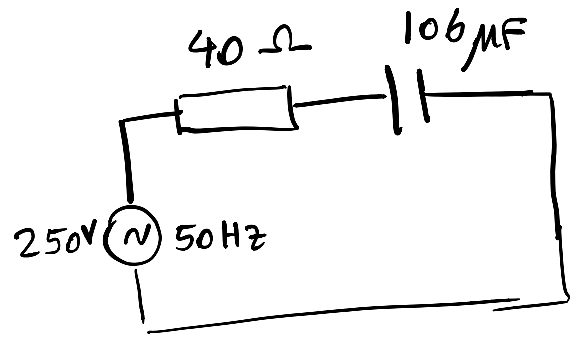
AC circuits.

A 106 μF capacitor is connected in series with a 40 Ω resistor across a 250 V, 50 Hz supply.

Calculate: a) the impedance

(b) the current, (c) power factor.



part a)

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 106 \times 10^{-6}} = 30\,\Omega$$

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{40^2 + 30^2} = 50\,\Omega$$

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part b)

current $i = \frac{V}{Z} = \frac{250}{50} = 5\text{ A}$

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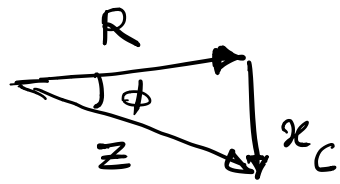
part c)

power factor : P.F. $= \cos\phi = \frac{R}{Z}$



$$P.F. = \frac{40}{50} = 0.8$$

The P.F. is leading because the circuit is capasitive.

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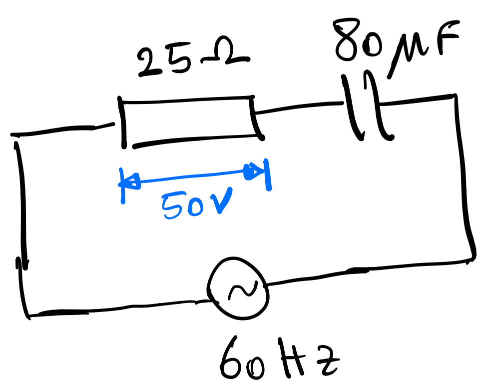
2) calculate, for the circuit shown in the figure:



a) the circuit current

b) the voltage across the capacitor

c) the supply voltage

d) the phase angle of the circuit.

calculate impedance: $Z = ?$

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 60 \times 80\times10^{-6}} = 33.16\,\Omega$$

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{25^2 + 33.16^2} = 41.5\,\Omega$$

a) current = ?

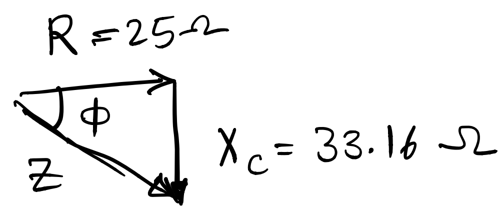
$$i = \frac{V_R}{R} = \frac{50}{25} = 2\text{ A}$$

b) $V_C = ?$

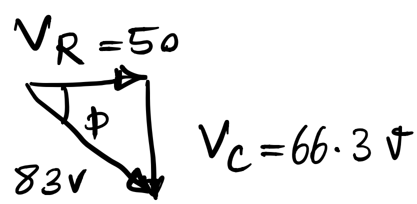
$$V_C = i\,X_C = 2 \times 33.16 = 66.3\text{ V}$$

c) $$V_{supply} = \sqrt{V_R^2 + V_C^2} = \sqrt{50^2 + 66.3^2} = 83\text{ V}$$

d) $$\phi = \tan^{-1}\frac{X_C}{R}$$



$$\phi = \tan^{-1}\frac{33.16}{25}$$

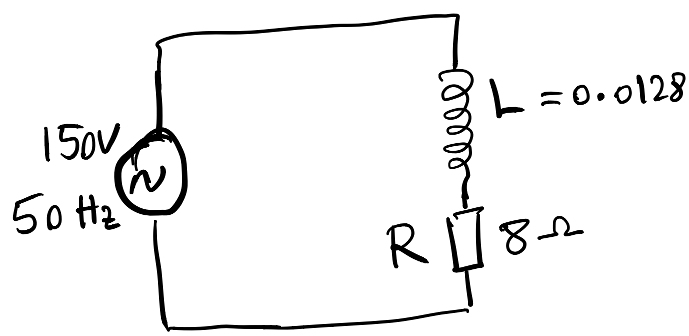


$$\phi = 53^\circ$$

3) A coil, of resistance 8 Ω and inductance of 0.0128 H, is connected to a 150 V, 50 Hz supply.

Calculate: (a) the impedance of the coil
(b) the current which will flow,
(c) the power factor, (d) the power absorbed by the coil.

$X_L = 2\pi f L$



$X_L = 2\pi \times 50 \times 0.0128 = 4\ \Omega$

(a) $Z = ?$

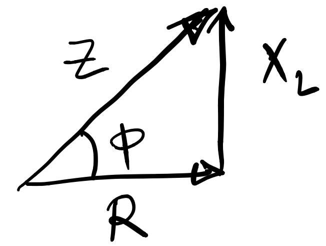
$Z = \sqrt{R^2 + X_L^2} = \sqrt{8^2 + 4^2} = 8.94\ \Omega$

(b) current = ?

$i = \frac{V}{Z} = \frac{150\ V}{8.94} = 16.77\ A$

(c) $P.F. = \cos\phi = \frac{R}{Z}$

$P.F. = \frac{8}{8.94}$



$P.F. = 0.895$ (lagging) because the circuit is inductive

(d) The power absorbed (L does not consume power)

$Power = V.I = RI.I = RI^2 = 16.77^2 \times 8$

$= 2250\ W$

$V = RI$ or $I = \frac{V}{R}$

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4) when a d.c. supply at 240V is applied to the ends of a certain coil, the current in the coil is 20 A.
If an a.c. supply at 240V, 50 Hz is applied to the coil, the current in the coil is 12.15 A.

Calculate the resistance, impedance, inductance, and reactance of the coil.

For the d.c. supply the reactance of the coil $X_L = 0$, since $X_L = 2\pi f L$ and $f = 0$ for d.c.

So the resistance of the coil: $R_L = \frac{240}{20} = 12\,\Omega$

For a.c. supply, the impedance of the coil Z :

$$Z = \frac{v}{i} = \frac{240}{12.15} = 19.8\,\Omega$$

$$Z = \sqrt{X_L^2 + R^2} \longrightarrow Z^2 = X_L^2 + R^2$$

(?)

$$X_L = \sqrt{Z^2 - R^2} = \sqrt{19.8 - 12^2} = 15.7\,\Omega$$

$$X_L = 2\pi f L \Longrightarrow L = \frac{X_L}{2\pi f} = \frac{15.7}{2\pi \times 50} = 50\,mH$$

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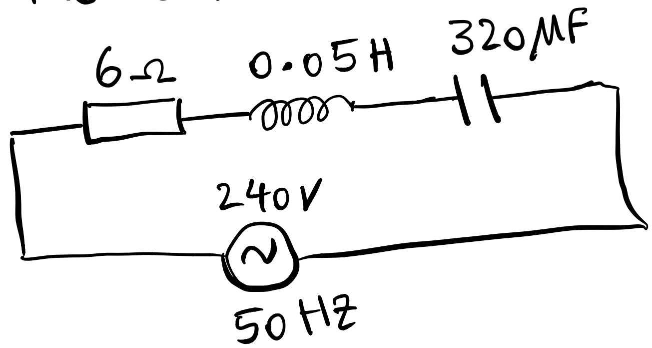
5) A circuit comprises a resistance of 6 Ω, an inductance of 0.05 H and a capacitance of 320 μF, all connected in series. An alternating supply at 240 V, 50 Hz is applied to the ends of the circuit.

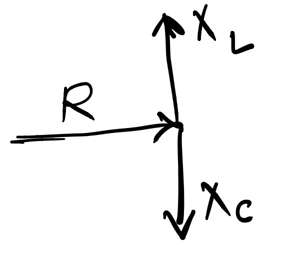
Calculate the current taken.



$X_L = 2\pi f L = 2\pi \times 50 \times 0.05 = 15.7\ \Omega$

$X_c = 1/(2\pi f C) = 1/(2\pi \times 50 \times 320 \times 10^{-6}) = 9.95\ \Omega$

$Z = \sqrt{R^2 + (X_L - X_c)^2}$



$Z = \sqrt{6^2 + (15.7 - 9.95)^2} = 8.3\ \Omega$

$i = V/Z = 240/8.3 = 28.87\ A$

6) A coil having a resistance of $5\,\Omega$ and an inductance of 0.2 H is connected in series with a capacitor of $150\,\mu F$ to 100V, 50 Hz mains.

Find: (a) the voltage across the coil and (b) the power factor of the whole circuit stating whether it is lagging or leading.