Practice Midterm Exam, ECEN 3400, Fall 2013
1 hour, in class
Prof. Zoya Popovic

Closed everything, no calculators (you will not need one)
All estimates within a factor of 2 will receive full credit if the units are correct.

Questions and Problems from the list are chosen to cover Ch.3-11
Total points: 33, Maximum number of points: 30

QUESTIONS:

Q1: Inside an imaginary closed surface S the total charge is zero. Does this mean that at all points of *S* the vector **E** is zero? Explain. *(Ch.5, 3 points)*

Q2: A metal foil of thickness *a* is introduced between and parallel to the plates of a parallel-plate capacitor that are a distance *d (d>a)* apart. If the area of the foil and the capacitor plates is *S*, what is the capacitance of the capacitor without, and with the foil? *(Ch.8, 4 points)*

Q3: Prove that on a boundary surface in a DC (time-invariant) current field, $J_{1norm}=J_{2norm}$. *(Ch.10, 3 points)*

PROBLEMS:

P1: Twenty small charged bodies each carrying a charge $Q=10^{-10}C$ are brought into an uncharged metallic shell of radius R=5cm. Evaluate the potential of the shell and the electric field strength on its surface. *(Ch.6, 7 points)*

P2: The permittivity between the plates of a parallel plate capacitor varies as $\varepsilon(x)=\varepsilon_0(2+x/d)$, where *x* is the distance from one of the plates, and *d* is the distance between the plates. If the area of the plates is *S*, calculate the capacitance of the capacitor. Determine the volume and surface polarization charges if the plate at *x=0* is charged with a charge *Q (Q>0)*, and the other with –*Q*. *(Ch.8, 8 points)*

P3: A dielectric sphere of radius *a* and permittivity ε is situated in a vacuum and is charged throughout its volume with volume density of free charges $\rho(r)=\rho_0\, a/r$, where *r* is the distance from the sphere center. Determine the electric energy of the sphere. *(Ch.9, 8 points)*