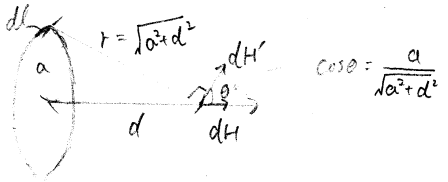
H22

問 2

(1)



$$dH' = \frac{I_1}{4\pi r^2} dl$$

$$H' = \int_0^{2\pi a} \frac{I_1}{4\pi (a^2+d^2)} dl$$

$$= \frac{a I_1}{2(a^2+d^2)}$$

$$H = H' \cos\theta$$

$$= \frac{a^2 I_1}{2(a^2+d^2)^{\frac{3}{2}}}$$

(2)

$$\Phi_{21} = \mu_0 H S$$

$$\Phi_{21} = \frac{\mu_0 a^2 I_1}{2(a^2+d^2)^{\frac{3}{2}}} \pi b^2 \quad [Wb]$$

(3)

$$M I_1 = \Phi_{21}$$

$$M = \frac{\mu_0 a^2 b^2 \pi}{2(a^2+d^2)^{\frac{3}{2}}} \quad [H]$$

(4)

$$\Phi_{12} = M I_2$$

$$= \frac{\mu_0 a^2 b^2 \pi}{2(a^2+d^2)^{\frac{3}{2}}} I_2$$

(5)

$$F = \frac{\partial M}{\partial d} I_1 I_2$$

$$= -\frac{\mu_0 a^2 b^2 \pi \cdot \frac{3}{2}(a^2+d^2)^{\frac{1}{2}} 2d}{2(a^2+d^2)^3} I_1 I_2$$

$$= -\frac{3\mu_0 a^2 b^2 \pi d}{2(a^2+d^2)^{\frac{5}{2}}} I_1 I_2 \quad [N]$$

$F < 0$ より x 軸負の方向