Signals and systems

- Books
- Text : Digital Signal Processing

  By Tarun kumar Rawat

  Oxford publications
- Reference : Signals and systems

  By Tarun Kumar Rawat

  Oxford publications

Content summary

- Time domain and frequency domain study of signals and systems
- Time Domain study of signals
  How signals change with time
  Classification of signals
- Frequency domain study of signals
  Which frequencies are present. What are their
  amplitudes and phases

Content summary

- Time domain description of systems
  - Impulse response
    - Output for any input can be computed
- Frequency domain description of systems
  - Transfer function
    - Output frequency spectrum can be computed for a given input frequency spectrum

Syllabus

- Syllabus

  Discrete Time signals and systems: Convolution and Correlation. Discrete time Fourier series. Discrete time Fourier Transform. Filter concepts. Discrete Fourier transform. Optimum linear filters
- Note about syllabus

  Discrete signals and systems are emphasized. But the following topics for continuous time signals will be covered

  Convolution

  Fourier Transform

Examination scheme

- Mid semester Exam : 20 %
- End semester Exam : 40 %
- Computer simulations Exam : 20 %

  Scilab
- Project : 20 %

  Teams of 4. Form teams with diverse capabilities

  (1) Programming

  (2) Creativity

  (3) Communication skills

Teaching scheme

- Monday :11 to 12.30: Theory and Problem solving
- Wednesday : 11 to 12.30 : Theory and Problem solving
- Friday : 11 to 12 : Scilab Programming+ some topics in Analog Signals and systems

Fridays : All students must bring laptops with Scilab loaded

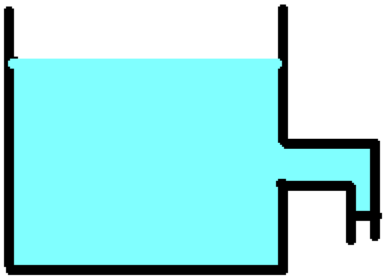
Scilab is a freeware similar to Matlab

SIGNALS

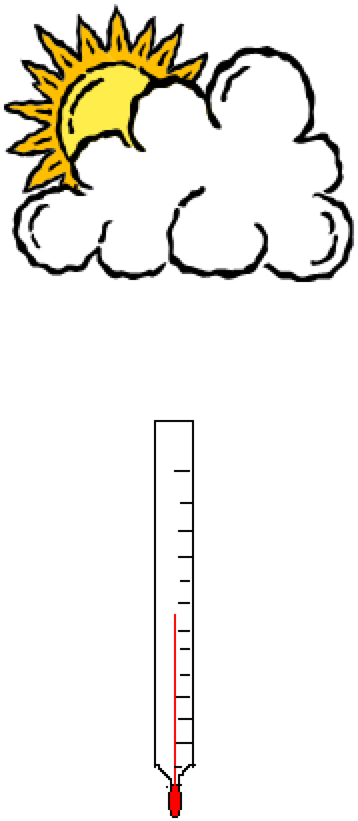
- Any physical quantity that changes with time or space or both is a signal
- We first look at signals which are functions of time

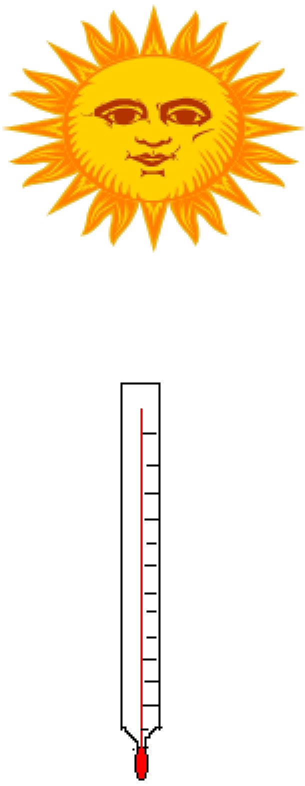
EXAMPLES

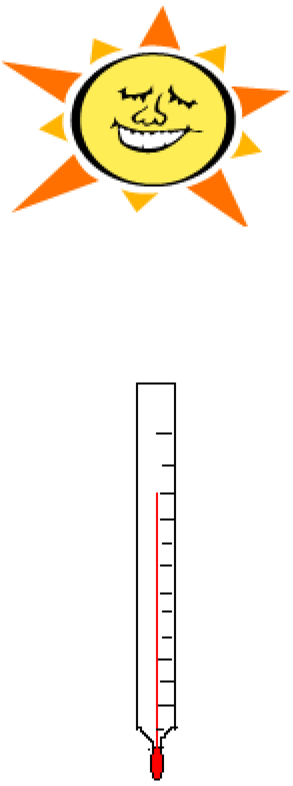
- 1. Water level in a tank



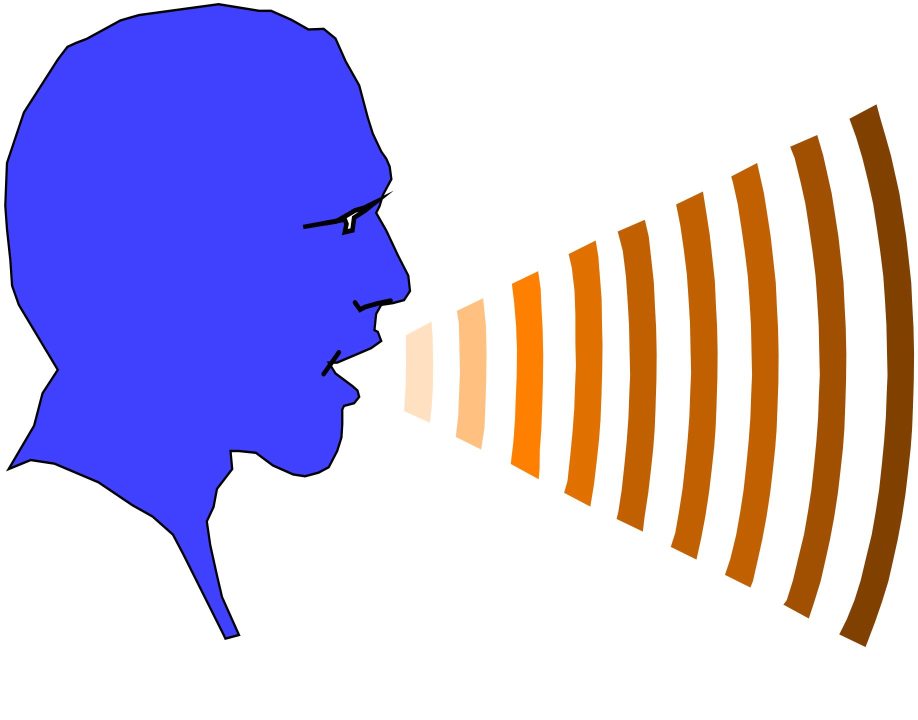
2. Room Temperature



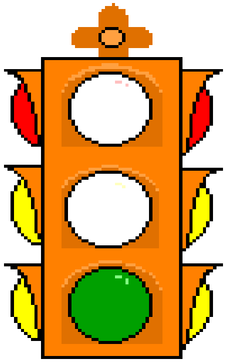




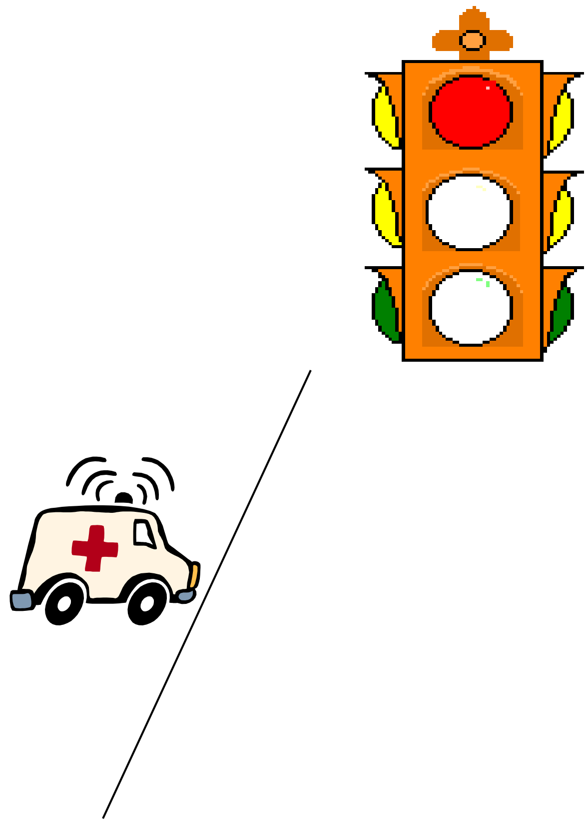
3. Sound Signals



4. Light Signals



4. Light Signals



Signals as functions of space coordinates

- A still picture or an image is an example
- The light intensity of each point is a function of the location of the point
- Thus light intensity is a function of x,y coordinates.

Signals as functions of space and time

- Moving picture
- Light intensity of each point is a function of its space coordinates
- It is also a function of time

Scanning

- By the process of scanning the dependence on space coordinates can be converted into dependence on time.
- Thus we have a signal which is a function of time alone.

Conversion of signals into Electrical form

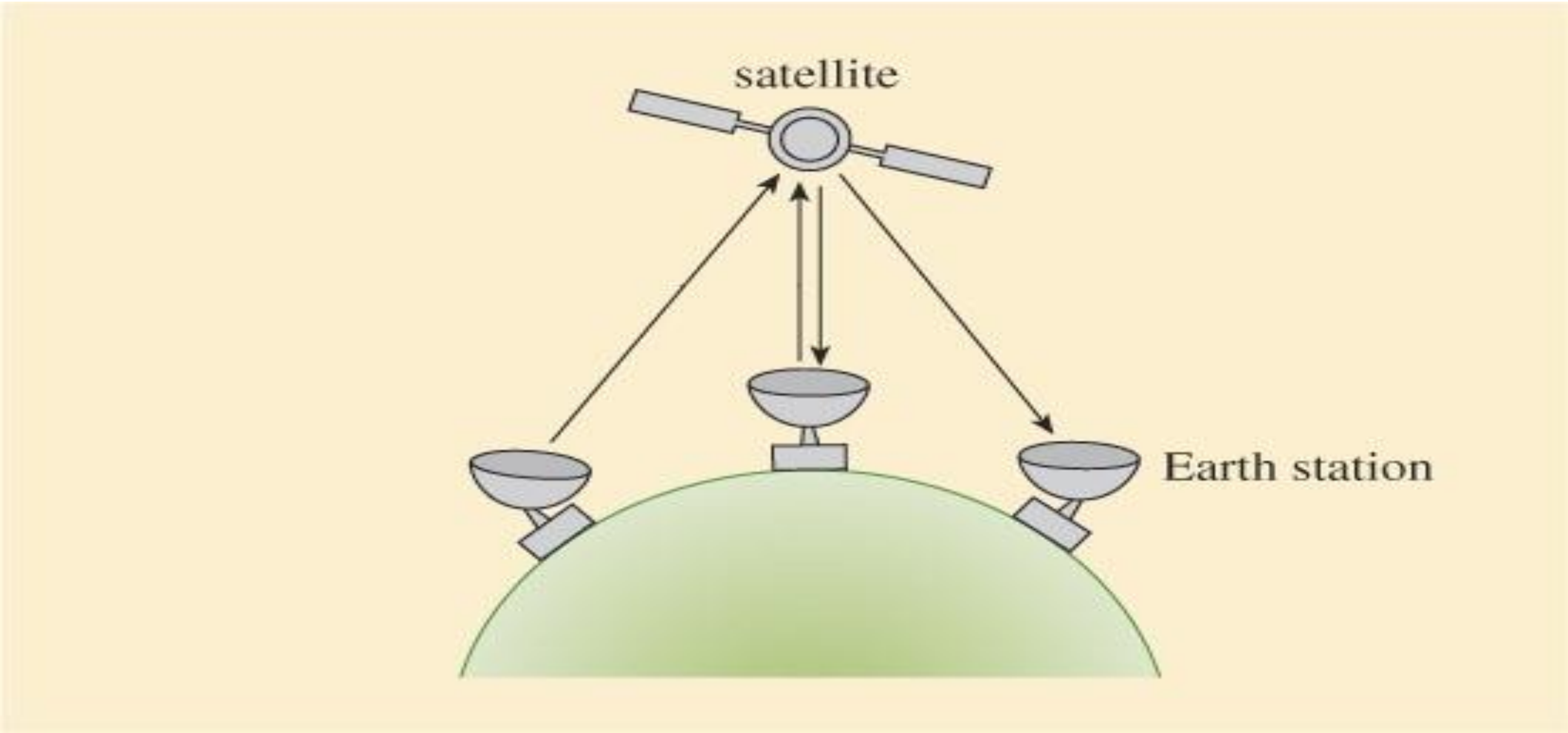
Why ?

How ?

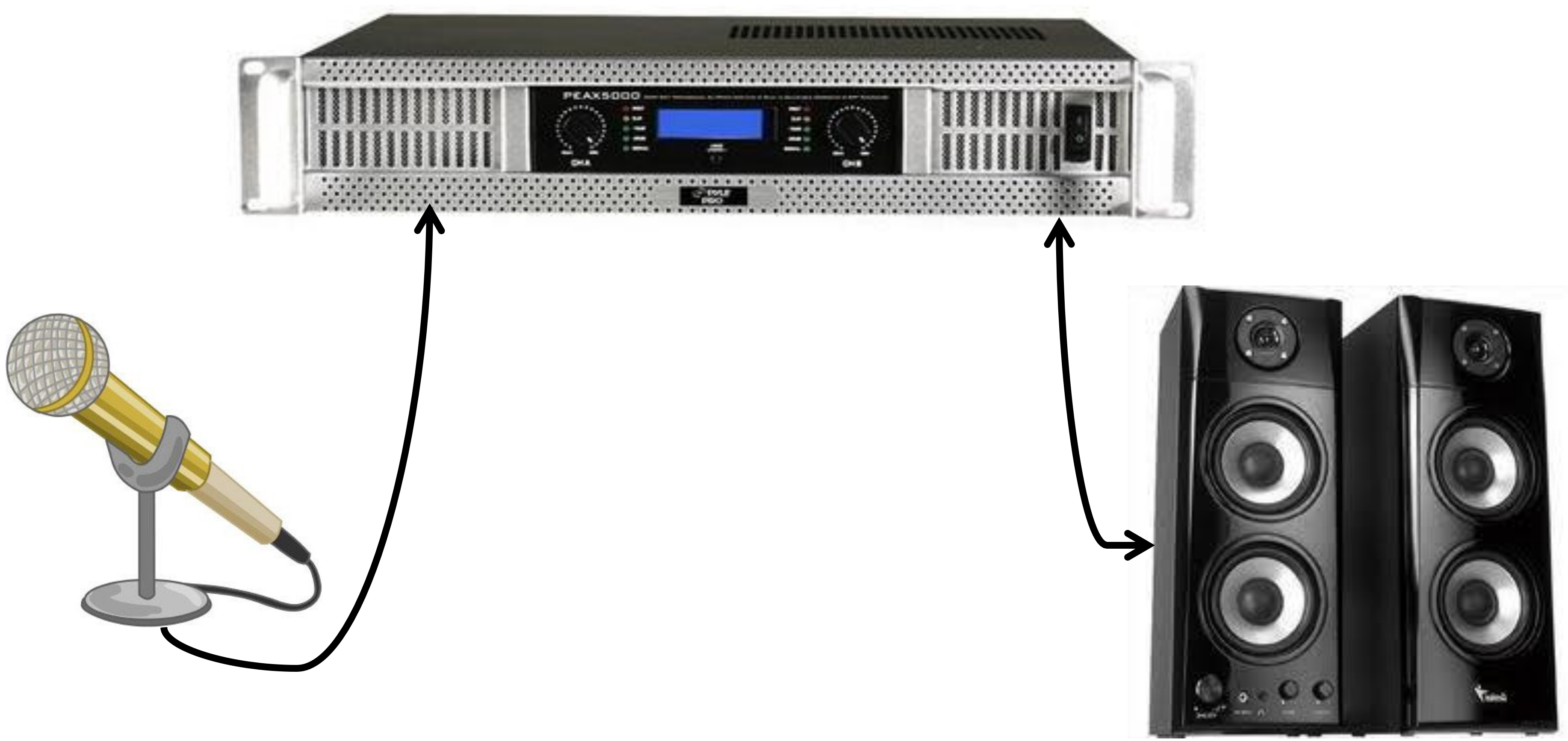
ADVANTAGES

Transmission is easy

Easy transmission of electrical signals



Processing is Easy



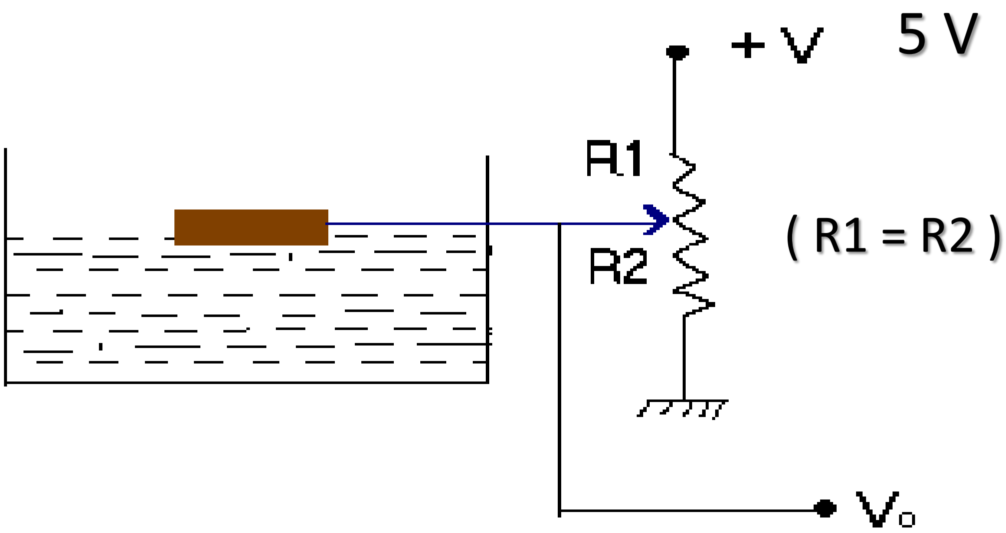
Processing options

- Addition of two or more signals
- Subtraction of signals
- Multiplication
- Division
- Differentiation
- Integration
- Filtering

Transducers

Convert one form of signal into another form of signal.

1. Potentiometer



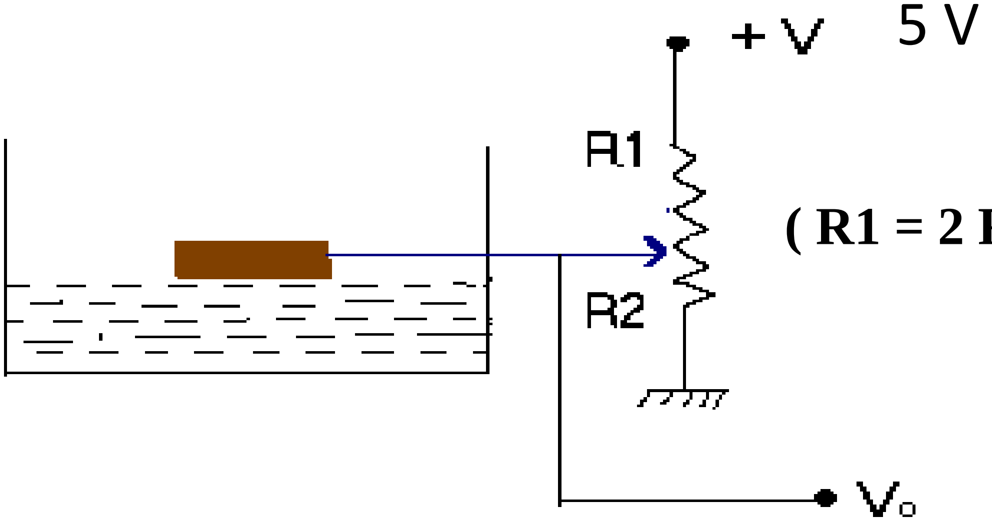
$$Vo = \frac{V\ (R2)}{R1 + R2}$$

Vo = 2.5 V

Transducers

Convert one form of signal into another form of signal.

1. Potentiometer



$$Vo = \frac{V \ R2}{R1 + R2}$$

Vo = 1.67 V

Transducers

2. Thermocouple

3. Microphone

4. TV Camera

Transducers

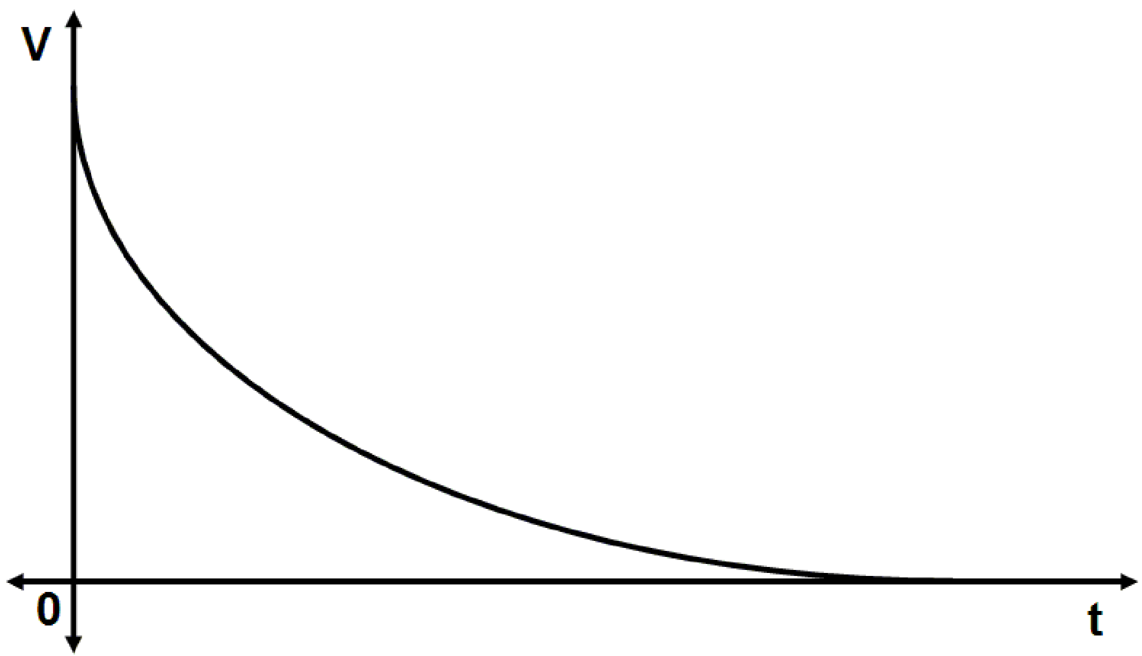
5. Stepper motor
6. Heater
7. Loud speaker
8. TV picture tube

Classification of Signals

1. Predictable Signal
2. Unpredictable Signal

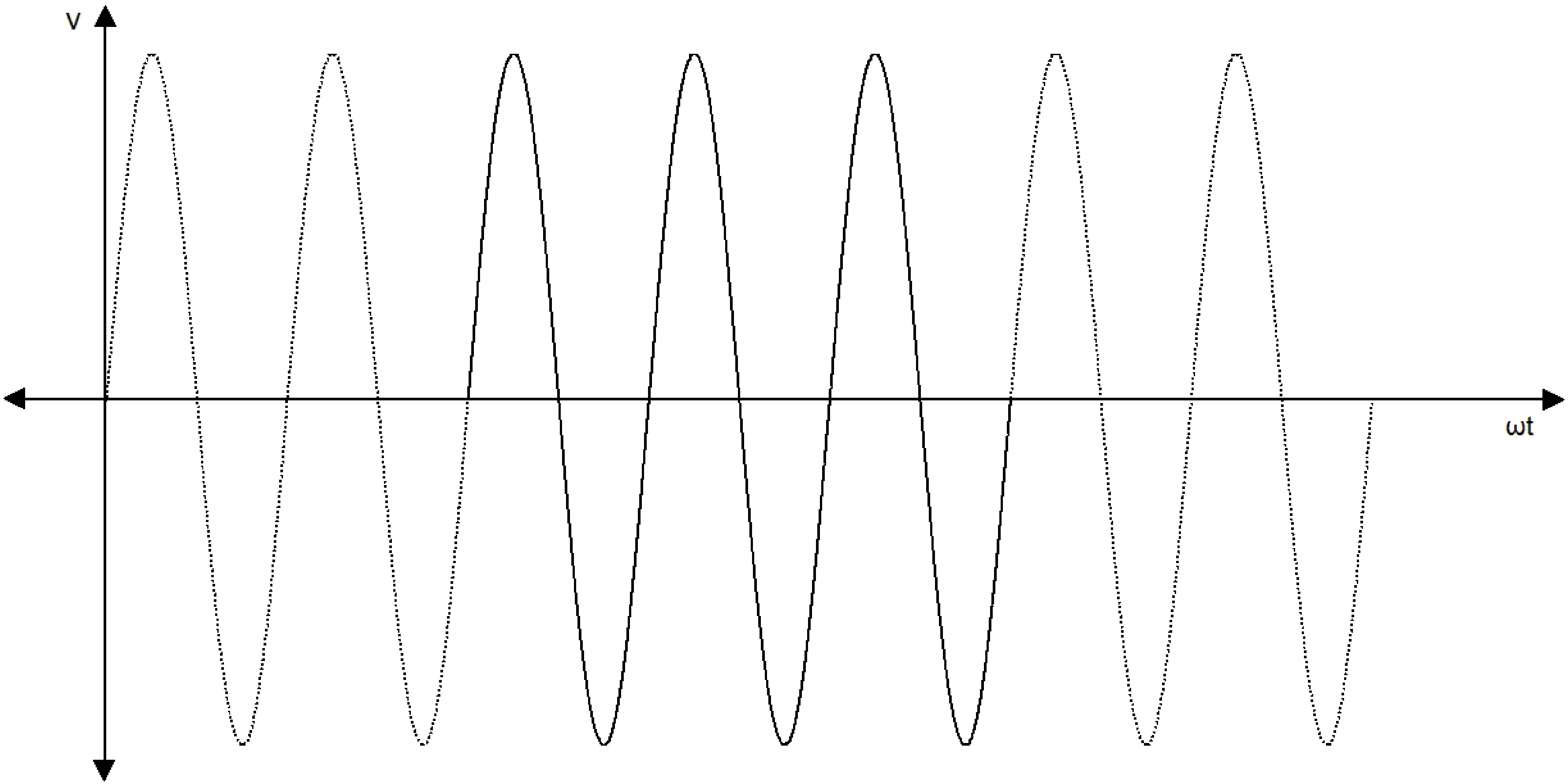
Examples of Predictable Signals

1. $V = Vm\ e^{-t/RC}$



Examples of Predictable Signals

2. v = Vm Sin wt



Unpredictable Signals

1. Information carrying signal
2. Noise Signal

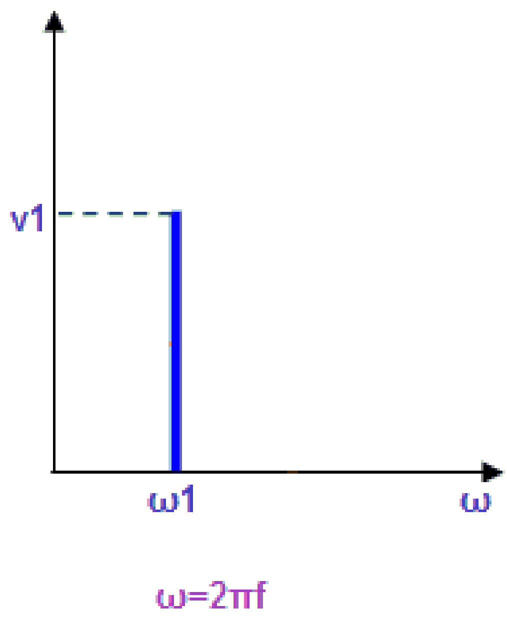
Frequency Domain Description

Assumption: Signal expressible as sum of number of sine waves.

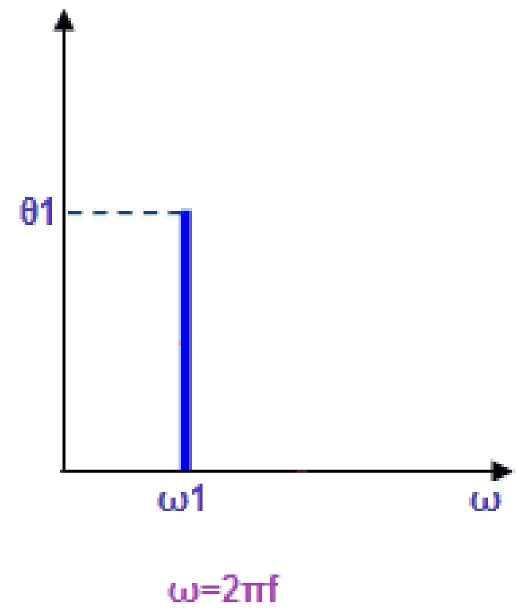
1. Audio Signal : 20 Hz to 20 KHz
2. Video signal : D.C. to 5 MHz
3. Instrumental Signal : D.C. to few Hz

Spectrum of a sine wave

$$V = V_1 \sin(\omega_1 t + \theta_1)$$



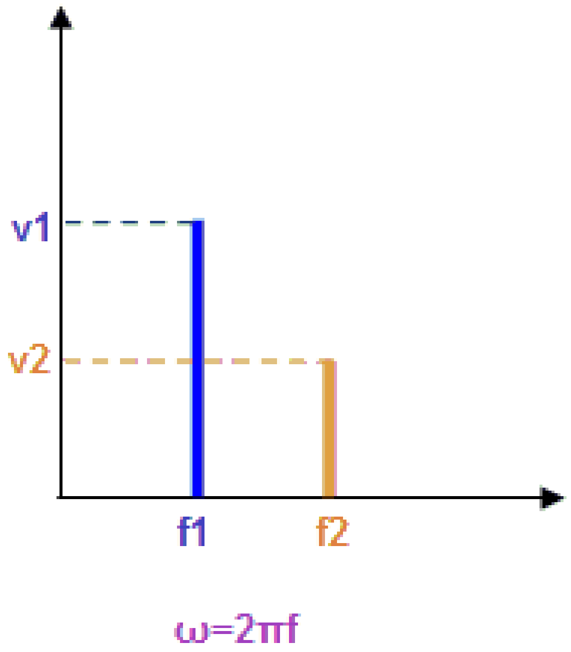
Amplitude Spectrum

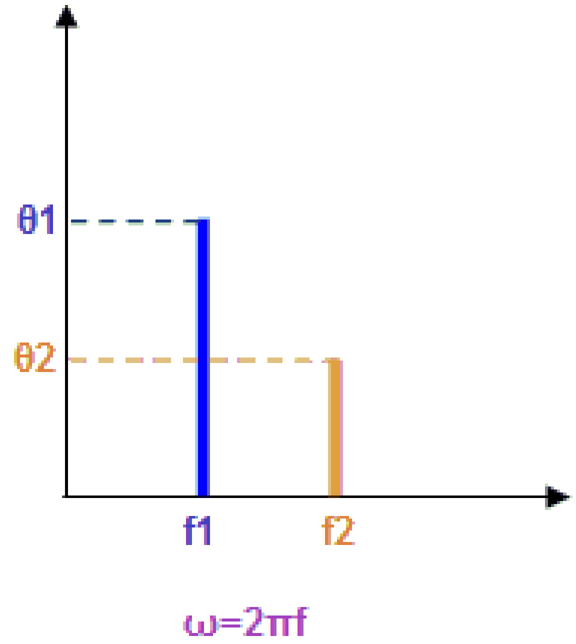


Phase Spectrum

Signal containing two sine waves

$$V = V_1 \sin(\omega_1 t+\theta_1)+V_2 \sin(\omega_2 t+\theta_2)$$





One more example

$$V = V_1\sin(\omega_1 t+\theta_1)+V_2\sin(\omega_1 t+\theta_2)+V_3\sin(\omega_2 t+\theta_3)$$

$$V = V_4\sin(\omega_1 t+\theta_4)+V_3\sin(\omega_2 t+\theta_3)$$

$$\overline{V}_4 = \overline{V}_1+\overline{V}_2$$

$$\overline{V}_4 = V_1 \angle\theta_1 + V_2 \angle\theta_2$$

$$\overline{V}_4 = V_4 \angle\theta_4$$

Spectrum of periodic signals

- Fourier series

  Components at f_0 , $2f_0$ etc

  Amplitude and phase plots

Spectrum of non-periodic signals

- Continuous spectrum
- Amplitude spectrum important

  A/Hz
- Fourier Transform