Phasor Review

Two sinusoids with frequency $\omega = 2\pi$ are represented in the phasor domain as

$\mathbf{V}_1 = 5\sqrt{2}\angle 45°$ and $\mathbf{V}_2 = \dfrac{10}{1+j}$

Using phasor manipulation, express each of the following combinations as a cosine function. You should only need a calculator on number 3 for basic arithmetic operations.:

1) $\mathbf{V}_1 + \mathbf{V}_2$
2) $\mathbf{V}_1\mathbf{V}_2$
3) $\mathbf{V}_1$ **- 2**$\mathbf{V}_2$

Phase Review

Given that $x(t) = A\cos(\omega_0 t)$ answer the following questions:

4) If A=5 and $\omega_0 = 2\pi$ find the phase shift of x(t-2) in degrees.

5) If A=5 and $\omega_0 = \dfrac{\pi}{3}$ find the phase shift of x(t-2) in degrees. Why does the same time delay create a different phase shift?

6) If A=5 and $\omega_0 = 2\pi$ find the phase shift of x(t+3.5) in degrees.

7) If A=5 and $\omega_0 = \omega$, where ω is a variable representing the frequency, plot the phase shift of x(t-2) as a function of frequency.

The next few questions operate in reverse. If $x_1(t) = A\cos(\omega_0 t)$ and $x_2(t) = A\cos(\omega_0 t - \theta)$:

8) If A=4, $\omega_0 = 2\pi$, and $\theta = 45°$, what is the equivalent time delay, t_0, that satisfies $x_2(t) = x_1(t - t_0)$.

9) If A=4, $\omega_0 = 2\pi 100$, and $\theta = 45°$, what is the equivalent time delay, t_0, that satisfies $x_2(t) = x_1(t - t_0)$.

10) If A=4, $\omega_0 = 2\pi 100$, and $\theta = -90°$, what is the equivalent time delay, t_0, that satisfies $x_2(t) = x_1(t - t_0)$.

Complex Number Review

11) If $z = \dfrac{2-j}{3+2j}$, then the **magnitude** of z, $|z|$, is

a) $\dfrac{\sqrt{5}}{\sqrt{13}}$ b) $\dfrac{\sqrt{3}}{\sqrt{5}}$ c) $\dfrac{\sqrt{1}}{\sqrt{5}}$ d) 1

12) If $z = \dfrac{1}{1+j}$, then the **phase** of z, $\measuredangle z$, is

a) 0^o b) 45^o c) -45^o d) -90^o

13) The **magnitude** of $z = j$ is

a) 1 b) -1 c) 0 d) none of these

14) The **phase** of $z = -1$ is

a) 0^o b) 45^o c) 90^o d) 135^o e) 180^o f) none of these

15) The **magnitude** of $z = (2+j)e^{j\omega t}$ is

a) $\sqrt{3}$ b) $\sqrt{3}e^{j\omega t}$ c) $\sqrt{5}$ d) $\sqrt{5}e^{j\omega t}$ e) none of these

16) If z is a complex number with complex conjugate z^*, and we know $|z| = 2$, then $|z^*|$ is equal to

a) -2 b) 2 c) it is not possible to determine

17) If z is a complex number with complex conjugate z^*, and we know $\angle z = 45^o$, then $\angle z^*$ is equal to

a) 45^o b) -45^o c) it is not possible to determine

18) Using Euler's identity, we can write $\cos(\omega t)$ as

a) $\dfrac{e^{j\omega t}+e^{-j\omega t}}{2}$ b) $\dfrac{e^{j\omega t}-e^{-j\omega t}}{2}$ c) $\dfrac{e^{j\omega t}+e^{-j\omega t}}{2j}$ d) $\dfrac{e^{j\omega t}-e^{-j\omega t}}{2j}$

19) Using Euler's identity, we can write $\sin(\omega t)$ as

a) $\dfrac{e^{j\omega t}+e^{-j\omega t}}{2}$ b) $\dfrac{e^{j\omega t}-e^{-j\omega t}}{2}$ c) $\dfrac{e^{j\omega t}+e^{-j\omega t}}{2j}$ d) $\dfrac{e^{j\omega t}-e^{-j\omega t}}{2j}$

Filtering Review

Problems 20-22 refer to a system with transfer function $H(s)=\frac{10}{s+3}$. Assume the input to this system is $x(t)=2\cos(3t+30^o)$

20) In steady state, the **magnitude** of the output will be

a) $\frac{20}{3}$ b) $\frac{20}{\sqrt{18}}$ c) $\frac{20}{\sqrt{8}}$ d) $\frac{20}{6}$

21) In steady state, the **phase** of the output will be

a) 30^o b) 45^o c) -15^o d) -45^o

22) The **bandwidth** (-3 dB point) of the system is

a) 10 Hz b) 10 radians/sec c) 3 radians/sec d) 3 Hz

23) Assume $x(t)=3\cos(2t-5)$ is the input to a system with transfer function

$$H(j\omega)=\begin{cases} 3e^{-j2\omega} & |\omega|<3 \\ 2 & else \end{cases}$$

the output $y(t)$ in steady state will be

a) $y(t)=6\cos(2t-5)$ b) $y(t)=9\cos(2t-5)$
c) $y(t)=9\cos(2t-5)e^{-j4}$ d) $y(t)=9\cos(2t-9)$

24) Assume $x(t)=2\cos(3t)$ is the input to system with transfer function $H(j\omega)=2e^{-j\omega}$. In steady state the output of the system will be

a) $y(t)=4\cos(3t)e^{-j\omega}$ b) $y(t)=4\cos(3t)e^{-j3}$ c) $y(t)=4\cos(3t-3)$
d) $y(t)=4\cos(3t+3)$ e) none of these

25) Assume $x(t) = 2\cos(t) + 5\sin(2t) + 6\sin(3t)$ is the input to a system with transfer function $H(j\omega) = 3\Pi\left(\frac{\omega}{5}\right)$. In steady state the output of the system will be

a) $y(t) = [2\cos(t) + 5\sin(2t) + 6\sin(3t)]\left[3\text{rect}\left(\frac{\omega}{5}\right)\right]$

b) $y(t) = 6\cos(t) + 15\sin(2t) + 18\sin(3t)$

c) $y(t) = 6\cos(t) + 15\sin(2t)$

d) none of these

26) Assume $x(t) = 2\cos(3t) + 4\cos(5t)$ is the input to a system with transfer function given by

$$H(j\omega) = \begin{cases} 2 & 4 < |\omega| < 6 \\ 0 & else \end{cases}$$

The output of the system in steady state will be

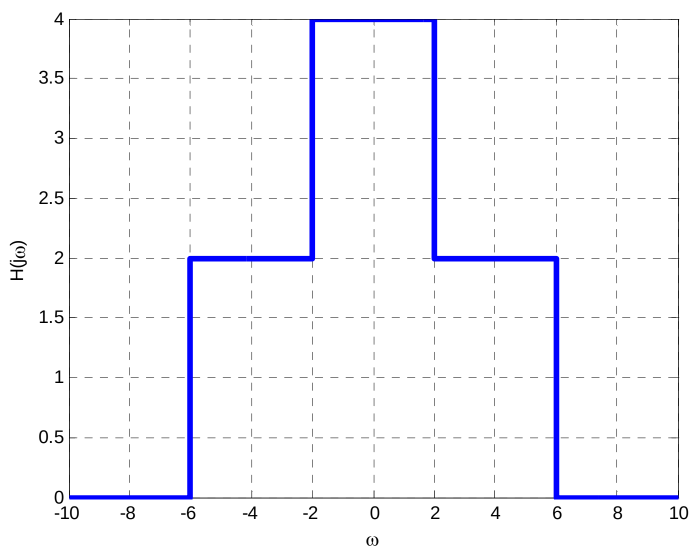
a) $y(t) = 4\cos(3t) + 8\cos(5t)$

b) $y(t) = 8\cos(5t)$

c) $y(t) = 4\cos(3t)$

d) none of these

27) Assume $x(t) = \cos(t) + \cos(5t) + \cos(9t)$ is the input to a system with transfer function given below:

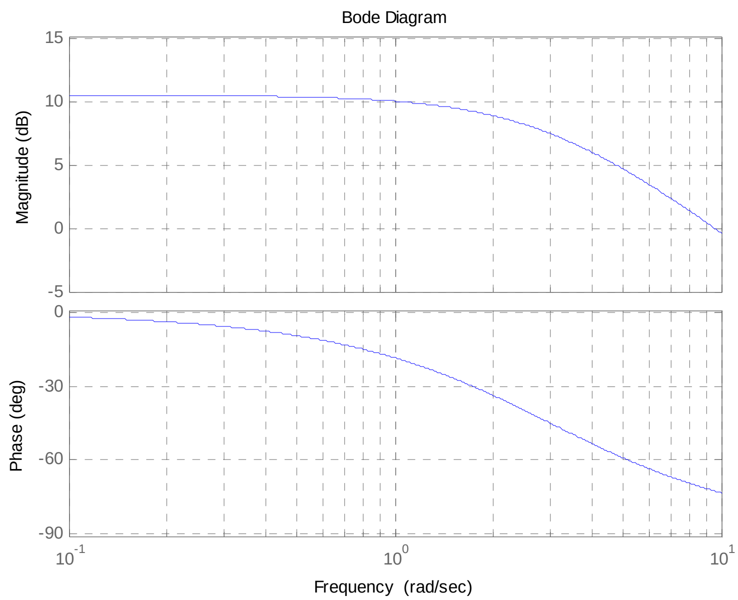


The output of this system in steady state will be

a) $y(t) = 4\cos(t) + 4\cos(5t)$ b) $y(t) = 4\cos(t) + 2\cos(5t) + \cos(9t)$

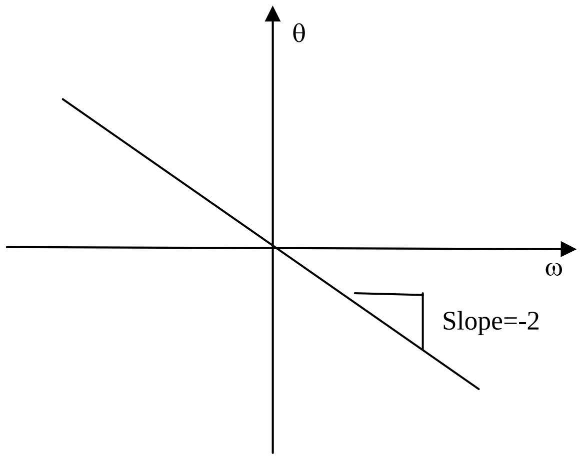
c) $y(t) = 4\cos(t) + 2\cos(5t)$ d) none of these

28) The following figure displays the magnitude and phase of a transfer function $H(s)$ as a function of frequency ω. The input to this system is $x(t) = 2\cos(3t + 30^o)$. Determine an expression for the **output** of the system in steady state.



Answers:

1) $10\cos(2\pi t - 0°)$ 2) $50\cos(2\pi t - 0°)$ 3) $15.81\cos(2\pi t - 108°)$
4) $-720°$ or $0°$ 5) $-120°$ 6) $1260°$ or $180°$

7) 

8) $t_0 = \frac{1}{8}$ 9) $t_0 = \frac{1}{800}$ 10) $t_0 = -\frac{1}{400}$

Complex Number Review: 11) b   12) c   13) a   14) e   15) c   16) b   17) b   18) a   19) d

Filtering Review: 20) b 21) c 22) c 23) d 24) c 25) c 26) b 27) c
28) $y(t) \approx 4.7\cos(3t - 15^o)$ (This is the same problem as 20 and 21)