

EE214000 Electromagnetics, Fall, 2020

Homework #5, due in class at 12 pm, noon, Monday, Dec. 14, 2020

Late submission won't be accepted!

Problems 1. (P.5-8), 2. (P.5-13), 3. (P. 5-14), 4. (P.5-22) in DK Cheng's textbook

5. (20 points) Consider the following device having a top flat electrode at $y = d$ biased at V_0 and a bottom flat electrode at $y = 0$ grounded to a zero potential. Ignore the fringe fields near the edge of the electrodes. The electrons boil off the bottom electrode and propagate upward, while colliding with some neutral molecules (for example, air molecules) and moving at a constant speed

$\vec{v} = -\mu_e \vec{E}$, where μ_e is the mobility of the electrons, and $\vec{E} = E_y \hat{a}_y$. In the space-charge limited regime, the electric field at $y = 0$ is zero. At a steady state, the current density between the two electrodes is a constant $\vec{J} = -J_0 \hat{a}_y$. (1)

Express the volume charge density ρ as a function of J_0 and E_y . (2) Insert ρ into the Poisson's equation to write a differential equation for E_y . (3) Find E_y as a function of y . (4) Find V_0 as a function of J_0 .

