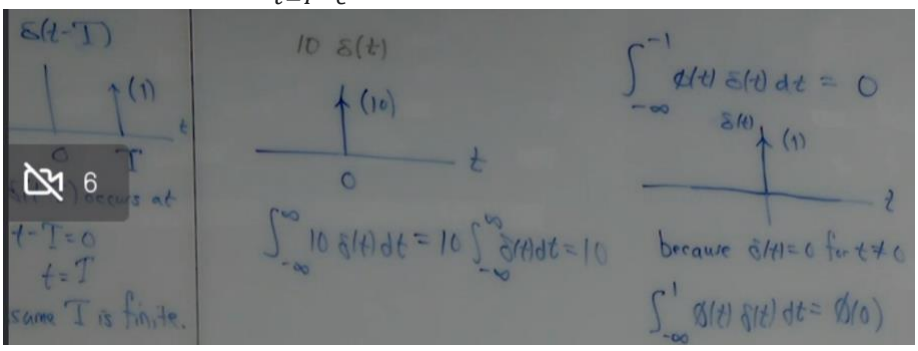
[10:30am] Review of signals and systems

- Signals are **functions**.
  - Can be either continuous $x(t)$ or discrete $x[n]$
  - Many uses. For example, a signal may represent a voltage, temperature, or the luminance of a pixel in an image.
  - Signals can be described in many ways
    - List of numbers for a discrete signal
    - Set of properties that the signal satisfies.
    - Piecewise definition
    - May be a **generalized function** like the Dirac delta
- Continuous-time signals $x(t)$ are typically a function of a continuous time variable t with units of seconds.
- Discrete-time signals $x[n]$ are typically a function of an integer n representing the time index in units of samples.
- Digital signals are quantized in amplitude, while analog signals are not
- Discrete signals are sampled in time, while continuous signals are not
  - The term "analog" is often shorthand for "analog and continuous-time"
  - Likewise, the term "digital" is often shorthand for "digital and discrete-time"
  - For example, an "Analog to digital" converter is actually an "analog and continuous-time to digital and discrete-time" converter
- Continuous-time Unit impulse (Dirac Delta)
  - Take some **unit area** pulse. For example $p(t) = \frac{1}{2\epsilon}\text{rect}\left(\frac{t}{2\epsilon}\right)$
  - Take the limit as the area stays the same but the width goes to zero

$$\delta(t) = \lim_{\epsilon \to 0} p(t)$$

  - Amplitude of $\delta(t)$ is undefined. However its area is equal to one.
  - S**ifting property:** For any signal $x(t)$, any time shift T, and any $\epsilon > 0$,

$$\int_{t=T-\epsilon}^{T+\epsilon} x(t)\delta(t-T) = x(T)$$

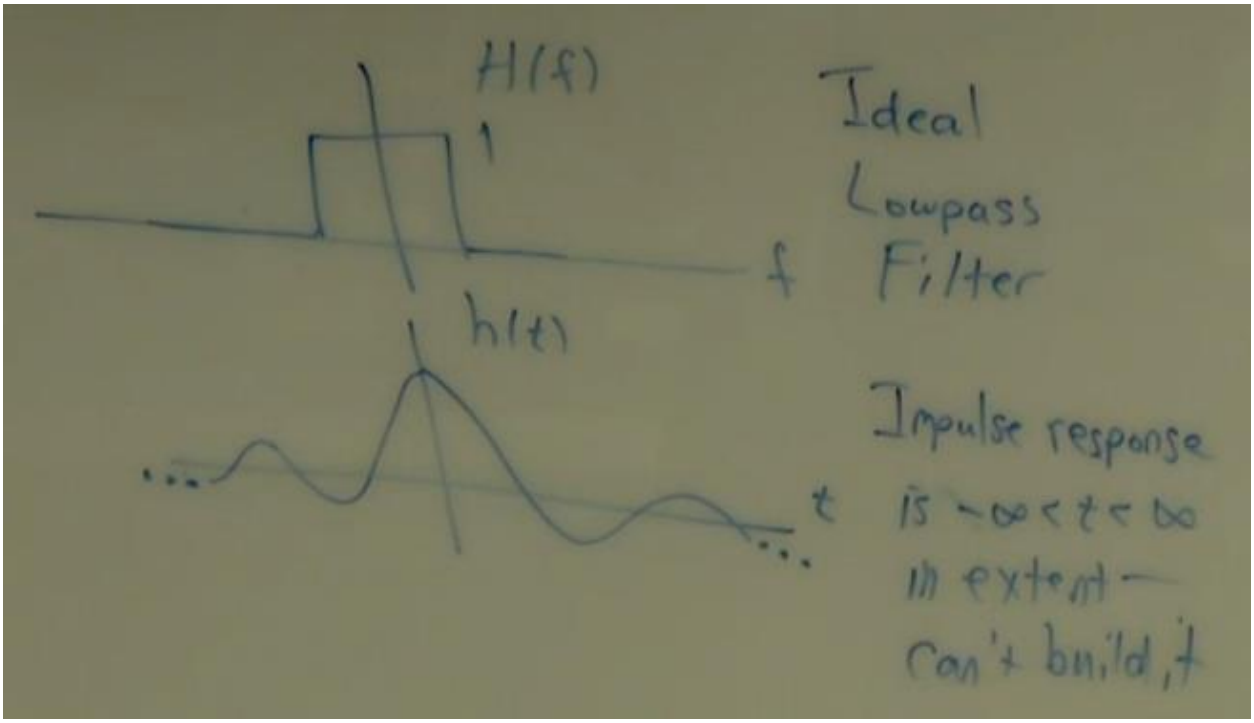


- Convolution of signal with Dirac delta shifted by T

$$x(t) * \delta(t - T) = x(t - T)$$

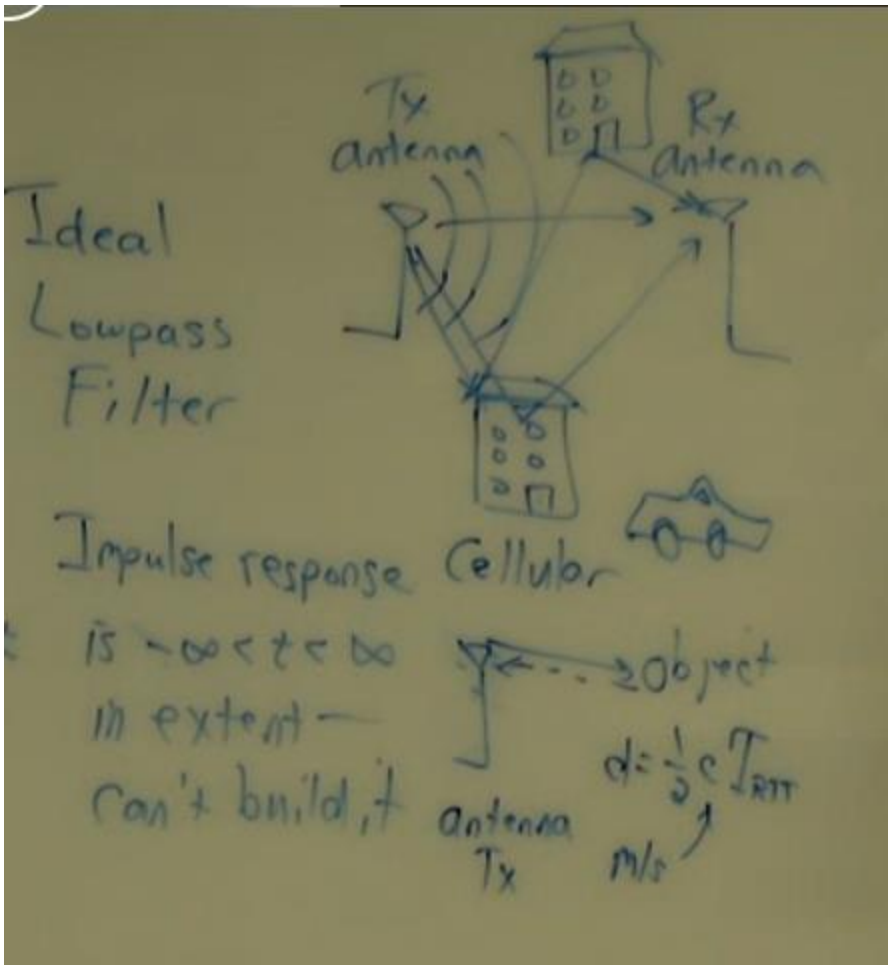
- Connection between Dirac delta an unit step functions

$$u(t) = \int_{\tau=-\infty}^{t} \delta(\tau) d\tau$$



[11:20 am]

- Upcoming career fairs
  - Machine learning, software engineering, embedded systems companies are increasingly at technology and science career fair (not engineering expo)
- Interactive filter demo: https://www.falstad.com/dfilter/
- Sweep/Chirp signal. Energy concentrated at a specific frequency which either increases or decreases over time. Used in sonar, radar, communications, test and measurement, and many other applications.
  - Preview of lecture 14 on matched filtering



- Preview of Pseudonoise sequences (Lab 4)