ELEMENTS OF ELECTRICAL ENGINEERING
Course Code : UE25EE141A/B

PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING (UE25EE141A/B)

Numerical Examples on Series AC Circuits

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Numerical Example 1

Question:

A capacitor is used in series with a tungsten- filament bulb rated at 500W,100V, so that it gives its rated illumination when connected to a 220V,50Hz supply. Calculate the value of the capacitance, current drawn from the supply. Find the power factor.

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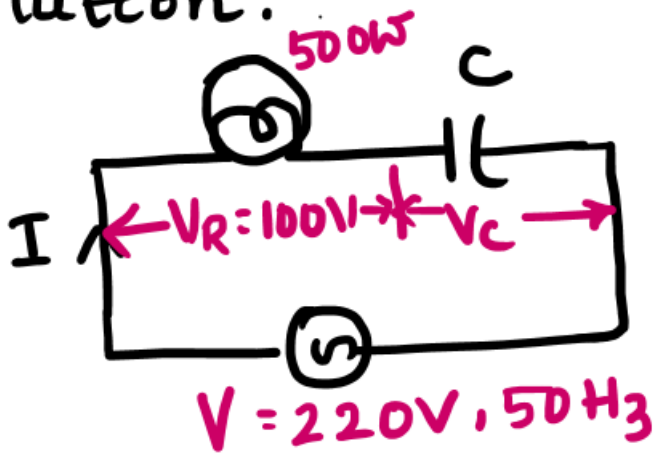
Numerical Example

Solution:



$$V^2 = V_R^2 + V_C^2$$

$$V_C^2 = 220^2 - 100^2$$

$$V_C = 195.95V$$

$$I_{Bulb} = \frac{P}{V} = \frac{500}{100} = 5A$$

Since it is a series network, current is same in all the elements. Hence current drawn is 5A.

$$X_C = \frac{V_C}{I} = \frac{195.95}{5} = 39.19\Omega$$

$$C = \frac{1}{2\pi f X_C} = 81.27\mu F$$

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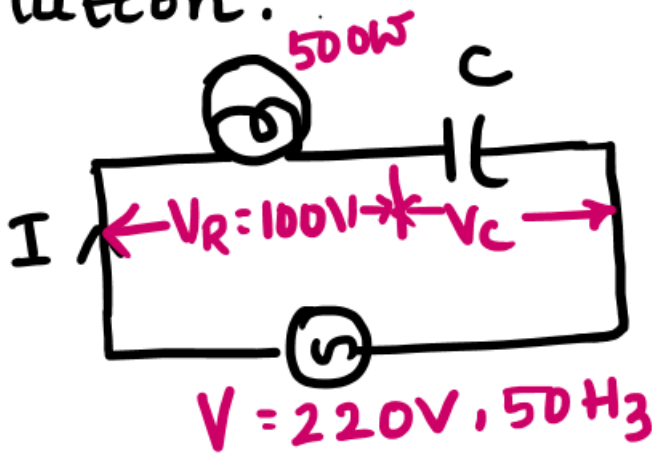
Numerical Example – Solution (Contd..)

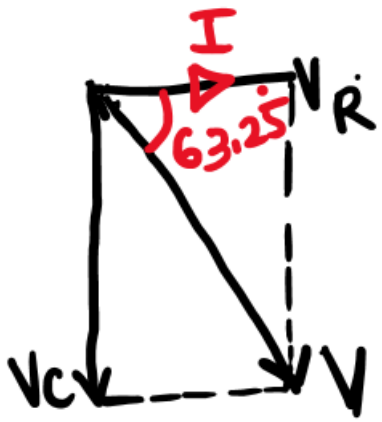
Solution:



$$Pf, \cos\phi = \frac{P}{S}$$

$$\cos\phi = \frac{500}{220 \times 5} = 0.4545 \text{ lead}$$

Phasor dia



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Numerical Example 2

Question:

3 coils A,B and C are connected in series. When a current of 3A is passed through the circuit, the voltage drops are respectively 12V, 6V and 9V on direct current and 15V, 9V and 12Von alternating current. Find for each of the coils i) internal parameters, ii) power dissipated when alternating current flows through the circuit, (iii)the applied voltage across it. Draw the phasor diagram. Find the overall power factor of the circuit.

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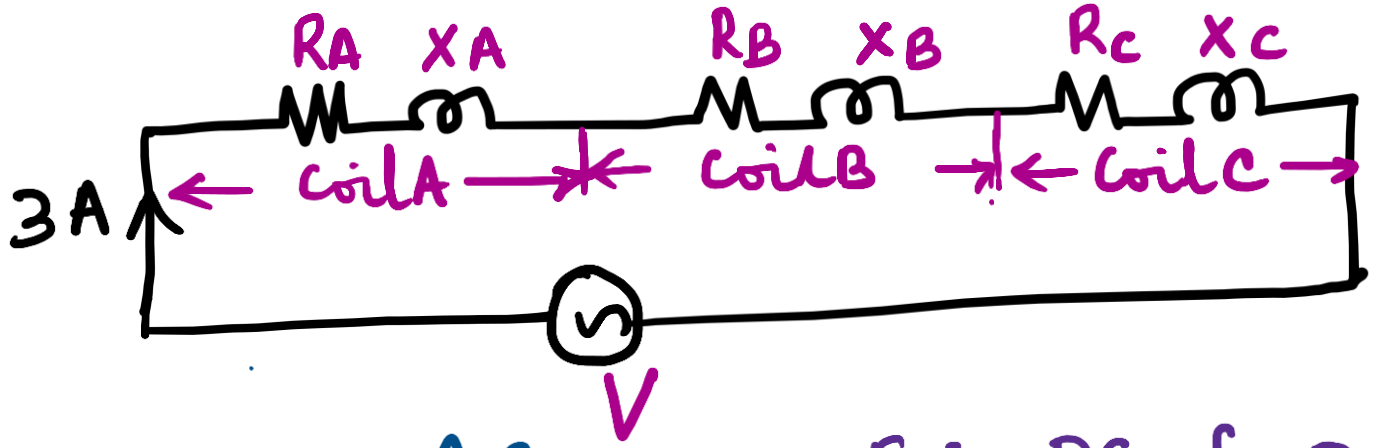
Numerical Example 2

Solution :



On DC

$V_A = 12V$

$V_B = 6V$

$V_C = 9V$

On AC

$V_A = 15$

$V_B = 9V$

$V_C = 12V$

For DC $f = 0$, $X_L = 0$

$\therefore$ coil behaves like a Pure resistor $\therefore$

$R_A = V_A/I = 12/3 = 4\Omega$

$R_B = V_B/I = 6/3 = 2\Omega$

$R_C = V_C/I = 9/3 = 3\Omega$

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Numerical Example 2

For AC supply

$Z_A = V_A/I = 15/3 = 5\Omega$; $X_A = \sqrt{Z_A^2 - R_A^2} = \sqrt{5^2 - 4^2} = 3\Omega$

$Z_B = V_B/I = 9/3 = 3\Omega$; $X_B = \sqrt{Z_B^2 - R_B^2} = \sqrt{3^2 - 2^2} = 2.23\Omega$

$Z_C = V_C/I = 12/3 = 4\Omega$; $X_C = \sqrt{Z_C^2 - R_C^2} = \sqrt{4^2 - 3^2} = 2.64\Omega$

$\vec{I} = 3\angle 0^\circ$ (Reference)

$\vec{V_A} = \vec{I} Z_A = 3(4 + j3) = 15\angle 36.86^\circ$

$\vec{V_B} = \vec{I} Z_B = 3(2 + j2.23) = 8.98\angle 48.11^\circ$

$\vec{V_C} = \vec{I} Z_C = 3(3 + j2.64) = 11.99\angle 41.35^\circ$

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Numerical Example 2

Applied voltage $\vec{V} = \vec{V_A} + \vec{V_B} + \vec{V_C}$

$= 15\angle 36.86 + 8.98\angle 48.11 + 11.99\angle 41.35$

$= 35.86\angle 41.16$

Power dissipated $= I^2 R_T$

$= 3^2(4+2+3)$

$= 81\,W$

Overall Pf $= \cos(41.16)$

$= 0.752$ lag

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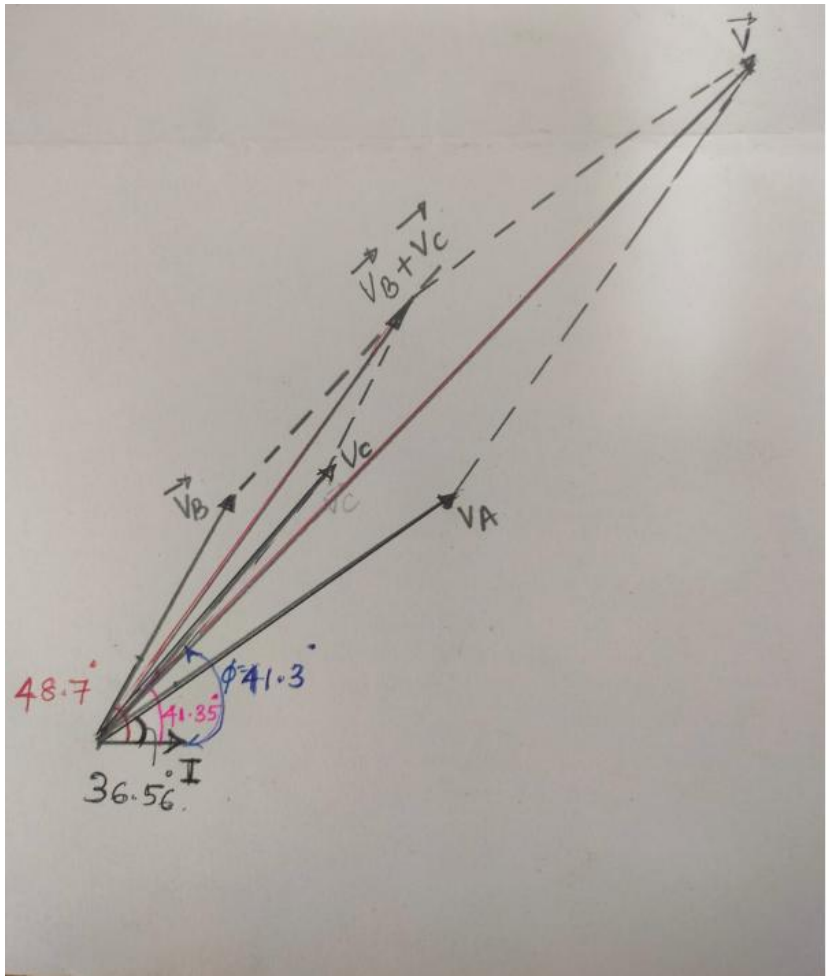
Numerical Example 2

Phasor diagram:



$V_A \angle \phi_A = 15 \angle 36.56$

$V_B \angle \phi_B = 9 \angle 48.7$

$V_C \angle \phi_B = 12 \angle 41.7$

$I \angle 0 = 3 \angle 0$ (Reference)

$V \angle \phi = 35.85 \angle 41.3$

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Text Book & References

Text Book:

1. "Basic Electrical Engineering" S.K Bhattacharya, 1st Edition Pearson India Education Services Pvt. Ltd., 2017
2. "Basic Electrical Engineering", D. C. Kulshreshta, 2nd Edition, McGraw-Hill. 2019
3. "Special Electrical Machines" E G Janardanan, PHI Learning Pvt. Ltd., 2014

Reference Books:

1. "Engineering Circuit Analysis" William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023

2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.

THANK YOU

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