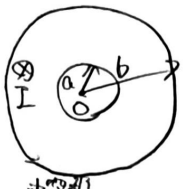
H14 電気磁気学 演習課題 (2024/12/10)

[課題19]

(a) 6.10.



(1) ガウスの法則より.

$$\oint_S B\,dS = 0$$

$$2\pi r = 0$$

したがって

$$B = 0\ [T]$$

(2) 導体部

アンペアの法則より.

$$\oint_C B_s\,ds = \mu_0 \Sigma I_n$$

$$(左辺) = \mu_0 \cdot \frac{I}{b^2\pi - a^2\pi} \cdot (r^2\pi - a^2\pi)$$

$$= \mu_0 I \frac{r^2 - a^2}{b^2 - a^2}$$

$$(右辺) = B \cdot 2\pi r \text{ より}.$$

$$B = \frac{1}{2\pi r} \cdot \mu_0 \cdot I \cdot \frac{r^2 - a^2}{b^2 - a^2}$$

$$= \frac{\mu_0 I (r^2 - a^2)}{2\pi r (b^2 - a^2)}\ [T]$$

(3) 導体外部

アンペアの法則より.

$$\oint B\,ds = \mu_0 \Sigma I_n$$

$$(左辺) = B \cdot 2\pi r$$

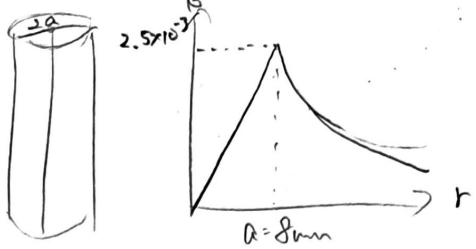
$$(右辺) = \mu_0 I$$

$$(左辺) = (右辺)$$

$$B = \frac{\mu_0 I}{2\pi r}\ [T]$$

$I = 100\ [A]$

(b) $2a = 16\ [mm]$, $\mu_0 = 4\pi \times 10^{-7}\ [H/m]$



$$B = \frac{\mu_0 I}{2\pi r} \text{ より}$$

$$B = \frac{4\pi \times 10^{-7} \cdot 100}{2\pi \cdot 8 \times 10^{-3}}$$

$$= \frac{10^{-2}}{4} = 2.5 \times 10^{-3}$$

H14 電気磁気学 演習課題 (2024/12/24)

[課題20]

(a)

(a1) $B = \frac{\mu_0 NI}{2\pi r}$ [T]

(a2) 6.4

$r = 5\times10^{-2}$, $N = 1200$, $I = 40\times10^{-3}$

(a1)より

$B = \frac{4\pi\times10^{-7}\cdot 1200\cdot 40\times10^{-3}}{2\pi\cdot 5\times10^{-2}}$

$= 4\times10^{-8}\cdot 1200\cdot 4$

$= 19200\times10^{-8} = 1.92\times10^{-4}$ [T]

(a3) $B = \mu_0 nI$ [T]

(a4) 6.5

$n = 50$ 回/cm $= 5000$ 回/m

$I = 25\times10^{-3}$

(a3)より

$B = 4\pi\times10^{-7}\cdot 5000\cdot 25\times10^{-3}$

$= 1.57\times10^{-4}$ [T]

(b)

(b1) $f = IB\sin\theta$ [N/m]

(b2) 6.15

$B = 0.15$, $I = 10$, $\theta = 90°$

(b1)より

$f = 10\cdot 0.15\cdot \sin 90° = 1.5$ [N/m]

$F = 1.5\cdot 30\times10^{-2} = 45\times10^{-2}$ [N]

(b3) $f = \frac{\mu_0 I_1 I_2}{2\pi r}$ [N/m]

(b4) 6.17

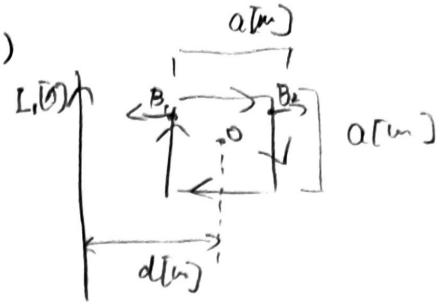
$I_1 = 10$A, $I_2 = 20$A, $r = 10\times10^{-2}$

(b3)より

$f = \frac{4\pi\times10^{-7}\cdot 10\cdot 20}{2\pi\cdot 10\times10^{-2}} = 4\times10^{-4}$ [N/m]

吸引力

(c)



$d = 0.01$, $a = 0.01$

$\mu_0 = 4\pi\times10^{-7}$, $I_1, I_2 = 0.5$

$B_1 = \frac{\mu_0 I}{2\pi r}$ より

$B_1 = \frac{\mu_0 I_1}{2\pi(d-\frac{a}{2})}$

$f_{10} = \frac{\mu_0 I_1 I_2}{2\pi(d-\frac{a}{2})} = \frac{4\pi\times10^{-7}\cdot 0.5\cdot 0.5}{2\pi(0.01-0.005)} = 1\times10^{-5}$ [N/m]

$B_2 = \frac{\mu_0 I_1}{2\pi(d-\frac{a}{2})}$

$f_{20} = \frac{\mu_0 I_1 I_2}{2\pi(d+\frac{a}{2})} = \frac{4\pi\times10^{-7}\cdot 0.5\cdot 0.5}{2\pi(0.01+0.005)} = 3.3\times10^{-6}$ [N/m]

$(f_{10}-f_{20})\cdot a = 6.67\times10^{-8}$ [N]