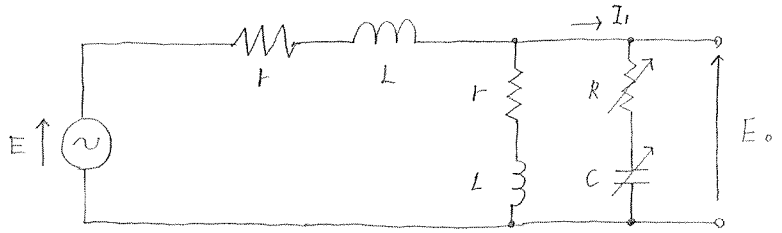
No.

Date

平成16年　交流回路・アナログ電子回路

問1



(1)　$E = (r + j\omega L) I + E_0$

$E_0 = \left(R + \frac{1}{j\omega C}\right) I_1$

$I = I_1 + \frac{E_0}{r + j\omega L}$

$\therefore \quad E = (r + j\omega L)\left(\frac{E_0}{R + \frac{1}{j\omega C}} + \frac{E_0}{r + j\omega L}\right) + E_0 = \frac{r + j\omega L}{R + \frac{1}{j\omega C}} E_0 + 2E_0$

$= \frac{-\omega^2 CL + j r\omega C}{1 + jR\omega C} E_0 + 2E_0 = \frac{E_0}{1 + jR\omega C}\{2 - \omega^2 CL + j(r\omega C + 2R\omega C)\}$

$\therefore \left|\frac{E_0}{E}\right| = \frac{\sqrt{1 + R^2\omega^2 C^2}}{\sqrt{(2 - \omega^2 CL)^2 + \omega^2 C^2 (r + 2R)^2}}$

(2)　$I_1 = \frac{E_0 j\omega C}{1 + jR\omega C}$

$|I_1| = \frac{|E_0|\omega C}{\sqrt{1 + R^2\omega^2 C^2}} = \frac{\omega C}{\sqrt{1 + R^2\omega^2 C^2}} \cdot \frac{\sqrt{1 + R^2\omega^2 C^2} \cdot |E|}{\sqrt{(2 - \omega^2 CL)^2 + \omega^2 C^2 (r + 2R)^2}}$

$= \frac{\omega C |E|}{\sqrt{(2 - \omega^2 CL)^2 + \omega^2 C^2 (r + 2R)^2}} = \frac{|E|}{\sqrt{\left(\frac{2}{\omega C} - \omega L\right)^2 + (r + 2R)^2}}$

(3)　$E = (r + j\omega L)\left(I_1 + \frac{1}{r + j\omega L} E_0\right)$

$= (r + j\omega L)\left\{I_1 + \frac{1}{r + j\omega L}\left(R + \frac{1}{j\omega C}\right) I_1\right\} = I_1\left(r + j\omega L + R + \frac{1}{j\omega C}\right)$

$= I_1\left\{r + R + j\left(\omega L - \frac{1}{\omega C}\right)\right\}$

同位相より虚部0となるので　$\omega L - \frac{1}{\omega C} = 0$

$\therefore \quad C = \frac{1}{\omega^2 L}$

(4)　$P = R \cdot |I_1|^2$

$= \frac{R E^2}{\left(\frac{2}{\omega C} - \omega L\right)^2 + (r + 2R)^2}$

分母が最小の時 P 最大より　$\frac{2}{\omega C} = \omega L \rightarrow C = \frac{1}{\omega^2 L}$

また　$\frac{r^2}{R} + 4r + 4R$ を y とおくと

$y' = -\frac{r^2}{R^2} + 4 = 0$ の時の R は　$4 = \frac{r^2}{R^2} \rightarrow R = \frac{r}{2}$

このとき P は最大となる。

$\therefore \quad C = \frac{1}{\omega^2 L}, \quad R = \frac{r}{2}$