5.6 章末問題解答

5.1

(1)

$$
\begin{aligned}
|1-j3| &= \sqrt{10}, \\
1-j3 &= \sqrt{10}(\cos 71.6^\circ - j\sin 71.6^\circ)
\end{aligned}
$$

(2)

$$
\begin{aligned}
\left|\frac{1+j}{1-j}\right| &= 1, \\
\frac{1+j}{1-j} &= 1(\cos 90^\circ + j\sin 90^\circ)
\end{aligned}
$$

(3)

$$
\begin{aligned}
\left|\frac{c+jd}{a+jb}\right| &= \sqrt{\frac{c^2+d^2}{a^2+b^2}}, \\
\frac{c+jd}{a+jb} &= \sqrt{\frac{c^2+d^2}{a^2+b^2}}\left\{\cos\left(\tan^{-1}\frac{ad-bc}{ac+bd}\right) + j\sin\left(\tan^{-1}\frac{ad-bc}{ac+bd}\right)\right\}
\end{aligned}
$$

5.2

$\theta = 54.2^\circ$

ベクトル図は省略

5.3

(1)

$$10\angle 60^\circ = 5 + j5\sqrt{3}$$

(2)

$$16\angle 210^\circ = -8\sqrt{3} - j8$$

5.4

(1)

$$\dot{z}_1 \cdot \dot{z}_2 = j600$$

(2)

$$\dot{z}_1^3 = -1000$$

(3)

$$\frac{\dot{z}_1}{\dot{z}_2} = \frac{\sqrt{3}}{12} + j\frac{1}{12}$$

5.5

（省略）

5.6

(a)

$$\dot{I}_1 = 10\angle 53.1^\circ,\ \ I_1 = 10\ [\mathrm{A}]$$
$$\dot{I}_2 = 5,\ \ I_2 = 5\ [\mathrm{A}]$$
$$\dot{I} = 11 + j8 = 13.6\angle 36.0^\circ,\ \ I = 13.6\ [\mathrm{A}]$$

(b)

$$P = 550\ [\mathrm{W}]$$

5.7

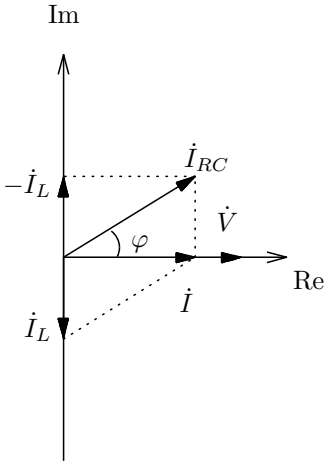

図 1　問題 5.7(a) のベクトル図

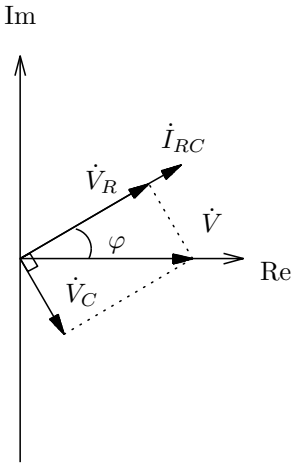

図 2　問題 5.7(b) のベクトル図

5.8

$$R = 17.3\ [\Omega],\ C = 318\ [\mu F]$$

5.9

(a)

$$\dot{Y} = 0.053\varepsilon^{j30^\circ}$$

(b) 抵抗とキャパシタの並列回路であり，

$$R = 21.8\ [\Omega],\ C = 70.3\ [\mu F]$$

5.10

$$\dot{Z} = 5 + j9.32,\ |\dot{Z}| = 10.6$$

5.11

(a)

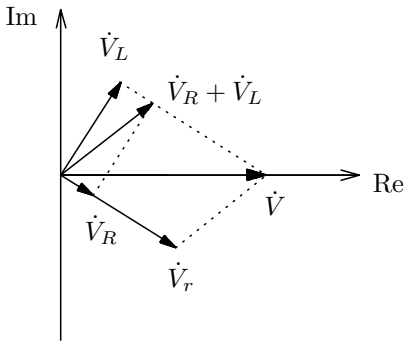

図 3　問題 5.11 のベクトル図

(b)

$$R = 4.93\ [\Omega],\ \ X_L = 10.1\ [\Omega]$$

5.12

(a)

$$\dot{I} = 20\angle 36.86^\circ$$

(b)

$$\dot{V}_1 = 80\angle 36.86^\circ$$
$$\dot{V}_2 = 60\angle 126.96^\circ$$
$$\dot{V}_3 = 120\angle -53.1^\circ$$

5.13

(a)

$$\dot{I}_1 = 5$$
$$\dot{I}_2 = 10\angle -53.13^\circ$$
$$\dot{I}_3 = 5\angle 36.86^\circ$$
$$\dot{I} = \dot{I}_1 + \dot{I}_2 + \dot{I}_3 = 15.8\angle -18.4^\circ$$

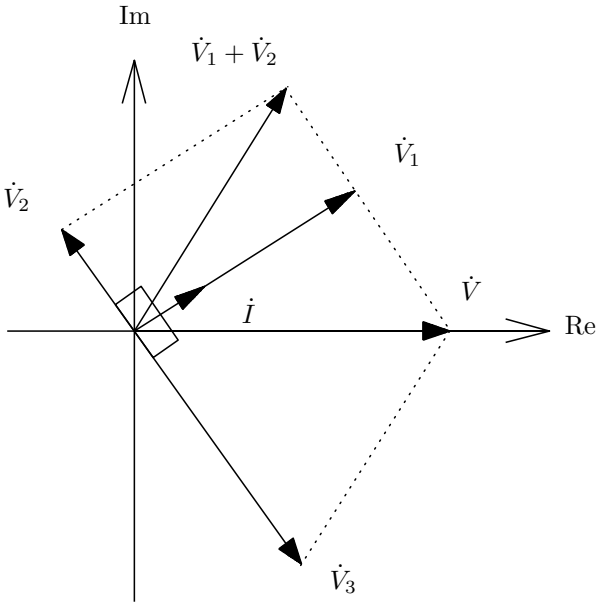

図 4　問題 5.12 のベクトル図

(b)

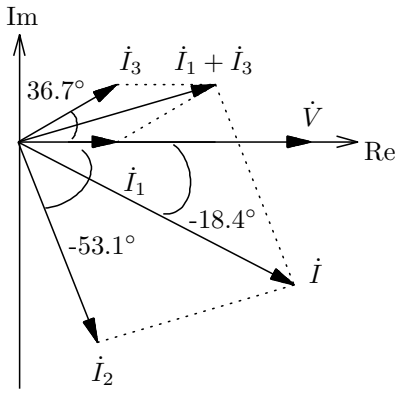

図 5　問題 5.13 のベクトル図

5.14

$$\dot{Z} = 5 + j9.3$$

5.15

$$|\dot{I}| = 20.6 \text{ [A]}$$

5.16

$$P = \frac{1}{T}\int_0^T \sqrt{2}V\sin\omega t \cdot \sqrt{2}I\sin(\omega t+\varphi)dt = VI\cos\varphi$$

5.17

$$I = \sqrt{\frac{1}{T}\int_0^T i^2(t)dt} = \sqrt{\frac{{I_m}^2}{T}\int_0^T \sin^2(\omega t+\varphi)dt} = \sqrt{\frac{{I_m}^2}{2}},\ \ \rightarrow I_m = \sqrt{2}I$$

5.18

(a)

$$P = \frac{R}{R^2 + \left(\frac{1}{\omega C}\right)^2}V^2$$

(b)

$$P = \frac{V^2}{R}$$

5.19

(a)

$$\dot{I}_L = \frac{\dot{V}}{r+j\omega L},\ \ \dot{I}_C = j\omega C\dot{V}$$
$$\dot{I} = \dot{I}_L + \dot{I}_C = \left(\frac{1}{r+j\omega L} + j\omega C\right)\dot{V}$$

(b)

$$\cos\varphi = \frac{r}{\sqrt{r^2+\omega^2\{L(1-\omega^2 LC)-r^2C\}^2}}$$

(c)

$$r = \sqrt{\frac{L(1-\omega^2 LC)}{C}}$$

5.20

$$R_L = \sqrt{r^2+(\omega L)^2}$$

5.21

$$R_L = 10.0\ [\Omega],\ \ |\dot{I}_R| = 5.0\ [\mathrm{A}],\ \ P = 250.0\ [\mathrm{W}]$$

5.22

$$f = 116.0 \text{ [Hz]}$$

5.23

$$R = 20.0 \text{ [}\Omega\text{]}$$

5.24

$$\omega = \frac{1}{\sqrt{LC}}$$

5.25

(a)

$$\dot{I} = \frac{\dot{V}}{(r + jx)(1 - \omega^2 CL) + j\omega L} = \frac{\dot{V}}{r\left(1 - \omega^2 LC\right) + j\left\{x\left(1 - \omega^2 LC\right) + \omega L\right\}}$$

(b)

$$\omega = \frac{1}{\sqrt{LC}}, \quad |\dot{I}| = \frac{|\dot{V}|}{\omega L} = \sqrt{\frac{C}{L}}|\dot{V}|$$