Q: Why study signals & systems?

A: Fundamental to solving engineering problems

* Model the problem of interest as a "system" Often involves writing down the mathematical description of the input/output signals & their relationship.

* Analze the system: Usually involves the study of various possible signals associated with the system

* Design a new system: Requires deciding a suitable system architecture as well as finding good system parameters.

* Implement and test the system: Check the system & the input/output signals to see whether the performance is satisfactory.

* The scope of this course

Signals Systems

① Signals vs. LTI systems.

② New Analytical Tools:

Fourier transform, Laplace transform

z-transform, convolution integral ...

"Convolution sum" as in convolutional neural networks in machine learning.

③ Important applications:

Filters, AM/FM radios ECE 440, VIP Beyond-5G team, ECE544

Quantization, sampling,

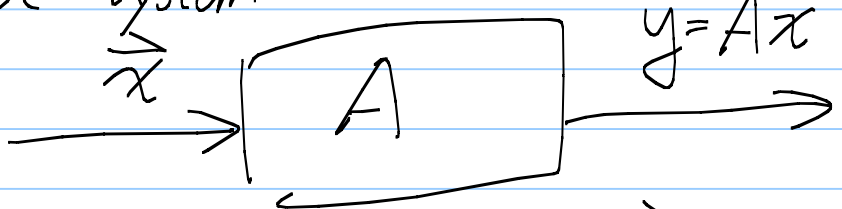
digital signal processing, etc. ECE 438, ECE538

Definition: We say a system is linear

Q: How to check whether a system is linear or not?

Example: Consider a 2×2 matrix A.

A a system



input $\vec{x}=\begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$ output $\vec{y}=\begin{pmatrix} y_1 \\ y_2 \end{pmatrix}=A\begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$

Q: Is such a system linear?

A: Step 1:

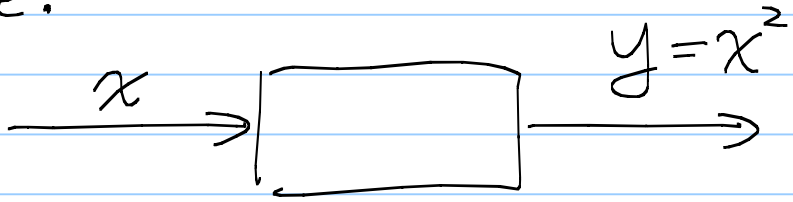
(do not assign any value to $\vec{x}_1$ & $\vec{x}_2$ we want to use $\vec{x}_1$, $\vec{x}_2$ to represent <u>any</u> signals)

Step 2:

Q: Are all sys linear?

Ans:

Example:



Q: Show that such a sys is non-linear.

Ans: Step 1:

Step 2: