Lecture 4 — Classifications/Interconnections of Systems

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- System Representation
  - A system takes a signal as an input and transforms it into an output
  - This is written as $x(t)$ passed through transformation function $T\{\cdots\}$ makes $y(t)$
- Linear Systems and the Principle of Superposition
  - A homogenous system has zero output for zero input (if $x(t)$ transforms to $y(t)$, then $ax(t) \to ay(t)$)
  - Additive: $x_1(t)$ causes response $y_1(t)$ and $x_2(t)$ causes response $y_2(t)$, then $x_1(t) + x_2(t)$ causes $y_1(t) + y_2(t)$
  - A linear system is both homogenous and additive (the superposition principle applies)
- Linearity
  - The system with an input-output relationship $y(t) = t^2x(t)$ is linear
  - We can prove linearity by saying:

$$x_1(t) \to y_1(t) = T\{x_1(t)\} = t^2x_1(t) \quad \text{and} \quad x_2(t) \to y_2(t) = T\{x_2(t)\} = t^2x_2(t)$$

  - and then proving:

$$T\{a_1x_1(t) + a_2x_2(t)\} = t^2(a_1x_1(t) + a_2x_2(t)) = a_1t_1(t) + a_2y_2(t)$$

  - The system with an input-output relationship $y(t) = x^2(t)$ is non-linear