NOTES Class 44

Examples on Balanced Star connected Three Phase System:

Numerical Example 1:

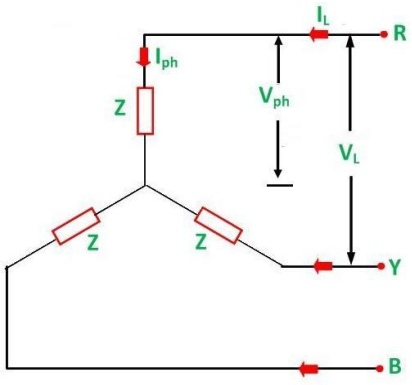
Question:

A balanced 3 phase load consists of three coils, each of 4Ω resistance and 0.02H inductance. Determine the total active and reactive power when the coils are connected in star, if the supply voltage is 400V, 50 Hz.

Solution :

Note: In three phase systems, by default, the voltages and currents given are line voltage and line current respectively.

Similarly, power given is three phase power by default.



Given Data:

Line voltage, V_L = 400V ; f = 50Hz

Resistance per phase, R = 4Ω

Inductance per phase, L = 0.02H

Calculations:

Inductive reactance per phase, $X_L = 2\pi fL = 6.28\Omega$

Impedance per phase, $Z = R+jX_L = (4+j6.28)\Omega$

Hence, $|Z| = 7.45\Omega$; Phase Angle, $\phi = 57.5°$

Since star connected system, Phase voltage, $V_{ph} = \frac{L}{\sqrt{3}} = 230.94V$

Hence, Phase current, $I_{ph} = \frac{V_{Ph}}{|Z|} = 31A$

Therefore, Line current, $I_L = I_{ph} = 31A$

Three phase Active Power, $P_{3\text{-phase}} = 3*P_{1\text{-phase}} = 3*V_{ph}*I_{ph}*\cos(\phi) = 11.54KW$

Alternatively, $P_{3\text{-phase}} = \sqrt{3}*V_L*I_L*\cos(\phi) = 11.54KW$

Alternatively, $P_{3\text{-phase}} = 3*I_{ph}^2*R = 11.54KW$

Similarly, Three phase Reactive Power,

$Q_{3\text{-phase}} = 3*Q_{1\text{-phase}} = 3*V_{ph}*I_{ph}*\sin(\phi) = 18.11KVAR$

Alternatively, $Q_{3\text{-phase}} = \sqrt{3}*V_L*I_L*\sin(\phi) = 18.11KVAR$

Alternatively, $Q_{3\text{-phase}} = 3*I_{ph}^2*X_L = 18.11KVAR$

Numerical Example 2

Question:

A balanced 3Φ, star connected load of 100KW takes a leading current of 80A when connected to a 3Φ, 1.1KV, 50Hz supply. Find the resistance, impedance, and the capacitance of the load per phase. Also calculate the power factor of the load.

Solution :

Given Data:

Line voltage, $V_L = 1.1KV$; $f = 50Hz$

Line current, I_L = 80A

Three phase Active Power, $P_{3\text{-phase}}$ = 100KW

Calculations:

Since star connected system, Phase current, $I_{ph} = I_L$ = 80A

And Phase voltage, $V_{ph} = \frac{L}{\sqrt{3}}$ = 635.08V

Impedance per phase, $Z = \frac{V_{ph}}{I_{ph}}$ = 7.94Ω

$P_{3\text{-phase}}$ = 100KW = $3*I_{ph}^2*R$; Hence, R = 5.21Ω

Capacitive reactance per phase, $X_C = \sqrt{(Z^2 - R^2)}$ = 5.99Ω

Hence, Capacitance per phase, $C = \frac{1}{\omega X_C}$ = 531.25µF

Powerfactor of the load, $\cos\phi = \frac{R}{Z}$ = 0.656 Lead

Alternative solution:

Since star connected system, Phase current, $I_{ph} = I_L$ = 80A

And Phase voltage, $V_{ph} = \frac{L}{\sqrt{3}}$ = 635.08V

Impedance per phase, $Z = \frac{V_{ph}}{I_{ph}}$ = 7.94Ω

$P_{3\text{-phase}}$ = 100KW = $\sqrt{3}*V_L*I_L*\cos(\phi)$

Hence, Powerfactor of the load, cosϕ = 0.656 Lead

Resistance per phase, R = Z*cosϕ = 5.21Ω

Capacitive reactance per phase, $X_C = \sqrt{(Z^2 - R^2)}$ = 5.99Ω

Hence, Capacitance per phase, $C = \frac{1}{\omega X_C}$ = 531.25µF