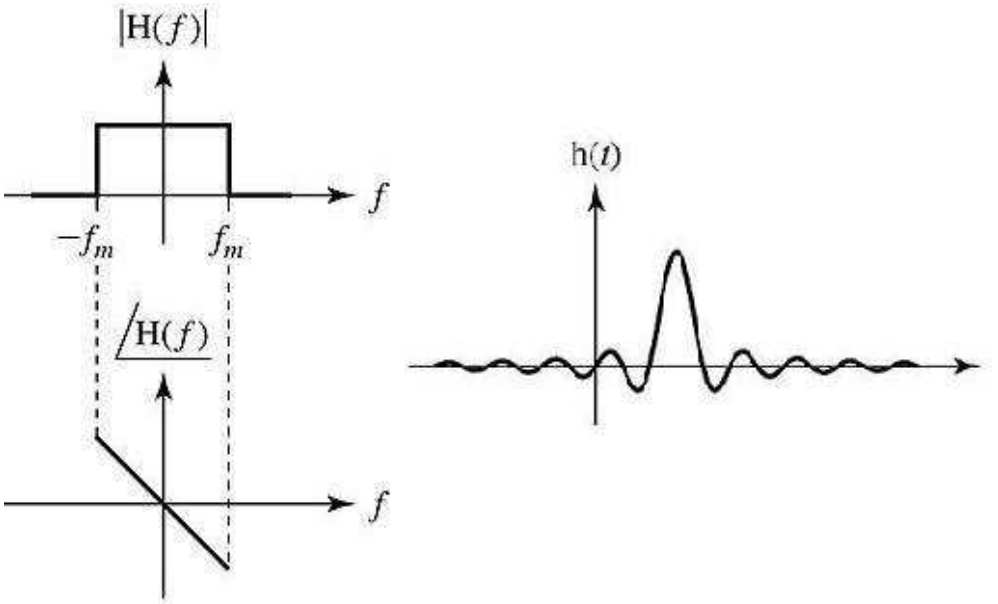
ENSC380
Lecture 21

Objectives:

- Signals and Systems Fourier Analysis:
  - Causal Filters

Ideal vs. Causal Filters

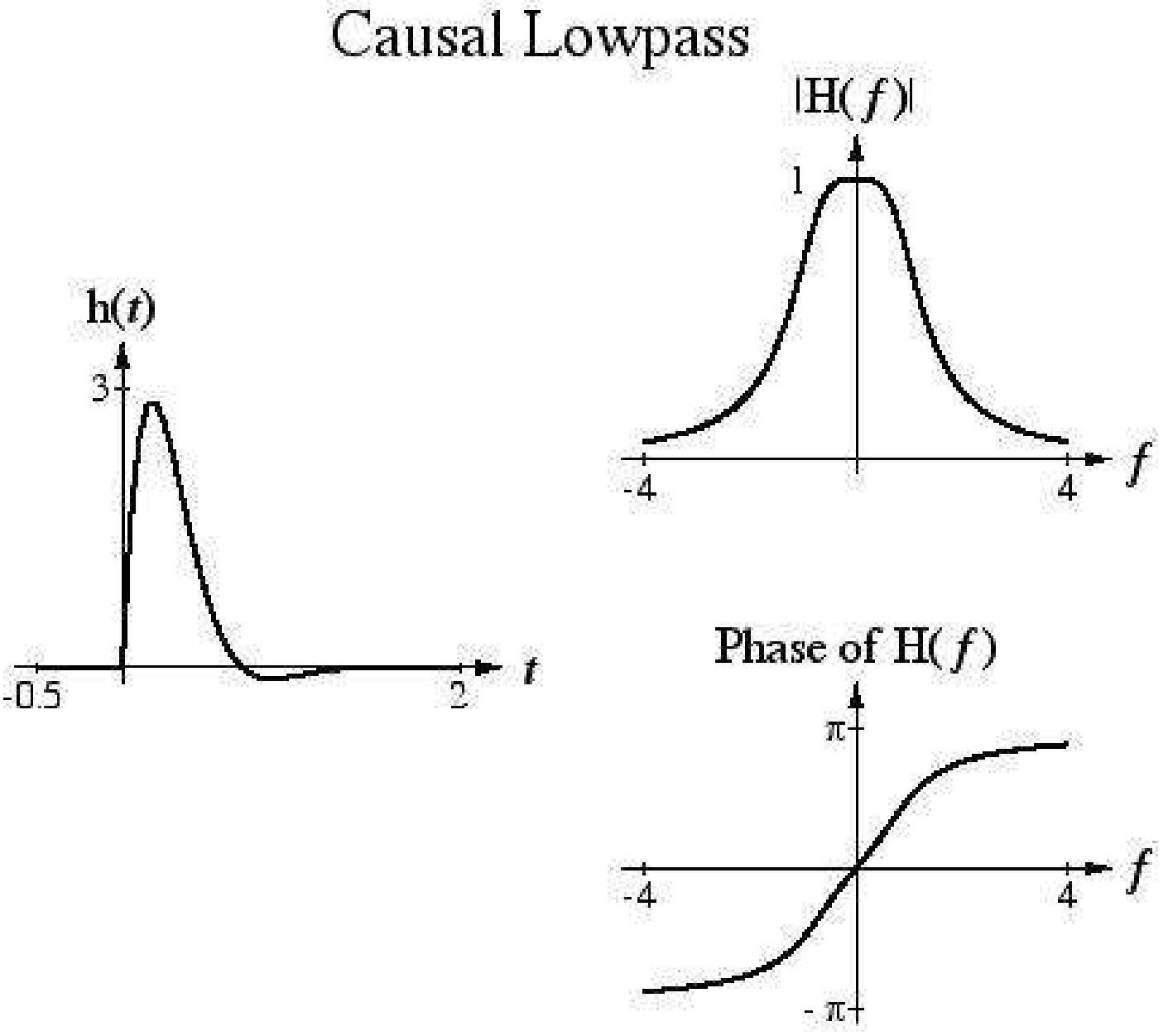
- The filters mentioned in Lecture 20 are “ideal” filters. For example, the transfer function and impulse response of the ideal CT LP-filter are:



- For a filter to be realizable, it should be “Causal”. Is the above filter causal? Why?

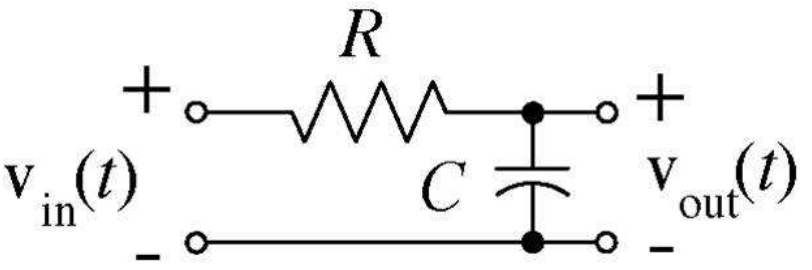
- It is however possible to closely approximate ideal filters with causal filters.
- An example of an approximation for the LP-filter is given:

Causal Lowpass Filter



Example 1:RC LPF

Let's study the RC Low Pass Filter (LPF) below:



Example 2

Find the output voltage of the above filter, if the input voltage is $v_i(t) = \sin(2\pi f_0 t)$.

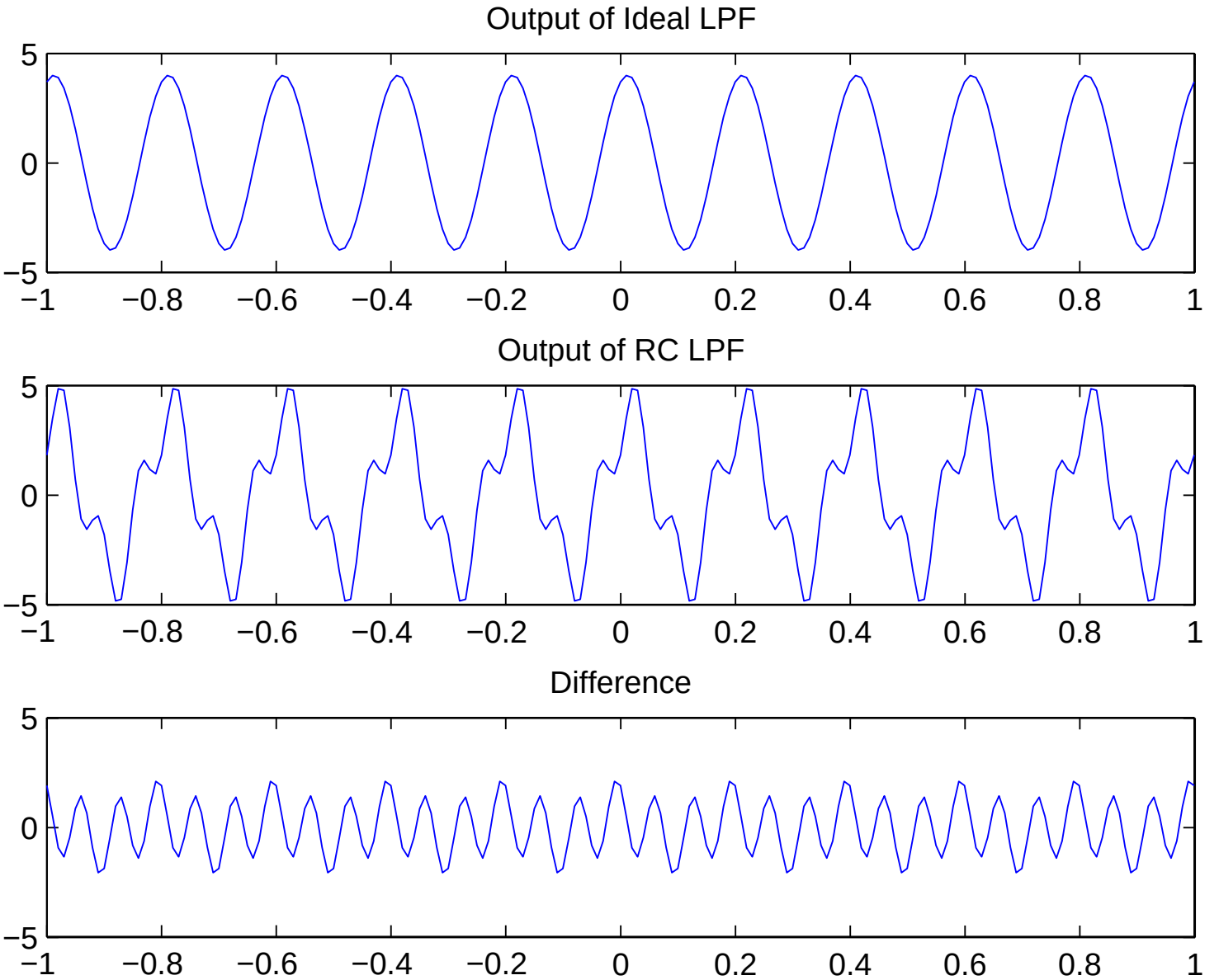
Example 3: RC-LPF vs Ideal LPF

An ideal LPF with bandwidth $f_c = 10$(kHz) and a phase $\angle H(f) = -\frac{\pi}{40} f$ (f is in kHz), has been approximated with an RC LPF with $\frac{1}{2\pi RC} = 10$(kHz). The input voltage to both filters is

$$v_i(t) = 4\cos(2\pi f_1 t) + 3\sin(2\pi f_2 t) \qquad \text{where} \quad f_1 = 5kHz \quad f_2 = 15kHz$$

Find the output voltages of the two filters and compare.

Example 3 (Cont.)



Example of a Causal HPF