Solution to ECE Test #1 S09

For each active filter below the frequency response is $\mathrm{H}(f)=\dfrac{\mathrm{V}_o(f)}{\mathrm{V}_i(f)}$. Answer the following questions about each filter. (Assume each operational amplifier is ideal.)

(a) What is the slope in dB/decade of the magnitude Bode diagram of the frequency response at very low frequencies (approaching zero)?

A -20 , B -20 , C 0 , D 20 , E 0 , F 0

A: At low frequencies the feedback acts like a capacitor and the filter acts like an integrator, -20 dB/decade. At high frequencies the feedback acts like a resistor and the filter acts like a simple constant gain, 0 dB/decade. According to the definitions, neither a lowpass nor a highpass filter.

$$\mathrm{H}(f)=-\frac{R_f+1/j2\pi fC_f}{R_i}=-\frac{j2\pi fR_fC_f+1}{j2\pi fR_iC_f}\ ,\ \text{at}\ f\to 0\quad \mathrm{H}(f)\cong-\frac{1}{j2\pi fR_iC_f}$$

and it acts like an integrator with a slope of -20 dB/decade

$At\ f\to\infty\quad \mathrm{H}(f)\cong-\dfrac{R_f}{R_i}$ the frequency response is constant with a slope of 0 dB/decade

B:

$$\mathrm{H}(f)=-\frac{1/j2\pi fC_f}{R_i}=-\frac{1}{j2\pi fR_iC_f}$$

, this is an integrator with a slope of -20 dB/decade at all frequencies

According to the definitions, neither a lowpass nor a highpass filter.

C:

At low frequencies the input impedance acts like a resistor and the filter has a constant gain, 0 dB/decade. At high frequencies the input impedance acts like a capacitor and the filter is like a differentiator, +20 dB/decade.
According to the definitions, neither a lowpass nor a highpass filter.

$$\mathrm{H}(f) = -\frac{R_f}{\dfrac{R_i / j2\pi fC_i}{R_i + 1/j2\pi fC_i}} = -\frac{j2\pi fC_i R_i R_f + R_f}{R_i} \quad \text{, at } f \to 0 \quad \mathrm{H}(f) \cong -\frac{R_f}{R_i}$$

and the frequency response is constant with a slope of 0 dB/decade.

$At\, f \to \infty \quad \mathrm{H}(f) \cong -j2\pi fC_i R_f$ the frequency response is like a differentiator with a slope of +20 dB/decade

D:

At low frequencies the feedback acts like a resistor and the frequency response is like a differentiator, +20 dB/decade. At high frequencies the feedback acts like a capacitor and the frequency response is the ratio of two capacitive impedances and the frequency response is constant, 0 dB/decade. Highpass filter.

$$\mathrm{H}(f) = -\frac{\dfrac{R_f / j2\pi fC_f}{R_f + 1/j2\pi fC_f}}{1/j2\pi fC_i} = -\frac{j2\pi fR_f C_i}{j2\pi fR_f C_f + 1} \quad \text{, at } f \to 0 \quad \mathrm{H}(f) \cong -j2\pi fR_f C_i$$

and the frequency response is like a differentiator with a slope of +20 dB/decade.

$At\, f \to \infty \quad \mathrm{H}(f) \cong -\frac{C_i}{C_f}$ the frequency response is constant with a slope of 0 dB/decade

E:

At low frequencies the input impedance acts like a resistor and the frequency response is constant, 0 dB/decade. At high frequencies the input impedance acts like a capacitor and the frequency response is like a differentiator, +20 dB/decade. According to the definitions, neither a lowpass nor a highpass filter.

$$\mathrm{H}(f) = \frac{R_f + \dfrac{R_i / j2\pi fC_i}{R_i + 1/j2\pi fC_i}}{\dfrac{R_i / j2\pi fC_i}{R_i + 1/j2\pi fC_i}} = \frac{j2\pi fC_i R_i R_f + R_f + R_i}{R_i} \quad \text{, at } f \to 0 \quad \mathrm{H}(f) \cong \frac{R_f + R_i}{R_i}$$

and the frequency response is constant with a slope of 0 dB/decade. At $f \to \infty \quad \mathrm{H}(f) \cong j2\pi fC_i R$ the frequency response is like a differentiator with a slope of +20 dB/decade

F:

At low frequencies the feedback acts like a resistor and the frequency response is constant, 0 dB/decade. At high frequencies the feedback acts like a capacitor and the frequency response is like an integrator, -20 dB/decade. Lowpass filter.

$$\mathrm{H}(f) = -\frac{\dfrac{R_f / j2\pi f C_f}{R_f + 1/j2\pi f C_f}}{R_i} = -\frac{R_f}{j2\pi f C_f R_i R_f + R_i} \quad , \text{ at } f \to 0 \quad \mathrm{H}(f) \cong -\frac{R_f}{R_i}$$

and the frequency response is constant with a slope of 0 dB/decade. At $f \to \infty$

$\mathrm{H}(f) \cong -\dfrac{1}{j2\pi f C_f R_i}$ the frequency response is like an integrator with a slope of -20 dB/decade

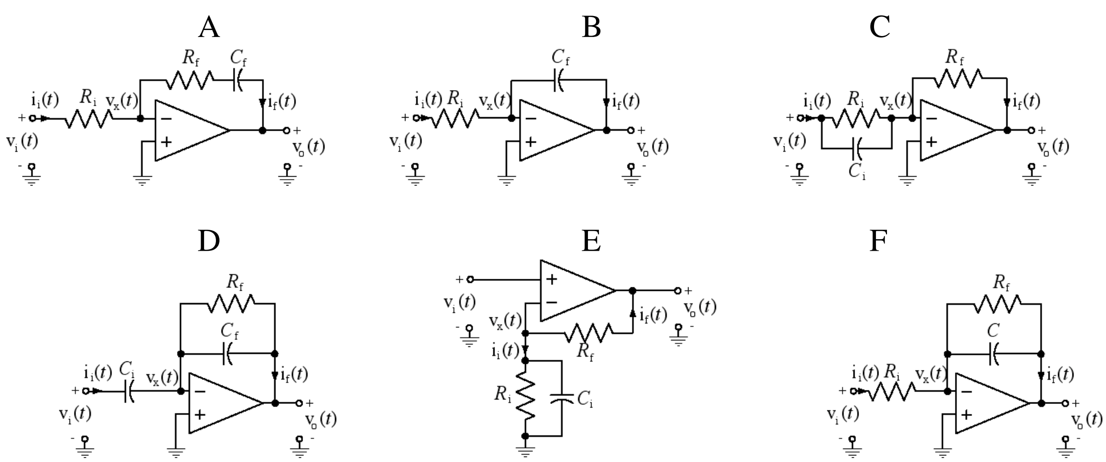
(b) What is the slope in dB/decade of the magnitude Bode diagram of the frequency response at very high positive frequencies (approaching infinity)?

A 0 , B -20 , C 20 , D 0 , E 20 , F -20

(c) Using the following definitions of lowpass and highpass, categorize each filter. If it is lowpass or highpass write that. If it is neither lowpass nor highpass, just write “neither”.

Lowpass $\lvert \mathrm{H}(0) \rvert$ is non-zero and finite , $\lvert \mathrm{H}(\infty) \rvert = 0$	Highpass $\lvert \mathrm{H}(0) \rvert = 0$, $\lvert \mathrm{H}(\infty) \rvert$ is non-zero and finite

A Neither , B Neither , C Neither , D Highpass , E Neither , F Lowpass



Solution to ECE Test #1 S09

For each active filter below the frequency response is $H(f) = \frac{V_o(f)}{V_i(f)}$. Answer the following questions about each filter. (Assume each operational amplifier is ideal.)

(a) What is the slope in dB/decade of the magnitude Bode diagram of the frequency response at very low frequencies (approaching zero)?
A ______ , B ______ , C ______ , D ______ , E ______ , F ______

A -20 , B 20 , C 0 , D 0 , E -20 , F 0

(b) What is the slope in dB/decade of the magnitude Bode diagram of the frequency response at very high positive frequencies (approaching infinity)?
A ______ , B ______ , C ______ , D ______ , E ______ , F ______

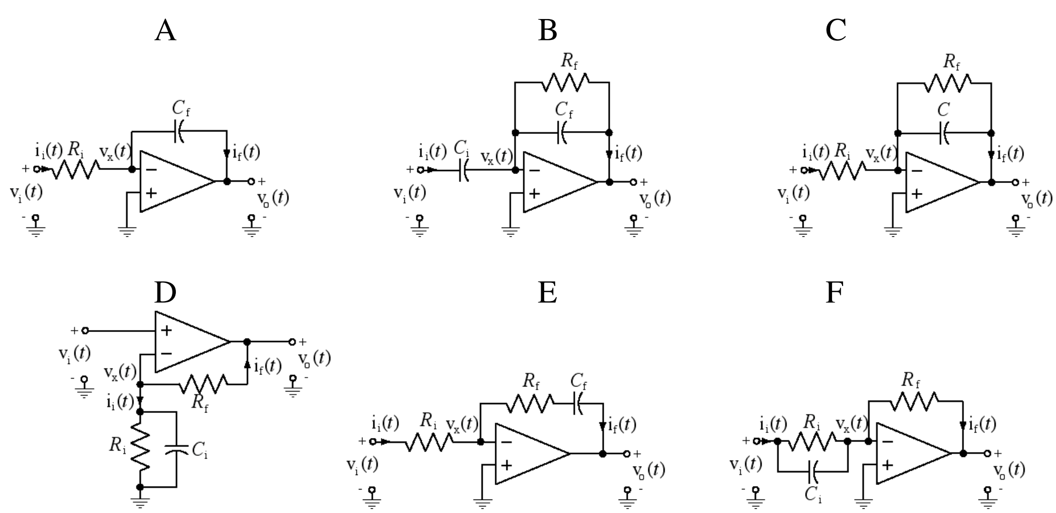
A -20 , B 0 , C -20 , D 20 , E 0 , F 20

(c) Using the following definitions of lowpass and highpass, categorize each filter. If it is lowpass or highpass write that. If it is neither lowpass nor highpass, just write "neither".

Lowpass $\|H(0)\|$ is non-zero and finite , $\|H(\infty)\| = 0$	Highpass $\|H(0)\| = 0$, $\|H(\infty)\|$ is non-zero and finite

A ______ , B ______ , C ______ , D ______ , E ______ , F ______

A Neither , B Highpass , C Lowpass , D Neither , E Neither , F Neither



Solution to ECE Test #1 S09

For each active filter below the frequency response is $\mathrm{H}(f) = \frac{\mathrm{V}_o(f)}{\mathrm{V}_i(f)}$. Answer the following questions about each filter. (Assume each operational amplifier is ideal.)

(a) What is the slope in dB/decade of the magnitude Bode diagram of the frequency response at very low frequencies (approaching zero)?
A ______ , B ______ , C ______ , D ______ , E ______ , F ______

A 0 , B 0 , C -20 , D -20 , E 20 , F 0

(b) What is the slope in dB/decade of the magnitude Bode diagram of the frequency response at very high positive frequencies (approaching infinity)?
A ______ , B ______ , C ______ , D ______ , E ______ , F ______

A 20 , B -20 , C 0 , D -20 , E 0 , F 20

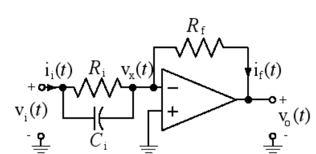
(c) Using the following definitions of lowpass and highpass, categorize each filter. If it is lowpass or highpass write that. If it is neither lowpass nor highpass, just write "neither".

Lowpass $\lvert \mathrm{H}(0) \rvert$ is non-zero and finite , $\lvert \mathrm{H}(\infty) \rvert = 0$	Highpass $\lvert \mathrm{H}(0) \rvert = 0$, $\lvert \mathrm{H}(\infty) \rvert$ is non-zero and finite

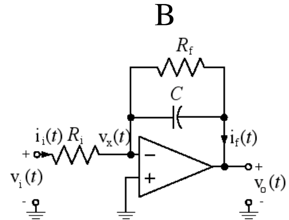
A ______ , B ______ , C ______ , D ______ , E ______ , F ______

A Neither , B Lowpass , C Neither , D Neither , E Highpass , F Neither

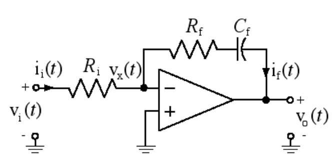
A



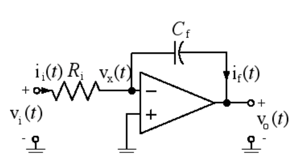
B



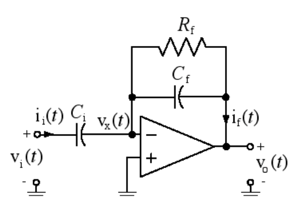
C



D



E



F