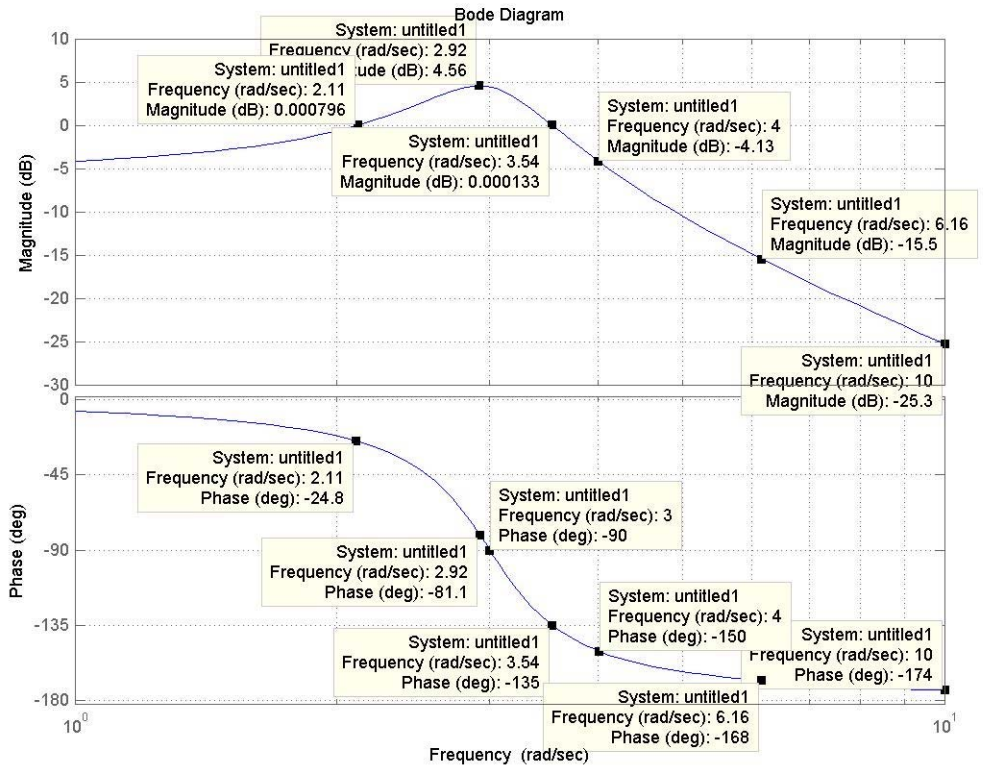
1.)



a.)

1. By checking the final slop (– 40 db/dec), we know the difference of orders (Denominator – Numerator) is 2. Besides, no rising for phase plot but all the way through to – 180°, therefore, we conclude "no zeros" and with damping ratio less than 0.707 (due to the peak on the magnitude plot).
2. The Transfer Function should have the form as: $\dfrac{K}{\omega_n^{\,2}\left[\left(\dfrac{S^2}{\omega_n^{\,2}}\right)+\left(\dfrac{2\zeta S}{\omega_n}\right)+1\right]}$.
3. Substitute $S = i\omega$ into T.F., we have our F.R.F.
4. From 90° crossing, we know $\omega_n \cong 3\,(\text{rad/sec})$.
5. For $\omega << \omega_n$, $20\log(FRF) \cong 20\log(\dfrac{K}{3^2}) \cong -4(db)$. $\Rightarrow K \cong 5.7$
6. For $\omega = \omega_n$, $20\log(FRF) \cong 20\log(\dfrac{K}{3^2}) - 20\log(2\xi) \cong -4 - 20\log(2\xi)$

   $\cong 4.5(db), \Rightarrow \xi \cong 0.19$

7. Therefore, our T.F. is approximately: $\frac{5.7}{S^2+1.14S+9}$

[Note: The Bode plot above is actually generated by $T.F.=\frac{5}{S^2+S+9}$]

b.) When $\omega=4$, and from plot we know that $20\log(\left|\frac{Output}{Input}\right|)\cong -4.13\,(db)$,

$\left|\frac{Output}{Input}\right|=10^{-\frac{4.13}{20}}\cong 0.6216$; hence, $|Output|=5*0.6216\cong 3.1$. From the phase plot, we know the $\phi\cong -150^{\circ}$. Therefore, $Output\equiv 3.1\sin(4t-150^{\circ})$.

[Note: the phase angle is in "rad" for "4t" part.]

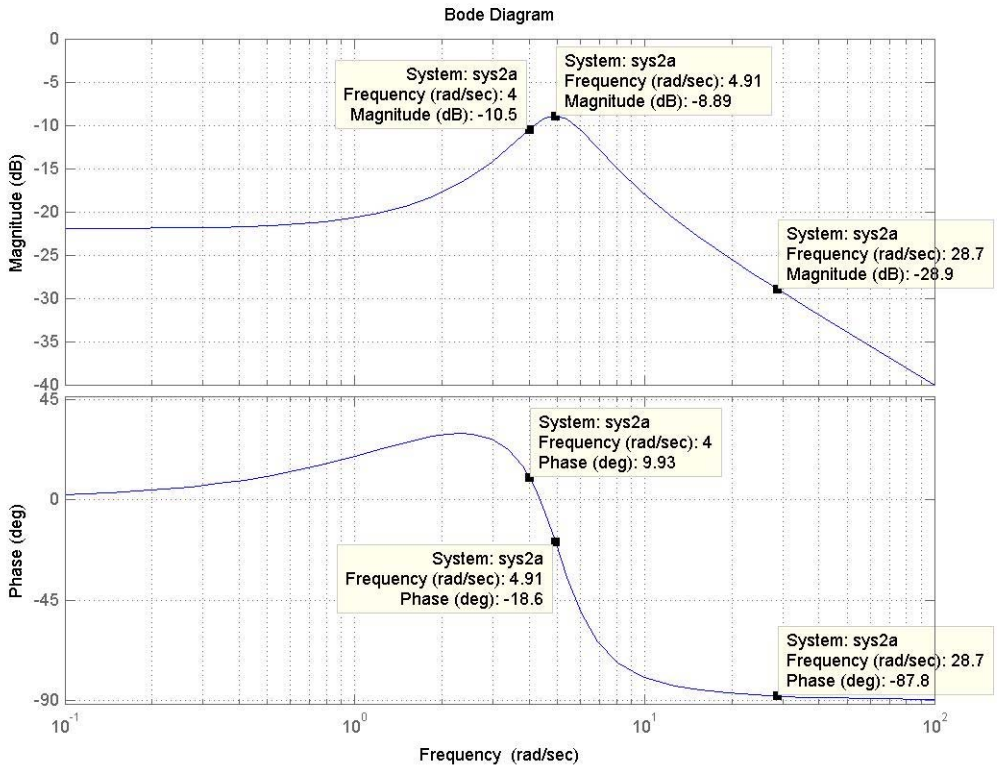
c.) Output = Input $\Rightarrow$ find 0 (db). From Magnitude plot, we have $\omega\cong 2.1\&3.5\,(rad/\sec)$.

d.) From Magnitude plot, the "peak" happens at $\omega\cong 2.9\,(rad/\sec)$.

e.) One-tenth of the peak $\Rightarrow -20\,(db)$ from the peak. From Magnitude plot, it happens at $\omega\cong 6.2\,(rad/\sec)$.

f.) Exactly out of phase $\Rightarrow$ Phase angle has 180° difference. From Phase plot, it happens at $\omega\cong \geq 10\,(rad/\sec)$.

2a.)



a.) T.F. is given.

b.) When $\omega = 4$, and from plot we know that $20\log(\left|\frac{Output}{Input}\right|) \cong -10.5\,(db)$,

$\left|\frac{Output}{Input}\right| = 10^{-\frac{10.5}{20}} \cong 0.3$; hence, $|Output| = 5*0.3 \cong 1.5$. From the phase plot, we know the $\phi \cong 9.9^{\circ}$. Therefore, $Output \equiv 1.5\sin(4t + 9.9^{\circ})$. [Note: the phase angle is in "rad" for "4t" part.]

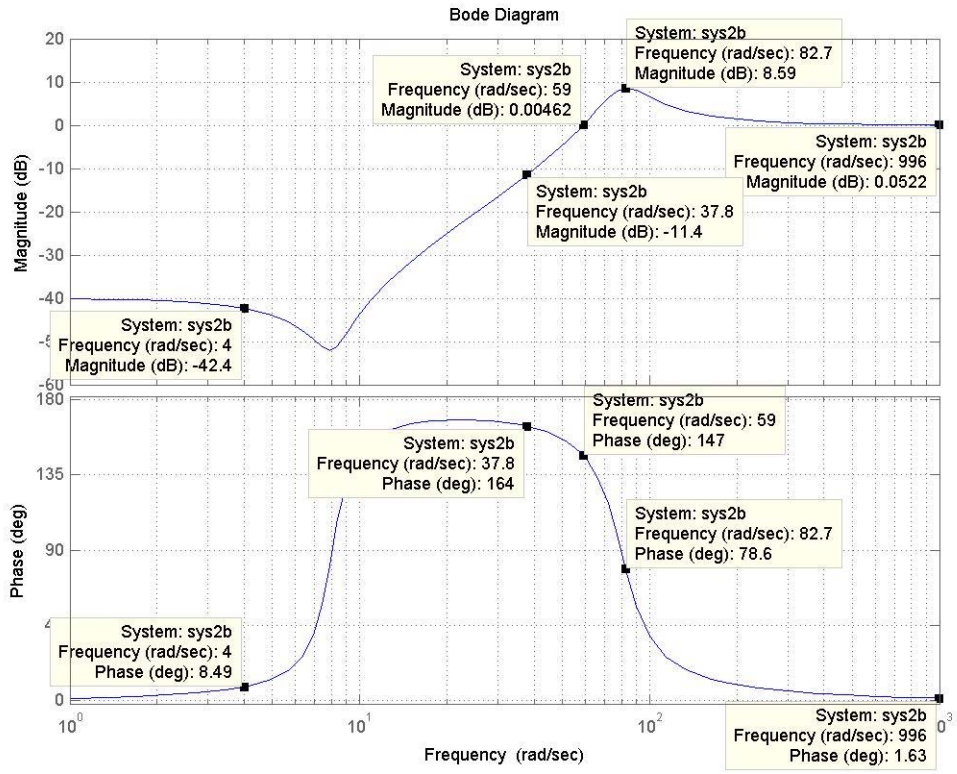
c.) Output = Input $\Rightarrow$ find 0 (db). From Magnitude plot, we have NONE.

d.) From Magnitude plot, the "peak" happens at $\omega \cong 4.91(rad/\sec)$.

e.) One-tenth of the peak $\Rightarrow -20(db)$ from the peak. From Magnitude plot, it happens at $\omega \cong 28.7\,(rad/\sec)$.

f.) Exactly out of phase $\Rightarrow$ Phase angle has 180° difference. From Phase plot, we have NONE.

2b.)



a.) T.F. is given.

b.) When $\omega = 4$, and from plot we know that $20\log(\left|\frac{Output}{Input}\right|) \cong -42.4\,(db)$,

$\left|\frac{Output}{Input}\right| = 10^{-\frac{42.4}{20}} \cong 0.0076$; hence, $|Output| = 5 * 0.0076 \cong 0.038$. From the phase plot, we know the $\phi \cong 8.5^{\circ}$. Therefore, $Output \equiv 0.038\sin(4t + 8.5^{\circ})$. [Note: the phase angle is in "rad" for "4t" part.]

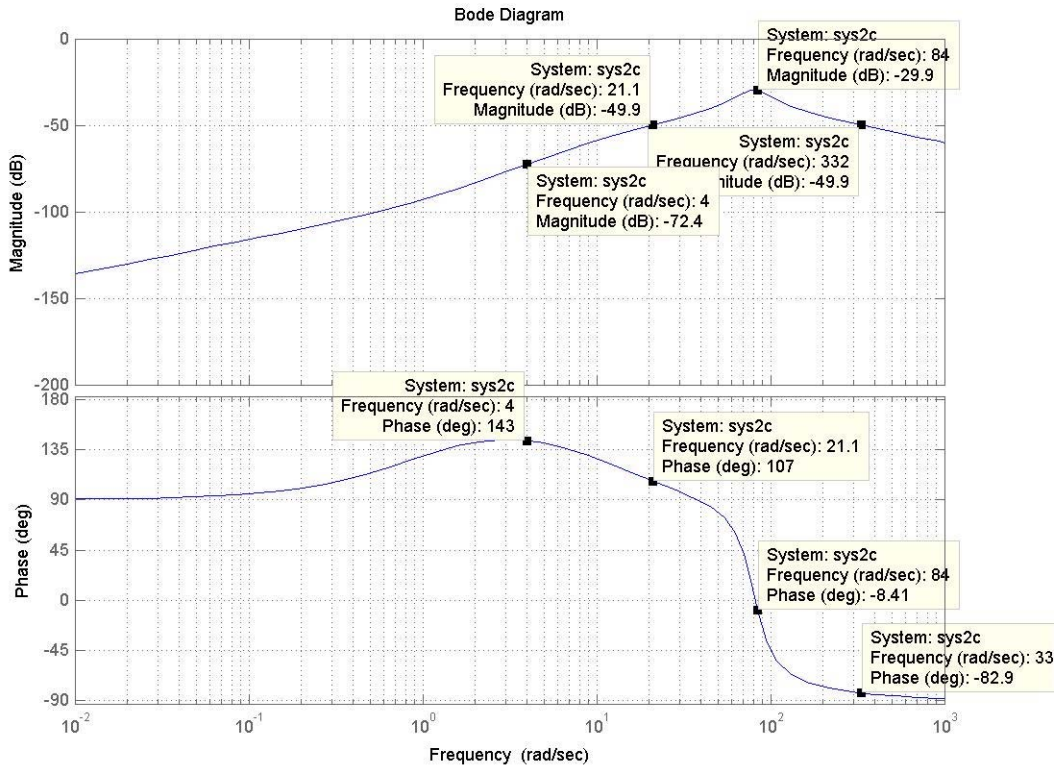
c.) Output = Input $\Rightarrow$ find 0 (db). From Magnitude plot, we have $\omega \cong 59$ & $\omega \geq 1000\,(rad/\sec)$.

d.) From Magnitude plot, the "peak" happens at $\omega \cong 82.7\,(rad/\sec)$.

e.) One-tenth of the peak $\Rightarrow -20\,(db)$ from the peak. From Magnitude plot, it happens at $\omega \cong 37.8\,(rad/\sec)$.

f.) Exactly out of phase $\Rightarrow$ Phase angle has 180° difference. From Phase plot, we have NONE.

2c.)



a.) T.F. is given.

b.) When $\omega = 4$, and from plot we know that $20\log(\left|\frac{Output}{Input}\right|) \cong -72.4\,(db)$,

$\left|\frac{Output}{Input}\right| = 10^{-\frac{72.4}{20}} \cong 0.00024$; hence, $|Output| = 5 * 0.00024 \cong 0.012$. From the phase plot, we know the $\phi \cong 143^{\circ}$. Therefore, $Output \equiv 0.012\sin(4t + 143^{\circ})$. [Note: the phase angle is in "rad" for "4t" part.]

c.) Output = Input $\Rightarrow$ find 0 (db). From Magnitude plot, we have NONE.

d.) From Magnitude plot, the "peak" happens at $\omega \cong 84\,(rad/\sec)$.

e.) One-tenth of the peak $\Rightarrow -20\,(db)$ from the peak. From Magnitude plot, it happens at $\omega \cong 21.1 \& \omega \cong 332\,(rad/\sec)$.

f.) Exactly out of phase $\Rightarrow$ Phase angle has 180° difference. From Phase plot, we have NONE.