① Text, 12-1

$h_1(t) = 3e^{-10t}u(t)$

$h_2(t) = \delta(t) - 3e^{-10t}u(t)$

(a) parallel

$h(t) = h_1(t) + h_2(t) = 3e^{-10t}u(t) + \delta(t) - 3e^{-10t}u(t)$

$= \delta(t)$

$\boxed{H(f) = 1}$

(b) series

$h(t) = h_1(t) * h_2(t)$

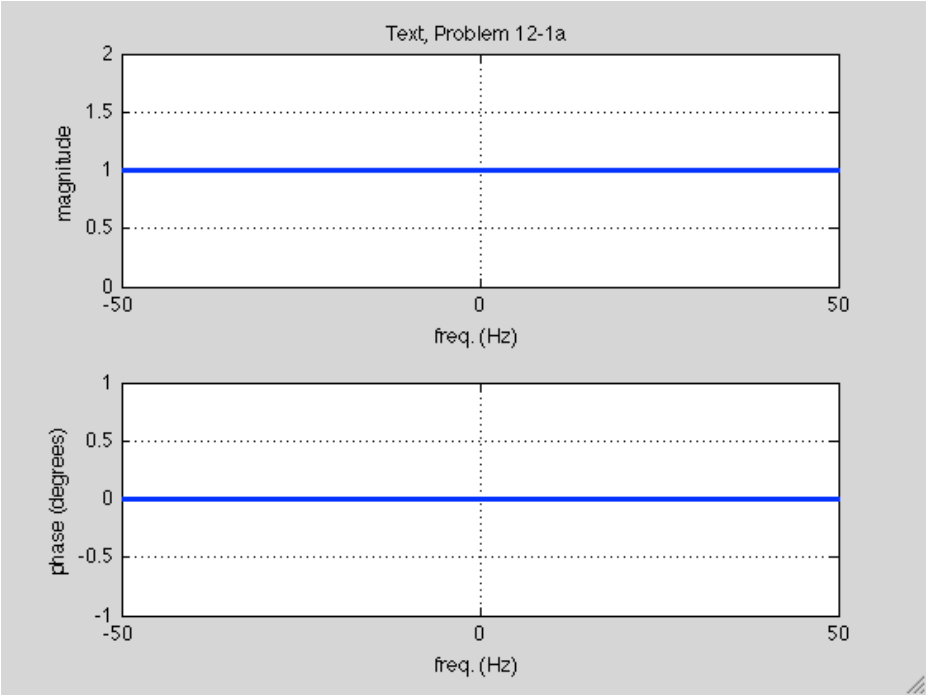
$H(f) = H_1(f) \cdot H_2(f)$

$= \frac{3}{j2\pi f + 10} \cdot \left[1 - \frac{3}{j2\pi f + 10}\right]$

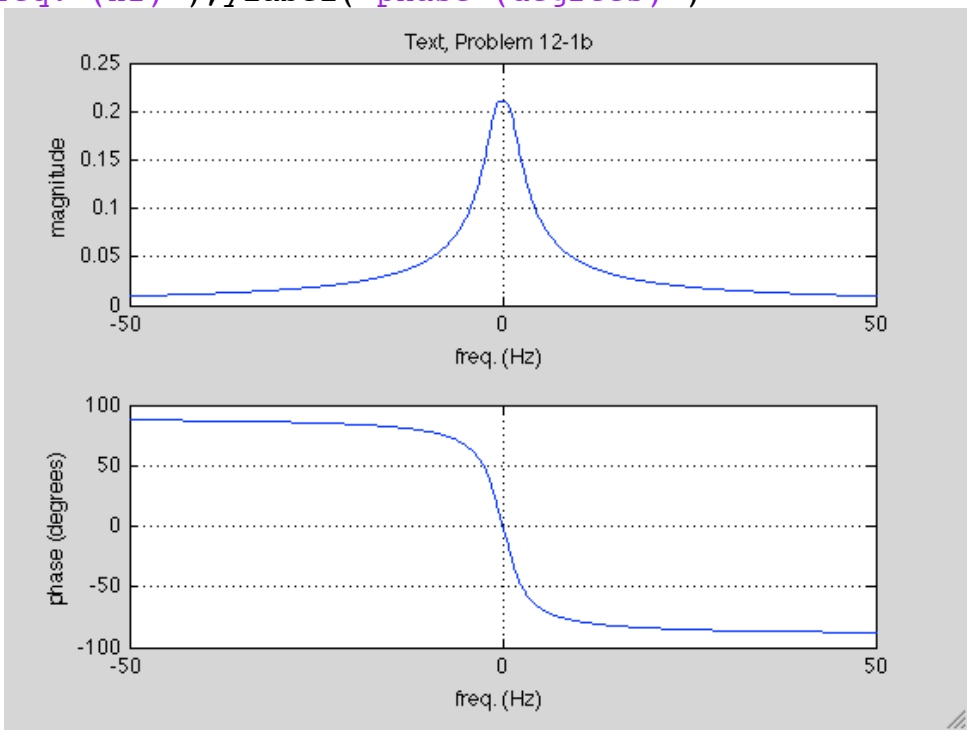
$= \frac{3}{j2\pi f + 10} \cdot \frac{j2\pi f + 10 - 3}{j2\pi f + 10}$

$= \frac{3(j2\pi f + 7)}{(j2\pi f + 10)^2}$

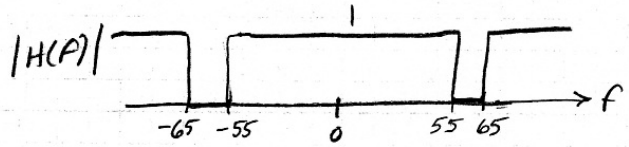
```
% Text, 12-1a
f=-50:.1:50;
H=ones(size(f));
Hmag=abs(H);
Hphase=angle(H)*180/pi;
figure(1),subplot(2,1,1),plot(f,Hmag,'linewidth',3),grid on
xlabel('freq. (Hz)'),ylabel('magnitude'),title('Text, Problem 12-
1a')
subplot(2,1,2),plot(f,Hphase,'linewidth',3),grid on
xlabel('freq. (Hz)'),ylabel('phase (degrees)')
```

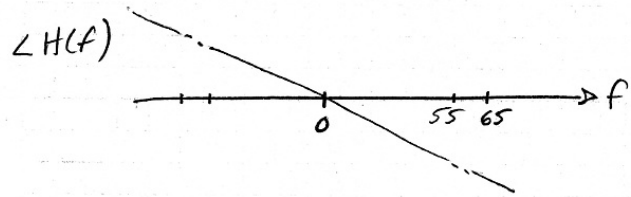



```
% Text, 12-1b
f=-50:.1:50;
H=3*(j*2*pi*f+7)./(j*2*pi*f+10).^2;
Hmag=abs(H);
Hphase=angle(H)*180/pi;
figure(2),subplot(2,1,1),plot(f,Hmag),grid on
xlabel('freq. (Hz)'),ylabel('magnitude'),title('Text, Problem 12-
1b')
subplot(2,1,2),plot(f,Hphase),grid on
xlabel('freq. (Hz)'),ylabel('phase (degrees)')
```

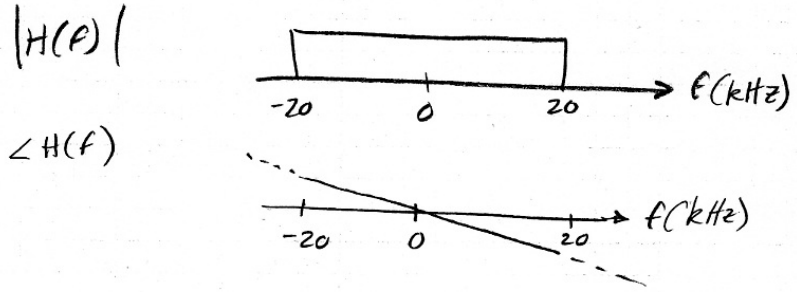


(2) To remove a specific annoying tone, use a bandstop filter. The stop band should be narrow to minimize the removal of good frequency information. Here is a bandstop filter that could work:





(3) A low pass filter will easily solve this problem



(4) Text, 12-3

$$h(t) = 10\,\text{rect}\left(\frac{t-.01}{.02}\right) = 10\,\text{rect}(50t - \tfrac{1}{2})$$

$$10\,\text{rect}(t) \xrightarrow[t\to t-\frac{1}{2}]{} 10\,\text{rect}(t-\tfrac{1}{2}) \xrightarrow[t\to 50t]{} 10\,\text{rect}(50t-\tfrac{1}{2})$$

$$10\,\text{sinc}(f) \longrightarrow 10\,\text{sinc}(f)e^{-j\pi f} \longrightarrow 10\left(\tfrac{1}{50}\right)\text{sinc}\left(\tfrac{f}{50}\right)e^{-j\pi f/50}$$

$$\text{so} \quad H(f) = \tfrac{1}{5}\,\text{sinc}\left(\frac{f}{50}\right)e^{-j\pi f/50}$$

```
% Text, problem 12-3

f=-400:0.1:400;
H=1/5*sinc(f/50).*exp(-j*pi*f/50);
Hmag=abs(H);
Hphase=angle(H)*180/pi;
figure(3),subplot(2,1,1),plot(f,Hmag,'linewidth',3),grid on
xlabel('freq. (Hz)'),ylabel('magnitude'),title('Text, Problem 12-3')
subplot(2,1,2),plot(f,Hphase,'linewidth',3),grid on
xlabel('freq. (Hz)'),ylabel('phase (degrees)')
```

Based on the magnitude response plot, the **null bandwidth is 50 Hz** (50 Hz is the 1st positive null, so the pass band runs from 0 Hz to 50 Hz)