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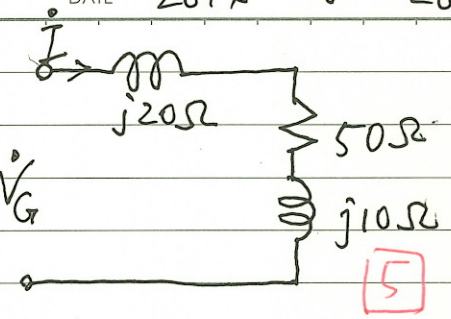
H26 電力システム中間試験

問1 30



(1) $\dot{V}_G = \frac{14.1}{\sqrt{2}} \angle 0 \text{ kV} = 10 \angle 0 \text{ kV}$ ~~10~~ 5

(2) $\cos\theta_L = \frac{50}{\sqrt{50^2+10^2}} = \frac{5}{\sqrt{26}} = 0.98$ 5

$\cos\theta_G = \frac{50}{\sqrt{50^2+(20+10)^2}} = \frac{5}{\sqrt{34}} = 0.857$

(3) $\dot{I} = \frac{\dot{V}_G}{\dot{Z}_T + \dot{Z}_L} = \frac{10\angle 0}{50+j30} = \frac{1}{\sqrt{34}} \angle -\tan^{-1}3/5 \text{ kA}$

$\therefore |\dot{I}|^2 = \frac{1}{34}$

ゆえに

$\dot{S}_G = (\dot{Z}_T + \dot{Z}_L)|\dot{I}|^2 = (50+j30)\frac{1}{34} = 1.47 + j0.882$ 10

$P_G = 1.47 \text{ MW}$, $Q_G = 0.882 \text{ MVar}$, $|\dot{S}_G| = \sqrt{1.47^2+0.882^2} = 1.714 \text{ MVA}$

(4) $\dot{S}_L = \dot{Z}_L|\dot{I}|^2 = (50+j10)\frac{1}{34} = 1.47 + j0.294$ 10

$\therefore P_L = 1.47 \text{ MW}$, $Q_L = 0.294 \text{ MVar}$, $|\dot{S}_L| = 1.499 \text{ MVA}$

問2 ~~20~~ 10

(1) $S_b = V_b I_b = 10\text{kV} \times 0.2\text{kA} = 2\text{MVA}$

$Z_b = V_b / I_b = \frac{10}{0.2} = 50\,\Omega$ 5 ~~10~~

(2) $\dot{V}_G = \frac{10}{10} = 1.0 \text{ pu}$

$\dot{Z}_T = \frac{j20}{50} = j0.4 \text{ pu}$

$$\dot{z}_L = \frac{50+j10}{50} = 1.0 + j0.2 \text{ pu}$$

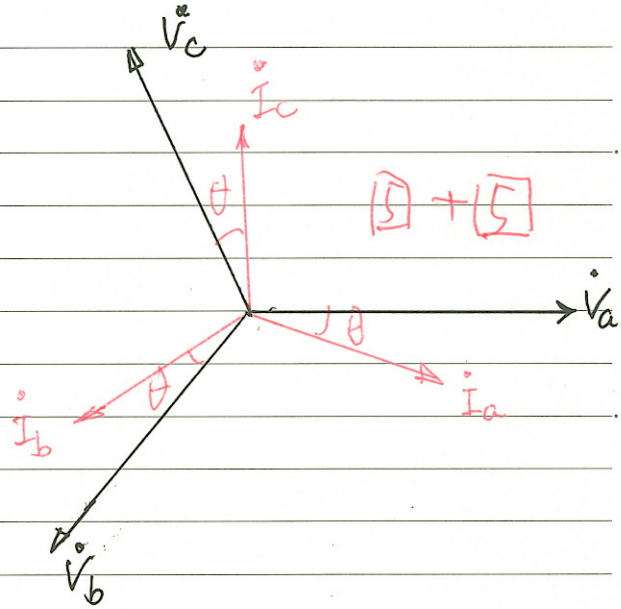
$$\dot{S}_G = \frac{1.47+j0.882}{2} = 0.735 + j0.441 \text{ pu}$$

$$\dot{S}_L = \frac{1.47+j0.294}{2} = 0.735 + j0.147 \text{ pu}$$

[5]

問3 20

(1), (2)



[5]+[5]

(3) 中性線を使う必要はない。

理由は

$\dot{I}_a + \dot{I}_b + \dot{I}_c = 0$ [5]

(4) 各相が独立に扱える。

理由：

① $\dot{I}_a + \dot{I}_b + \dot{I}_c = 0$, ② 各相インピーダンス，線間リアクタンスが同じ。

[5]

問4. 20

相電圧 $|\dot{V}| = \frac{\sqrt{3}}{\sqrt{3}} = 1.0$ pu, 一相分電力 $\dot{S}_{1\phi} = \frac{2.1+j0.6}{3}$

$= 0.7 + j0.2$ pu

(1) $\dot{V}_p = 1.0\angle 0$, $\dot{S}_{1\phi} = \dot{V}_p \dot{I}_p^*$ より

$\dot{I}_p = \dot{S}_{1\phi}^* = 0.7 - j0.2$ pu [5]

(2) 損失電力

$P_{loss} + jQ_{loss} = \dot{z}_p |\dot{I}_p|^2 = (0.02+j0.4) \times 0.53 = 0.01 + j0.212$

よって

$P_{loss} = 0.01$ pu, $Q_{loss} = 0.212$ pu [5]

(3) 受電端1相分電力

$$\dot{S}_{r,1\phi} = \dot{S}_{1\phi} - (P_{loss} + jQ_{loss}) = 0.7 + j0.2 - (0.01 + j0.212)$$

$$= 0.69 - j0.012$$

よって、三相分は

$$\dot{S}_{r,3\phi} = 3\dot{S}_{r,1\phi} = 2.07 - j0.036$$ [10]

一方、受電端相電圧 $\dot{V}_r$ は

$$\dot{S}_{r,1\phi} = \dot{V}_r \dot{I}_p^* \rightarrow \dot{V}_r = \frac{\dot{S}_{r,1\phi}}{\dot{I}_p^*} \rightarrow |\dot{V}_r| = \left|\frac{\dot{S}_{r,1\phi}}{\dot{I}_p}\right|$$

よって、受電端線間電圧は

$$|\dot{V}_{r,l-l}| = \sqrt{3}\,|\dot{V}_r| = \sqrt{3} \times \sqrt{\frac{0.69^2 + j0.012^2}{0.7^2 + 0.2^2}} = 1.642 \text{ pu}$$

問5

(1) 各線路のアドミタンスを回路図に示す。

$$\frac{1}{0.2 + j0.8} = \frac{0.2 - j0.8}{0.2^2 + 0.8^2} = 0.294 - j1.176$$

$$\frac{1}{0.1 + j0.5} = \frac{0.1 - j0.5}{0.1^2 + 0.5^2} = 0.364 - j1.923$$

$$\frac{1}{0.1 + j0.4} = \frac{0.1 - j0.4}{0.1^2 + 0.4^2} = 0.588 - j2.353$$

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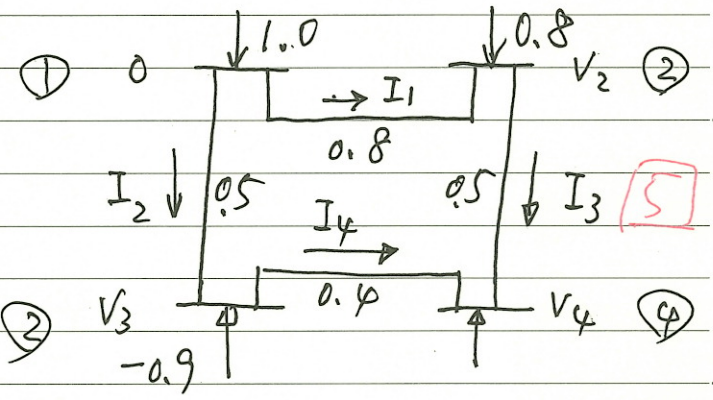
よって

$$\dot{y} = \begin{bmatrix} 0.658-j3.099 & -0.294+j1.176 & -0.364+j1.923 & 0 \\ * & 0.658-j3.099 & 0 & -0.364+j1.923 \\ * & * & 0.952-j4.276 & -0.588+j2.353 \\ * & * & * & 0.952-j4.276 \end{bmatrix}$$ [5]

(2) 右図



[5]

(3) ノード1～3の電流方程式

$$1.0 = \frac{0-V_2}{0.8} + \frac{0-V_3}{0.5} \quad (1)$$

$$0.8 = \frac{V_2-0}{0.8} + \frac{V_2-V_4}{0.5} \quad (2)$$

$$-0.9 = \frac{V_3-0}{0.5} + \frac{V_3-V_4}{0.4} \quad (3)$$

式(1)より $V_3 = -(0.5+0.625V_2)$ (4)

式(2)より $V_4 = -0.4+1.625V_2$ (5)

これを式(3)に代入すると

$V_2 = \cancel{3.32} - 0.051$

$\therefore \cancel{V_3 = -2.575}, \cancel{V_4 = -4.995}$ $\therefore V_3 = -0.468$, $V_4 = -0.483$

[5]

(4) 主和定

$\therefore \delta_2 = -0.051$ rad, $\delta_2 = -0.468$ rad, $\delta_3 = -0.483$ rad

$I_1 = \frac{0-(-0.051)}{0.8} = 0.064 \Longrightarrow$ ①→②に流れる電力：0.064 pu

$I_2 = \frac{0-(-0.468)}{0.5} = +1.296 \Longrightarrow$ ①→③ ：0.936 pu

$I_3 = \frac{-0.051-(-0.483)}{0.5} = 0.864 \Rightarrow$ ②→④ ：0.864 pu

$I_4 = \frac{-0.468-(-0.483)}{0.4} = 0.0375 \Rightarrow$ ③→④ ：0.0375 pu

[5]

よって、負荷2の有効電力 $\cong 0.864+0.0375 \cong 0.9$ pu