Indian Institute of Technology Patna
Department of Electrical Engineering
EE381 - Power Systems
Autumn - 2022
Quiz - II — Solution.
November 17, 2022

There are 5 problems. They carry equal marks.

$(5 \times 2 = 10)$

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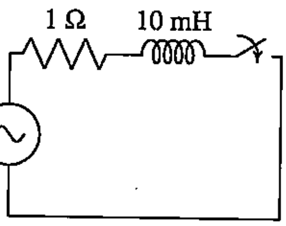
1. In the circuit shown below, the switch is closed at $t = 0$. Find the value of DC offset of the current at the time of switching.



$\omega L = 10 \times 10^{-3} \times 377 \ \Omega$

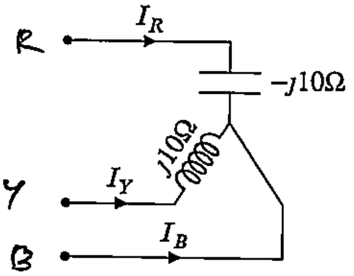
$R = 1 \ \Omega$

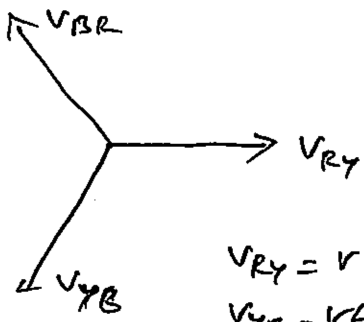
$$i(t) = \frac{V_{max}}{|Z|} \left(\sin(377t + 30 - \phi) - \sin(30^\circ - \phi)\, e^{-\frac{t \times R}{L}} \right)$$

$$i_{dc} = -\frac{100}{|Z|} \sin(30 - \phi) \quad \text{at } t = 0$$

$$\boxed{i_{dc} = 18.1748 \ A}$$

2. A three phase balanced source is applied to the load shown below. The phase sequence is RYB. Find $|\frac{I_R}{I_Y}|$.





$V_{RY} = V\angle 0^\circ$
$V_{YB} = V\angle -120^\circ$
$V_{BR} = V\angle -240^\circ$

$$-V_{RY} + I_R(-j10) - I_Y(j10) = 0 \quad -(1)$$

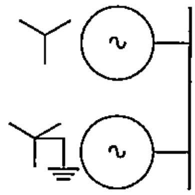
$$-V_{YB} + I_Y \times j10 = 0 \quad -(2)$$

(2) $\Rightarrow$ $$I_Y = \frac{V\angle -120^\circ}{j10} = \frac{V}{10}\angle -210^\circ$$

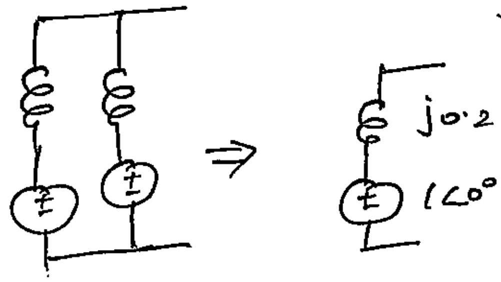
From (1) $$I_R = \frac{V}{10}\angle -150^\circ$$

$$\boxed{\left|\frac{I_R}{I_Y}\right| = \frac{\frac{V}{10}}{\frac{V}{10}} = 1}$$

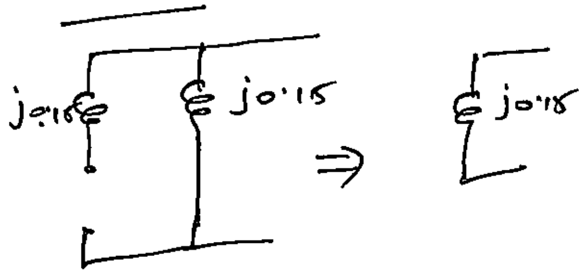
3. Two identical unloaded generators are connected in parallel as shown in the figure. Both the generators are having positive, negative and zero sequence impedances of $j0.4$p.u., $j0.3$p.u.and $j0.15$ p.u.,respectively. If the pre-fault voltage is 1 p.u., find the fault current in per unit for a line-to-ground (L- G)fault at the terminals of the generators.



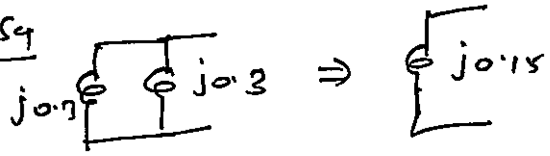
+ve Seq



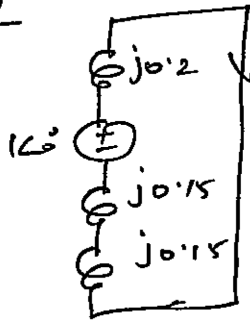
Zero Seq



-ve Seq



For a SLG Fault:



$I_{f0} = \frac{I_f}{3}$

$I_f = \frac{3 \times 1}{j0.5}$

$I_f = 6\angle -90$ p.u

$|I_f| = 6$ pu

4. The incremental costs in Rs/MWhr of two generating units of a plant are

$$\frac{dF_1}{dP_1} = 0.008P_1 + 9.6 \quad \frac{dF_2}{dP_2} = 0.012P_2 + 8$$

Calculate the saving in Rs/hr if a load of 200 MW is shared optimally rather than equally.

For optimal scheduling

$$\frac{dF_1}{dP_1} = \frac{dF_2}{dP_2}$$

$P_1 + P_2 = 200$

By solving this

$P_1 = 40$ MW

$P_2 = 160$ MW

For equal sharing

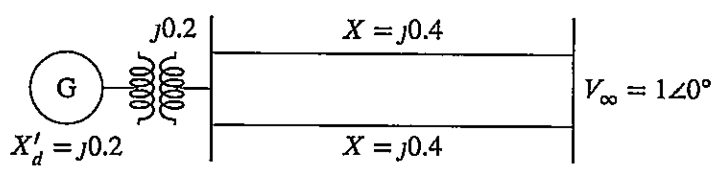
$P_1 = 100$ MW

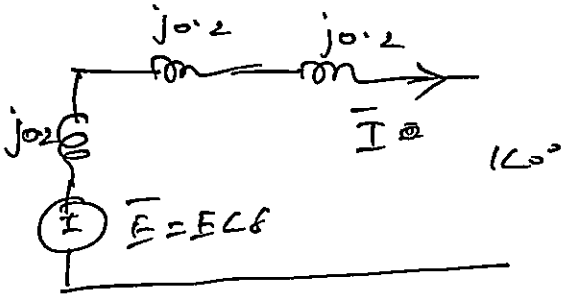
$P_2 = 100$ MW

$$\text{Saving} = \int_{40}^{100} \left(\frac{dF_1}{dP_1}\right) dP_1 + \int_{160}^{100} \left(\frac{dF_2}{dP_2}\right) dP_2$$

Saving = 36 Rs/hr

5. In the single machine infinite bus system shown below, the generator is delivering the real power of 1 p.u. at 0.8 power factor lagging to the infinite bus. Find the power angle of the generator in degrees .





$|\bar{I}| = \frac{1}{1 \times 0.8}$

$= \left(\frac{P}{V \times \cos\phi}\right)$

$\bar{I} = \frac{1}{0.8} \angle -\cos^{-1} 0.8$

$E\angle\delta = 1\angle 0° + \bar{I} \times j0.6$

$E\angle\delta = 1.57 \angle 22.48°$

$\delta = 22.48°$