2017 Fall PHYS2310 電磁學（Electromagnetism) Final Exam. (double sides)

[Griffiths Chs. 4-7.1] 2018/01/11, 10:10am – 12:00am, 教師：張存續

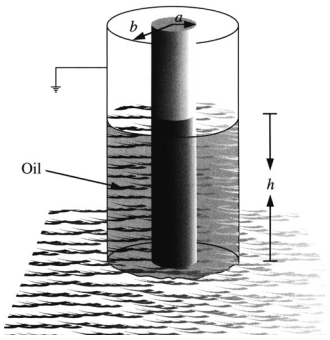
◇ Answer the questions as complete as possible.

1. (20%) Two long coaxial cylindrical metal tubes (inner radius *a*, outer radius *b*) stand vertically in a tank of dielectric oil (susceptibility χ_e, mass density ρ). The inner one is maintained at potential *V*, and the outer one is grounded (See the figure).

(a) Find the electric field **E** in the air part and the oil part? (8%)

(b) Find the capacitance? (6%)

(c) Find the height (*h*) that the oil rises in the space between the tubes? (6%)

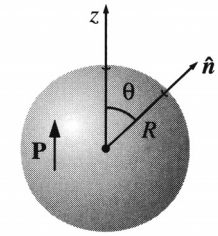


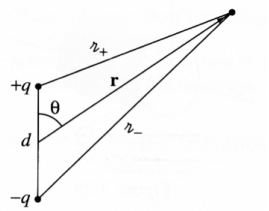
2. (20%) Consider a uniformly polarized dielectric sphere of radius *R*. $\mathbf{P} = P_0\hat{\mathbf{z}}$

(a) Find the surface bound charge density σ_b and the volume bound charge density ρ_b. (10%)

(b) Find the potential *V* of the dipole sphere for $r \geq R$. (10%)

[Hint: Use the dipole approximation, or $V = \frac{1}{4\pi\varepsilon_0}\oint_S \frac{\sigma_b}{\wr}\,da' + \frac{1}{4\pi\varepsilon_0}\int_v \frac{\rho_b}{\wr}\,d\tau']$.





3. (20%) Boundary conditions and applications.

(a) $\nabla\cdot\mathbf{D} = \rho_f$. Find the boundary condition for the normal component of **D**, $D^{\perp}$. (6%)

(b) $\nabla\times\mathbf{H} = \mathbf{J}_f$. Find the boundary condition for the tangential component of **H**, $\mathbf{H}^{//}$. (6%)

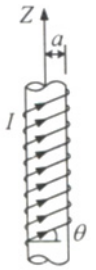
(c) Consider the interface between two dielectric materials with ε_1 and ε_2 as shown in the figure. Find the relations between the normal and the tangential components of the electric fields. Assume that there is no surface charge, i.e., $\sigma_f = 0$. (8%)

$$\frac{\varepsilon_1,\ E_1^{\perp},\ E_1^{//}}{\varepsilon_2,\ E_2^{\perp},\ E_2^{//}}$$

4. (20%) An infinitely long solenoid with air core having a radius a and n closely wound turns per unit length, as shown in the figure. The windings are slanted (傾斜) at an angle θ and carry a current I.

(a) Find the z-component of the magnetic flux density (B_z) both inside and outside the solenoid. (10%) [Hint: Use Ampere's law.]

(b) Find the ϕ-component of the magnetic flux density (B_ϕ) both inside and outside the solenoid. (10%) [Hint: Use cylindrical coordinates, r, ϕ, z.]



5. (20%) A long cylinder of radius R carries a magnetization $\mathbf{M}=M_0\hat{\mathbf{z}}$, where M_0 is a constant.

(a) Find $\mathbf{J}_b$ within the material and $\mathbf{K}_b$ on the surface of the material. (10%)

(b) Find the magnetic field $\mathbf{B}$ due to $\mathbf{M}$ for points inside ($r \le R$) and outside the cylinder ($r \ge R$). (10%)