

HI4 電氣磁気学 演習課題 (2024/10/8)

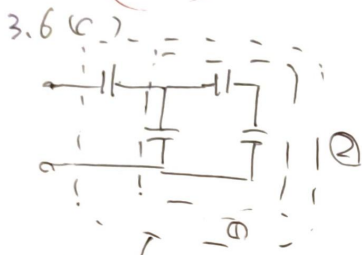
[課題13]

(a) 3.6(a)

$$\frac{1}{0.1+0.2} + \frac{1}{0.4+0.3} = 0.21 [\mu F]$$

3.6 (b)

$$\frac{1}{(\frac{1}{0.5} + \frac{1}{0.5})} + \frac{1}{(\frac{1}{0.5} + \frac{1}{0.5})} = 0.5 [\mu F]$$



① $\left(\frac{1}{100} + \frac{1}{100} \right) + 100 = 150$

② $\frac{1}{150} + \frac{1}{100} = 60 [pF]$

(b) (b1)

$$W = \frac{1}{2} C V^2$$

(b2)

$$W = \frac{1}{2} \cdot 2 \times 10^{-8} \cdot (10^3)^2 = 1 [J]$$

(c) $W = \frac{1}{2} C V^2$

$$1 = \frac{1}{2} C \cdot (5 \times 10^4)^2$$

$$1 = \frac{1}{2} C \cdot 25 \times 10^8$$

$$\frac{2}{25 \times 10^8} = C$$

$$C = \frac{2}{25 \times 10^8}$$

$$= \frac{2}{25} \times 10^{-8}$$

$$C = 8 \times 10^{-6} = 8 [\mu F]$$

(d) (d1) $C = C_1 + C_2 [F]$

(d2) $Q = C V$

$$Q = C_1 V_1 + C_2 V_2 [C]$$

(d3) $W_1 = \frac{1}{2} C_1 V_1^2, W_2 = \frac{1}{2} C_2 V_2^2$

$$W = W_1 + W_2 = \frac{1}{2} (C_1 V_1^2 + C_2 V_2^2) [J]$$

(d4) $W = \frac{1}{2} \frac{Q^2}{C}, (d1), (d2) \text{ 用}$

$$W = \frac{1}{2} \frac{C_1 V_1 + C_2 V_2}{C_1 + C_2} = \frac{C_1 V_1 + C_2 V_2}{2(C_1 + C_2)} [J]$$

[課題 14]

(a) $\epsilon = \epsilon_0 \epsilon_r \epsilon_0$

$F = \frac{Q_1 Q_2}{4\pi \epsilon_0 \epsilon_r r^2} [N]$

(b) (b1)

$C_0 = \frac{\epsilon_0 S}{d} = \frac{8.85 \times 10^{-12} \cdot \pi \cdot (5 \times 10^{-3})^2}{1 \times 10^{-3}}$

$= 6.95 \times 10^{-11} [F]$

(b2)

$C = \frac{\epsilon_0 \epsilon_r S}{d} = 6.95 \times 10^{-11} \cdot \epsilon_r [F]$

(b3) C の値は 2.80

(b4)

$C - C_0 = 125 \times 10^{-12}$

$6.95 \times 10^{-11} \epsilon_r - 6.95 \times 10^{-11} = 125 \times 10^{-12}$

$6.95 \times 10^{-11} \epsilon_r = 125 \times 10^{-12} + 6.95 \times 10^{-11}$

$\epsilon_r = \frac{125 \times 10^{-12} + 6.95 \times 10^{-11}}{6.95 \times 10^{-11}}$

$= 2.80$

(c) (c1)

$d = \frac{50 \times 10^{-9}}{5 \times 10^8} = 1.0 [nm]$

(c2)

$C = \epsilon_0 \epsilon_r \frac{S}{d} [F]$

(c3) $S = \frac{Cd}{\epsilon_0 \epsilon_r}$

$= \frac{250 \times 10^{-12} \cdot 10 \times 10^{-3}}{8.85 \times 10^{-12} \cdot 4.2}$

$= 0.0672 \dots$

$= 6.7 \times 10^{-2} [m^2]$

(d)

$E_0 = \frac{Q}{\epsilon_0 S}$

$E = \frac{Q}{\epsilon_0 \epsilon_r S} \epsilon_r$

$Q = E_0 \epsilon_0 S = \epsilon_0 \epsilon_r S E$

$E_0 = \epsilon_r E$

$E = \frac{E_0}{\epsilon_r}$