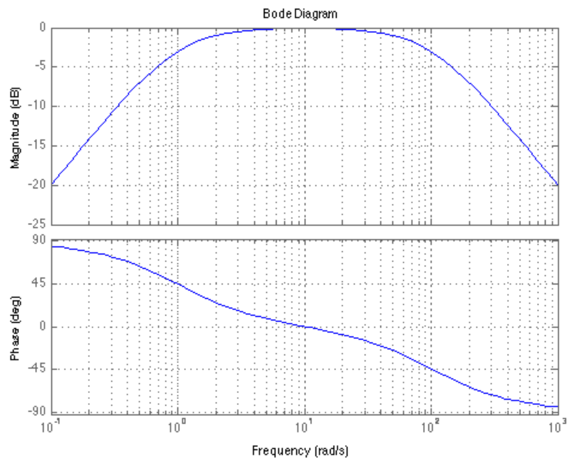


A system's Bode plots are shown at left.

1. Estimate the system's transfer function:
The initial slope is +20 db/dec, so there is a zero at $s = 0$. From the two corners, there are poles at $\omega = 1$ and $\omega = 100$. Thus, the TF is

$$TF = \frac{K * s}{(s+1)(s+100)} = \frac{K}{100} * \frac{s}{(s+1)(s/100+1)}$$

To determine K, pick a convenient frequency; for example, at $\omega = 1$:

$$\begin{array}{ll} \text{zero } s = 0 & \rightarrow \ 0 \ db \\ \text{poles} + 1 & \rightarrow \ -3 \ db \\ \text{pole} \dfrac{s}{100} + 1 & \rightarrow \ 0 \ db \end{array}$$

Adding those terms, we see that the magnitude (without $K/100$) is -3 db, which matches the plot at $\omega = 1$. Thus the magnitude of $K/100$ must also be 0 db, i.e., $K = 100$. The complete TF is

$$\boxed{TF = \frac{100s}{(s+1)(s+100)}}$$

2. What kind of filter (if any) is this system? *Bandpass*

3. What is this system's bandwidth (if any)? $1 \le \omega \le 100$

4. What is the response of this system to an input of $100sin(1000t)$?

   At $\omega = 1000$ we have -20 db, so the magnitude ratio is 1/10. The phase is approximately -90^o, so the output is

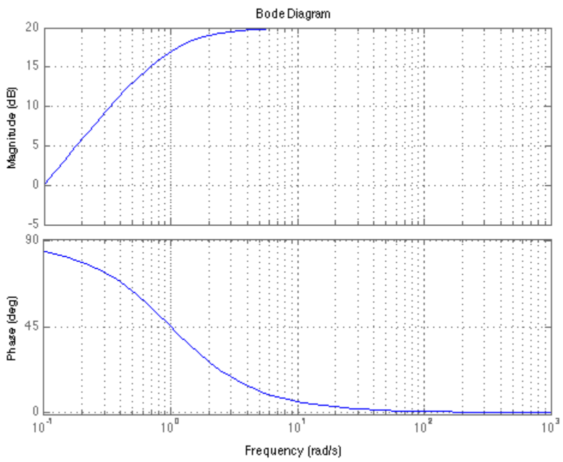
$$\boxed{y(t) = 10sin(1000t - 90^o) = 10sin(1000t - \pi/2)}$$

5. Briefly but precisely describe how to convert the system into a low-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   We need to flatten the left end, so we may simply remove the zero. This creates a low-pass filter. In addition, we could remove one of the poles (but this isn't necessary).

6. Briefly but precisely describe how to convert the system into a high-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   We need to flatten the right end, so remove either one of the two poles.



A system's Bode plots are shown at left.

1. Estimate the system's transfer function:
The initial slope is +20 db/dec, so there is a zero at $s = 0$. From the corner, there is a pole at $\omega = 1$. Thus, the TF is

$$TF = \frac{K * s}{(s+1)}$$

To determine K, pick a convenient frequency; for example, at $\omega = 1$:

$$\begin{array}{lcl} \text{zero } s = 0 & \rightarrow & 0 \ db \\ \text{poles} + 1 & \rightarrow & -3 \ db \end{array} \tag{1}$$

Adding those terms, we see that the magnitude (without K) is -3 db, but the plot at $\omega = 1$ reads +17 db. Thus the magnitude of K must be +20 db, i.e., $K = 10$. The complete TF is

$$\boxed{TF = \frac{10s}{(s+1)}}$$

2. What kind of filter (if any) is this system? $\underline{\quad Highpass \quad}$

3. What is this system's bandwidth (if any)? $\underline{\quad 1 \leq \omega \quad}$

4. What is the response of this system to an input of $100sin(1000t)$?

   At $\omega = 1000$ we have +20 db, so the magnitude ratio is 10. The phase is approximately 0^o, so the output is

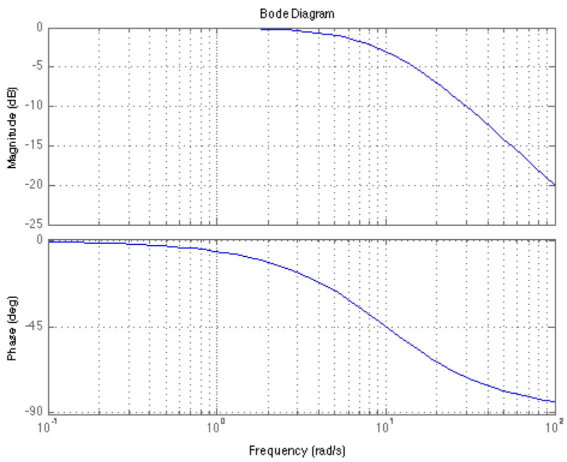
$$\boxed{y(t) = 1000sin(1000t)}$$

5. Briefly but precisely describe how to convert the system into a low-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   We need to flatten the left end, so we may simply remove the zero. This creates a low-pass filter, since the pole now creates a corner followed by a -20 db/decade slope.

6. Briefly but precisely describe how to convert the system into a band-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   Add a pole anywhere but $s = 0$



A system's Bode plots are shown at left.

1. Estimate the system's transfer function:
The initial slope is 0, followed by a corner at $\omega = 10$, followed by a slope of -20 db/dec, so there is a pole at $s = -10$. Thus, the TF is

$$TF = \frac{K}{(s+10)} = \frac{K}{10} * \frac{1}{s/10+1}$$

To determine K, pick a convenient frequency; for example, at $\omega = 1$, the term $1/(s/10+1)$ has 0 db. Since the plot shows 0 db, we also need $K/10$ to have 0 db, so $K = 10$:

$$\boxed{TF = \frac{10}{s+10}}$$

2. What kind of filter (if any) is this system? *Lowpass*

3. What is this system's bandwidth (if any)? $0 \le \omega \le 10$

4. What is the response of this system to an input of $100sin(1000t)$?

   At $\omega = 100$ we have -20 db and a slope of -20 db that continues to higher frequencies, so at $\omega = 1000$ the plot would show -40 db. Thus, the magnitude ratio is 1/100. The phase is approximately -90^o, so the output is

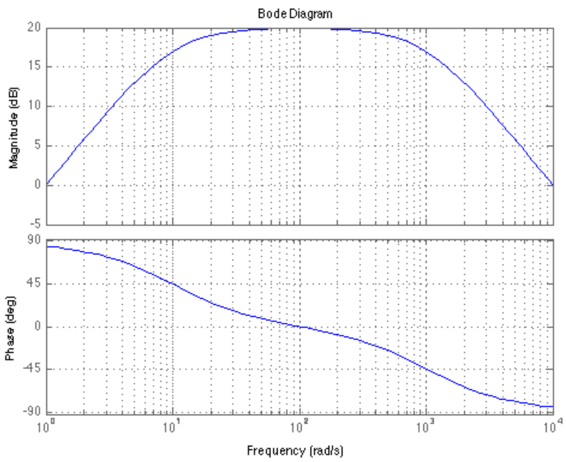
$$\boxed{y(t) = sin(1000t - 90^o) = sin(1000t - \pi/2)}$$

5. Briefly but precisely describe how to convert the system into a high-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   Add a zero to the left of $\omega = 10$

6. Briefly but precisely describe how to convert the system into a band-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   Add a zero somewhere to the left of $\omega = 10$, then add a second pole anywhere to the right of that zero.



A system's Bode plots are shown at left.

1. Estimate the system's transfer function:
The initial slope is +20 db/dec, so there is a zero at $s = 0$. From the two corners, there are poles at $\omega = 10$ and $\omega = 1000$. Thus, the TF is

$$TF = \frac{K * s}{(s+10)(s+1000)} = \frac{K}{1000} * \frac{s}{(s+10)(s/1000+1)}$$

To determine K, pick a convenient frequency; for example, at $\omega = 1$:

$$\begin{array}{ll} \text{zero } s = 0 & \rightarrow\ 0\ db \\ \text{pole}(s+10) & \rightarrow\ 0\ db \\ \text{pole}\dfrac{s}{1000}+1 & \rightarrow\ 0\ db \end{array}$$

Adding those terms, we see that the magnitude (without $K/1000$) is 0 db, which matches the plot at $\omega = 1$. Thus the magnitude of $K/1000$ must also be 0 db, i.e., $K = 1000$. The complete TF is

$$\boxed{TF = \frac{1000s}{(s+10)(s+1000)}}$$

2. What kind of filter (if any) is this system? *Bandpass*

3. What is this system's bandwidth (if any)? $10 \le \omega \le 1000$

4. What is the response of this system to an input of $100 sin(1000t)$?

   At $\omega = 1000$ we have 17 db, so the magnitude ratio is 7.08. The phase is -45^o, so the output is

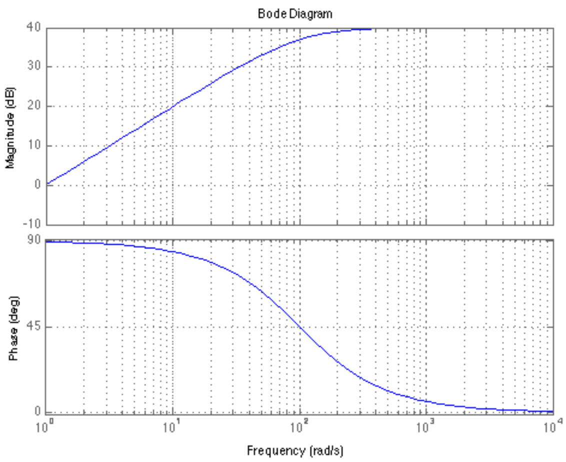
$$\boxed{y(t) = 708 sin(1000t - 45^o) = 708 sin(1000t - \pi/4)}$$

5. Briefly but precisely describe how to convert the system into a low-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   We need to flatten the left end, so we may simply remove the zero. This creates a low-pass filter. In addition, we could remove one of the poles (but this isn't necessary).

6. Briefly but precisely describe how to convert the system into a high-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   We need to flatten the right end, so remove either one of the two poles.



A system's Bode plots are shown at left.

1. Estimate the system's transfer function:
The initial slope is +20 db/dec, so there is a zero at $s = 0$. From the corner, there is a pole at $\omega = 100$. Thus, the TF is

$$TF = \frac{K * s}{(s + 100)} = \frac{K}{100} \frac{s}{s/100 + 1}$$

To determine K, pick a convenient frequency; for example, at $\omega = 1$:

$$\begin{aligned} \text{zero } s = 0 & \quad \rightarrow \; 0 \; db \\ \text{poles} + 100 & \quad \rightarrow \; 0 \; db \end{aligned} \tag{2}$$

Adding those terms, we see that the magnitude (without K) is 0 db, and the plot at $\omega = 1$ reads 0 db. Thus the magnitude of $K/100$ must be 0 db, i.e., $K = 100$. The complete TF is

$$\boxed{TF = \frac{100s}{(s + 100)}}$$

2. What kind of filter (if any) is this system? *Highpass*

3. What is this system's bandwidth (if any)? $100 \leq \omega$

4. What is the response of this system to an input of $100sin(1000t)$?

   At $\omega = 1000$ we have +40 db, so the magnitude ratio is 100. The phase is -45^o, so the output is

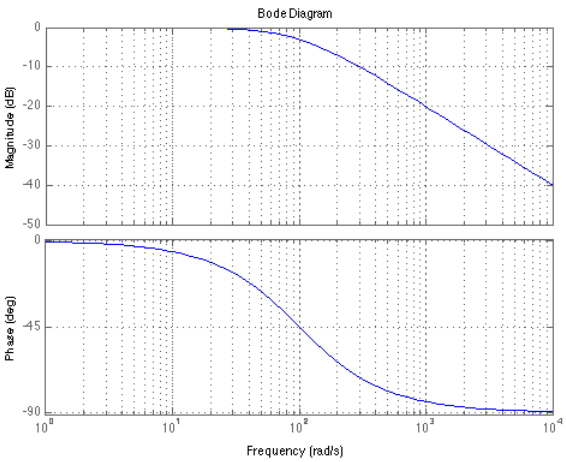
$$\boxed{y(t) = 10,000sin(1000t - 45^o) = 10,000sin(1000t - \pi/4)}$$

5. Briefly but precisely describe how to convert the system into a low-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   We need to flatten the left end, so we may simply remove the zero. This creates a low-pass filter, since the pole now creates a corner followed by a -20 db/decade slope.

6. Briefly but precisely describe how to convert the system into a band-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   Add a pole anywhere but 0 (i.e., a pole at any real number).



A system's Bode plots are shown at left.

1. Estimate the system's transfer function:
The initial slope is 0, followed by a corner at $\omega = 100$, followed by a slope of -20 db/dec, so there is a pole at $s = -100$. Thus, the TF is

$$TF = \frac{K}{(s+100)} = \frac{K}{100} * \frac{1}{s/100+1}$$

To determine K, pick a convenient frequency; for example, at $\omega = 1$, the term $1/(s/100+1)$ has 0 db. Since the plot shows 0 db, we also need $K/100$ to have 0 db, so $K = 100$:

$$\boxed{TF = \frac{100}{s+100}}$$

2. What kind of filter (if any) is this system? *Lowpass*

3. What is this system's bandwidth (if any)? $0 \leq \omega \leq 100$

4. What is the response of this system to an input of $100 sin(1000t)$?

   At $\omega = 100$ we have -20 db, so the magnitude ratio is 1/100. The phase is approximately -90^o, so the output is

   $$\boxed{y(t) = sin(1000t - 90^o) = sin(1000t - \pi/2)}$$

   (the phase angle is actually a little less than 90, say, 85^o)

5. Briefly but precisely describe how to convert the system into a high-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   Add a zero to the left of $\omega = 100$

6. Briefly but precisely describe how to convert the system into a band-pass filter by adding or subtracting poles or zeros, OR, explain why it is impossible to do so. Be specific about the numerical values of any poles(s) and/or zero(s) to be added (or subtracted) from the system's TF.

   Add a zero somewhere to the left of $\omega = 100$, then add a second pole anywhere to the right of that zero.