EE 735 HW#1: Electrostatics

Due date: 11.55pm, 09/08/2016

Penalty for late submissions: 20% per week

1. **Familiarize with Matlab:** Mention the options to find inverse of a matrix (or matrix division). Discuss the salient features.

2. **Numerical solution of steady state continuity equations**: Use Newton's method to find a root of the equation $f(x) = x^2 - 4\cos(x) = 0$. Generate a plot (i.e., a figure) to check the rate of convergence of the solution.

3. **Finite difference method**: Using Taylor series expansion for a function f(x), provide approximate expressions for the first and second derivative. Comment on the order of magnitude of errors introduced in this scheme.

4. **Numerical solution of Poisson's equation**: for the following cases. For each of the cases listed below, also provide analytical solutions and compare with numerical results, if possible. Assume at least 100 grid points for numerical solutions.

    a. Assume two metal plates A and B are kept at a separation of 100μm in free space. Plate A is grounded (at x=0) and while plate B is held at a potential of 1V (at x=100μm). Find the potential profile from Plate A to Plate B.
    b. For the same configuration as above, assume both plates are grounded, and a charge sheet of zero thickness but with charge of -10^{-6}C/cm^2 is placed at a distance of 30μm from plate A towards plate B. Find the potential profile from Plate A to Plate B.
    c. For the problem (a), assume that the dielectric constant of varies as a function of spatial co-ordinate as follows
        $\varepsilon_r = 1, \quad 0 < x < 60\mu m$
        $\varepsilon_r = 7, \quad 60\mu m < x < 100\mu m$
        Find the potential profile from Plate A to Plate B and compare it with that of case (a).
    d. Assuming the conditions in case (a), assume that the region between A and B has a charge density of $q \times 10^{16}$ cm^{-3}, where q is the electronic charge. Find the potential profile between the plates A and B.

5. As a continuation of Question 3, describe the finite difference scheme to solve the Poisson's equation in 2 dimensions.

6. Using the above scheme, solve for the electrostatics of two parallel plates mentioned in Q. 4a. Assume that the width of the plates is 10μm, while the separation between them is the same as mentioned in Q.4a.

7. Modify your 2-D code to find the capacitance of the following system which consist of an infinite plate as one electrode and a periodic array of smaller plates as the second electrode.

   (a) Assume that the smaller plates are at zero potential and 1V is applied at the larger plate with d=10μm. Find the capacitance of the system
   (b) Plot the capacitance as a function of the variable d (i.e., over a range of 1-100μm)