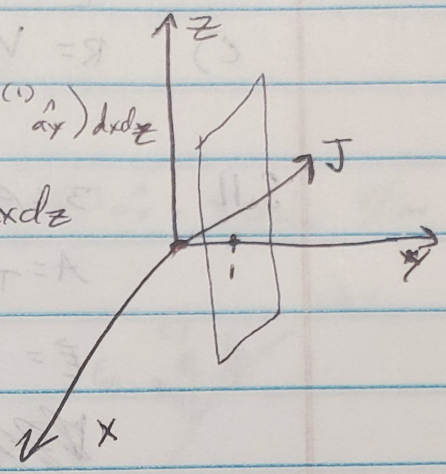
5.1a. $\vec{J} = -10^4\left(\sin 2x\, e^{-2y}\hat{a}_x + \cos 2x\, e^{-2y}\hat{a}_y\right)$ kA/m²

$= -\rho_e \mu_e \vec{E} = \sigma \vec{E} = I/s$

$0 < x < 1 \qquad 0 < z < 2$

$y = 1$

find I. $\qquad I = \int_s \vec{J} \cdot d\vec{S}$



$I = \int_0^2 \int_0^1 -10^4\left(\sin 2x\, e^{-2(1)}\hat{a}_x + \cos 2x\, e^{-2(1)}\hat{a}_y\right) dx\, dz$

$= -1000e^{-2}\int_0^2\int_0^1 \sin 2x\, dx\, dz + \int_0^2\int_0^1 \cos 2x\, dx\, dz$

$= -2000e^{-2}\int_0^1 \sin 2x\, dx + \int_0^1 \cos 2x\, dx$

$= -2000e^{-2}(0.7083 + 0.455)$

$= \boxed{-3147.899\text{kA}}$

5.2. $\vec{J} = -10^{-4}(y\hat{a}_x + x\hat{a}_y)$ A/m² $\qquad y = 0 \qquad -\hat{a}_y$

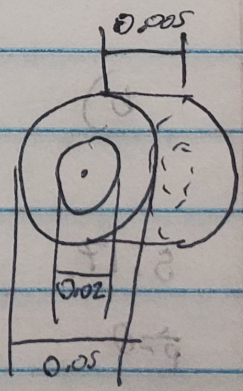
$0 < x < 2 \qquad 0 < z < 1$

$I = \int_0^1 \int_0^2 -10^{-4}\, x\, \hat{a}_y\, dx\, dz$

$= -0.0001 \int_0^2 x\, dx\, \hat{a}_y$

$= -0.0002\hat{a}_y \Rightarrow \boxed{0.0002(-\hat{a}_y)\text{ A}}$

5.10. $\vec{E} = \frac{0.5}{\rho}\hat{a}_\phi$ V/m $\qquad \sigma = 1.5E^7$ S/m



$\vec{E} = -\nabla V$

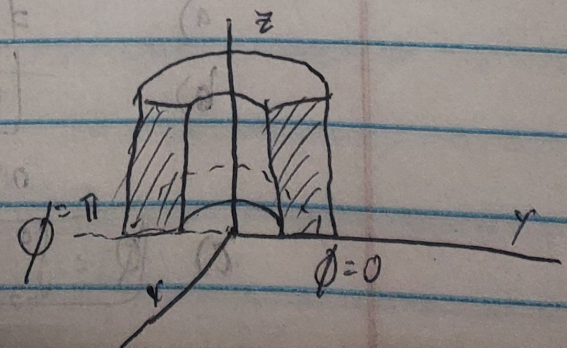
$E_\phi = -\left(\frac{1}{\rho}\right)\frac{\partial V}{\partial \phi} = 0.5/\rho$

$\int 0.5/\rho\, d\phi = \int -1/\rho \frac{\partial V}{\partial \phi}\phi$

$0.5\int_0^\pi \rho^{-1}\, d\phi = \rho^{-1} V$

$0.5\int_0^\pi d\phi = V$

a) $V(\pi) - V(0) = \boxed{-0.5\text{ V}}$



$I = \int_s \vec{J} \cdot d\vec{s}$ $\quad \vec{J} = \sigma \vec{E}$ $\quad J_\phi = \sigma \left(\frac{1}{\rho}\right) E_\phi$

$= \sigma \left(\frac{1}{\rho}\right)\left(\frac{0.5}{\rho}\right)$

$\rho = 1 \rightarrow = \frac{\sigma}{2\rho^2} = 3.75$

$\int_0^{2\pi} \int_{0.01}^{0.025} 3.75 \rho \, d\rho \, d\phi = 7.5\pi \int_{0.01}^{0.025} \rho \, d\rho = 7.5\pi (0.000625)$

b) $= \boxed{0.00616 \text{ A}}$

c) $R = V/I = \frac{0.05}{0.00616} = \boxed{-81.17 \, \Omega}$

S.11 $3 < \rho < 25$ cm $\quad I_\rho = 3A \quad \vec{E} = \sigma \vec{J} = \sigma \left(\frac{I}{A}\right)$

$A = \pi(0.05 - 0.03) = 0.02\pi \quad \sigma = 0.05 \text{ S/m}$

$\vec{E} = 0.05 \left(\frac{3}{0.02\pi}\right) \hat{\rho} = 7.5/\pi \text{ V/m}$

$V = -E \Delta \rho$

a) $= \boxed{-0.15/\pi \text{ V}}$

$R = V/I = -0.15/\pi / 3 = \boxed{\frac{0.05}{\pi} \, \Omega}$

$\iiint \rho \, dV = \iiint \sigma E^2 \, dV$

$= \int_0^{2\pi} \int_{0.03}^{0.05} \int_0^{l} \sigma E^2 \rho \, dz \, d\rho \, d\phi$

$= \left(\frac{7.5}{\pi}\right)^2 (0.05)(2\pi)(l) \int_{0.03}^{0.05} \rho \, d\rho$

$= \left(\frac{7.5}{\pi}\right)^2 (0.05)(2\pi)(l)(0.0008)$

b) $= \boxed{0.001431 \text{ W}}$

S.17. $V = 100xz/(x^2+4)$ V (freespace) find $\vec{D}$ at $z=0$

$\vec{\rho} = 0 \quad \vec{D} = \epsilon_0 \vec{E} \quad \vec{E} = -\nabla V = -\left(100z\left(\frac{x^2-4}{(x^2+4)^2}\right)\hat{a}_x + 0\hat{a}_y + \left(\frac{100x}{x^2+4}\right)\hat{a}_z\right)$

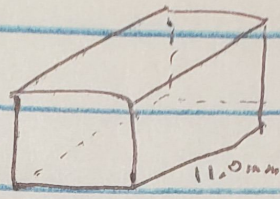
a) $= \boxed{\epsilon_0 \left(\frac{100x}{x^2+4}\right)\hat{a}_z}$

b) $\boxed{d/dz\left(\frac{100x}{x^2+4}\right) = 0}$

$0 < x < 2 \quad -3 < y < 0$

c) $\boxed{\Phi = \int_{-3}^{0} \int_0^2 \vec{D}_s \cdot d\vec{s} = 0}$ equipotential surface, no V, no E, no Q

5.26



$e = 1.8E^{18}\ m^{-3}$ $\quad h = 3E^{18}\ m^{-3}$

$\mu_e = 0.082\ m^2/V\cdot s$ $\quad \mu_h = 0.0021\ m^2/V\cdot s$

$\rho = \frac{1}{q_e}\left(e\mu_e + h\mu_h\right) = 9.225\ E^{-3}$ $\quad R = \rho l/A$

$A = 0.0015 * 0.002$ $\quad l = 0.011$

$\boxed{R = 3666.7\ \Omega}$

5.31 $\quad x=0$ $\quad x>0 \rightarrow \epsilon_{r_1} = 3$ $\quad x<0 \rightarrow \epsilon_{r_2} = 5$ $\quad \vec{E}_1 = 80\hat{a}_x - 60\hat{a}_y - 30\hat{a}_z\ V/m$

a) ① $= E_{N1}$

b) $80\hat{a}_x - 60\hat{a}_y - 30\hat{a}_z = E_{T1}$

c) $80\hat{a}_x - 60\hat{a}_y - 30\hat{a}_z = E_1$

d) $\arctan(0) = 0° = \theta_1$

e) $D_{N_2} = \epsilon_2\epsilon_0 E_{N_2}$ $\quad E_{N_2} = E_{N_1} = 0$ $\quad D_{N_2} = 0$

f) $D_{T_2} = \epsilon_0\epsilon_{r_2}E_{T_2} = 5\epsilon_0\left(80\hat{a}_x - 60\hat{a}_y - 30\hat{a}_z\right)\ C/m^2$

g) $5\epsilon_0\left(80\hat{a}_x - 60\hat{a}_y - 30\hat{a}_z\right)\ C/m^2$

h) $P_2 = P_0\left(\epsilon_{r_2} - 1\right)D_2 = 4D_2 = 20\epsilon_0\left(80\hat{a}_x - 60\hat{a}_y - 30\hat{a}_z\right)\ C/m^2$

i) $\arctan(0) = 0° = \theta_2$