Homework Problem Set #7

(Due date: 2011/04/25)

This problem set covers materials of Lesson 9. The full score is 40 points.

1) (15%) Fig. 1 shows a simplified model of *pn*-junction. A depletion region is formed during $-d_p < x < d_n$, where net charge densities $-eN_A$ (C/m^3) and eN_D (C/m^3) exist for $-d_p < x < 0$ and $0 < x < d_n$, respectively. Note that $N_A d_p = N_D d_n$ holds to maintain the electric neutrality. Let the potential $V(-d_p) = 0$, find the potential distribution $V(x)$ for $-d_p < x < d_n$ by solving Poisson's equation (with suitable boundary conditions).

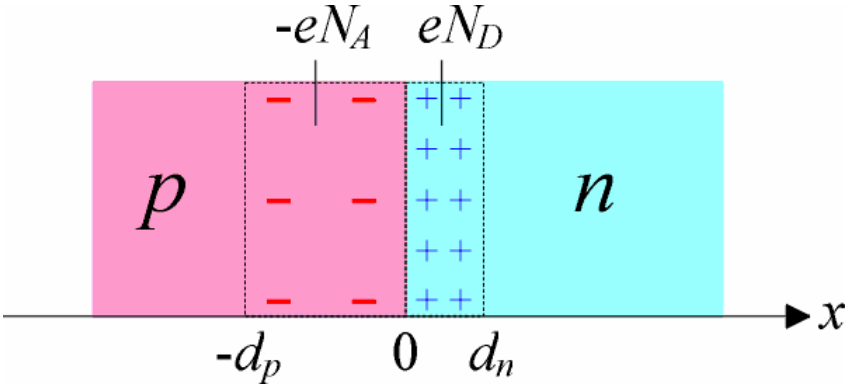

Fig. 1. *pn*-junction.

2) Consider a coaxial cable capacitor with the same geometry as that shown in Fig. 9-4 in the lecture notes, while the space between the conducting surfaces ($a < r < b$) is filled with two dielectric media of permittivities ε_1, ε_2 according to:

$$\varepsilon = \begin{cases} \varepsilon_1, \text{for } \phi \in (0, \pi/2) \\ \varepsilon_2, \text{for } \phi \in (\pi/2, 2\pi) \end{cases} \quad (r, \phi \text{ are with cylindrical coordinates}).$$

2a) (10%) Deposit charges of $+Q$ and $-Q$ on the inner and outer conducting surfaces, respectively. Find the electric flux density $\vec{D}$ in the dielectric region $a < r < b$.

(*Hint*: Use boundary condition.)

2b) (5%) Find the corresponding capacitance C, and the effective permittivity ε_{eff} if $\varepsilon_{eff} \equiv \dfrac{C \ln(b/a)}{2\pi L}$ (justified by the result of Example 9-3 in the lecture notes).

3) (10%) Problem **P.3–32** of the textbook.