)^2+.4 = .4997
x(7) = -.4x(6)^3+.6x(6)^2+.4 = .4999
x=.5
-.4(.5)^3+.6(.5)^2+.4 = .5

4)
I used Matlab notation because that's how I learned how to do this using an example from class, but I did these calculations on TI-84 (I assume that counts as "hand calculations" because I can't do [6.7857,-1;8.7857,9.8571]^-1 [-2.5829;-2.5880] without a calculator)

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f=[x1^2-2x1-x2=3;    upwards opening parabola
   x1^2+x2^2=41]    circle
J=[2x1-2,-1;
    2x1,2x2]

x_0=[2;3]
Dx_0=[1;1]
C=[3;41]

k=0
f_0=[x1^2-2x1-x2;x1^2+x2^2]=[-3;13]
Dc_0=C-f_0=[6;28]
J_0=[2x1-2,-1;2x1,2x2]=[2,-1;4,6]
Dx_0=J_0\Dc_0=[4;2]
x_1=x_0+Dx_0=[6;5]
k=1
f_1=[x1^2-2x1-x2;x1^2+x2^2]=[19;61]
Dc_1=C-f_1=[-16;-20]
J_1=[2x1-2,-1;2x1,2x2]=[10,-1;12,10]
Dx_1=J_1\Dc_1=[-1.6071;-0.0714]
x_2=x_1+Dx_1=[4.3929;4.9286]
k=2
f_2=[x1^2-2x1-x2;x1^2+x2^2]=[5.5829;43.5880]
Dc_2=C-f_2=[-2.5829;-2.5880]
J_2=[2x1-2,-1;2x1,2x2]=[6.7857,-1;8.7857,9.8571]
Dx_2=J_2\Dc_2=[-0.3706;0.0678]
x_3=x_2+Dx_2=[4.0222;4.9964]
k=3
f_3=[x1^2-2x1-x2;x1^2+x2^2]=[3.13374;41.1420]
Dc_3=C-f_3=[-0.1374;-0.1420]
J_3=[2x1-2,-1;2x1,2x2]=[6.0444,-1;8.0444,9.9928]
Dx_3=J_3\Dc_3=[-0.0221;0.0036]
x_4=x_3+Dx_3=[4.0001;5.0000]
k=4
f_4=[x1^2-2x1-x2;x1^2+x2^2]=[3.0005;41.0005]
```
that's converged enough for me to say x1=4 and x2=5