Signal Analysis
Lect 1

Introduction

- **why is signal processing important**
  1. To reduce in an electrical signals
  2. To make desired changes to the signal
  3. Derive useful information from the signal
- **Example of signals**
  - Electrodiogram Signal (ECG)
  - Magnetic Resonance Image (IMR) data as 2-dimensional signal
  - FTSE 100 index in a day as signal (time series)

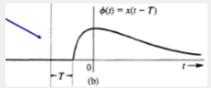
Signals Classification

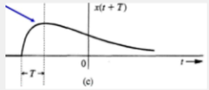
Deterministic and probabilistic signals
Causal and non-causal
Even and Odd signals

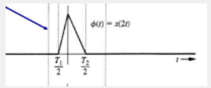
Continuous or Discrete time signals
Analog or Digital signals
Periodic or Aperiodic signals
Energy and power signals

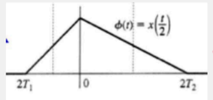
- **Signal is periodic if** $x(t) = x(t + T_0)$ for all t, with $T = \frac{1}{f} = \frac{2\pi}{\omega}$
- **even and odd signals** $x(t) = \underbrace{\frac{x(t) + x(-t)}{2}}_{even} + \underbrace{\frac{x(t) - x(-t)}{2}}_{odd}$ $\quad x(t) = x_e(t) + x_o(t)$

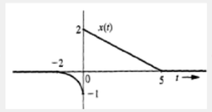
Useful Segnal Operatioins

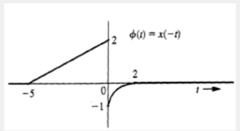
- **Time Shifting**
  - 

    $\phi(t + T) = x(t)$ — Signals may be delayed by time T:
  - 

    $\phi(t - T) = x(t)$ — Advanced by time T
- **Time Scalling**
  - 

    $\phi(t/2) = x(t)$ — Compressed in time by a factor of 2
  - 

    $\phi(2t) = x(t)$ — Expanded in time by a factor of 2
- **Time Reversal**
  - 

    $\phi(t) = x(-t)$
  - 

  - Reflected about the vertical axis (Time Reversed)

Energy signals and Power signals

- **Signal Energy Ex**
  - Energy must be finite, which means signal amplitude = 0 as |t| = infinite — $E_x = \int_{-\infty}^{\infty} x^2(t)\,dt$
  - A signal is an energy signal only if — $0 < E < \infty \rightarrow P = 0$
- **Signal Power Px**
  - amplitude x(t) not 0 when t = infinite
    - $P_x = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2\,dt$ — $p = \frac{1}{T}\int_0^T x(t)^2 dt$
    - $P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2$
  - A signal is a Power Signal only if — $0 < P < \infty \quad \rightarrow E = \infty$

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