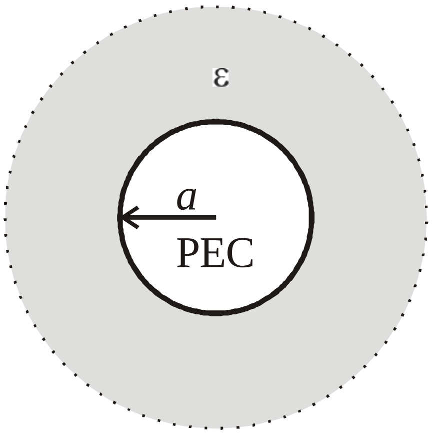
EE 381 Electric & Magnetic Fields Examination #3
(Fall 2xxx)

Name __Example_______

Instructions: Place answers in indicated spaces. Use notation as given in class for coordinates and vectors. **Show all work for full credit**. Attach equation sheet and hand-in with exam.

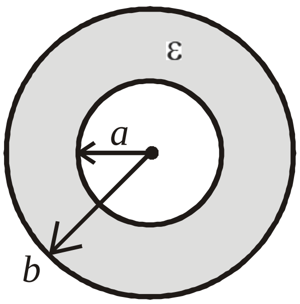
1) A solid sphere (radius a) composed of a perfect electrical conductor (PEC) is embedded in a dielectric material where $\varepsilon = 4.2\varepsilon_0$. If the PEC sphere supports an evenly distributed surface charge density of $\rho_s = 59.5$ nC/m^2, find the electric field $\bar{E}$ and electric flux density vector $\bar{D}$ just inside the sphere (i.e., $r = a^-$) and outside the sphere (i.e., $r = a^+$).



$\bar{E}(r = a^-) =$ ____________**0**__________________ $\bar{D}(r = a^-) =$ ____________**0**__________________

$\bar{E}(r = a^+) =$ ______$\hat{a}_r 1600$ V/m___________ $\bar{D}(r = a^+) =$ ______$\hat{a}_r 59.5$ nC/m^2 _________

2) For the spherical capacitor shown, the region between the conductors ($a < r < b$) is filled with a dielectric $\varepsilon = \varepsilon_r\varepsilon_0$. If the center conductor supports an evenly distributed charge of $-Q$, the electric flux density vector is $\bar{D} = -\hat{a}_r \dfrac{Q}{4\pi r^2}$ for $a < r < b$. Calculate the polarization vector $\bar{P}$ and bound volume charge density ρ_{pv} for $a < r < b$. Also, find the bound surface charge density ρ_{ps} on the interior and exterior surfaces of the dielectric (i.e., $r = a^+$ and $r = b^-$).



$\bar{P} = \underline{-\hat{a}_r \dfrac{Q}{4\pi r^2}\left(1 - \dfrac{1}{\varepsilon_r}\right)}$

$\rho_{pv} = \underline{\mathbf{0}}$

$\rho_{ps}(r = a^+) = \underline{\dfrac{Q}{4\pi a^2}\left(1 - \dfrac{1}{\varepsilon_r}\right)}$

$\rho_{ps}(r = b^-) = \underline{\dfrac{-Q}{4\pi b^2}\left(1 - \dfrac{1}{\varepsilon_r}\right)}$

2) A current distribution yields a vector magnetic potential of $\bar{A} = 4xy\,\hat{a}_x + 6xy\,\hat{a}_y - 9z\,\hat{a}_z$ (Wb/m). Find the magnetic flux density and magnetic field if $\mu = \mu_0$. Also, find the magnetic flux upward through the surface defined by $z = 10$ m, -1 m $\leq x \leq 0$, and $0 \leq y \leq 1.2$ m.

$\bar{H} = \hat{a}_z\left(4.775y - 3.183x\right)$ MA/m

$\bar{B} = \hat{a}_z\left(6y - 4x\right)$ Wb/m^2

Magnetic flux = **6.72 Wb**

3) A length L of coaxial line has charge Q on the inner conductor (radius $a = 2$ mm) and charge $-Q$ on the outer conductor (radius $b = 6$ mm) yielding an electric flux density $\bar{D} = \hat{a}_\rho \dfrac{Q}{2\pi L\rho}$ for $a < \rho < b$. The region between the conductors is filled with a lossy dielectric ($\varepsilon = 3\varepsilon_0$ and $\sigma = 2 \times 10^{-6}$ S/m). Find the capacitance and resistance between the conductors of the coaxial line if $L = 12$ m.

C = **__1.823 nF__** R = **__7285.4 Ω__**