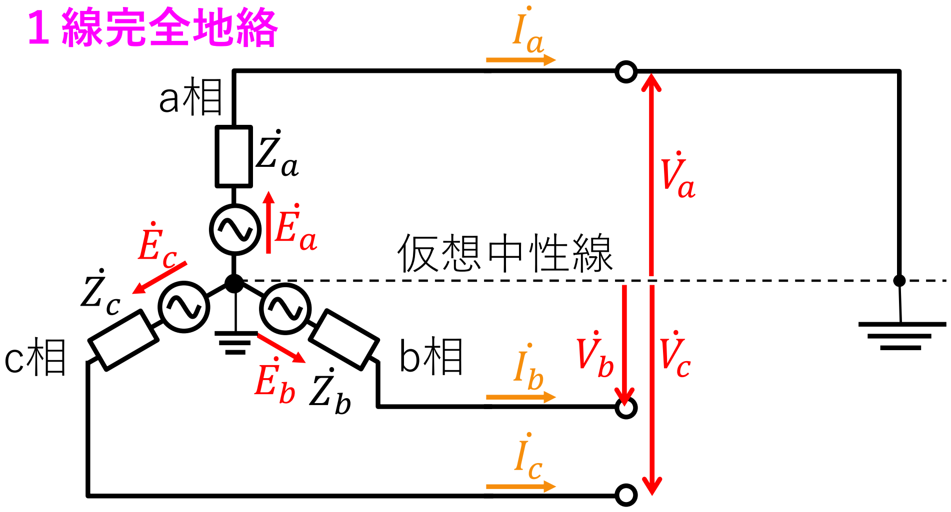
対称座標法（2）《無負荷発電機の地絡計算１》

１線完全地絡



回路条件

$\dot{V}_a = 0$ …①

$\dot{I}_b = \dot{I}_c = 0$ …②

求める値

$\dot{V}_b$，　$\dot{V}_c$，　$\dot{I}_a$

②,③,④,⑤より　$\dot{I}_0 = \dot{I}_1 = \dot{I}_2$ …⑥

⑦に①,⑥,⑧,⑨,⑩を代入　$\dot{V}_a = -\dot{Z}_0\dot{I}_0 + \dot{E}_a - \dot{Z}_1\dot{I}_1 - \dot{Z}_2\dot{I}_2 = \dot{E}_a - (\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2)\dot{I}_0 = 0$

$$\dot{I}_0 = \frac{\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2} \quad \cdots ⑪$$

⑫に⑥,⑪を代入　$\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = \dfrac{3\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2}$

⑬に,⑥,⑧,⑨,⑩,⑪を代入　$\dot{V}_b = \dfrac{(a^2-1)\dot{Z}_0 + (a^2 - a)\dot{Z}_2}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2}\dot{E}_a$

⑭に,⑥,⑧,⑨,⑩,⑪を代入　$\dot{V}_c = \dfrac{(a-1)\dot{Z}_0 + (a - a^2)\dot{Z}_2}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2}\dot{E}_a$

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots ⑧ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots ⑨ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots ⑩ \end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots ⑦ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots ⑬ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots ⑭ \end{cases}$$

$$\begin{cases} \dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c) \end{cases}$$

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots ⑫ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 \end{cases}$$

$$\begin{cases} \dot{I}_0 = \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) & \cdots ③ \\ \dot{I}_1 = \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) & \cdots ④ \\ \dot{I}_2 = \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) & \cdots ⑤ \end{cases}$$

対称座標法（2）　**1線完全地絡の計算**

$\dot{V}_a = 0$ …①

$\dot{I}_b = \dot{I}_c = 0$ …②

②,③,④,⑤より、

$$\left.\begin{aligned}\dot{I}_0 &= \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) = \frac{1}{3}\dot{I}_a \\ \dot{I}_1 &= \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) = \frac{1}{3}\dot{I}_a \\ \dot{I}_2 &= \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) = \frac{1}{3}\dot{I}_a\end{aligned}\right\} \dot{I}_0 = \dot{I}_1 = \dot{I}_2 \quad \cdots⑥$$

⑦に①,⑥,⑧,⑨,⑩を代入

$$\dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 = -\dot{Z}_0\dot{I}_0 + \dot{E}_a - \dot{Z}_1\dot{I}_1 - \dot{Z}_2\dot{I}_2$$
$$= \dot{E}_a - (\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2)\dot{I}_0 = 0$$

$$\dot{I}_0 = \frac{\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2} \quad \cdots⑪$$

⑫に⑥,⑪を代入

$$\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = \frac{3\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2}$$

⑬に,⑥,⑧,⑨,⑩,⑪を代入

$$\dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2$$
$$= -\dot{Z}_0\dot{I}_0 + a^2(\dot{E}_a - \dot{Z}_1\dot{I}_0) - a\dot{Z}_2\dot{I}_0$$
$$= a^2\dot{E}_a - (\dot{Z}_0 + a^2\dot{Z}_1 + a\dot{Z}_2)\dot{I}_0$$
$$= \frac{a^2(\dot{Z}_0+\dot{Z}_1+\dot{Z}_2)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2}\dot{E}_a - \frac{(\dot{Z}_0+a^2\dot{Z}_1+a\dot{Z}_2)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2}\dot{E}_a$$
$$= \frac{(a^2-1)\dot{Z}_0 + (a^2 - a)\dot{Z}_2}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2}\dot{E}_a$$

⑭に,⑥,⑧,⑨,⑩,⑪を代入

$$\dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2$$
$$= -\dot{Z}_0\dot{I}_0 + a(\dot{E}_a - \dot{Z}_1\dot{I}_0) - a^2\dot{Z}_2\dot{I}_0$$
$$= a\dot{E}_a - (\dot{Z}_0 + a\dot{Z}_1 + a^2\dot{Z}_2)\dot{I}_0$$
$$= \frac{a(\dot{Z}_0+\dot{Z}_1+\dot{Z}_2)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2}\dot{E}_a - \frac{(\dot{Z}_0+a\dot{Z}_1+a^2\dot{Z}_2)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2}\dot{E}_a$$
$$= \frac{(a - 1)\dot{Z}_0 + (a - a^2)\dot{Z}_2}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2}\dot{E}_a$$

発電機の基本式

$$\begin{cases}\dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots⑧ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots⑨ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots⑩\end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases}\dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots⑦ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots⑬ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots⑭\end{cases}$$

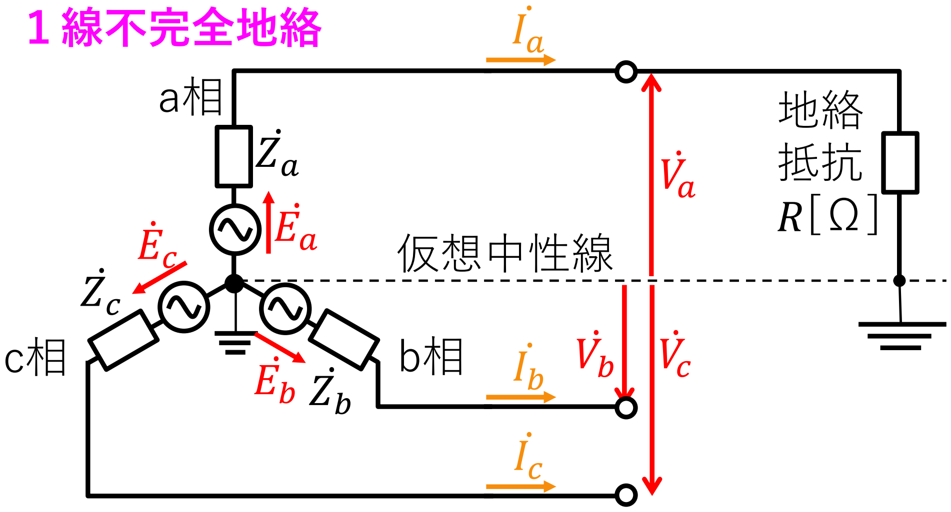
$$\begin{cases}\dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c)\end{cases}$$

$$\begin{cases}\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots⑫ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2\end{cases}$$

$$\begin{cases}\dot{I}_0 = \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) & \cdots③ \\ \dot{I}_1 = \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) & \cdots④ \\ \dot{I}_2 = \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) & \cdots⑤\end{cases}$$

対称座標法（２）《無負荷発電機の地絡計算２》

１線不完全地絡



回路条件

$\dot{V}_a = R\dot{I}_a$ …①

$\dot{I}_b = \dot{I}_c = 0$ …②

②,③,④,⑤より、$\dot{I}_0 = \dot{I}_1 = \dot{I}_2$ …⑥

⑦に①,⑥,⑧,⑨,⑩を代入 $\dot{V}_a = -\dot{Z}_0\dot{I}_0 + \dot{E}_a - \dot{Z}_1\dot{I}_1 - \dot{Z}_2\dot{I}_2 = \dot{E}_a - (\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2)\dot{I}_0 = 3R\dot{I}_0$

$$\dot{I}_0 = \frac{\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R} \cdots ⑪$$

⑫に⑥,⑪を代入 $\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = \dfrac{3\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R}$

⑬に,⑥,⑧,⑨,⑩,⑪を代入 $\dot{V}_b = \dfrac{(a^2-1)\dot{Z}_0 + (a^2 - a)\dot{Z}_2 + 3a^2R}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R}\dot{E}_a$

⑭に,⑥,⑧,⑨,⑩,⑪を代入 $\dot{V}_c = \dfrac{(a-1)\dot{Z}_0 + (a - a^2)\dot{Z}_2 + 3aR}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R}\dot{E}_a$

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots ⑧ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots ⑨ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots ⑩ \end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots ⑦ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots ⑬ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots ⑭ \end{cases}$$

$$\begin{cases} \dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c) \end{cases}$$

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots ⑫ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 \end{cases}$$

$$\begin{cases} \dot{I}_0 = \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) & \cdots ③ \\ \dot{I}_1 = \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) & \cdots ④ \\ \dot{I}_2 = \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) & \cdots ⑤ \end{cases}$$

対称座標法（２）　**１線不完全地絡の計算**

$\dot{V}_a = R\dot{I}_a$ …①

$\dot{I}_b = \dot{I}_c = 0$ …②

②,③,④,⑤より、

$$\left.\begin{aligned}\dot{I}_0 &= \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) = \frac{1}{3}\dot{I}_a \\ \dot{I}_1 &= \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) = \frac{1}{3}\dot{I}_a \\ \dot{I}_2 &= \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) = \frac{1}{3}\dot{I}_a\end{aligned}\right\} \dot{I}_0 = \dot{I}_1 = \dot{I}_2 \cdots⑥$$

⑦に①,⑥,⑧,⑨,⑩を代入

$$\dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 = -\dot{Z}_0\dot{I}_0 + \dot{E}_a - \dot{Z}_1\dot{I}_1 - \dot{Z}_2\dot{I}_2$$

$$= \dot{E}_a - (\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2)\dot{I}_0 = R\dot{I}_a = 3R\dot{I}_0$$

$R\dot{I}_a = \mathrm{R}(\dot{I}_0 + \dot{I}_1 + \dot{I}_2) = 3R\dot{I}_a$

⑫

$$\dot{I}_0 = \frac{\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R} \cdots⑪$$

⑫に⑥,⑪を代入

$$\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = \frac{3\dot{E}_a}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R}$$

⑬に,⑥,⑧,⑨,⑩,⑪を代入

$$\dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2$$

$$= -\dot{Z}_0\dot{I}_0 + a^2(\dot{E}_a - \dot{Z}_1\dot{I}_0) - a\dot{Z}_2\dot{I}_0$$

$$= a^2\dot{E}_a - (\dot{Z}_0 + a^2\dot{Z}_1 + a\dot{Z}_2)\dot{I}_0$$

$$= \frac{a^2(\dot{Z}_0+\dot{Z}_1+\dot{Z}_2+3R)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2+3R}\dot{E}_a - \frac{(\dot{Z}_0+a^2\dot{Z}_1+a\dot{Z}_2)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2+3R}\dot{E}_a$$

$$= \frac{(a^2-1)\dot{Z}_0 + (a^2 - a)\dot{Z}_2 + 3a^2R}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R}\dot{E}_a$$

⑭に,⑥,⑧,⑨,⑩,⑪を代入

$$\dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2$$

$$= -\dot{Z}_0\dot{I}_0 + a(\dot{E}_a - \dot{Z}_1\dot{I}_0) - a^2\dot{Z}_2\dot{I}_0$$

$$= a\dot{E}_a - (\dot{Z}_0 + a\dot{Z}_1 + a^2\dot{Z}_2)\dot{I}_0$$

$$= \frac{a(\dot{Z}_0+\dot{Z}_1+\dot{Z}_2+3R)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2+3R}\dot{E}_a - \frac{(\dot{Z}_0+a\dot{Z}_1+a^2\dot{Z}_2)}{\dot{Z}_0+\dot{Z}_1+\dot{Z}_2+3R}\dot{E}_a$$

$$= \frac{(a-1)\dot{Z}_0 + (a - a^2)\dot{Z}_2 + 3aR}{\dot{Z}_0 + \dot{Z}_1 + \dot{Z}_2 + 3R}\dot{E}_a$$

発電機の基本式

$$\begin{cases}\dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots⑧ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots⑨ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots⑩\end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases}\dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots⑦ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots⑬ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots⑭\end{cases}$$

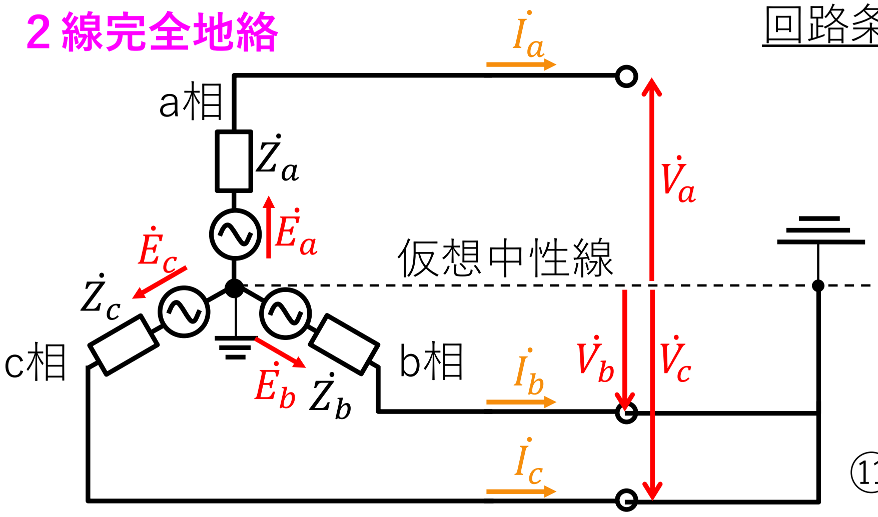
$$\begin{cases}\dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c)\end{cases}$$

$$\begin{cases}\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots⑫ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2\end{cases}$$

$$\begin{cases}\dot{I}_0 = \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) & \cdots③ \\ \dot{I}_1 = \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) & \cdots④ \\ \dot{I}_2 = \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) & \cdots⑤\end{cases}$$

対称座標法（2）《無負荷発電機の地絡計算３》

2線完全地絡



回路条件　$\dot{V}_b = \dot{V}_c = 0$ ⋯①　$\dot{I}_a = 0$ ⋯②

①,③,④より、$\dot{V}_0 = \dot{V}_1 = \dot{V}_2$ ⋯⑤

⑥に②,⑤,⑦,⑧,⑨を代入

$$\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = -\frac{\dot{V}_0}{\dot{Z}_0} + \frac{\dot{E}_a - \dot{V}_0}{\dot{Z}_1} - \frac{\dot{V}_0}{\dot{Z}_2} = 0$$

$$\dot{V}_0 = \frac{\dot{Z}_0\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a = \dot{V}_1 = \dot{V}_2 \quad \cdots⑩$$

⑪に⑩を代入 $\dot{V}_a = \dfrac{3\dot{Z}_0\dot{Z}_2}{\dot{Z}_0\dot{Z}_1 + \dot{Z}_1\dot{Z}_2 + \dot{Z}_0\dot{Z}_2}\dot{E}_a$

⑦,⑩より

$$\dot{I}_0 = -\frac{\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a \cdots⑫$$

⑧,⑩より

$$\dot{I}_1 = \frac{\dot{Z}_0+\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a \cdots⑬$$

⑨,⑩より

$$\dot{I}_2 = -\frac{\dot{Z}_0}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a \cdots⑭$$

⑮に⑫,⑬,⑭を代入　$\dot{I}_b = \dfrac{(a^2 - a)\dot{Z}_0 + (a^2 - 1)\dot{Z}_2}{\dot{Z}_0\dot{Z}_1 + \dot{Z}_1\dot{Z}_2 + \dot{Z}_0\dot{Z}_2}\dot{E}_a$

⑯に⑫,⑬,⑭を代入　$\dot{I}_c = \dfrac{(a - a^2)\dot{Z}_0 + (a - 1)\dot{Z}_2}{\dot{Z}_0\dot{Z}_1 + \dot{Z}_1\dot{Z}_2 + \dot{Z}_0\dot{Z}_2}\dot{E}_a$

なお、$\dot{I}_b + \dot{I}_c = 3\dot{I}_0$となる

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots⑦ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots⑧ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots⑨ \end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots⑪ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots③ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots④ \end{cases}$$

$$\begin{cases} \dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c) \end{cases}$$

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots⑥ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 & \cdots⑮ \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 & \cdots⑯ \end{cases}$$

$$\begin{cases} \dot{I}_0 = \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) \\ \dot{I}_1 = \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) \\ \dot{I}_2 = \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) \end{cases}$$

対称座標法（２）　**2線完全地絡の計算**

$\dot{V}_b=\dot{V}_c=0$ …①　　$\dot{I}_a=0$ …②

①より $\dot{V}_b-\dot{V}_c=0$ に,③,④を代入

$$\dot{V}_0+a^2\dot{V}_1+a\dot{V}_2-(\dot{V}_0+a\dot{V}_1+a^2\dot{V}_2)=0$$

$$(a^2-a)(\dot{V}_1-\dot{V}_2)=0$$

$a^2-a\neq 0$ より $\dot{V}_1=\dot{V}_2$

③より $\dot{V}_b=\dot{V}_0+(a^2+a)\dot{V}_1=0$

$a^2+a=-1$ より $\dot{V}_0=\dot{V}_1=\dot{V}_2$ …⑤

⑥に②,⑦,⑧,⑨を代入

$$\dot{I}_a=\dot{I}_0+\dot{I}_1+\dot{I}_2=-\frac{\dot{V}_0}{\dot{Z}_0}+\frac{\dot{E}_a-\dot{V}_0}{\dot{Z}_1}-\frac{\dot{V}_0}{\dot{Z}_2}=0$$

$$\frac{\dot{E}_a}{\dot{Z}_1}-\left(\frac{1}{\dot{Z}_0}+\frac{1}{\dot{Z}_1}+\frac{1}{\dot{Z}_2}\right)\dot{V}_0=0$$

$$\dot{V}_0=\frac{\dot{Z}_0\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a=\dot{V}_1=\dot{V}_2 \quad \cdots\text{⑩}$$

⑪に⑩を代入 $\dot{V}_a=\dot{V}_0+\dot{V}_1+\dot{V}_2=3\dot{V}_0$

$$=\frac{3\dot{Z}_0\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$$

⑦,⑩より $\dot{I}_0=-\frac{\dot{V}_0}{\dot{Z}_0}=-\frac{\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$ …⑫

⑧,⑩より $\dot{I}_1=\frac{\dot{E}_a-\dot{V}_0}{\dot{Z}_1}=\frac{\dot{Z}_0+\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$ …⑬

⑨,⑩より $\dot{I}_2=-\frac{\dot{V}_0}{\dot{Z}_2}=-\frac{\dot{Z}_0}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$ …⑭

⑮に⑫,⑬,⑭を代入

$$\dot{I}_b=\dot{I}_0+a^2\dot{I}_1+a\dot{I}_2=\frac{-\dot{Z}_2+a^2(\dot{Z}_0+\dot{Z}_2)-a\dot{Z}_0}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$$

$$=\frac{(a^2-a)\dot{Z}_0+(a^2-1)\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$$

⑯に⑫,⑬,⑭を代入

$$\dot{I}_c=\dot{I}_0+a\dot{I}_1+a^2\dot{I}_2=\frac{-\dot{Z}_2+a(\dot{Z}_0+\dot{Z}_2)-a^2\dot{Z}_0}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$$

$$=\frac{(a-a^2)\dot{Z}_0+(a-1)\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a$$

なお、$\dot{I}_b+\dot{I}_c=\frac{-3\dot{Z}_2}{\dot{Z}_0\dot{Z}_1+\dot{Z}_1\dot{Z}_2+\dot{Z}_0\dot{Z}_2}\dot{E}_a=3\dot{I}_0$

発電機の基本式

$$\begin{cases}\dot{V}_0=-\dot{Z}_0\dot{I}_0 & \cdots\text{⑦}\\ \dot{V}_1=\dot{E}_a-\dot{Z}_1\dot{I}_1 & \cdots\text{⑧}\\ \dot{V}_2=-\dot{Z}_2\dot{I}_2 & \cdots\text{⑨}\end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases}\dot{V}_a=\dot{V}_0+\dot{V}_1+\dot{V}_2 & \cdots\text{⑪}\\ \dot{V}_b=\dot{V}_0+a^2\dot{V}_1+a\dot{V}_2 & \cdots\text{③}\\ \dot{V}_c=\dot{V}_0+a\dot{V}_1+a^2\dot{V}_2 & \cdots\text{④}\end{cases}$$

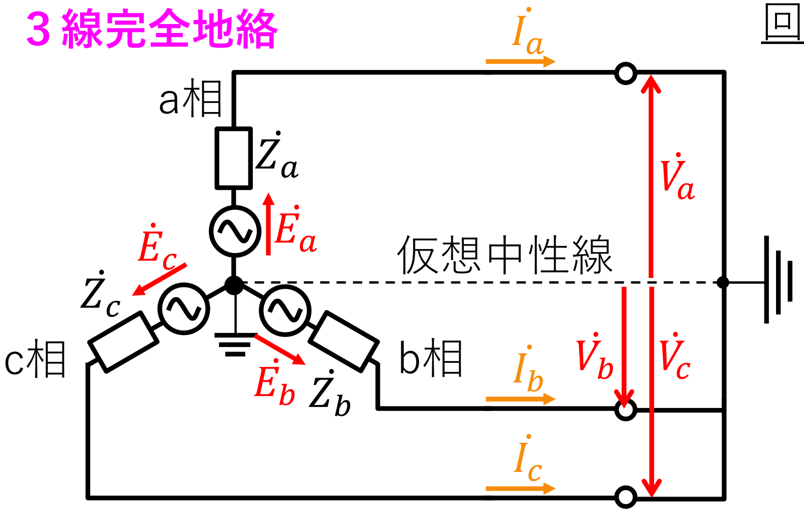
$$\begin{cases}\dot{V}_0=\frac{1}{3}(\dot{V}_a+\dot{V}_b+\dot{V}_c)\\ \dot{V}_1=\frac{1}{3}(\dot{V}_a+a\dot{V}_b+a^2\dot{V}_c)\\ \dot{V}_2=\frac{1}{3}(\dot{V}_a+a^2\dot{V}_b+a\dot{V}_c)\end{cases}$$

$$\begin{cases}\dot{I}_a=\dot{I}_0+\dot{I}_1+\dot{I}_2 & \cdots\text{⑥}\\ \dot{I}_b=\dot{I}_0+a^2\dot{I}_1+a\dot{I}_2 & \cdots\text{⑮}\\ \dot{I}_c=\dot{I}_0+a\dot{I}_1+a^2\dot{I}_2 & \cdots\text{⑯}\end{cases}$$

$$\begin{cases}\dot{I}_0=\frac{1}{3}(\dot{I}_a+\dot{I}_b+\dot{I}_c)\\ \dot{I}_1=\frac{1}{3}(\dot{I}_a+a\dot{I}_b+a^2\dot{I}_c)\\ \dot{I}_2=\frac{1}{3}(\dot{I}_a+a^2\dot{I}_b+a\dot{I}_c)\end{cases}$$

対称座標法（２）《無負荷発電機の地絡計算４》

３線完全地絡



３線完全短絡と同じ

回路条件　$\dot{V}_a = \dot{V}_b = \dot{V}_c = 0$ …①

①,③,④,⑤より　$\dot{V}_0 = \dot{V}_1 = \dot{V}_2 = 0$ …⑥

⑥,⑦より　$\dot{I}_0 = 0$ …⑩

⑥,⑧より　$0 = \dot{E}_a - \dot{Z}_1\dot{I}_1$　$\dot{I}_1 = \dfrac{\dot{E}_a}{\dot{Z}_1}$ …⑪

⑥,⑨より　$\dot{I}_2 = 0$ …⑫

⑬に⑩,⑪,⑫を代入　$\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 0 + \dfrac{\dot{E}_a}{\dot{Z}_1} + 0 = \dfrac{\dot{E}_a}{\dot{Z}_1}$

⑭に⑩,⑪,⑫を代入　$\dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 = 0 + \dfrac{a^2\dot{E}_a}{\dot{Z}_1} + 0 = \dfrac{a^2\dot{E}_a}{\dot{Z}_1}$

⑮に⑩,⑪,⑫を代入　$\dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 = 0 + \dfrac{a\dot{E}_a}{\dot{Z}_1} + 0 = \dfrac{a\dot{E}_a}{\dot{Z}_1}$

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots ⑦ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots ⑧ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots ⑨ \end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 \end{cases}$$

$$\begin{cases} \dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \cdots ③ \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \cdots ④ \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c) \cdots ⑤ \end{cases}$$

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots ⑬ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 & \cdots ⑭ \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 & \cdots ⑮ \end{cases}$$

$$\begin{cases} \dot{I}_0 = \frac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) \\ \dot{I}_1 = \frac{1}{3}(\dot{I}_a + a\dot{I}_b + a^2\dot{I}_c) \\ \dot{I}_2 = \frac{1}{3}(\dot{I}_a + a^2\dot{I}_b + a\dot{I}_c) \end{cases}$$