ELEMENTS OF ELECTRICAL ENGINEERING (UE24EE141B)

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Unit 2 – Lecture 36 - Numerical Examples on Series-Parallel AC Circuits

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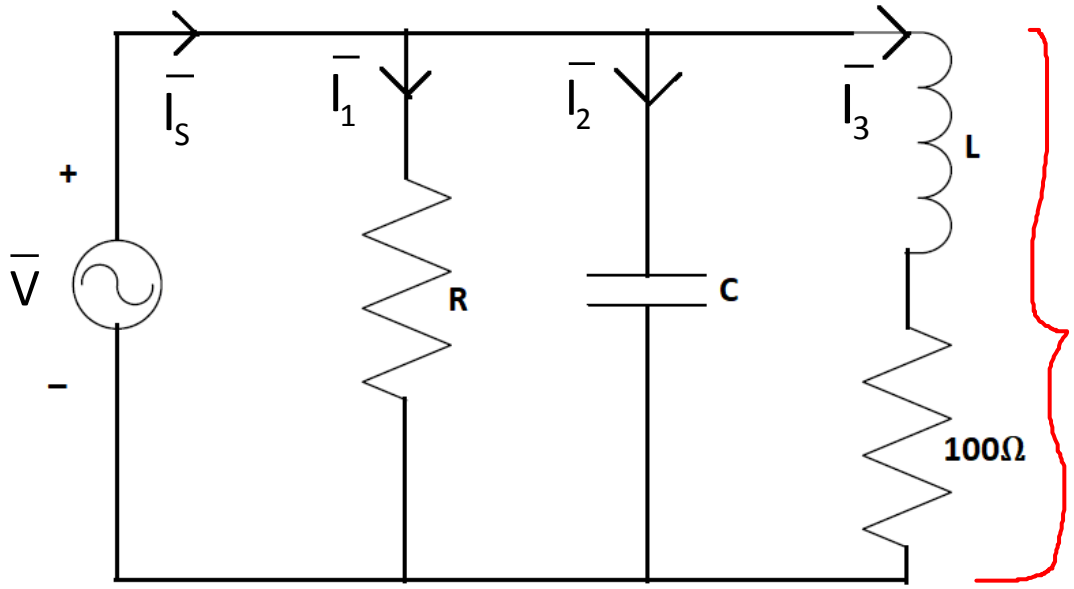
Numerical Example 3

Question:

A voltage of 200 V is applied to a pure resistor (R), a pure capacitor, C and a lossy inductor coil with resistance of 100 Ω, all of them connected in parallel. The total current is 2.45 A, while the component currents are 1.5, 2.0 and 1.2 A respectively. Find the total power factor and also the power factor of the coil. Also find the total active and reactive power.

Numerical Example 3

Solution:



Let us consider supply voltage as reference

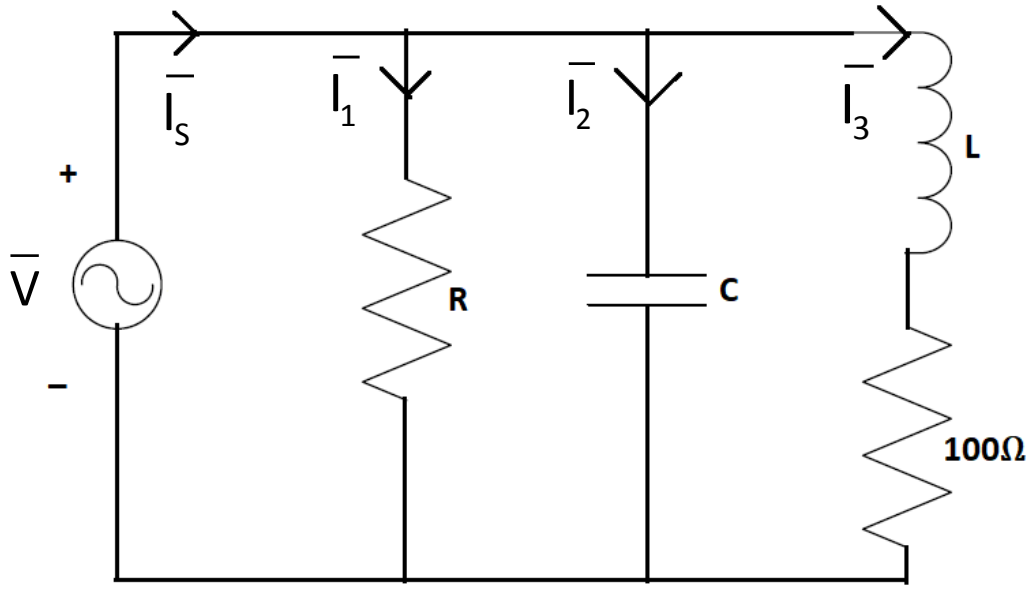
$$\Rightarrow \bar{V} = 200\angle 0° \text{ V}$$

Therefore, $\bar{I}_1 = 1.5\angle 0° \text{ A}$; $\bar{I}_2 = 2\angle 90° \text{ A}$

In branch 3, $|Z_3| = \frac{200}{1.2} = 166.66\Omega$

Numerical Example 3

Solution:



Therefore, $\phi_3 = \cos^{-1}(\frac{r_3}{|Z_3|}) = 53.13° \Rightarrow \bar{I}_3 = 1.2\angle -53.13°$ A

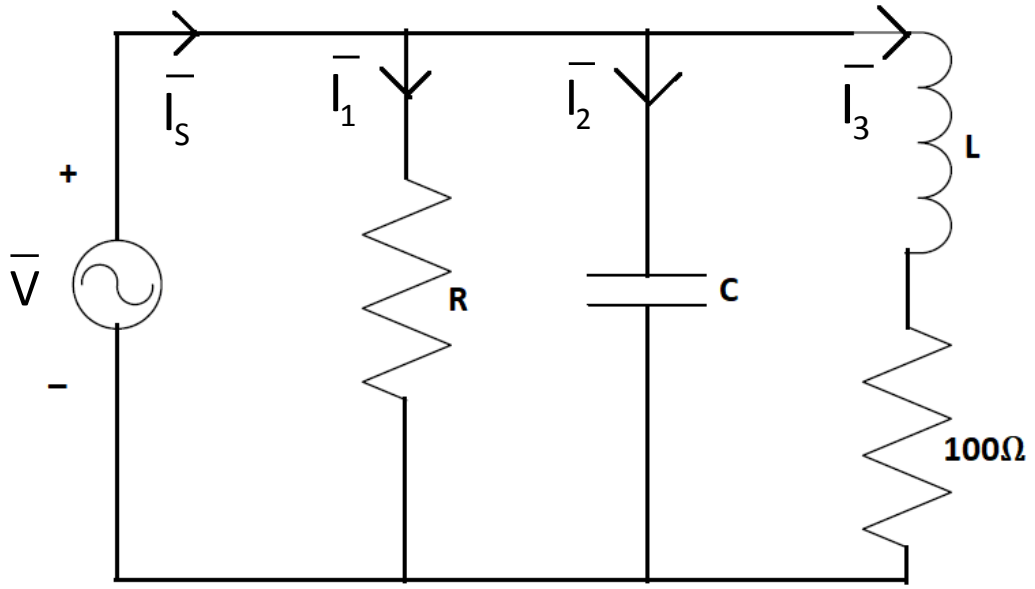
Hence, $\bar{I}_S = \bar{I}_1 + \bar{I}_2 + \bar{I}_3 = 2.45\angle 25.1°$ A

Phase Angle of the network = $\phi = \angle\bar{V} - \angle\bar{I}_s = -25.1°$

Overall Power factor = $\cos\phi = 0.905$ Lead

Numerical Example 3

Solution:



Power factor of the coil = $\cos\phi_3$ = 0.6 Lag

Total Active Power, $P_T = V*I_S*\cos\phi$ = 443.45W

Total Reactive Power, $Q_T = V*I_S*\sin\phi$ = -207.85 VAR

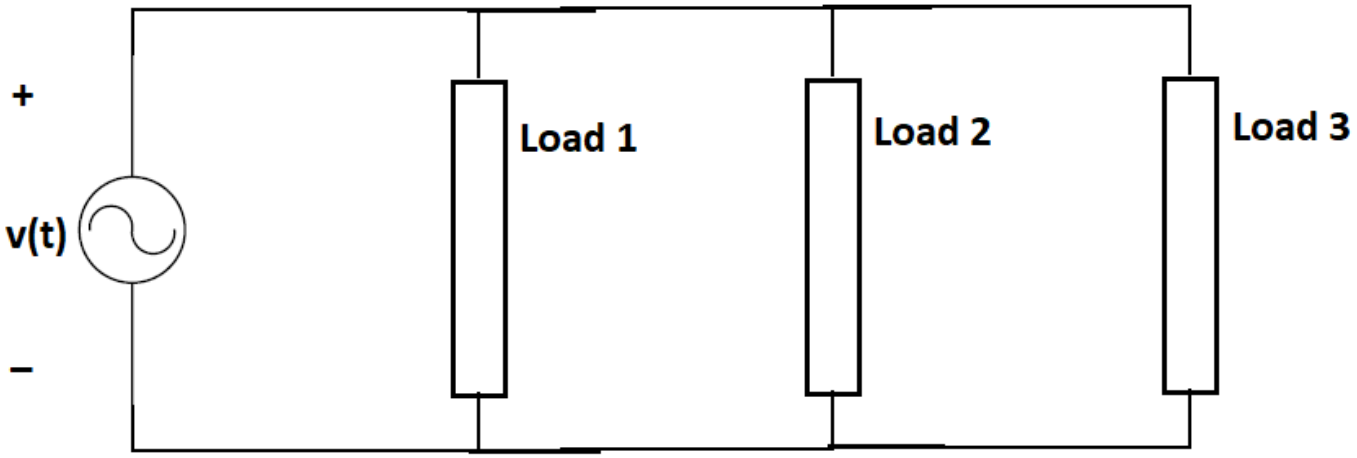
Numerical Example 4

Question:

The load connected across an AC supply consists 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 total power drawn from the supply in (KW and KVA) and its power factor. What would be the KVAR rating of a capacitor to bring the power factor to unity and how must the capacitor be connected?

Numerical Example 4

Solution:



Load 1 : Heating Load $\Rightarrow$ Resistive $\Rightarrow$ $\cos\phi_1 = 1$

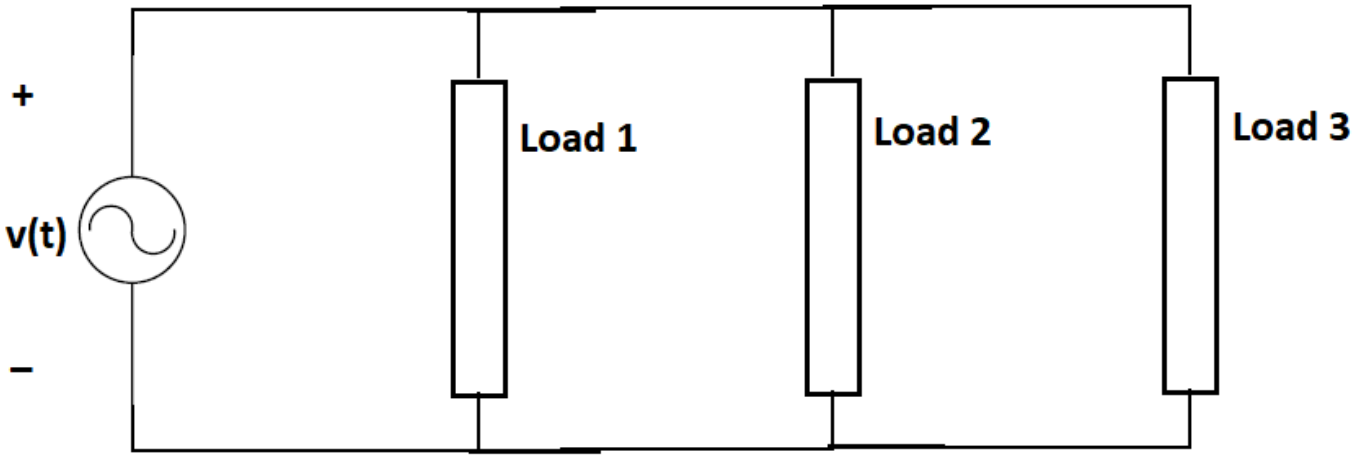
$P_1 = 15\text{KW}$ (given)

$Q_1 = 0$

$S_1 = \sqrt{P_1^2 + Q_1^2} = 15\text{KVA}$

Numerical Example 4

Solution:



Load 2 : Motor Load $\Rightarrow$ Inductive

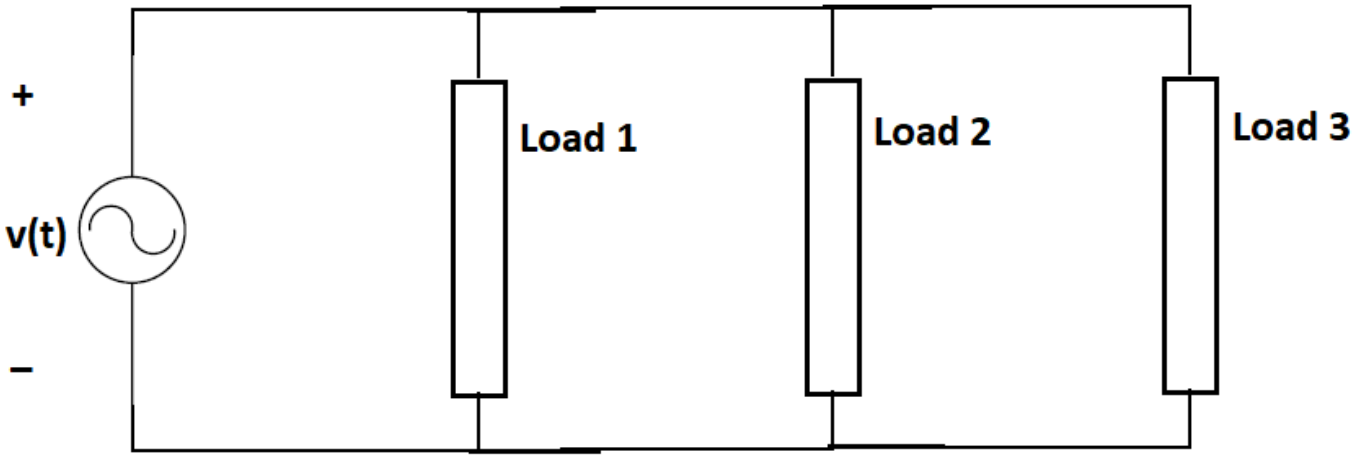
S_2 = 40KVA & $\cos\phi_2$ = 0.6 Lag (given)

$P_2 = S_2\cos\phi_2$ = 24KW

$Q_2 = \sqrt{S_2^2 - P_2^2}$ = 32KVAR

Numerical Example 4

Solution:



Load 3 : Inductive Load

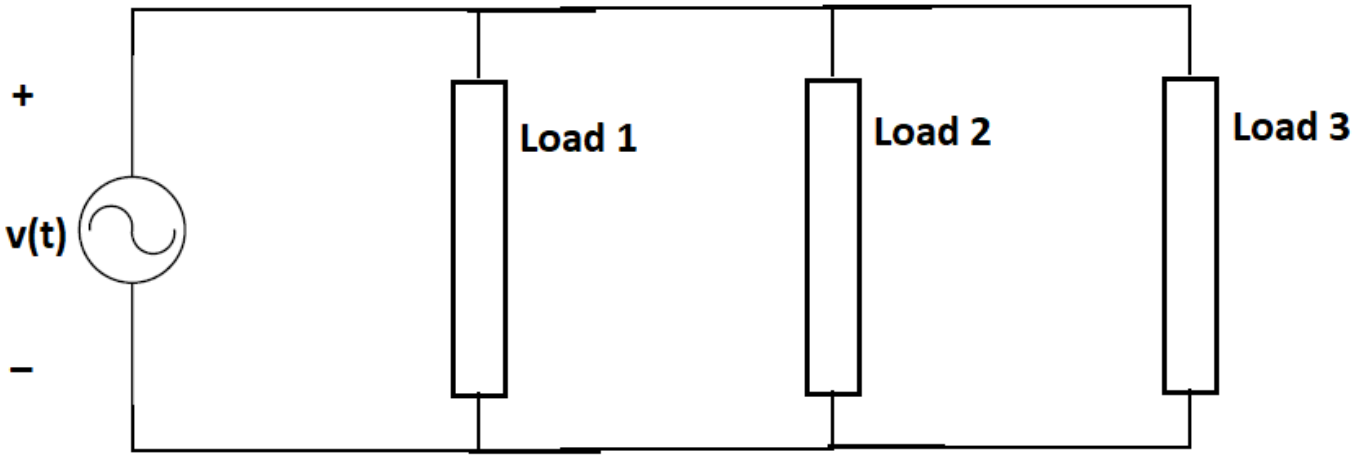
P_3 = 20KW & $\cos\phi_3$ = 0.8 Lag (given)

$$S_3 = \frac{P_3}{\cos\phi_3} = 25\text{KVA}$$

$$Q_3 = \sqrt{S_3^2 - P_3^2} = 15\text{KVAR}$$

Numerical Example 4

Solution:



Net Active Power, $P_T = P_1 + P_2 + P_3 = 59KW$

Net Reactive Power, $Q_T = Q_1 + Q_2 + Q_3 = 47KVAR$

Net Apparent Power, $S_T = \sqrt{P_T^2 + Q_T^2} = 75.43KVA$

To make overall power factor unity, net reactive power must be zero. Hence, connect a capacitor of rating 47KVAR in parallel to achieve this.

Numerical Example 5

Question:

b) An AC circuit has two branches A & B connected in parallel across a 230V, 50 Hz supply. Branch A consists of a coil with inductance 100mH and resistance 10Ω. Branch B takes a leading current from the supply. If the total power drawn from the source is 1KW and the overall power factor is 0.6 Lag, determine the resistance and capacitance in branch B.

Numerical Example 3

c)	The power consumed in the inductive load is 5 kW at 0.6 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 improves to 0.8 lagging.	8

	c)	A single-phase AC network consists of impedances Z_1 and Z_2 connected in parallel. This parallel combination is connected in series with another impedance Z_3. If this network is connected across a 200V, 50Hz AC supply & the supply current is 10A at a lagging power factor of 0.6, determine i) Impedance Z_2 if $Z_1 = (15+j20)\ \Omega$ & $Z_3 = (6+j8)\ \Omega$ ii) Branch currents in Z_1 and Z_2 iii) Reactive Powers in Z_1 and Z_2	8M

THANK YOU

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