H14 電気磁気学 演習課題 (2024/10/8)

[課題 3]

(a) 3.6(a)

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

3.6(b)

$$\frac{1}{\left(\frac{1}{0.5}+\frac{1}{0.5}\right)+\left(\frac{1}{0.5}+\frac{1}{0.5}\right)}$$

$$=0.5\ [\mu F]$$

3.6(c)

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

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

(b)(b1) $W=\frac{1}{2}CV^2$

(b2) $W=\frac{1}{2}\cdot 2\times10^{-6}\cdot(10^3)^2$

$=1\ [J]$

(c) $W=\frac{1}{2}CV^2$ より.

$1=\frac{1}{2}C\cdot(5\times10^2)^2$

$1=\frac{1}{2}C\cdot 25\times10^4$

$\frac{2}{25\times10^4}=C$

$C=\frac{2}{25}\times10^{-4}$

$C=8\times10^{-6}$

$=8\ [\mu F]$

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

(d2) $Q=CV$ より.

$Q=C_1V_1+C_2V_2\ [C]$

(d3) $W_1=\frac{1}{2}C_1V_1^2$, $W_2=\frac{1}{2}C_2V_2^2$ より,

$W=W_1+W_2=\frac{1}{2}(C_1V_1^2+C_2V_2^2)\ [J]$

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

$W=\frac{1}{2}\frac{C_1V_1+C_2V_2}{C_1+C_2}$

$=\frac{C_1V_1+C_2V_2}{2(C_1+C_2)}\ [J]$

H14 電気磁気学 演習課題 (2024/10/15)

[課題 14]

(a) $\varepsilon = \varepsilon_0 \varepsilon_r$ より,

$$F = \frac{Q_1 Q_2}{4\pi \varepsilon_0 \varepsilon_r r^2} \ [\mathrm{N}]$$

(b) (b1)

$$C_0 = \frac{\varepsilon_0 S}{d} = \frac{8.85\times10^{-12}\cdot\pi\cdot(5\times10^{-2})^2}{1\times10^{-3}}$$

$$= 6.95\times10^{-11} \ [\mathrm{F}]$$

(b2)

$$C = \frac{\varepsilon_0 \varepsilon_r S}{d} = 6.95\times10^{-11}\cdot\varepsilon_r \ [\mathrm{F}]$$

(b3) Cの方が大きい.

(b4)

$$C - C_0 = 125\times10^{-12}$$

$$6.95\times10^{-11}\varepsilon_r - 6.95\times10^{-11} = 125\times10^{-12}$$

$$6.95\times10^{-11}\varepsilon_r = 125\times10^{-12} + 6.95\times10^{-11}$$

$$\varepsilon_r = \frac{125\times10^{-12} + 6.95\times10^{-11}}{6.95\times10^{-11}}$$

$$= 2.80$$

(c) (c1)

$$d = \frac{5.0\times10^{-3}}{5\times10^{-3}} = 1.0 \ [\mathrm{mm}]$$

(c2)

$$C = \varepsilon_0 \varepsilon_r \frac{S}{d} \ [\mathrm{F}]$$

(c3)

$$S = \frac{Cd}{\varepsilon_0 \varepsilon_r}$$

$$= \frac{2.50\times10^{-12}\cdot 1.0\times10^{-3}}{8.85\times10^{-12}\cdot 4.2}$$

$$= 0.0672\cdots$$

$$= 6.7\times10^{-2} \ [\mathrm{m^2}]$$

(d)

$$E_0 = \frac{Q}{\varepsilon_0 S}$$

$$E = \frac{Q}{\varepsilon_0 \varepsilon_r S} \text{ より.}$$

$$Q = E_0 \varepsilon_0 S = E \varepsilon_0 \varepsilon_r S$$

$$E_0 = \varepsilon_r E$$

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