

A) The Phasor Form Of The Sinusoid $20 \cos(4t + 139^\circ)$ Is 20 .b) Using Phasors, The Value Of $1 \cos(20t +$

A) The Phasor Form Of The Sinusoid $20 \cos(4t + 139^\circ)$ Is 20

Understanding the phasor representation of sinusoidal signals is fundamental in electrical engineering, especially in the analysis of AC circuits. Consider the sinusoid $20 \cos(4t + 139^\circ)$. Its amplitude is 20, its angular frequency is 4 rad/sec, and its phase shift is 139° . When converted into its phasor form, this sinusoid can be represented as a complex number that encapsulates both magnitude and phase, simplifying the analysis of signals especially when dealing with superposition or impedance calculations. The key point here is that the magnitude of the phasor directly corresponds to the amplitude of the sinusoid, and the phase corresponds to the phase shift of the wave.

Understanding the Sinusoid

- Amplitude: 20
- Angular frequency: 4 rad/sec
- Phase shift: 139°

Converting to Phasor Form

The general form of a sinusoid in the time domain is:

$$v(t) = A \cos(\omega t + \phi)$$

where:

- A = amplitude
- ω = angular frequency
- ϕ = phase angle in degrees or radians

The corresponding phasor is a complex number expressed as:

$$V = A\angle\phi$$

or in rectangular form as:

$$V = A \cos(\phi) + j A \sin(\phi)$$

Phasor Representation of $20 \cos(4t + 139^\circ)$

- The magnitude is 20
- The phase angle is 139°

Therefore, the phasor can be written as:

$$V = 20\angle 139^\circ$$

This form is particularly useful for circuit analysis, as it enables straightforward addition of sinusoidal voltages and currents by simply adding their phasors algebraically.

Using Phasors, The Value Of $\cos(20t + \dots)$

In the second part of the discussion, the focus is on determining the value of a sinusoid of the form $\cos(20t + \dots)$. Using phasors, this process simplifies to representing the sinusoid as a complex number and analyzing its properties. Though the phase angle is not specified in the given fragment, the method remains the same regardless of the phase value. We will explore the general approach for calculating the instantaneous value of such a sinusoid using phasor concepts.

General Approach to Phasor Analysis

1. Identify the amplitude (A), angular frequency (ω), and phase angle (ϕ) of the sinusoid.
2. Express the sinusoid as a phasor: $V = A\angle\phi$.
3. Use the phasor to perform desired operations or calculations.
4. Convert the phasor back to the time domain if needed, using the inverse transformation:

$$v(t) = \operatorname{Re}\{V e^{j\omega t}\} = A \cos(\omega t + \phi)$$

Calculating the Instantaneous Value

Suppose the sinusoid is:

$$v(t) = 1 \cos(20t + \varphi)$$

with an unknown phase φ . The steps are:

1. Express the phasor as:

$$V = 1\angle\varphi$$

1. If φ is known, the instantaneous value at time t is:

$$v(t) = \operatorname{Re}\{V e^{j20t}\} = A \cos(20t + \varphi)$$

where:

- A = magnitude of the phasor (here, 1)
- φ = phase angle in radians or degrees

In the absence of a specified phase angle, it's common to assume $\varphi = 0^\circ$, which simplifies the sinusoid to:

$$v(t) = \cos(20t)$$

Practical Application: Example Calculation

- Given: $v(t) = 1 \cos(20t + \varphi)$
- Assuming $\varphi = 30^\circ$, then the phasor is:

$$V = 1\angle 30^\circ$$

The instantaneous value at time t is:

$$v(t) = \cos(20t + 30^\circ)$$

Summary of Phasor Methodology

- Convert sinusoidal signals into their phasor form for simplified analysis.
- Phasors allow for easy addition, subtraction, and multiplication, which correspond to

superposition and impedance calculations in circuit theory.

- The inverse process involves converting the phasor back into the time domain to find the instantaneous value.

Conclusion

The use of phasors significantly streamlines the analysis of sinusoidal signals in electrical systems. For the specific sinusoid $20 \cos(4t + 139^\circ)$, the phasor form is simply $20\angle 139^\circ$, capturing both magnitude and phase in a compact form. When dealing with other sinusoidal signals like $1 \cos(20t + \phi)$, the same principles apply: identify the amplitude and phase, represent the signal as a phasor, perform calculations in the complex domain, and convert back to the time domain to find instantaneous values. Mastery of phasor analysis is essential for engineers working with AC circuits, signal processing, and communications, providing a powerful tool for simplifying complex sinusoidal interactions.

Frequently Asked Questions

What is the phasor form of the sinusoid $20 \cos(4t + 139^\circ)$?

The phasor form is $20\angle 139^\circ$, representing the magnitude and phase angle of the sinusoid.

How do you convert a cosine sinusoid to its phasor form?

Express the sinusoid as a complex exponential and identify the magnitude and phase angle; the phasor is then written as magnitude $\angle$ phase.

What is the significance of using phasors in analyzing sinusoidal signals?

Phasors simplify the addition, subtraction, and multiplication of sinusoidal signals by representing them as complex numbers with magnitude and phase.

Given the sinusoid $20 \cos(4t + 139^\circ)$, what is its amplitude and phase?

Amplitude is 20, and phase angle is 139° .

Using phasors, how do you find the value of $1 \cos(20t + \theta)$?

Express the sinusoid as a phasor with magnitude and phase, then analyze or combine it algebraically as a complex number.

What is the general method to convert a sinusoidal function to its phasor representation?

Identify the amplitude and phase, then write the phasor as magnitude $\angle$ phase in degrees or radians.

How does phase shift affect the phasor representation of a sinusoid?

The phase shift directly corresponds to the angle component of the phasor, shifting its position in the complex plane.

Can phasors be used to analyze multiple sinusoidal signals simultaneously?

Yes, by representing each sinusoid as a phasor, their superposition can be easily computed through vector addition.

What are the advantages of using phasors over direct time-domain analysis?

Phasors simplify calculations involving sinusoidal signals, especially for steady-state analysis in AC circuits, by converting differential equations into algebraic ones.

Additional Resources

Understanding the Phasor Representation of Sinusoidal Signals: An In-Depth Analysis

The concept of phasors has revolutionized the way engineers and physicists analyze sinusoidal signals, especially in the context of alternating current (AC) circuits and signal processing. By transforming complex sinusoidal functions into a simplified, rotating vector form in the complex plane, phasors provide an elegant method for handling amplitude, phase, and frequency components simultaneously. This article delves into the phasor form of sinusoidal signals, focusing on specific examples such as $20 \cos(4t + 139^\circ)$ and $\cos(20t + \text{last})$, offering detailed explanations, practical insights, and analytical techniques.

1. Foundations of Sinusoidal Functions and Phasors

1.1 Sinusoidal Functions in Engineering and Physics

Sinusoidal functions, represented mathematically as sines and cosines, are fundamental to describing oscillatory phenomena across various disciplines. In electrical engineering, these functions model

voltage and current waveforms in AC circuits; in physics, they describe wave phenomena such as sound waves and electromagnetic waves.

A general sinusoidal function can be expressed as:

$$x(t) = A \cos(\omega t + \phi)$$

where:

- A is the amplitude (peak value),
- ω is the angular frequency ($\omega = 2\pi f$),
- ϕ is the phase angle (in degrees or radians),
- t is time.

These functions are periodic, with a period $T = \frac{2\pi}{\omega}$.

1.2 The Concept of Phasors

While sinusoidal functions are straightforward, their analysis becomes cumbersome when dealing with sums, differences, or transformations in circuits. The phasor concept simplifies this by representing a sinusoid as a rotating vector (or complex exponential) in the complex plane.

Definition of a Phasor:

A phasor is a complex number $\tilde{X}$ that encodes the amplitude and phase of a sinusoid:

$$\tilde{X} = A e^{j\phi}$$

where:

- A is the magnitude (corresponding to the amplitude),
- ϕ is the phase angle,
- j is the imaginary unit ($j^2 = -1$).

The real sinusoid can then be reconstructed as the real part of this complex exponential:

$$x(t) = \text{Re} \left\{ \tilde{X} e^{j\omega t} \right\}$$

This transformation allows for algebraic manipulation of sinusoidal signals as if they were complex numbers, simplifying addition, subtraction, and differentiation.

2. Phasor Representation of $20 \cos(4t + 139^\circ)$

2.1 Expressing the Signal as a Phasor

Given the sinusoid:

$$x(t) = 20 \cos(4t + 139^\circ)$$

the goal is to find its phasor representation.

Step 1: Identify amplitude and phase

- Amplitude $(A = 20)$
- Phase $(\phi = 139^\circ)$

Step 2: Convert phase to radians (if necessary)

Since some calculations are easier in radians:

$$\phi = 139^\circ \times \frac{\pi}{180} \approx 2.427 \text{ radians}$$

Step 3: Construct the phasor

The phasor $\tilde{X}$ is:

$$\tilde{X} = A e^{j\phi} = 20 e^{j 2.427}$$

or, in rectangular form:

$$\tilde{X} = 20(\cos 2.427 + j \sin 2.427)$$

Calculating:

$$\cos 2.427 \approx -0.76$$

$$\sin 2.427 \approx 0.65$$

Thus:

$$\tilde{X} \approx 20 \times (-0.76 + j 0.65) = -15.2 + j 13$$

Summary:

The phasor is approximately:

$$\boxed{\tilde{X} \approx -15.2 + j 13}$$

which can be represented as a complex number in the Argand plane.

Step 4: Reconstruct the sinusoid

The time-domain signal:

$$x(t) = \operatorname{Re} \left\{ \tilde{X} e^{j 4 t} \right\}$$

which confirms the original sinusoid.

2.2 Significance of the Phasor Form

- Simplification of Calculations: When multiple sinusoidal signals are involved, their phasors can be algebraically added or subtracted to find resultant waveforms.
- Frequency Domain Analysis: Phasors facilitate analysis in the frequency domain, especially in AC circuit analysis, where impedance and transfer functions are expressed as complex quantities.
- Visualization: The vector's magnitude indicates the amplitude, while its angle indicates the phase difference relative to a reference.

3. Using Phasors to Determine the Value of $\cos(20t + \text{ast})$

3.1 General Approach to Phasor Representation

The process of converting a sinusoid like:

$$x(t) = \cos(20t + \text{ast})$$

to a phasor involves:

- Extracting amplitude (A) (here, 1, since the coefficient is implicit),
- Expressing phase (ast) ,
- Converting to complex form.

Note: The placeholder (ast) indicates an unknown phase angle. For the purpose of this analysis, assume a phase (θ) (say, in degrees).

Step-by-step:

1. Express the sinusoid:

$$x(t) = \cos(20t + \theta)$$

2. Form the phasor:

$$\tilde{X} = 1 \times e^{j \theta}$$

\]

which in rectangular form is:

\[

$$\tilde{X} = \cos \theta + j \sin \theta$$

\]

3. Reconstruct in the time domain:

\[

$$x(t) = \operatorname{Re} \left\{ \tilde{X} e^{j 20 t} \right\}$$

\]

Note: The phasor representation simplifies the analysis of this sinusoid, especially when combined with other signals or subjected to system operations.

3.2 Practical Applications and Implications

- Signal Superposition: Phasors enable straightforward addition of multiple signals, crucial in power systems and communication engineering.
- Impedance Calculations: In AC circuits, voltages and currents are represented as phasors; impedances are complex quantities that influence phase relationships.
- System Response Analysis: Transfer functions and system behavior are often described in the complex frequency domain using phasors.

4. Analytical Insights and Practical Applications

4.1 Advantages of Phasor Analysis

- Simplification of Differential Equations: Converting sinusoidal differential equations into algebraic equations in the complex domain.
- Efficiency: Reduces the complexity of calculations involving multiple sinusoidal signals.
- Intuitive Visualization: The rotating vector provides a visual understanding of amplitude and phase relationships.

4.2 Limitations and Considerations

- Steady-State Analysis Only: Phasors are primarily applicable to steady-state sinusoidal signals; they do not capture transient behaviors.
- Assumption of Linearity: Accurate when system responses are linear and time-invariant.
- Phase Uncertainty: When phase angles are unknown or variable, additional measurement or computation is necessary.

4.3 Real-World Applications

- Power System Engineering: Phasor Measurement Units (PMUs) monitor voltage and current phasors for grid stability.
- Communication Systems: Modulation schemes often utilize phase and amplitude manipulations represented via phasors.
- Control Systems: Frequency response analysis relies on phasor concepts to design stable controllers.

5. Summary and Concluding Remarks

The exploration of sinusoidal functions through the lens of phasors offers a powerful analytical approach that simplifies complex calculations, enhances visualization, and facilitates system analysis. The example of $20 \cos(4t + 139^\circ)$ illustrates how a sinusoid can be represented as a complex exponential, enabling straightforward addition and manipulation. Similarly, understanding the phasor form of $\cos(20t + \text{ast})$ reveals how phase and amplitude play crucial roles in signal behavior and system response.

By translating time-domain signals into the frequency domain via phasors, engineers can analyze, design, and optimize systems more efficiently. As technology advances, the importance of phasor analysis continues to grow, underpinning innovations in power systems, communications, and control

[A The Phasor Form Of The Sinusoid 20 Cos 4t 139 Is 20 B Using Phasors The Value Of 1 Cos 20t](#)

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