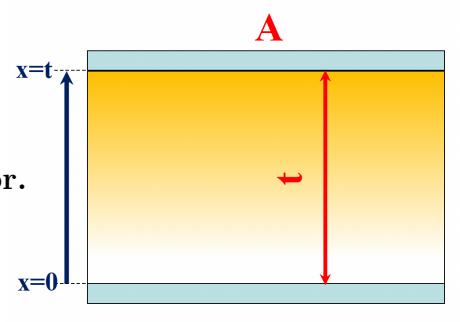
Physics 525 – Homework # 6

Due Apr. 3, 2024

6.1 (50 points) A flat capacitor is filled by dielectric with the dielectric permittivity distributed along the x axis as



$$\epsilon = \epsilon_1 + \epsilon_2 x$$

The thickness of the dielectric is t and the electrode's area is A.
Derive an expression for the capacitance of this capacitor.
You may find the following information useful.
The capitance of a flat capacitor is $C = \epsilon_0 \epsilon A/t$.

$$\int \frac{1}{ax+b} dx = \frac{1}{a} \ln |ax+b|$$

$$\ln x - \ln y = \ln \left(\frac{x}{y} \right)$$

$\epsilon_0 = 8.854 \times 10^{-12}$F/m.

6.2 (20 points) Consider a box shielded by the Pb in superconducting state.
The box is faced to magnetic field of 40mT and is at $T = 4.2$K.
The thickness of shielding material is 100 nm.
Calculate the residual field in the cavity and SE-shielding efficiency.