Electromagnetics Software Assignment

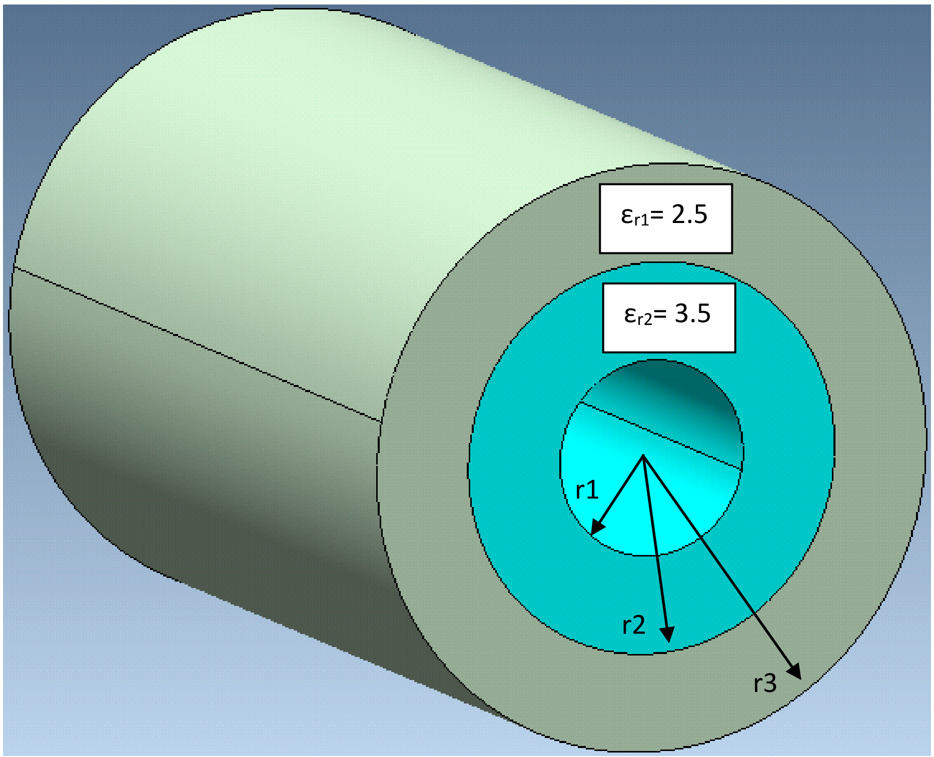
Submission Rules:

1- Only submit in PDF format, other formats will not be graded.
2- Submit the electrostatics solution as a PDF to electrostatic.assignment2018@gmail.com
3- Submit the magneto statics solution as a PDF to k.e.elsayed+submission@gmail.com
4- A PDF submitted to any other Email address that belongs to the course TAs but not one of the above addresses will not be graded.
5- The Electro PDF should have this label: Your_Full_Name_SeatNumber_Electro, the magneto PDF: Your_Full_Name_SeatNumber_Magneto. Example: Khaled_Essam_400_Electro. Incorrect labels will not be graded.
6- The assignment is due on December 10th 11:59 PM (10/12/2015). Assignments received after this exact date and time will not be graded.
7- Copied solutions will be awarded a grade of zero.

Electrostatics:

Note: Read the entire assignment before solving

The problem we will be simulating is shown below in the 3D view:



1) Start a new model and set grid and the units to millimetres.
2) It is required to:
    - examine the electric field and potential in the space between the conductors (the equipotential lines should be found).
    - determine the capacitance of the cylindrical capacitor.

3) The cylindrical capacitor with two layers of dielectric. The outer layer dielectric has relative permittivity ε_{r1}= 2.5 and the inner layer dielectric has relative permittivity of ε_{r2} = 3.5 .The radiuses are: r_1=1mm, r_2=2mm, r_3= 3mm and the length of the capacitor is L=10 mm .
Hint: you need to create two new dielectric materials for the two layers of dielectric. because the needed dielectrics with relative permittivities 2.5 and 3.5 do not exist in the standard Material library**.**
4) Define the inner cylinder (r_1=1mm)as an electrode with a voltage of 1 v and the outer cylinder (r_3=3mm) with a voltage of 0 v.
5) Use the following solving options:
    a. Solver options- Newton tolerance 1%, Maximum Newton Iterations 20, CG tolerance 0.01%, Polynomial order 4
    b. refine the mesh by specifying the maximum size of the elements=0.1.
6) calculate the capacitance using both equations : C=Q/V, C=2W/V^2
Q: charge, V: voltage difference between electrodes, W: stored electric energy.(compare this value with the analytical results)

7) plot V , |E|smoothed & |D|smoothed from (1,0) to (3,0) .(comment)

<u>Magneto statics:</u>

1) Set the unit to meters
2) Draw two parallel buses with current flowing in the opposite directions for two cases, in each case use copper: 5.77e7 Siemens/meter and sweeping distance of 1 m:
    a. Two bus bars with a square cross section. The height being 0.3 m and the width 0.1 m. One lies 0.2 m to the left of the origin and the other at 0.2 m to the right of the origin. Each has a current density of 10 A/mm^2 running in the same direction.
    b. Two bus bars with circular cross section. The radius being 0.1 m. One lies 0.2 m to the left of the origin and the other 0.2 m to the right of the origin. Each has a current density of 10 A/mm^2 running in opposite directions.
3) Draw the air box with the dimensions you find suitable.
4) The force between the bus bars can be found using the equation:

$$f = \frac{2 * 10^{-7}\, k\, i_1\, i_2}{d}\ N/m$$

k is a constant that depends on the shape of the bus. I1 and I2 are the currents in each bus bar. D is the distance between the centres of the bus bar. Simulate the two cases and in each case find the value of the constant k.
5) In the submitted PDF, plot the magnetic field density in each of the two cases and comment on the shape of the magnetic field and the resultant force.