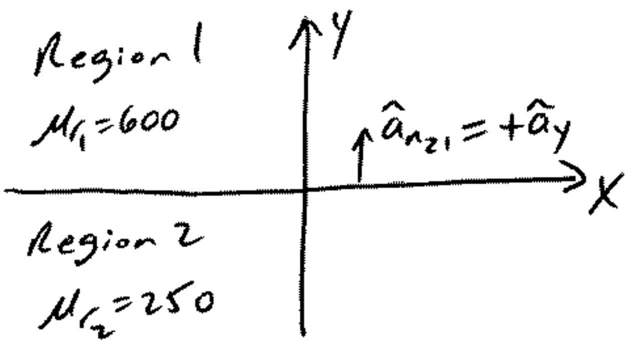
Let region 1 ($y > 0$) be nickel ($\varepsilon_{r1} = 1$, $\mu_{r1} = 600$, $\sigma_1 = 1.43\times10^7$ S/m) while region 2 ($y < 0$) is composed of cobalt ($\varepsilon_{r2} = 1$, $\mu_{r2} = 250$, $\sigma_2 = 1.6\times10^7$ S/m). If a magnetic field $\overline{H}_1 = 200\,\hat{a}_x - 400\,\hat{a}_y - 600\,\hat{a}_z$ (A/m) exists in region 1 near the boundary, find the unknown magnetic field, magnetization & magnetic flux density vectors (e.g., $\overline{M}_1$, $\overline{B}_1$, $\overline{H}_2$, $\overline{M}_2$, & $\overline{B}_2$) on both sides of the boundary. [Note: there is no mention of an impressed surface current.]



$\hat{a}_x$ & $\hat{a}_z$ are tangential

$$\overline{M}_1 = \chi_{m1}\overline{H}_1 = (\mu_{r1}-1)\overline{H}_1 = (600-1)(200\hat{a}_x - 400\hat{a}_y - 600\hat{a}_z)$$

$$\underline{\overline{M}_1 = 119.8\hat{a}_x - 239.6\hat{a}_y - 359.4\hat{a}_z \ (\text{KA/m})}$$

$$\overline{B}_1 = \mu_1\overline{H}_1 = \mu_{r_1}\mu_0\overline{H}_1 = 600(4\pi\times10^{-7})(200\hat{a}_y - 400\hat{a}_y - 600\hat{a}_z)$$

$$\underline{\overline{B}_1 = 0.1508\,\hat{a}_x - 0.3016\,\hat{a}_y - 0.4524\,\hat{a}_z \ (\text{Wb/m}^2)}$$

<u>Normal Boundary Condition</u> $\hat{a}_{n_{21}} \cdot (\overline{B}_2 - \overline{B}_1) = 0$

$$\hat{a}_y \cdot \left[(B_{2x}\hat{a}_x + B_{2y}\hat{a}_y + B_{2z}\hat{a}_z) - (0.1508\hat{a}_x - 0.3016\hat{a}_y - 0.4524\hat{a}_z)\right] = 0$$

$$B_{2y} + 0.3016 = 0 \Rightarrow B_{2y} = -0.3016 \ \text{Wb/m}^2$$

$$H_{2y} = \frac{B_{2y}}{\mu_2} = \frac{-0.3016}{250(4\pi\times10^{-7})} = -960 \ \text{A/m}$$

Tangential Boundary Condition

$$\hat{a}_{n_{21}} \times (\overline{H}_1 - \overline{H}_2) = \overline{J}_s$$

$$\hat{a}_y \times \left[(200\hat{a}_x - 400\hat{a}_y - 600\hat{a}_z) - (H_{2x}\hat{a}_x - 960\hat{a}_y + H_{2z}\hat{a}_z) \right] = 0$$

$$\hat{a}_y \times \left[(200 - H_{2x})\hat{a}_x + (-400 + 960)\hat{a}_y + (-600 - H_{2z})\hat{a}_z \right] = 0$$

$$-\hat{a}_z(200 - H_{2x}) + 0 + \hat{a}_x(-600 - H_{2z}) = 0$$

True if $\rightarrow$ $H_{2x} = 200 \text{ A/m}$ & $H_{2z} = -600 \text{ A/m}$

$$\underline{\underline{\overline{H}_2 = 200\hat{a}_x - 960\hat{a}_y - 600\hat{a}_z \ (\text{A/m})}}$$

$$\overline{M}_2 = \chi_{m2}\overline{H}_2 = (\mu_{r2} - 1)\overline{H}_2 = (250 - 1)(200\hat{a}_x - 960\hat{a}_y - 600\hat{a}_z)$$

$$\underline{\underline{\overline{M}_2 = 49.8\hat{a}_x - 239.04\hat{a}_y - 149.4\hat{a}_z \ (\text{kA/m})}}$$

$$\overline{B}_2 = \mu_2 \overline{H}_2 = 250(4\pi \times 10^{-7})\left[200\hat{a}_x - 960\hat{a}_y - 600\hat{a}_z\right]$$

$$\underline{\underline{\overline{B}_2 = 0.06283\hat{a}_x - 0.3016\hat{a}_y - 0.1885\hat{a}_z \ (\text{Wb/m}^2)}}$$