

1. How would you categorize this transfer function: lowpass, highpass, bandpass, other?
2. Find a circuit that corresponds to this transfer function.
3. Find an expression for the filter's output.

A unit-amplitude pulse with duration of one second serves as the

input to an RC-circuit having transfer function

**Problem 4.15: Circuits Filter!**

Reverberation corresponds to adding to a signal its delayed version.

1. Assuming τ represents the delay, what is the input-output relation for a reverberation system? Is the system linear and time- invariant? If so, find the transfer function; if not, what linearity or time invariance criterion does reverberation violate.
2. A music group known as the ROwls is having trouble selling its recordings. The record company's engineer gets the idea of applying different delay to the low and high frequencies and adding the result to create a new musical effect. Thus, the ROwls' audio would be separated into two parts (one less than the frequency ***f***0, the other greater than ***f***0), these would be delayed by τ***l*** and τ***h*** respectively, and the resulting signals added. Draw a block diagram for this new audio processing system, showing its various components.
3. How does the magnitude of the system's transfer function depend on the two delays?

**Problem 4.16: Reverberation**

A frequently encountered problem in telephones is echo. Here, because of acoustic coupling between the ear piece and microphone in the handset, what you hear is also sent to the person talking. That person thus not only hears you, but also hears her own speech delayed (because of propagation delay over the telephone network) and attenuated (the acoustic coupling gain is less than one).

Furthermore, the same problem applies to you as well: The acoustic coupling occurs in her handset as well as yours.

1. Develop a block diagram that describes this situation.
2. Find the transfer function between your voice and what the listener hears.
3. Each telephone contains a system for reducing echoes using electrical means. What simple system could null the echoes?

**Problem 4.17: Echoes in Telephone Systems**