جامعة المستقبل

كلية الهندسة والتقنيات الهندسية

قسم هندسة تقنيات الاجهزة الطبية

Course: Digital Signal Processing

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Lecture 1 and 2
Unit form for
Introduction to Digital Signal Processing

1. Overview:

A. Target population

For students of third year graduate studies, in the department of medical instrumentation engineering techniques.

B. Rationale

This unit introduces definitions of signal, processing and, digital.

C. Central Idea

The major topics discussed in this unit are included in the following outline.

- Bio-signal acquisition
- Description of signals
- Classification of bio-signals
- Processing of bio-signals
- Processing in time and frequency domains
- Analog, discrete, and digital signals
- Biomedical applications

D. Objectives:

Make the students able to:

1. Describe the Digital Signal Processing.
2. Explain how signal acquired and then digitized for digital hardware processing.
3. Recognize between time domain and frequency domain
4. Conceive the applications of bio-signal processing

2. Pretest:

For a given multiple choices, choose the most appropriate one.

1. Signal can be considered as,

a) Time dependent only one value.
b) Variation an alternative current only.
c) Continuous value only.
d) A physical quantity that varies with time, space or any other independent variable or variables.

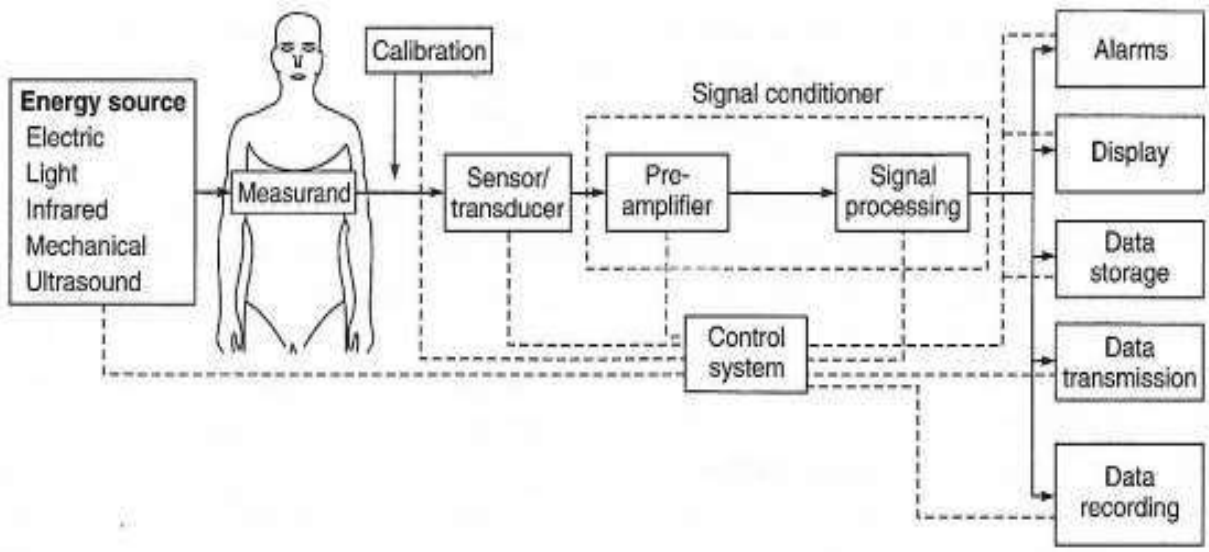
2. Processing of the signal can be applied in

a) Time domain only.
b) Frequency domain only.
c) Both time and frequency domains.

3. Introduction to Digital Signal Processing:

Signal is defined as any physical quantity that varies with time, space and any other independent variable or variables.

Signal conditioner is one of the main part of medical instrumentation system that signal produced by sensor or transducer processed in some fashion, as shown in figure.



General block diagram of a medical instrumentation system

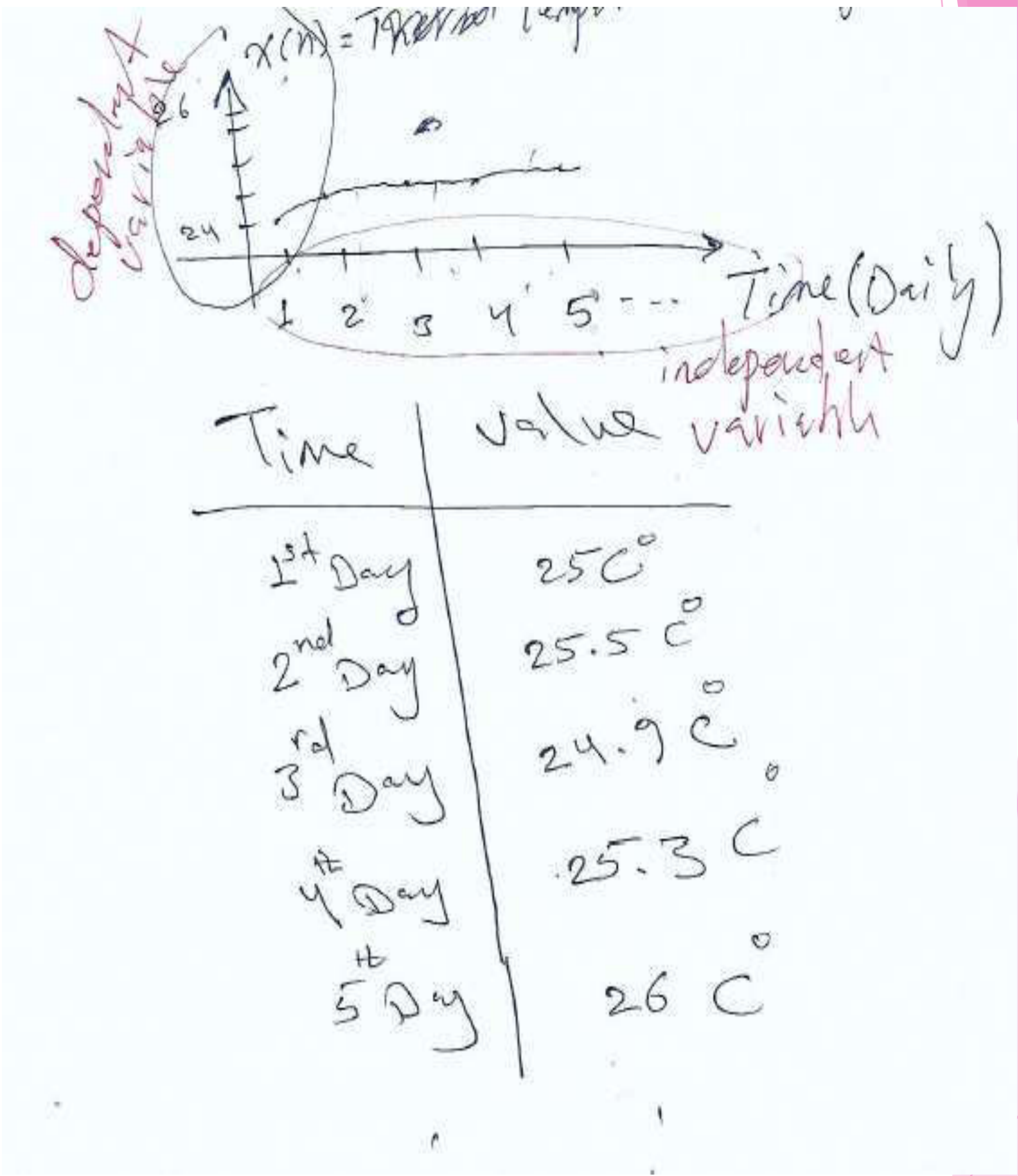


Figure that represents signal representation by dependent and independent variables

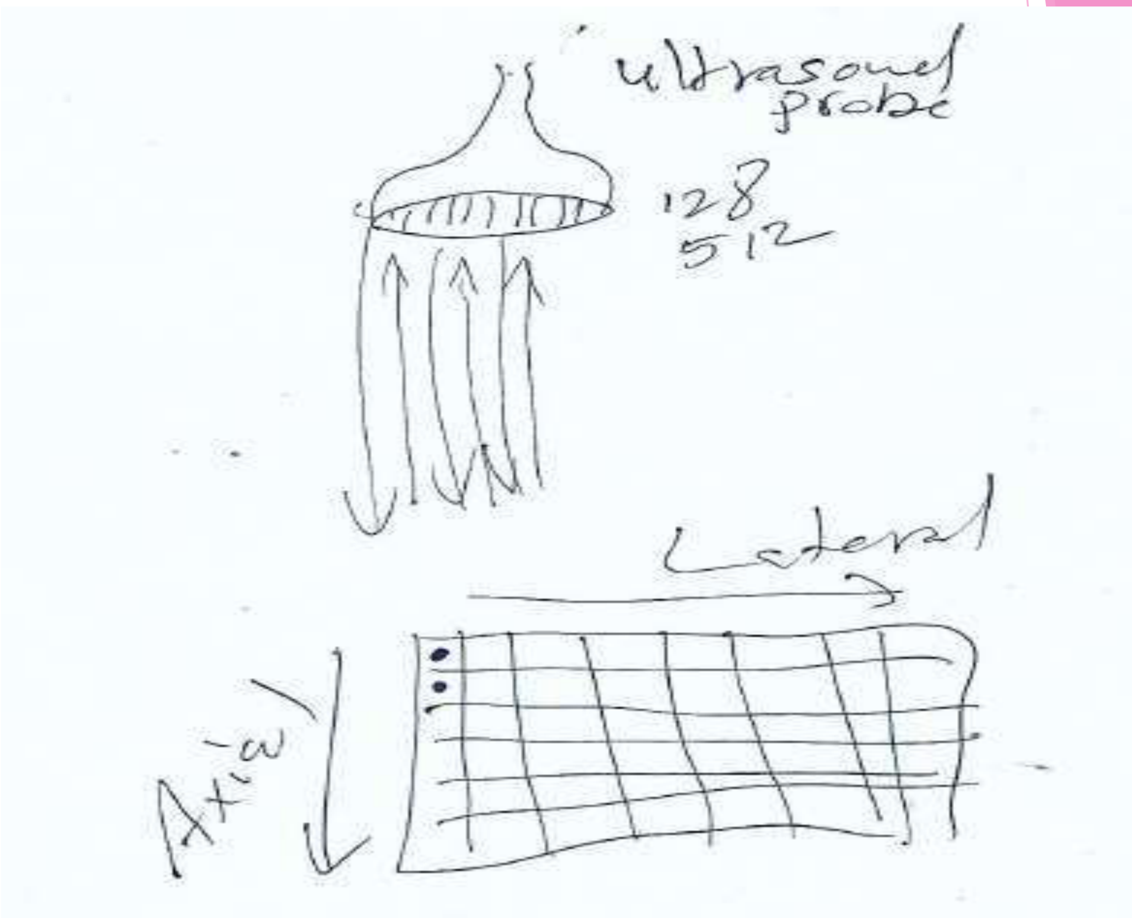


Figure that represents the ultrasound imaging modality and forming a signal of two independent variables (Two dimensional signal).

Mathematically, signal described by functions with one or more independent variables.

For example, the function below varies with one independent variable of time

$$s_1(t) = 5t$$

While the function below varies with two independent variables of space x and y

$$s(x, y) = 3x + 2xy + 10y^2 \quad .$$

Processing means operating in some fashion on signal to extract some useful information, such as spectrum analysis to determine the various frequency components of a signal and filtering the signal to extract some the required frequency component of the signal.

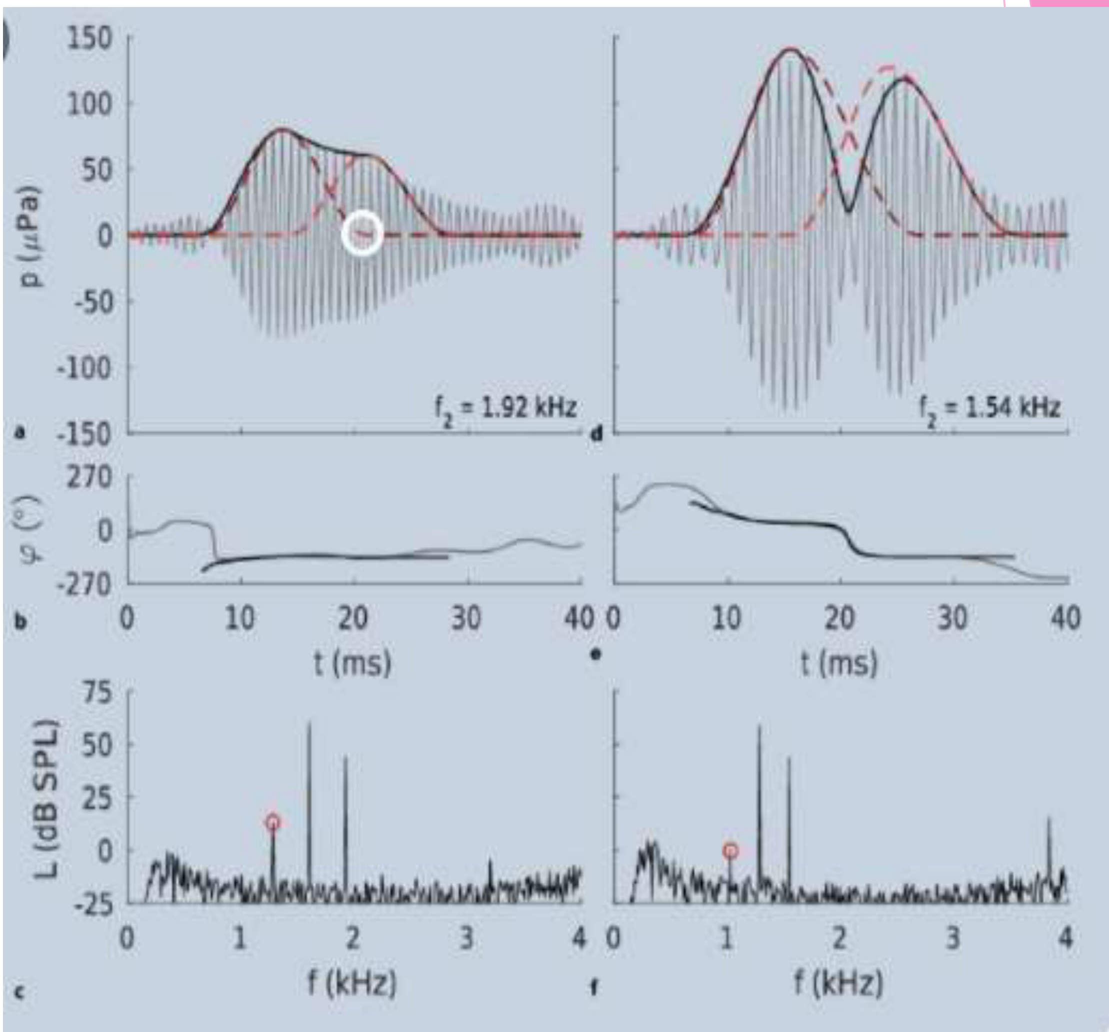


Figure that represents a biosignal of cochlea response and the frequency components

Digital means the processing is done with a digital computer or special purpose digital hardware.

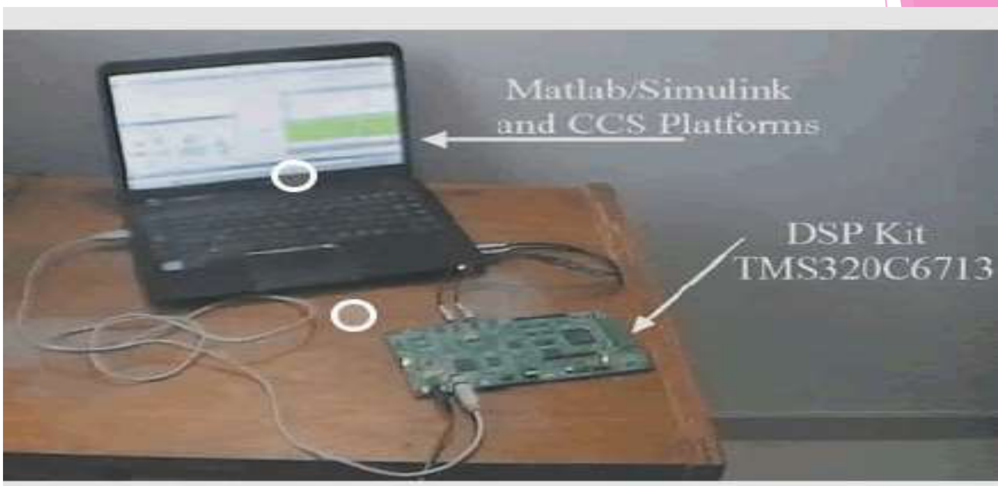


Figure that represents special purpose digital hardware of TMS320C6713 DSP processor

DISCRETE-TIME SIGNALS

In digital signal processing, signals are represented as sequences of numbers, called samples. A sample value of a typical discrete – time signal or sequence is denoted as x(n) with the argument n being an integer in the range - ∞ and ∞. It should be noted that x(n) is defined only for integer values of n. The graphical representation of a sequence x(n) with real – valued samples is illustrated in figure below.

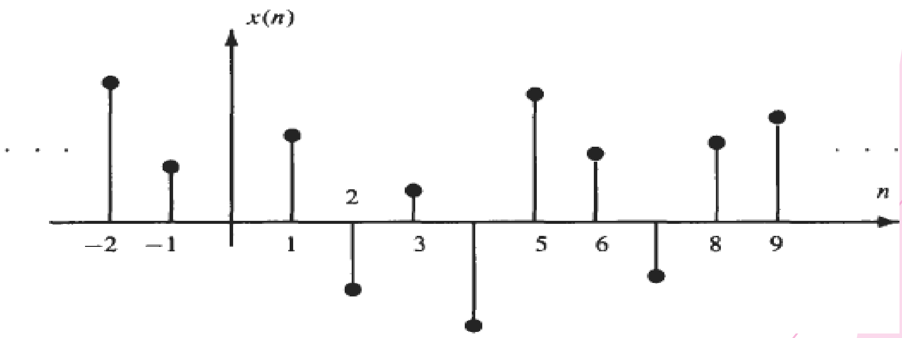


Figure that shows the graphical representation of a discrete-time signal x(n).

In some problems and applications it is convenient to view x(n) as a vector. Thus, the sequence values x(0) to x(N - 1) may often be considered to be the elements of a column vector as follows:

$$\mathbf{x} = [x(0),\ x(1), \ldots, x(N-1)]^T$$

Discrete-time signals are often derived by sampling a continuous-time signal, such as speech, with an analog-to-digital (A/D) converter.' For example, a continuous-time signal $x_a(t)$ that is sampled at a rate of fs = l/Ts samples per second produces the sampled signal $x(n)$, which is related to $x_a(t)$ as follows:

$$x(n) = x_a(nT_s)$$

Complex Sequences

In general, a discrete-time signal may be complex-valued. In some useful signal processing applications, complex signals can be obtained by Hilbert transform, where signal in complex form representation called analytic signal. A complex signal may be expressed either in term of its real and imaginary parts,

$$\mathrm{an(n)} = \mathrm{x}(n) + \mathrm{j}H(x(n))$$

or in polar form in terms of its magnitude and phase that is called complex envelope signal,

$$\mathrm{iq}(n) = |an(n)|\ \exp(-\mathrm{j}\ arg*an(n)+)$$

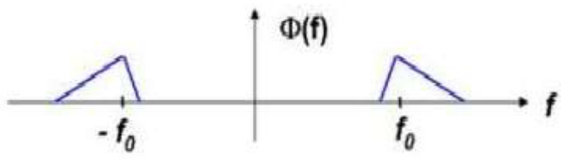
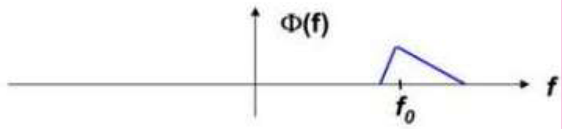
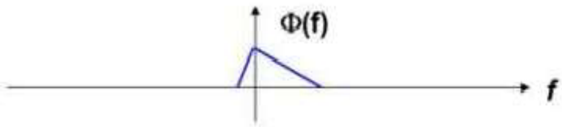
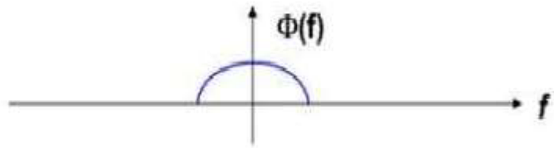
Whereas the phase may be obtained using

$$arg*an(n)+= \tan -1\, \frac{H(x(n))}{Rel(x(n))}$$

The envelope signal considered as an absolute vale of the analytic signal

$$\mathrm{env(n)} = |\mathrm{i}q(n)|$$

Table that illustrates raw, analytic, complex envelope, and envelope signals

signal	spectrum
Raw signal x(n)	
Analytic signal an(n)	
Complex envelope signal iq(n)	
Envelope signal env(n)	

4. Posttest:

1- Which one of the following signals that represents a discrete time signal?

a- x(t) = 2t.

b- x(t) = 2t+1.

c- x(n) = n+1 .

d- x(t) = t^2.

2 Continuous time signal converted to discrete time signal by

a. Sampling operation.

b. Convolution operation.

c. Correlation operation .

d. Quantization operation.