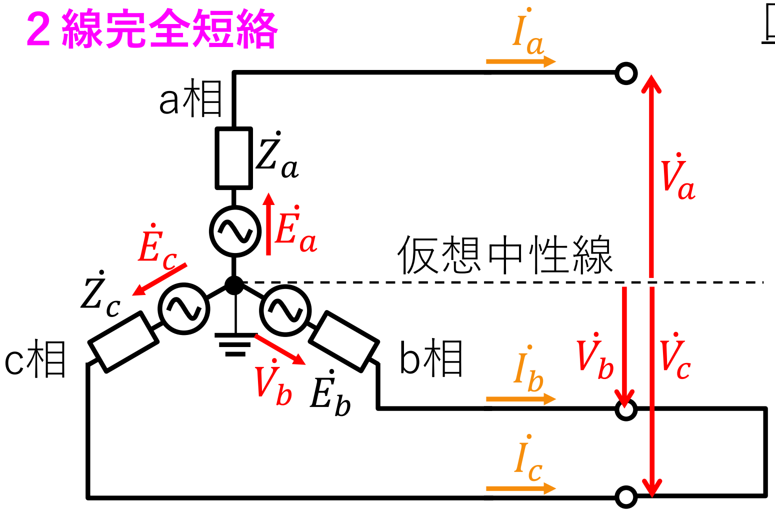
対称座標法（３）《無負荷発電機の短絡計算１》

２線完全短絡



回路条件

$\dot{V}_b = \dot{V}_c$ …① $\dot{I}_a = 0$ …② $\dot{I}_b + \dot{I}_c = 0$ …③

③に④,⑤を代入 $2\dot{I}_0 = \dot{I}_1 + \dot{I}_2$

②,⑥より $\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = 0$

$\therefore\ \dot{I}_0 = 0\ ,\ \dot{I}_1 = -\dot{I}_2$ …⑦

①に⑧,⑨を代入 $\dot{V}_1 = \dot{V}_2$ …⑩

⑩に⑦,⑪,⑫を代入 $\dot{I}_1 = \dfrac{\dot{E}_a}{\dot{Z}_1 + \dot{Z}_2} = -\dot{I}_2$ …⑬

④に⑦,⑬を代入

$\dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 = \dfrac{a^2 - a}{\dot{Z}_1 + \dot{Z}_2}\dot{E}_a$ …⑭

③に⑭を代入 $\dot{I}_c = -\dot{I}_b = \dfrac{a - a^2}{\dot{Z}_1 + \dot{Z}_2}\dot{E}_a$

⑮に⑦を代入 $\dot{V}_0 = -\dot{Z}_0\dot{I}_0 = 0$ …⑯

⑪に⑬を代入 $\dot{V}_1 = \dfrac{\dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2}\dot{E}_a = \dot{V}_2$ …⑰

⑱に⑯,⑰を代入 $\dot{V}_a = \dfrac{2\dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2}\dot{E}_a$

⑧に⑯,⑰を代入 $\dot{V}_b = -\dfrac{\dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2}\dot{E}_a = \dot{V}_c$

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots ⑮ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots ⑪ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots ⑫ \end{cases}$$

電流/電圧の定義式･対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots ⑱ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots ⑧ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots ⑨ \end{cases}$$

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

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots ⑥ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 & \cdots ④ \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 & \cdots ⑤ \end{cases}$$

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

対称座標法（３）　**２線完全短絡の計算**

$\dot{V}_b=\dot{V}_c$ ⋯①　$\dot{I}_a=0$ ⋯②　$\dot{I}_b+\dot{I}_c=0$ ⋯③

③に④,⑤を代入

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

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

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

②,⑥より$\dot{I}_a=\dot{I}_0+\dot{I}_1+\dot{I}_2=3\dot{I}_0=0$

$\therefore\ \dot{I}_0=0\ ,\ \dot{I}_1=-\dot{I}_2$ ⋯⑦

①より$\dot{V}_b-\dot{V}_c=0$に⑧,⑨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$\dot{V}_1=\dot{V}_2$ ⋯⑩

⑩に⑪,⑫,⑦を代入

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

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

④に⑦,⑬を代入

$$\dot{I}_b=\dot{I}_0+a^2\dot{I}_1+a\dot{I}_2=\frac{a^2-a}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a\quad\cdots⑭$$

③に⑭を代入　$\dot{I}_c=-\dot{I}_b=\dfrac{a-a^2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a$

⑮に⑦を代入　$\dot{V}_0=-\dot{Z}_0\dot{I}_0=0$ ⋯⑯

⑪に⑬を代入

$$\dot{V}_1=\dot{E}_a-\frac{\dot{Z}_1\dot{E}_a}{\dot{Z}_1+\dot{Z}_2}=\frac{\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a=\dot{V}_2\quad\cdots⑰$$

⑱に⑯,⑰を代入

$$\dot{V}_a=0+\frac{\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a+\frac{\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a=\frac{2\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a$$

⑧に⑯,⑰を代入

$$\dot{V}_b=0+\frac{a^2\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a+\frac{a\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a=\frac{(a^2+a)\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a$$

$$=-\frac{\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}\dot{E}_a=\dot{V}_c$$

発電機の基本式

$$\begin{cases}\dot{V}_0=-\dot{Z}_0\dot{I}_0 & \cdots⑮\\ \dot{V}_1=\dot{E}_a-\dot{Z}_1\dot{I}_1 & \cdots⑪\\ \dot{V}_2=-\dot{Z}_2\dot{I}_2 & \cdots⑫\end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases}\dot{V}_a=\dot{V}_0+\dot{V}_1+\dot{V}_2 & \cdots⑱\\ \dot{V}_b=\dot{V}_0+a^2\dot{V}_1+a\dot{V}_2 & \cdots⑧\\ \dot{V}_c=\dot{V}_0+a\dot{V}_1+a^2\dot{V}_2 & \cdots⑨\end{cases}$$

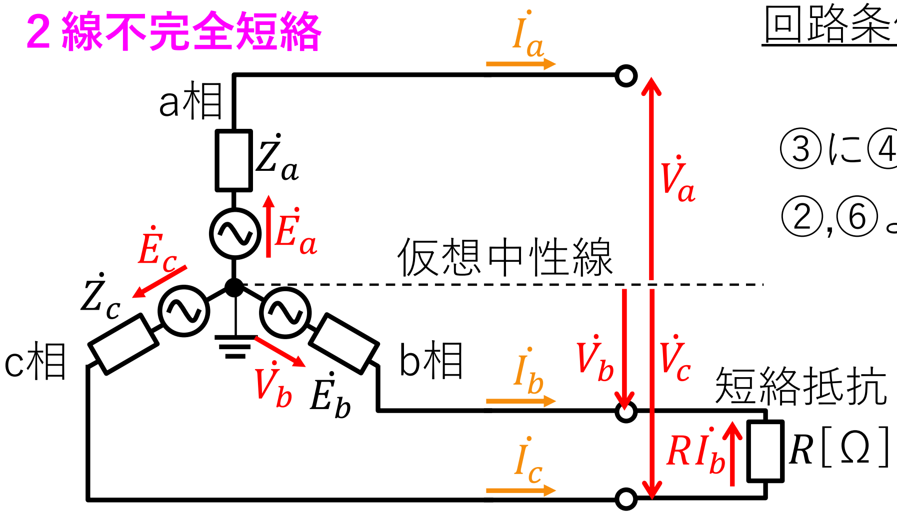
$$\begin{cases}\dot{V}_0=\frac{1}{3}(\dot{V}_a+\dot{V}_b+\dot{V}_c)\\ \dot{V}_1=\frac{1}{3}(\dot{V}_a+a\dot{V}_b+a^2\dot{V}_c)\\ \dot{V}_2=\frac{1}{3}(\dot{V}_a+a^2\dot{V}_b+a\dot{V}_c)\end{cases}$$

$$\begin{cases}\dot{I}_a=\dot{I}_0+\dot{I}_1+\dot{I}_2 & \cdots⑥\\ \dot{I}_b=\dot{I}_0+a^2\dot{I}_1+a\dot{I}_2 & \cdots④\\ \dot{I}_c=\dot{I}_0+a\dot{I}_1+a^2\dot{I}_2 & \cdots⑤\end{cases}$$

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

対称座標法（３）《無負荷発電機の短絡計算２》

２線不完全短絡



回路条件 $\dot{V}_b - \dot{V}_c = R\dot{I}_b$ …①

$\dot{I}_a = 0$ …②　$\dot{I}_b + \dot{I}_c = 0$ …③

③に④,⑤を代入　$2\dot{I}_0 = \dot{I}_1 + \dot{I}_2$

②,⑥より $\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = 0$

∴ $\dot{I}_0 = 0$，$\dot{I}_1 = -\dot{I}_2$ …⑦

①に④,⑦,⑧,⑨を代入

$\dot{V}_1 - \dot{V}_2 = R\dot{I}_1$ …⑩

⑩に⑪,⑫,⑦を代入

$$\dot{I}_1 = \frac{\dot{E}_a}{\dot{Z}_1 + \dot{Z}_2 + R} = -\dot{I}_2 \quad \cdots⑬$$

④に⑦,⑬を代入

$$\dot{I}_b = \frac{a^2 - a}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a \quad \cdots⑭$$

③に⑭を代入

$$\dot{I}_c = -\dot{I}_b = \frac{a - a^2}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$$

⑮に⑦を代入

$$\dot{V}_0 = -\dot{Z}_0\dot{I}_0 = 0 \quad \cdots⑯$$

⑪に⑬を代入

$$\dot{V}_1 = \frac{\dot{Z}_2 + R}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a \quad \cdots⑰$$

⑫に⑬を代入

$$\dot{V}_2 = \frac{\dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a \quad \cdots⑱$$

⑲に⑯,⑰,⑱を代入

$$\dot{V}_a = \frac{2\dot{Z}_2 + R}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$$

⑧に⑯,⑰,⑱を代入

$$\dot{V}_b = \frac{-\dot{Z}_2 + a^2 R}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$$

⑨に⑯,⑰,⑱を代入

$$\dot{V}_c = \frac{-\dot{Z}_2 + aR}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$$

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots⑮ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots⑪ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots⑫ \end{cases}$$

電流/電圧の定義式･対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots⑲ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots⑧ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots⑨ \end{cases}$$

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

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots⑥ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 & \cdots④ \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 & \cdots⑤ \end{cases}$$

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

対称座標法（２）　２線不完全短絡の計算

$\dot{V}_b - \dot{V}_c = R\dot{I}_b$ …①

$\dot{I}_a = 0$ …②　　$\dot{I}_b + \dot{I}_c = 0$ …③

③に④,⑤を代入

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

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

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

②,⑥より $\dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 = 3\dot{I}_0 = 0$

∴ $\dot{I}_0 = 0$, $\dot{I}_1 = -\dot{I}_2$ …⑦

①より $\dot{V}_b - \dot{V}_c = R\dot{I}_b$に④,⑦,⑧,⑨を代入

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

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

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

$\dot{V}_1 - \dot{V}_2 = R\dot{I}_1$ …⑩

⑩に⑪,⑫,⑦を代入

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

$\dot{I}_1 = \dfrac{\dot{E}_a}{\dot{Z}_1 + \dot{Z}_2 + R} = -\dot{I}_2$ …⑬

④に⑦,⑬を代入

$\dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 = \dfrac{a^2 - a}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$ …⑭

③に⑭を代入　$\dot{I}_c = -\dot{I}_b = \dfrac{a - a^2}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$

⑮に⑦を代入　$\dot{V}_0 = -\dot{Z}_0\dot{I}_0 = 0$ …⑯

⑪に⑬を代入

$\dot{V}_1 = \dot{E}_a - \dfrac{\dot{Z}_1\dot{E}_a}{\dot{Z}_1 + \dot{Z}_2 + R} = \dfrac{\dot{Z}_2 + R}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$ …⑰

⑫に⑬を代入　$\dot{V}_2 = \dfrac{\dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$ …⑱

⑲に⑯,⑰,⑱を代入

$$\dot{V}_a = \frac{\dot{Z}_2 + R}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a + \frac{\dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a = \frac{2\dot{Z}_2 + R}{\dot{Z}_1 + \dot{Z}_2 + R}\dot{E}_a$$

⑧に⑯,⑰,⑱を代入

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

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

⑨に⑯,⑰,⑱を代入

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

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots ⑮ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 & \cdots ⑪ \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 & \cdots ⑫ \end{cases}$$

電流/電圧の定義式・対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots ⑲ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots ⑧ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots ⑨ \end{cases}$$

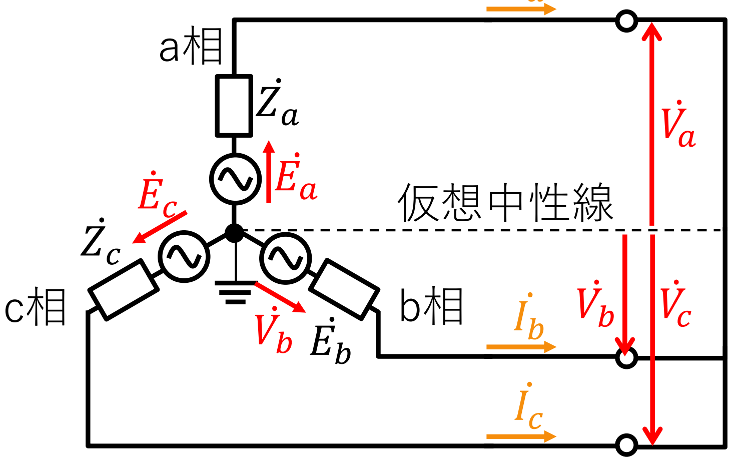
$$\begin{cases} \dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c) \end{cases}$$

$$\begin{cases} \dot{I}_a = \dot{I}_0 + \dot{I}_1 + \dot{I}_2 & \cdots ⑥ \\ \dot{I}_b = \dot{I}_0 + a^2\dot{I}_1 + a\dot{I}_2 & \cdots ④ \\ \dot{I}_c = \dot{I}_0 + a\dot{I}_1 + a^2\dot{I}_2 & \cdots ⑤ \end{cases}$$

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

対称座標法（３）《無負荷発電機の短絡計算３》

３線完全短絡



$\therefore\quad \dot{I}_a = \dfrac{\dot{E}_a}{\dot{Z}_1} \quad \dot{I}_b = \dfrac{a^2\dot{E}_a}{\dot{Z}_1} \quad \dot{I}_c = \dfrac{a\dot{E}_a}{\dot{Z}_1}$

回路条件　$\dot{I}_a + \dot{I}_b + \dot{I}_c = 0 \quad \cdots ①$

$\dot{V}_a = \dot{V}_b = \dot{V}_c \quad \cdots ②$

①,③より　$\dot{I}_0 = \dfrac{1}{3}(\dot{I}_a + \dot{I}_b + \dot{I}_c) = 0 \cdots ④$

④,⑤より　$\dot{V}_0 = -\dot{Z}_0\dot{I}_0 = 0 \quad \cdots ⑥$

②,⑦より　$\dot{V}_1 = \dfrac{1}{3}(1 + a + a^2)\dot{V}_a = 0 \quad \cdots ⑨$

②,⑧より　$\dot{V}_2 = \dfrac{1}{3}(1 + a^2 + a)\dot{V}_a = 0 \quad \cdots ⑩$

⑥,⑨,⑩より　$\dot{V}_0 = \dot{V}_1 = \dot{V}_2 = 0 \quad \cdots ⑪$

⑪,⑫,⑬,⑭より　$\dot{V}_a = \dot{V}_b = \dot{V}_c = 0$

3線完全地絡と同じ回路条件

$\dot{Z}_1 = \dot{Z}_2 = \dot{Z}$のとき、３線完全短絡電流 $\dot{I}_{s3}$ と ２線完全短絡電流 $\dot{I}_{s2}$の大きさは

$|\dot{I}_{s3}| = \left|\dfrac{\dot{E}_a}{\dot{Z}}\right| = \dfrac{E}{Z} \qquad |\dot{I}_{s2}| = \left|\dfrac{a^2 - a}{\dot{Z} + \dot{Z}}\dot{E}_a\right| = \left|\dfrac{j\sqrt{3}}{2\dot{Z}}\dot{E}_a\right| = \dfrac{\sqrt{3}}{2}\cdot\dfrac{E}{Z}$

$|\dot{I}_{s2}| = \dfrac{\sqrt{3}}{2}|\dot{I}_{s3}| \fallingdotseq 0.87|\dot{I}_{s3}|$

発電機の基本式

$$\begin{cases} \dot{V}_0 = -\dot{Z}_0\dot{I}_0 & \cdots ⑤ \\ \dot{V}_1 = \dot{E}_a - \dot{Z}_1\dot{I}_1 \\ \dot{V}_2 = -\dot{Z}_2\dot{I}_2 \end{cases}$$

電流/電圧の定義式･対称分式

$$\begin{cases} \dot{V}_a = \dot{V}_0 + \dot{V}_1 + \dot{V}_2 & \cdots ⑫ \\ \dot{V}_b = \dot{V}_0 + a^2\dot{V}_1 + a\dot{V}_2 & \cdots ⑬ \\ \dot{V}_c = \dot{V}_0 + a\dot{V}_1 + a^2\dot{V}_2 & \cdots ⑭ \end{cases}$$

$$\begin{cases} \dot{V}_0 = \frac{1}{3}(\dot{V}_a + \dot{V}_b + \dot{V}_c) \\ \dot{V}_1 = \frac{1}{3}(\dot{V}_a + a\dot{V}_b + a^2\dot{V}_c) \cdots ⑦ \\ \dot{V}_2 = \frac{1}{3}(\dot{V}_a + a^2\dot{V}_b + a\dot{V}_c) \cdots ⑧ \end{cases}$$

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

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