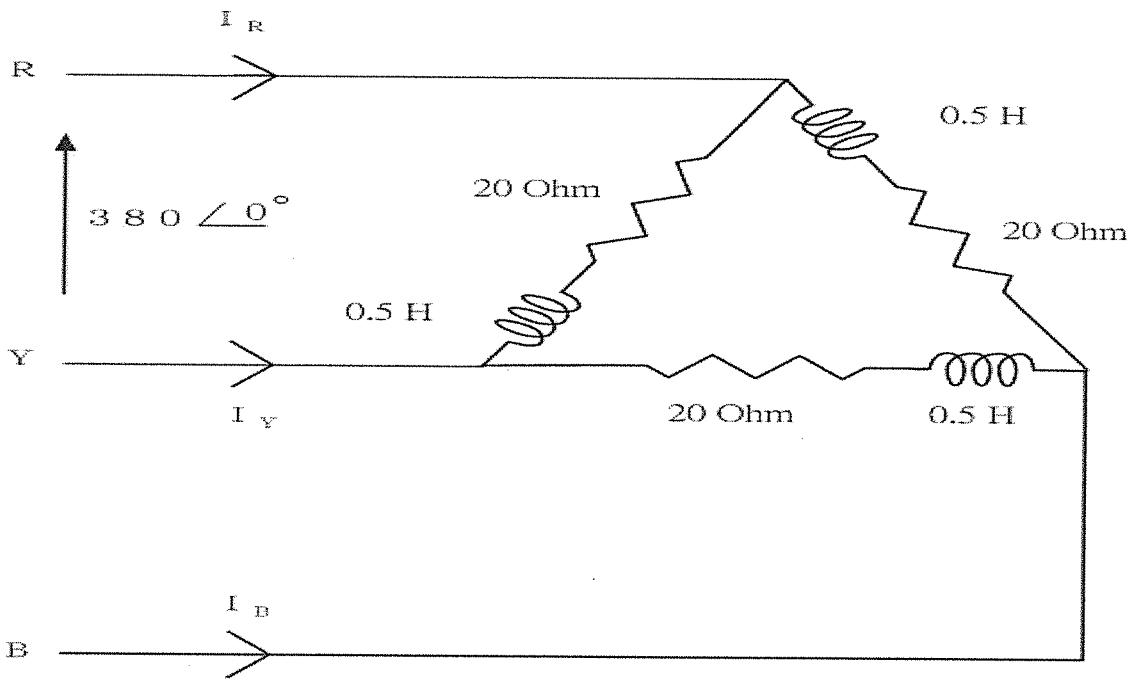
Electrical Technology MEC4105 — Tutorial 2 : Three phase System Solution

Q1 Three identical loads each consists of a 20 Ohm resistance in series with a 0.5 Henry inductor are delta connected to a 380 V, 50 Hz, 3 phase supply. Calculate:

i. The magnitude of the phase currents
ii. The magnitude of the line currents
iii. The power taken from the supply



Reactance of the load = $2\pi fL = 2 \times \pi \times 50 \times 0.5 = j\,157.1\ \Omega$

Impedance of each load = $20 + j\,157.1\Omega = 158.37\angle 82.7^\circ$

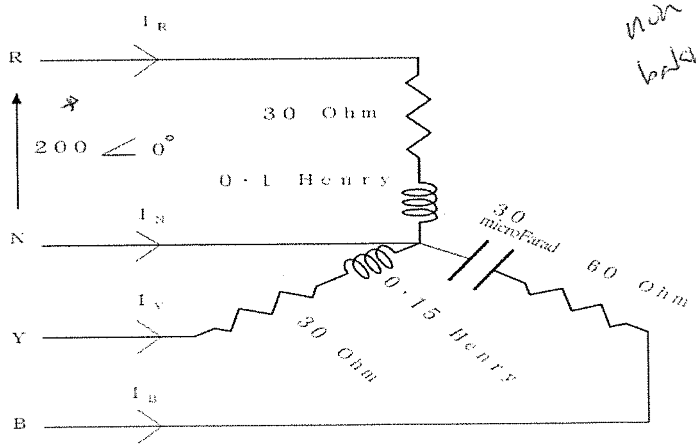
i) Magnitude of phase current = $\dfrac{380}{158.37} = 2.399\ A$

ii) Magnitude of Line current = $\sqrt{3} \times 2.399 = 4.155\ A$

iii) Total three phase power

$$= \sqrt{3} \times \text{Line Voltage} \times \text{Line Current} \times \cos\Phi$$
$$= \sqrt{3} \times V_L \times I_L \times \cos\Phi$$
$$= \sqrt{3} \times 380 \times 4.155 \times \cos\angle 82.7^\circ$$
$$= 347.49\ \text{W}.$$

Q2 Calculate the line currents, neutral current and the total three phase power dissipation.



L = 2 π f L, the load impedances are:

$Z_R = 30 + j\,2 \times \pi \times 50 \times 0.1$
$= 30 + j\,31.42\ \Omega = 43.44\angle 46^\circ$

$Z_Y = 30 + j\,2 \times \pi \times 50 \times 0.15$
$= 30 + j\,47.12\ \Omega = 55.86\angle 57.5^\circ$

$Z_B = 60 - j\,1/(2 \times \pi \times 50 \times 30e^{-6})$
$= 60 - j\,106.1\ \Omega = 121.89\angle -60.5^\circ$

Line current :

$$I_R = \frac{200\angle 0^\circ}{43.44\angle 46^\circ} = 4.604\angle -46^\circ\ \text{A} = 3.1982 - j3.3118\ \ \text{A}$$

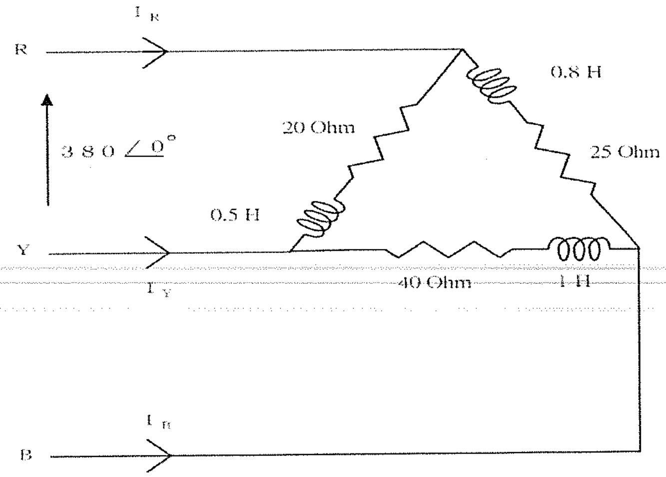
$$I_Y = \frac{200\angle -120^\circ}{55.86\angle 57.5^\circ} = 3.58\angle -177^\circ A = -3.5751 - j0.1874\,A$$

$$I_B = \frac{200\angle 120^\circ}{121.89\angle -60.5^\circ} = 1.6408\angle 180.5^\circ A = -1.6407 - j0.0143\,A$$

Neutral current : $I_N = I_R + I_Y + I_B = -2.0176 - j\,3.5135 = 4.0516\angle -119.9^\circ$ A

Total power = $I_R^2 R_R + I_Y^2 R_Y + I_B^2 R_B = 4.604^2 \times 30 + 3.58^2 \times 30 + 1.6408^2 \times 60 = 1182\text{W}$

Q3 Find (i) The load impedance in each phase
(ii) The phase current
(iii) The line currents
(iv) The power dissipated in each phase



(i) L = 2 π f L, the load impedances are:

$Z_{RY} = 20 + j157.1\Omega = 158.37\angle 82.7^\circ$

$Z_{YB} = 40 + j314.1\Omega = 316.64\angle 82.8^\circ$

$Z_{BR} = 25 + j251.3\Omega = 252.54\angle 84.3^\circ$

(ii) Phase current : $I_{RY} = \dfrac{380\angle 0^\circ}{158.37\angle 82.3} = 2.399\angle -82.7^\circ = 0.305 - j2.38A$

$$I_{YB} = \frac{380\angle -120^\circ}{316.64\angle 82.8} = 1.2\angle -202.7^\circ = -1.107 + j0.464A$$

$$I_{BR} = \frac{380\angle 120^\circ}{252.54\angle 84.3} = 1.505\angle 35.7^\circ = 1.222 + j0.878A$$

(iii) Line current : $I_R = I_{RY} - I_{YB} = 0.305 - j2.38 - 1.222 - j0.878 = -0.917 - j3.258 = 3.385\angle -105^\circ$

$I_Y = I_{YB} - I_{RY} = -1.107 + j0.464 - 0.303 + j2.38 = 1.41 + j2.844 = 3.17\angle 116^\circ$

$I_B = I_{BR} - I_{YB} = 1.222 - j0.878 + 1.107 - j0.464 = 2.329 + j0.414 = 2.366\angle 10.1^\circ$

(iv) Power dissipated due to I_{RY} = 2.399^2 x 20 = 115.1W
Power dissipated due to I_{YB} = 1.2^2 x 40 = 57.6W
Power dissipated due to I_{RY} = 1.505^2 x 25 = 56.25W