Chapter: 6 (10 Marks)
DIGITAL INSTRUMENTATION

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Contents

- Sample Data System, Sample and Hold Circuit
- Component of Data Acquisition System
- Interfacing to Computer

Sample Data System

- Systems that combine an analog part with some digital components
- sampled-data systems are responsible for converting the signals from analog to digital

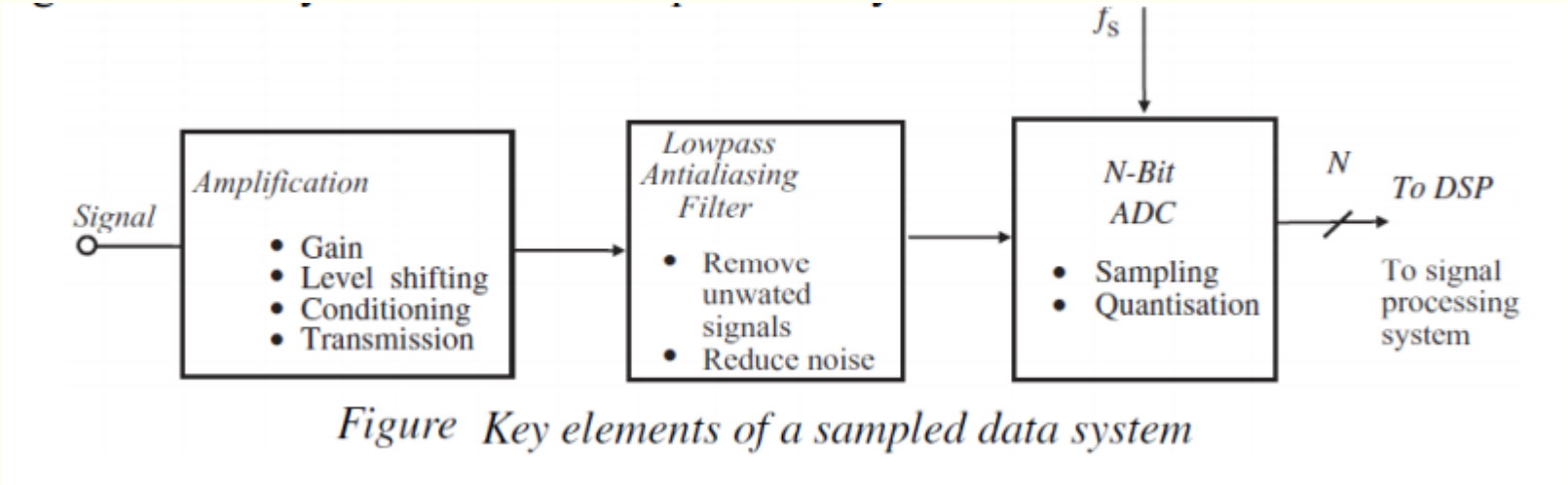


Figure Key elements of a sampled data system

Note: If fm = signal of max frequency, sampling frequency fs ≥ 2fm

Sampling

- process of converting analog signal to discrete signal, making analog signal to occur at particular interval of time.

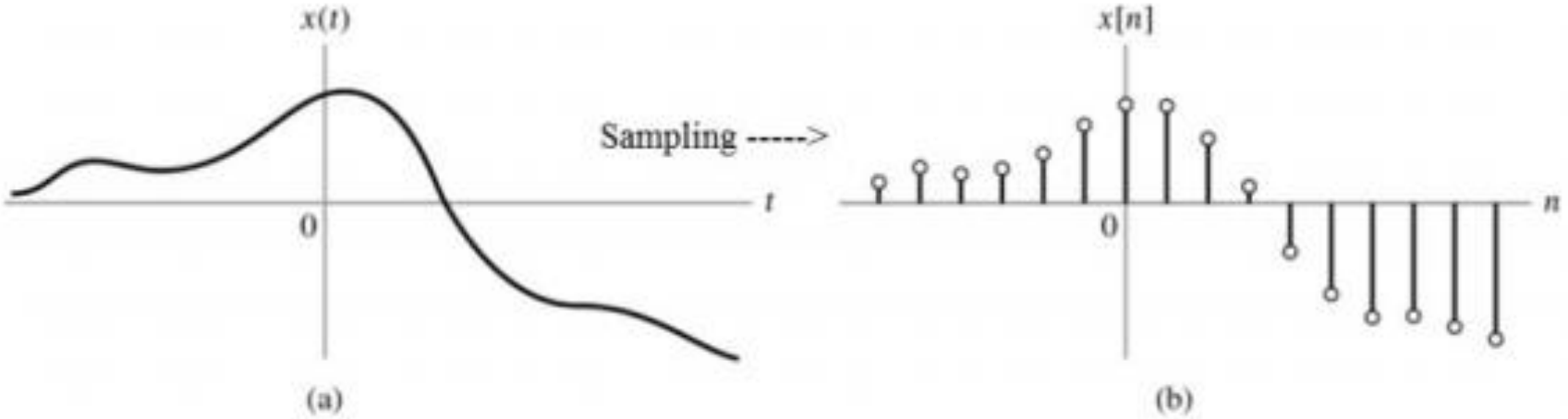


FIGURE: Sampling

Sampling Theorem/Nyquist Sampling Theorem

- According to Nyquist, a continuous time signal may be completely represented by its sample and recovered back if the minimum sampling frequency, fs > 2fm.

  Here,

  fs = sampling frequency

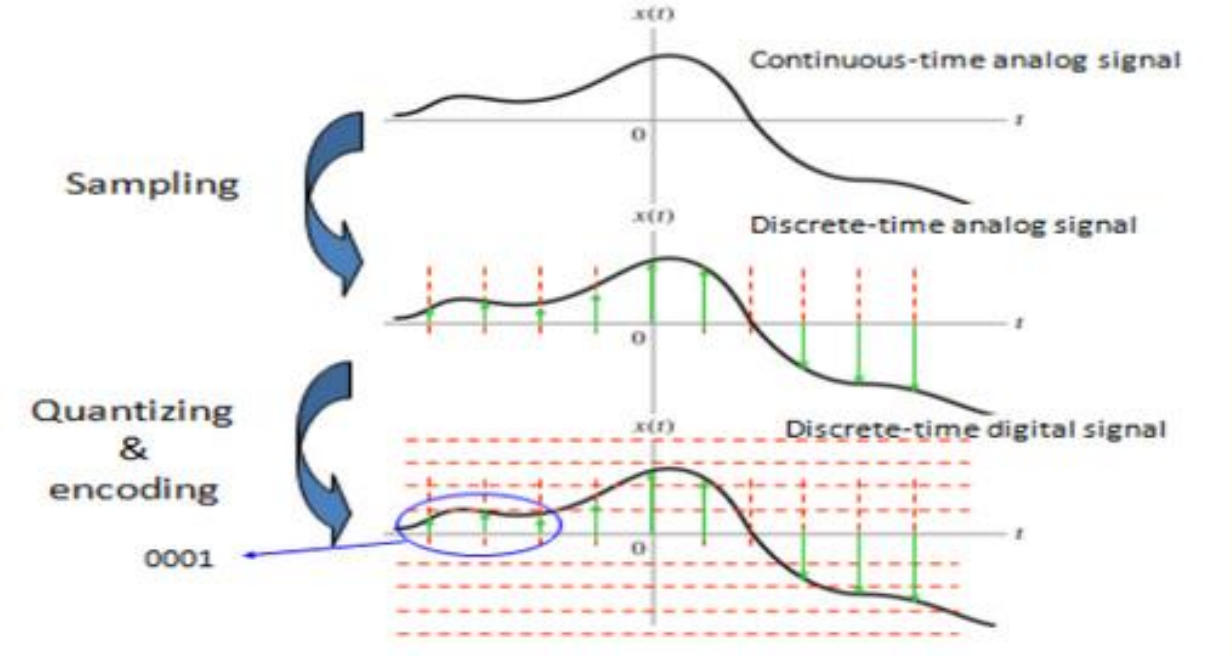
  fm = maximum frequency present in the signal

  The minimum sampling rate fs min = 2fm is called Nyquist sampling rate for distortion-less recovery of continuous signal and maximum sampling interval is called Nyquist interval and is given by:

  i.e. Ts max = 1/2fm = Tm/2

Quantization

- Input analog voltage in ADC can have any voltage range but, Digital o/p can have only 2^N discrete values for and N-bit ADC
- Therefore, whole range of analog signal is required to be represented suitably in 2^N intervals. This process is called quantization.
- Each interval is assigned to a unique N-bit binary code which is referred to as encoding



Sample and Hold Circuit

- The **Sample and Hold circui**t is an electronic circuit which creates the samples of voltage given to it as input, and after that, it holds these samples for the definite time.
- The time during which S/H circuit generates the sample of the input signal is called **sampling time.**
- The time during which it holds the sampled value is called **holding time.**

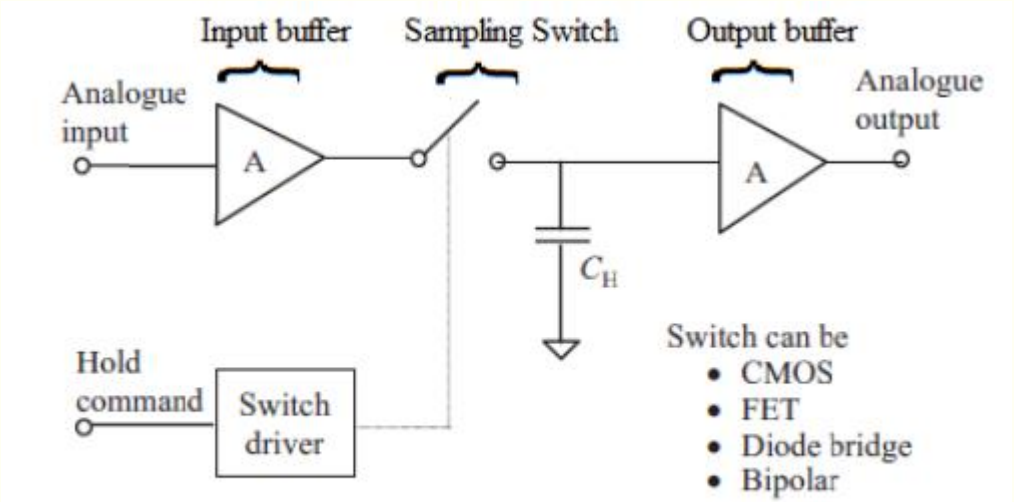
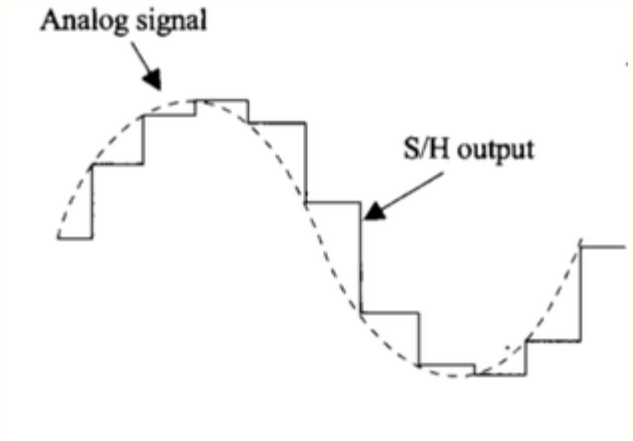


Figure: Sample and hold architecture



Components of Data Acquisition Systems(DAS)

- Data acquisition is the process of collecting input data (generally in digital form) rapidly, accurately, completely and economically as required.
- A typical data acquisition system consists of individual sensors (transducers) with their necessary signal conditioning, multiplexing signal conversion data processing, data handling and associated transmission, storage and display system.

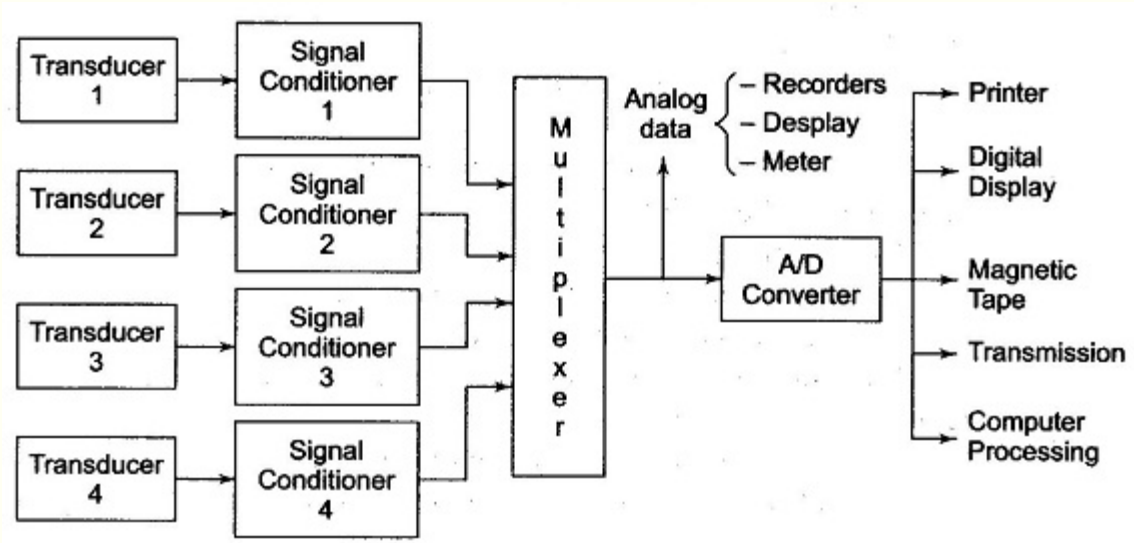


Fig. 17.1 Generalised Data Acquisition System

Components of Data Acquisition Systems(DAS)

- **Transducers**: It senses the change in parameter. A transducer converts temperature, pressure, level, length, position, etc. into electrical signal (voltage, current etc.)

- **Signal Conditioning Unit**: Signal conditioning circuits improve the quality of signals generated by transducers before they are further processed. Examples of signal conditioning are signal scaling, amplification, linearization, filtering, attenuation, excitation, common-mode rejection, and so on.

- **Multiplexer**: Multiplexing is the process of sharing a single channel to transmit the signal from different sources. Thus a multiplexer accepts multiple inputs and connect them to single channel. Multiplexing becomes necessary in data acquisition system when distance between transmitting and receiving point is large and multiple signals (quantities) are to be transmitted. Multiplexing is commonly accomplished by either time or frequency sharing of transmission channel between the individuals.

Components of Data Acquisition Systems(DAS)

- **Signal converter**: Used to convert the signal into a suitable form for further signal processing. A signal converter translates the analog signals to a form acceptable by the analog to digital converter. An example for signal converter is an amplifier for amplifying the low level.

- **ADC**: Analog to digital (A/D) conversion changes analog voltage or currentlevels into digital information. The conversion is necessary to enablethe computer to process or store the signals.

- **Auxiliary Equipments**: These contain devices foe system programming functions and digital data processing. Some typical functions done by auxiliary equipment are linearization and limit comparison of signals. These functions may be performed by individual devices or by a digital computer.

- **Digital recorders and printers**: These are used for data storage and display.l signal voltages produced by the transducers.

Components of Data Acquisition Systems(DAS)

Object/Characteristics of Data Acquisition System

- It must acquire necessary data at correct speed and time.
- It must use all data efficiently to inform operator about the state of plant.
- It must be able to collect, summarize and store data.
- It must be reliable, flexible and capable of being expanded for future requirements.
- It must be able to compute unit performance indices using online and real time data.

Application Data Acquisition System

- Data Acquisition Systems are used in a variety of industrial and scientific areas including aerospace, biomedical and telemetry industries.

Interfacing to a Computer

- In an instrumentation system, a digital computer is often used for more efficient, accurate and effective signal processing. Measuring devices are connected to the computer through an intermediate device is called interface.

Types of interface:

a. Parallel interface: E.g. Intel 8255A programmable parallel interface.

b. b. Serial interface. E.g. RS232 and USB.

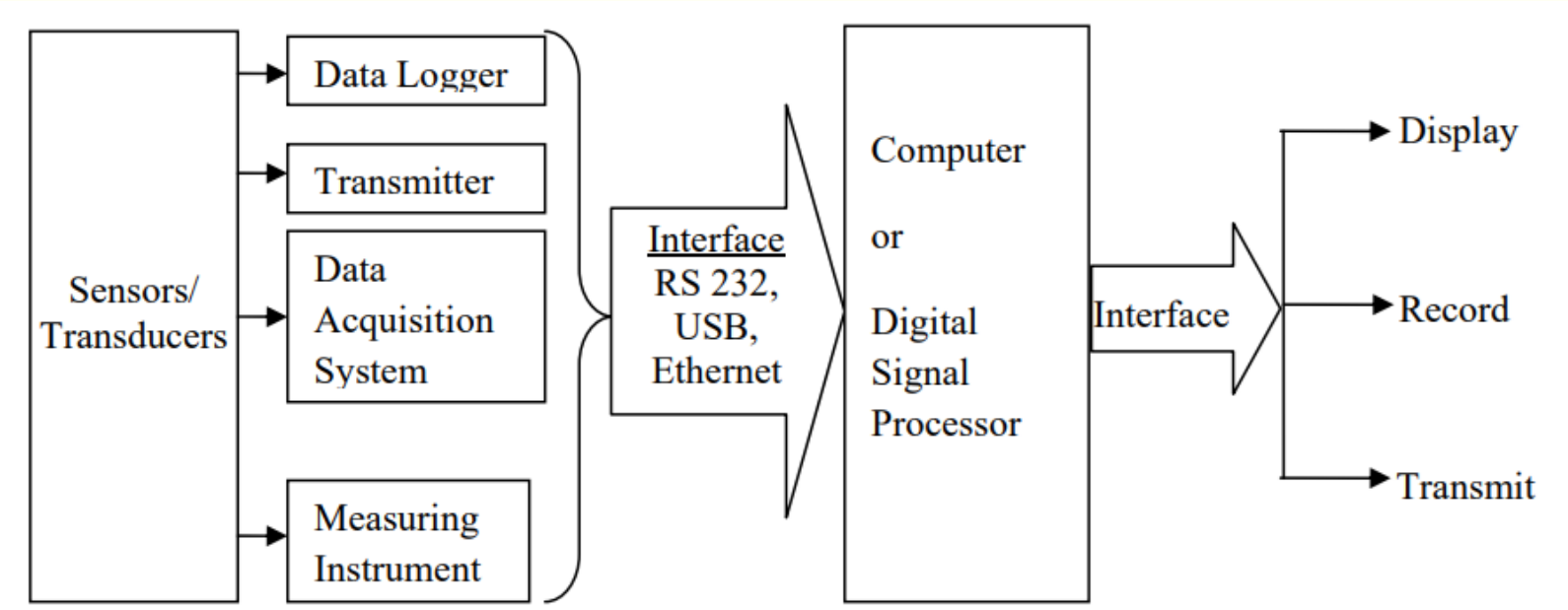


Figure: Interfacing to computer

Thank You!