ELEMENTS OF ELECTRICAL ENGINEERING (UE24EE141B)

Department of Electrical Engineering

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Unit 2 – Lecture 38 - NUMERICAL ON POWER FACTOR IMPROVEMENT

Department of Electrical & Electronics Engineering

Numerical Example

Question:

The load taken from AC supply consist of a heating load of 15kW, a motor load of 40kVA at 0.6 lag and a load of 20kW at 0.8 lag. Calculate the load from supply in kW & kVA and its power factor. what would be the kVAR rating of a capacitor to bring the power factor to unity and how would the capacitor be connected.

Solution:

Load 1: Heating Load

P_1=15kW, cosϕ=1

$\therefore Q_1 = 0$

$$so, \qquad S_1 = \sqrt{P_1^2 + Q_1^2} = 15kVA$$

Numerical Example

Load 2: Motor Load

$$S_2 = 40kVA, \ \cos\phi_2 = 0.6lag$$

$$S_2 = VI_2 \quad \therefore \phi_2 = 53.13^0$$

$$P_2 = VI_2\, cos\,\phi_2 = 24kW$$

$$Q_2 = VI_2\, sin\,\phi_2 = 32kVAR$$

Load 3: Inductive Load

$$P_3 = 20kW, \ \ \cos\phi_3 = 0.8lag$$

$$S_3 = 25kVA$$

$$Q_3 = VI_3\, sin\,\phi_3 = 15kVAR$$

Numerical Example

$$P_T = P_1 + P_2 + P_3$$

$$\therefore P_T = 59kW$$

$$Q_T = Q_1 + Q_2 + Q_3$$

$$\therefore Q_T = 47k\text{VAR}$$

$$S_T = \sqrt{P_T^2 + Q_T^2}$$

$$= \sqrt{(59k)^2 + (47k)^2}$$

$$S_T = 75.43kVA$$

Numerical Example

Overall Power Factor is

$$\cos\phi_T = \frac{P_T}{S_T} = 0.782lag$$

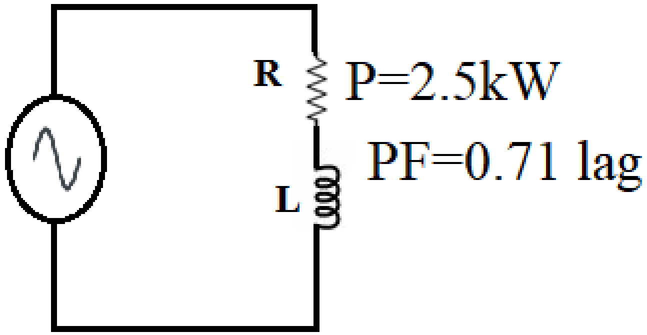
To bring the power Factor to Unity, Q_T must be 0.
Hence we need to connect a capacitor of 47kVAR rating in parallel with the circuit.

Numerical Example

Question:

The power consumed in the inductive load is 2.5 kW at 0.71 lagging power factor. The input voltage is 230 V, 50 Hz. Find the value of the capacitor C which must be placed in parallel, such that the resultant power factor of the input current is 0.866 lagging.

Solution:



$$P = VIcos\phi$$
$$I = 15.309\ A$$

$$\phi = cos^{-1}0.71 = 44.76$$

$$\therefore I = 15.309\angle -44.76°\ A$$

Numerical Example

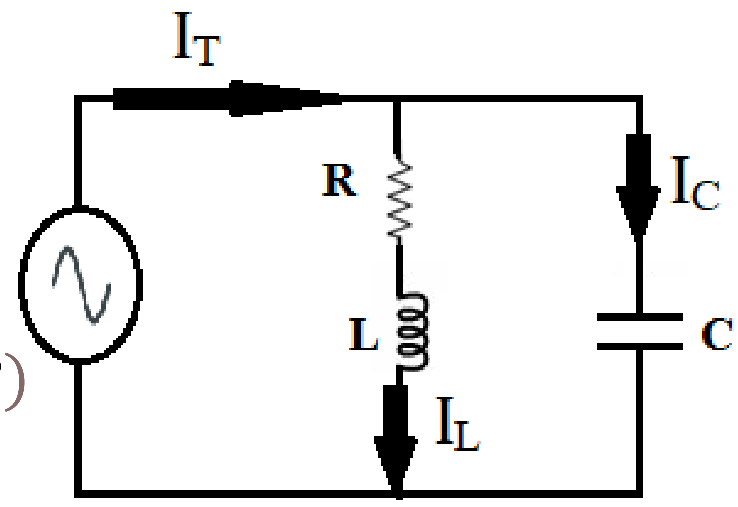
$By\ KCL$

$$I_T\angle -30° = (15.309\angle -44.76°) + (I_C\angle 90°)$$

By equating real parts.

$$I_T cos30° = (15.309\ cos44.76°) + (I_C\ cos90°)$$

$$I_T = 12.55A$$



$$I_C = I_T - I_L \quad (phasor\ sum\ )$$

$$I_C = (12.55\angle -30°) - (15.309\angle -44.76°)$$

$$\therefore \quad I_C = 4.504\angle 90°$$

$$\therefore X_C = \frac{V_C}{I_C} = \frac{230}{4.504} = 51.065\Omega \qquad C = \frac{1}{2\pi f X_c} = 62.33\mu f$$

Text Book & References

Text Book:

"Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 11th Edition, Pearson Education, 2012.

Reference Books:

1. "Basic Electrical Engineering - Revised Edition", D. C. Kulshreshta, Tata- McGraw-Hill, 2012.
2. "Basic Electrical Engineering", K Uma Rao, Pearson Education, 2011.
3. "Engineering Circuit Analysis", William Hayt Jr., Jack E. Kemmerly & Steven M. Durbin, 8th Edition, McGraw-Hill, 2012.
4. Google images

THANK YOU

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