The box shown below represents a circuit consisting only of resistors, inductors and capacitors. In frequency domain, it can be represented by an equivalent impedance.

Given:
\[ v(t) = 10 \cos(200\pi t + 15^\circ) \text{ V}; \quad i(t) = 2 \sin(200\pi t + 45^\circ) \text{ A}. \]

\[ \sin A = \cos(A - \pi/2) \]

2 (a) Find the time \( t \) when the voltage peaks up first time after \( t = 0 \).

\[ 2\omega t + \frac{15^\circ}{180^\circ} = 2\pi \]

\[ t = \frac{345^\circ}{180^\circ \times 2\pi} \approx 4.58 \text{ ms} \]

2 (b) Show phasor diagrams (phasors in complex plane) for voltage and current.

\[ V = 10 \angle 15^\circ \text{ V} \]

\[ I = 2 \angle -45^\circ \text{ A} \]

2 (c) What is the impedance of the box? Give your answer in the rectangular form.

\[ Z = \frac{V}{I} = 5 \angle 60^\circ = (2.5 + j4.33) \Omega \]

2 (d) If the above impedance is made of a resistor and a single energy-storage element (L or C) connected in series, find their values (values of R, L or C).

\[ Z = R + j\omega L = 2.5 + j4.33 \]

\[ R = 2.5 \Omega \]

\[ L = \frac{4.33}{200\pi} = 6.89 \text{ mH} \]

2 (e) If the above impedance is made of a resistor and a single energy-storage element (L or C), connected in parallel, find their values (values of R, L or C).

\[ \frac{1}{Z} = 0.1 - j0.1732 = \frac{1}{R} + \frac{1}{j\omega L} \]

\[ R = 10 \Omega \]

\[ L = 9.19 \text{ mH} \]
The box shown below represents a circuit consisting only of resistors, inductors, and capacitors. In frequency domain, it can be represented by an equivalent impedance.

Given: \( i(t) = 2 \cos(200\pi t + 15^\circ) \text{A}; \quad v(t) = 20\sin(200\pi t + 45^\circ) \text{V} \)

\( \sin A = \cos(A - \pi/2) \)

2. (a) Find the time \( t_0 \) when the voltage peaks up first time after \( t = 0 \).

\[
200\pi t + \frac{\pi}{4} = \frac{\pi}{2}
\]

\[
t = \frac{\pi}{4 \times 200\pi} = 1.25 \text{ ms}
\]

2. (b) Show phasor diagrams (phasors in complex plane) for voltage and current.

\[
\tilde{V} = 20 \angle -45^\circ \text{V}
\]

\[
\tilde{I} = 2 \angle 15^\circ \text{A}
\]

2. (c) What is the impedance of the box? Give your answer in the rectangular form.

\[
\tilde{Z} = \frac{\tilde{V}}{\tilde{I}} = \frac{20 \angle -45^\circ}{2 \angle 15^\circ} = 10 \angle -60^\circ \Omega
\]

\[
= (5 - j8.66) \Omega
\]

2. (d) If the above impedance is made of a resistor and a single energy-storage element (L or C) connected in series, find their values (values of R, L or C).

\[
\tilde{Z} = 5 - j8.66 = R - j\frac{1}{\omega C}
\]

\[
R = 5 \Omega
\]

\[
C = \frac{1}{8.66 \times 2 \times 10^{12}} = 184 \mu \text{F}
\]

2. (e) If the above impedance is made of a resistor and a single energy-storage element (L or C), connected in parallel, find their values (values of R, L or C).

\[
\frac{1}{\tilde{Z}} = \frac{1}{R} + \frac{1}{j\omega L} = \frac{1}{R} + \frac{j\omega C}{1} = \frac{1}{10 \angle -60^\circ} = (0.05 + j0.0866)
\]

\[
R = 20 \Omega
\]

\[
C = 138 \mu \text{F}
\]