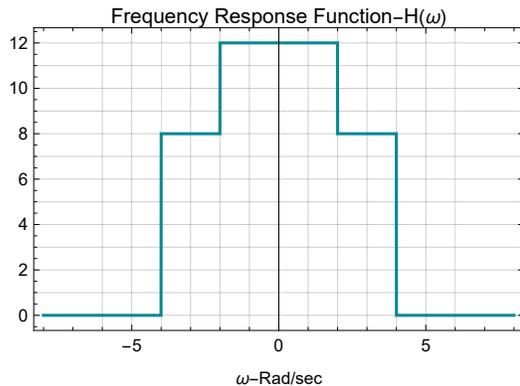


EECS 361
Homework #10

1. Section 5.2 Participation Activities
 - 5.2.1: Lowpass and highpass magnitude spectral responses.
 - 5.2.2: Bandpass and bandreject magnitude spectral responses.
 - 5.2.3: RC circuit lowpass filter (capacitor output).
 - 5.2.4: RC circuit highpass filter (resistor output).
2. Section 5.3 Participation Activities
 - 5.3.1: Ratio to dB conversions.
 - 5.3.2: dB to voltage ratio conversions.
3. (Concept: Power ratios and dB)
Exercise 5.3.2
4. (Concept: Voltage ratios and dB)
Exercise 5.3.3
5. Section 5.6 Participation Activities
 - 5.6.1: Bandpass filter responses and Q factor.
 - 5.6.2: Designing a bandpass filter for resonant frequency $f_o = 1$ MHz and $Q = 20$.
6. Section 5.9 Participation Activities
 - 5.9.1: Brick-wall lowpass filter response to odd square-wave input.
 - 5.9.3: Brick wall filter impulse responses.
 - 5.9.5: Brick wall bandpass response to rectified sine wave
7. (Concept: Frequency response as a weighting function applied to sinusoidal signals)
Given a frequency response, $H(\omega)$, shown below.



- a. Find the system output $y(t)$ for an input signal of $x(t) = \frac{1}{8}\cos(t) + \frac{1}{6}\cos(3t) + 100\cos(5t)$
 - b. Find the system impulse response, $h(t)$.
8. (Concept: Bandwidth)
Let a signal have a spectrum of $X(f) = \text{tri}(f/5000)$
 - a. Find the first zero bandwidth in Hz.
 - b. Find the 3dB bandwidth in Hz.
 - c. Find the equivalent rectangular bandwidth in Hz
 9. (Concept: Distortionless transmission)
Let $x(t) = 5000 \text{sinc}^2(5000\pi t)$ be input to an ideal lowpass filter with a bandwidth of B kHz
 - a. Find the smallest B in Hz such that the filter introduces no distortion.
 - b. Find the % energy in $x(t)$ in the frequency range $|f| < 2,500$ Hz?

10. (Concept: Filter design, extracting a cosine from a periodic signal)

Give $x(t)$ below with for $\tau=1\mu\text{s}$ and $T_0=10\mu\text{s}$. Design (specify) a system (filter) to convert $x(t)$ to $y(t)$
 $= A\cos(2\pi f_a t + \phi)$ where

$f_a=100\text{ kHz}$ and $A\neq 0$ and $-\pi<\phi<\pi$. Hint: See Instructor Note (above Example 4.8.1):

Filtering a Periodic Pulse Train

$$x(t) = \sum_{k=-\infty}^{\infty} \text{rect}\left(\frac{t - kT_0}{\tau}\right)$$

11. (Concept: 95% bandwidth)

Given $x(t)=u(t)e^{\frac{-t}{0.25}}$. The signal $x(t)$ is the input to a ILPF with a bandwidth B (in Hz) to produce an output $y(t)$.

Find B such that $y(t)$ contains 95% of the energy in $x(t)$. Hint: $\int \frac{1}{a^2 + x^2} dx = \frac{1}{a} \arctan\left(\frac{x}{a}\right)$

12. (Concept: Properties of a second order bandpass filter)

The transfer function for the voltage across the resistor in a series R, L, C circuit is given

$$H(f) = \frac{j2\pi fRC}{1 + j2\pi fRC - LC(2\pi f)^2}$$

a. Plot $20\log(|H(f)|)$ with $R=100\text{ Ohm}$, $L=0.0795\text{ Henry}$, $C = 2 * 10^{-6}\text{ Farad}$.

[Hint: It is recommended that you use the interactive tool on the class web page, see **Transfer Function for Series RLC circuit**; a link to this interactive graphic is also in the instructor notes in the zybook.]

b. Find the the resonant frequency for $R=100\text{ Ohm}$, $L=0.0795\text{ Henry}$,
 $C = 2 * 10^{-6}\text{ Farad}$.

c. For $R=100\text{ Ohm}$, $L=0.0795\text{ Henry}$, $C = 2 * 10^{-6}\text{ Farad}$.

Given $x(t)=\cos(2\pi 311t)$ find A in $y(t)=A \cos(2\pi 311t+\phi)$.

With these component values what is the attenuation in dB relative to the frequency response at the resonant frequency.

d. Find the 3dB bandwidth of $H(f)$.