Biomedical Instrumentation
20EI603
July/August 2023
Scheme of evaluation and Solutions

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Signature of faculty

Signature of HOD

20EI603

Hall Ticket Number:

III/IV B.Tech (Regular) DEGREE EXAMINATION

July/August, 2023 — **Electronics and Instrumentation Engineering**

Sixth Semester — **Biomedical Instrumentation**

Time: Three Hours — **Maximum:** 70 Marks

Answer question 1 compulsory. **(14X1 = 14Marks)**

Answer one question from each unit. **(4X14=56 Marks)**

			CO	BL	M
1	a)	List the problems encounter in measuring a living system?	CO1	L1	1M
	b)	Define resting potential?	CO1	L1	1M
	c)	List various physiological systems of the body?	CO1	L1	1M
	d)	What is the use of biomedical electrodes?	CO2	L2	1M
	e)	Draw and Interpret the ECG Waveform?	CO2	L2	1M
	f)	What are the various types of blood pressure measurement	CO2	L1	1M
	g)	Define Cardiac Output?	CO3	L2	1M
	h)	What is Phonocardiography	CO3	L2	1M
	i)	What is Dialysis?	CO4	L1	1M
	j)	What is the use of Defibrillator?	CO4	L2	1M
	k)	What is meant by an in vitro measurement?	CO1	L2	1M
	l)	List the uses of EEG?	CO2	L1	1M
	m)	List various blood flow measurement techniques?	CO3	L2	1M
	n)	What is the use of Bio-Chemical Electrodes?	CO4	L2	1M
		Unit-I			
2	a)	Write a detailed note on Man-Instrument System	CO1	L2	7M
	b)	Write a short note on physiology of Respiratory system	CO1	L3	7M
		(OR)			
3	a)	Explain the generation of action potential with neat diagram	CO1	L2	7M
	b)	Write a short note on physiology of Nervous system	CO1	L3	7M
		Unit-II			
4	a)	Discuss various types of electrodes used in biomedical instrumentation	CO2	L2	7M
	b)	With neat sketch draw and explain the block diagram of ECG machine.	CO2	L3	7M
		(OR)			
5	a)	Write a short note on Electomyographic measurements	CO2	L3	7M
	b)	Discuss in detail about EEG and 10-20 system	CO2	L3	7M
		Unit-III			
6	a)	With neat sketch explain the blood flow measurement by Ultrasonic blood flow meter	CO3	L3	7M
	b)	With a neat sketch explain the blood pressure measurement using Electrosphygmomano meter	CO3	L3	7M
		(OR)			
7	a)	Explain the techniques used to measure the cardiac output	CO3	L3	7M
	b)	Explain the blood flow measurement by Thermal Convection method	CO3	L3	7M
		Unit-IV			
8	a)	What is a pacemaker? Explain the various modes of pacemaker in detail.	CO4	L3	7M
	b)	Explain the reference and pH electrodes.	CO4	L2	7M
		(OR)			
9	a)	Write short note on Magnetic Resonance Imaging in Medical Imaging	CO4	L3	7M
	b)	Write a detailed note on diathermy and its applications	CO4	L3	7M

Scheme of Evaluation

1.	14 × 1 = 14M		
2(a)	Block diagram	: 4M	
	Description of all blocks	: 3M	
2(b)	Sketch of respiratory system	: 4M	
	Description	: 3M	
3(a)	Definition of action potential	: 2M	
	Generation mechanism of action potential	: 5M	
3(b)	Description of its function	: 7M	
4(a)	Classification of electrodes	: 1M	
	Description of 3 types of electrodes	: 3 × 2 = 6M	: 1
4(b)	Block diagram of ECG machine	: 4M	
	Operation	: 3M	
5(a)	Block diagram of EMG recorder or EMG	: 4M	
	Operation	: 3M	
5(b)	10-20 electrode placement diagram	: 4M	
	Procedure	: 3M	
6(a)	Block diagram	: 4M	
	Operation	: 3M	
6(b)	Block diagram	: 4M	
	Operation	: 3M	
7(a)	Schematic of any technique	: 4M	
	Working principle	: 3M	
7(b)	Schematic	: 2M	
	Working principle	: 5M	
8(a)	Definition	: 1M	
	Description of any 3 pacing modes	: 3 × 2 = 6M	
8(b)	Reference electrode	: 4M	
	Measuring electrode	: 3M	
9(a)	Block diagram of MRI system	: 4M	
	Description of working principle	: 3M	
9(b)	Diathermy principle	: 3M	
	Applications	: 4M	

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1(a) List the problems encounter in measuring a living system

Inaccessibility of variables to measurement
Variability of data
Lack of knowledge about interrelationships
Interaction among Physiological systems
Effect of the transducer on the measurement
Artifacts
Energy limitations
Safety considerations

(b) Define resting potential.

This membrane potential (under normal conditions) is called the resting potential of the cell. It is in the order of - 60 mV to - 100 mV

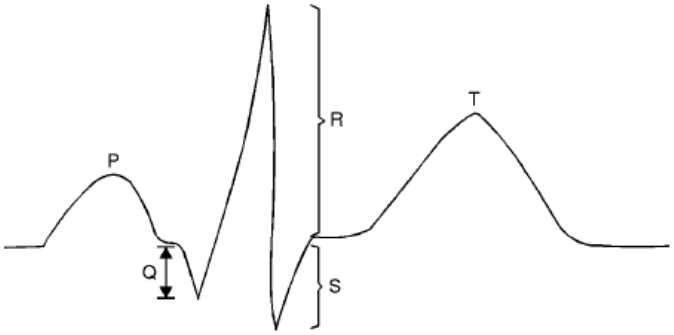
(c) List various physiological systems of the body

cardiovascular system, nervous system, Respiratory system

(d) What is the use of biomedical electrodes?

Electrodes are used to convert ionic potentials to electric potentials.
or
Used to record biopotentials

(e) Draw and Interpret the ECG Waveform.



The P wave represents depolarization of the atrial musculature.

The QRS complex is the combined result of the repolarization of the atria and the depolarization of the ventricles, which occur almost simultaneously.

The T wave is the wave of ventricular repolarization.

The U wave is the result of after-potentials in the ventricular muscle.

The P-Q interval represents the time during which the excitation wave is delayed in the fibers near the AV node.

(f) What are the various types of blood pressure measurement?

Direct method, Indirect methods : korotkoff method, Rheographic method, Differential auscultatory technique, Oscillometric measurement method.Ultrasonic Doppler shift method.

(g) Define Cardiac Output

Cardiac output is the quantity of blood delivered by the heart to the aorta per minute and its value is 4 to 6 liters/min.

(h) What is Phonocardiography?

It is a plot of high fidelity recording of the sounds and murmurs made by the heart with the help of the machine called phonocardiograph.

(i) What is Dialysis?

The clinical purification of blood by dialysis, as a substitute for the normal function of the kidney

(j) What is the use of Defibrillator?

Defibrillation is a procedure used to treat life threatening conditions that affect the rhythm of the heart such as cardiac arrhythmia, ventricular fibrillation and pulseless ventricular tachycardia.

The procedure involves the delivery of an electric shock to the heart which causes depolarisation of the heart muscles and re-establishes normal conduction of the heart's electrical impulse. The machine used to deliver this therapeutic shock to the heart is called a defibrillator.

(k) What is meant by an in vitro measurement?

An in vitro measurement is one performed outside the body, even though it relates to the functions of the body. An example of an in vitro measurement would be the measurement of the pH of a sample of blood that has been drawn from a patient.

(l) List the uses of EEG.

An EEG can be used to help diagnose and monitor a number of conditions affecting the brain. It may help identify the cause of certain symptoms – such as seizures (fits) or memory problems

(m) List various blood flow measurement techniques

Electromagnetic induction, Doppler effect, Thermal convection.

(n) What is the use of Bio-Chemical Electrodes.

To measure pO2 and pCO2.

2(a) Write a detailed note on Man-Instrument System

Components of the Man-Instrument system :

A block diagram of the man instrument system is shown in the following figure.

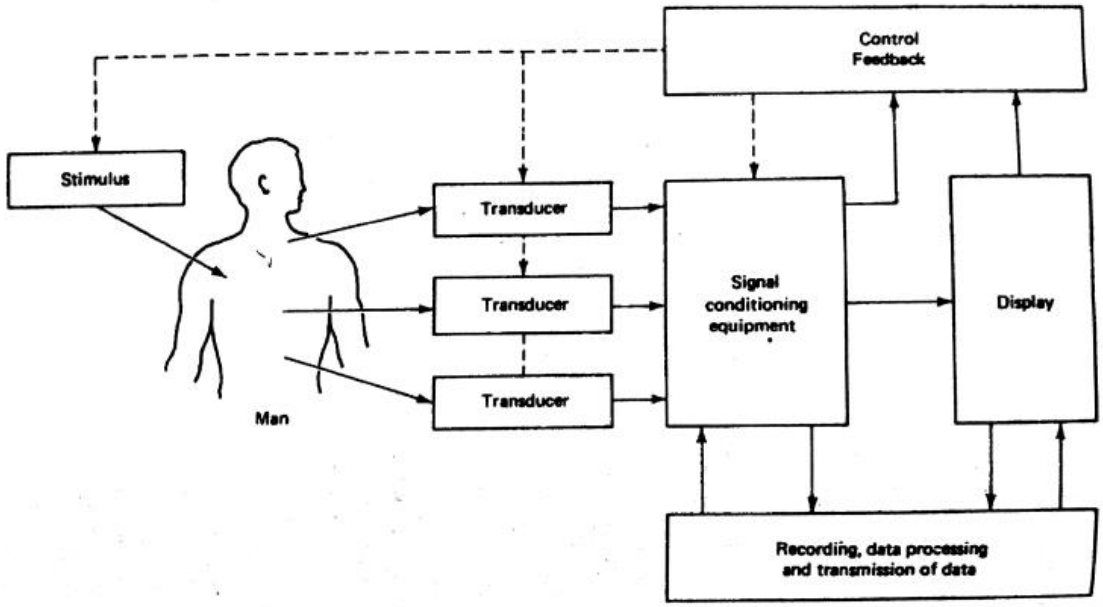


Fig: Block diagram of man-instrument system

The block diagram of man instrument system is shown above.

The system components are given below.

The subject :The subject is the human being on whom the measurements are made.

Stimulus:

In many measurements, the response to some form of external stimulus is required.

The instrumentation used to generate and present this stimulus to the subject is vital part of man-instrument system whenever responses are measured.

The stimulus may be visual (e.g., a flash of light), auditory (e.g., tone), tactile(e.g., a blow of Achilles tendom), or direct electrical stimulation of some part of the nervous system.

The transducer :

A transducer is defined as a device capable of converting one form of energy or signal to another.

In the man instrument system, each transducer is used to produce an electrical signal that is an analog of the phenomenon being measured.

The transducer may measure temperature, pressure, flow, or any of the other variables that can be found in the body.

Signal conditioning Equipment :

The part of the instrumentation system that amplifies, modifies, or in any other way changes the electrical output of the transducer is called signal conditioning (or sometimes signal-processing)

Signal conditioning equipment is also used to combine or relate the outputs of two or more transducers.

Display Equipment :

The display equipment converts the electrical output of the signal conditioning into a form that can be perceived by one of man's senses .

Its output is some form of visual, audible, or possibly tactile information. The display equipment may include a graphic pen recorder that produces a permanent record of the data.

Recording, data-processing, and Transmission equipment :

It is often necessary, or at least desirable, to record the measured information for possible later use or to transmit it from one location to another. Equipment for these functions is often a vital part of the man-instrument system.

Control Devices :

Where it is necessary or desirable to have automatic control of the stimulus, transducers, or any other part of the man instrument system, a control system is incorporated.

This system usually consists of feedback loop in which part of the output from the signal conditioning or display equipment is used to control the operation of the system in some way.

2(b) Write a short note on physiology of Respiratory system

The respiratory system :

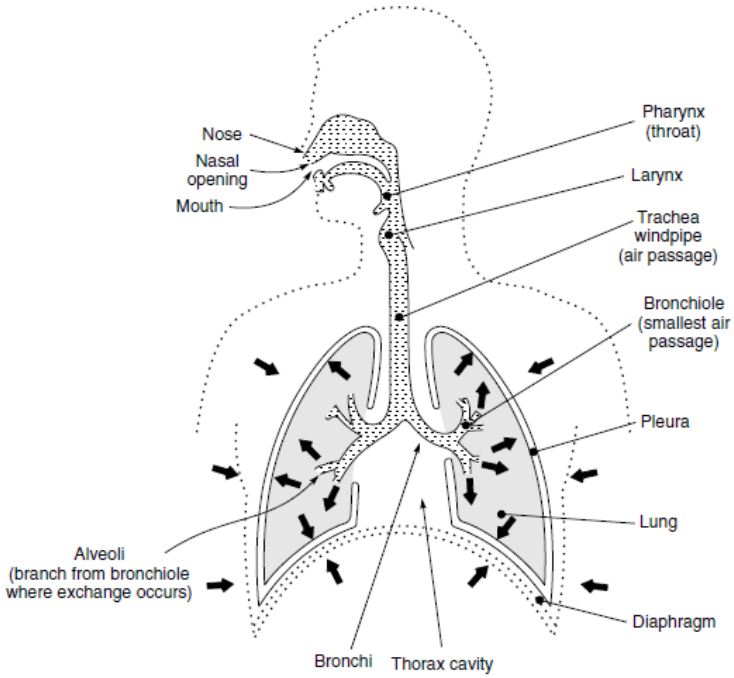


Fig : The respiratory system

The respiratory system is the pneumatic system.

An air pump (diaphragm), which alternatively creates negative and positive pressures in a scaled chamber (thoracic cavity), causes air to be sucked into and forced out of a pair of elastic bags (lungs) located within the compartment.

The bags are connected to the outside environment through a passageway (nasal cavities, pharynx, larynx, trachea, bronchi, and bronchioles), which at one point is in common with the tubing that carries liquids and solids to the stomach.

A special valving arrangement interrupts the pneumatic system whenever liquid or solid matter passes through the common region.

The passage way divides to carry air into each of the bags, where in it again sub divides many times to carry air into each of the bags, wherein it again subdivides many times to carry air into and out of each of many tiny air spaces (pulmonary alveoli) within the bags.

The dual air input to the system (nasal cavities) has an alternate vent (the mouth) for use in the event of nasal blockage and for other special purposes.

In the tiny air spaces of the bags is a membrane interface with the body's hydraulic system through which certain gases can diffuse.

Oxygen is taken into the fluid (blood) from the incoming air, and carbon dioxide is transferred from the fluid to the air, which is exhausted by the force of the pneumatic pump.

The pump operates with a two way override.

An automatic control center (respiratory center of the brain) maintains pump operation at a speed that is adequate to supply oxygen and carry off carbon dioxide as required by the system.

Manual control can take over at any time either to accelerate or to inhibit the operation of the pump.

Automatic control will return, however if a condition is created that might endanger the system.

System variables of primary importance are respiratory rate, respiratory air flow, respiratory volume, and concentration of CO2 in the expired air.

This system also has a number of relatively fixed volumes and capacities, such as tidal volume (the volume inspired or expired during each normal breath), inspiratory reserve volume (the additional volume that can be inspired after a normal inspiration), expiratory reserve volume (the additional amount of air that can be forced out of the lungs after normal expiration), residual volume (amount of air remaining in the lungs after all possible air has been forced out), and vital capacity (tidal volume, plus inspiratory reserve volume, plus expiratory reserve volume).

3(a) Explain the generation of action potential with neat diagram

In carrying out their various functions, certain systems of the body generate their own monitoring signals, which convey useful information about the functions they represent.

These signals are the bioelectric potentials associated with nerve conduction, brain activity, heartbeat, muscle activity, and so on.

Bioelectric potentials are ionic voltages produced as a result of the electrochemical activity of certain special types of cells.

Resting and Action potentials :

The basic building block of a body is a cell which is isolated from external environment by a semi permeable membrane.

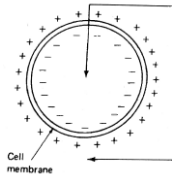


Fig :Cell

Diameter of the cell is 1mm, Thickness of the membrane is 0.01mm

Body is made up of cells, and conducting body fluids consisting Na^+, K^+, Cl^-.

Under normal conditions the membrane allows only K^+ and Cl^- ions and blocks Na^+ ions.

This results in two conditions.

First, the concentration of sodium ions (Na^+) inside the cell becomes much lower than that of the outside of the cell since the sodium ions are positive, this would tend to make the outside of the cell more positive than the inside.

Second, in an attempt to balance the electric charge, additional potassium ions(K+), enter the cell, causing a higher concentration of potassium on the inside than on the outside.

Charge balance cannot be achieved, because of the concentration imbalance of potassium ions. Equilibrium is reached with a potential difference across the membrane, negative on the inside and positive on the outside.

This membrane potential (under normal conditions) is called the resting potential of the cell. It is in the order of - 60 mV to - 100 mV.

The voltage inside the cell w.r.t outside is negative.

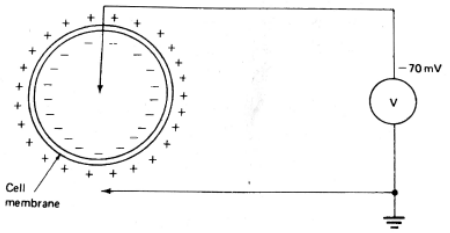


Fig : Polarized cell with its resting potential

When a stimulus is applied to the membrane, it changes its characteristics and allows some of the Na+ ions into the cell.

This movement of sodium ions into the cell constitutes an ionic current flow that further reduces the barrier of the membrane to sodium ions.

The net result is an avalanche effect in which sodium ions rush into the cell to try to reach a balance with the ions outside.

At the same time potassium ions, which were in higher concentration inside the cell during the resting state, try to leave the cell but are unable to move as rapidly as the sodium ions.

As a result, the cell has a slightly positive potential on the inside due to the imbalance of potassium ions.

This potential is known as the action potential and is approximately + 20 mV.

A cell that has been excited and that displays an action potential is said to be depolarized.

The process of changing from the resting state to the action potential is called depolarization.

Following Figure shows the ionic movements associated with depolarization

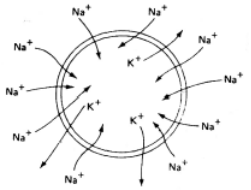


Fig : Depolarization of a cell. Na+ ions rush into the cell while K+ ions attempt to leave

After the application of stimulus the status of the cell is as follows.

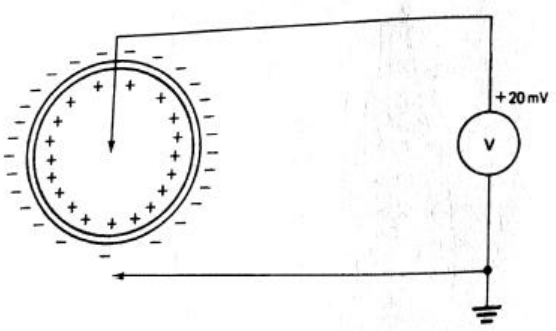


Fig : Depolarized cell during an action potential

The potential generated by the excited cell is called Action Potential.

The process of changing from resting potential to action potential is called Depolarization.

Once the rush of sodium ions through the cell membrane has stopped (a new state of equilibrium is reached), the ionic currents that lowered the barrier to sodium ions are no longer present and the membrane reverts back to its original, selectively permeable condition, wherein the passage of sodium ions from the outside to the inside of the cell is again blocked.

Were this the only effect, however, it would take a long time for a resting potential to develop again. But such is not the case.

By an active process, called a sodium pump, the sodium ions are quickly transported to the outside of the cell, and the cell again becomes polarized and assumes its resting potential. This process is called repolarization

Following Figure shows a typical action-potential waveform, beginning at the resting potential, depolarizing, and returning to the resting potential after repolarization.

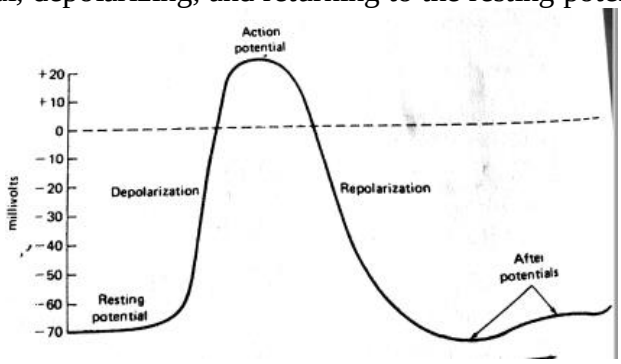


Fig : Waveform of action potential

3(b) Write a short note on physiology of Nervous system

The nervous system is the communication network for the body. Its center is a self-adapting central information processor or computer (brain) with memory, computational power, decision making capability, and a myriad (means extremely great number) of input-output channels.

By use of this computer, a person is able to make decisions, solve complex problems, feel emotions, integrate input information from all parts of te body, and coordinate output signals to produce meaningful behaviour.

There are millions of communication lines that bring sensory information into, and transmit control information out of the brain.

In general these lines are not single long lines but often complicated networks with many interconnections that are continually changing to meet the needs of the system.

By means of interconnection patterns, signals from a large number of sensory devices, which detect light, sound, pressure, heat, cold, and certain chemicals, are channelled to the appropriate parts of the computer, where they can be acted upon.

Similarly , output control signals are channelled to specific motor devices (motor units of muscles), which respond to the signals with some type of motion or force.

Feedback regarding every action controlled by the system is provided to the computer through appropriate sensors.

Information is usually coded in the system by means of electrochemical pulses (nerve action potentials) that travel along the signal lines (nerves).

The pulses can be transferred from one element of a network to another in one direction only, and frequently the transfer takes place only when there is the proper combination of elements acting on the next element in the chain.

In addition to the central computer, a large number of simple decision-making devices (spinal reflexes) are present to control directly certain motor devices from certain sensory inputs. A number of feedback loops are accomplished by this method.

In many cases, only situations where important decision making is involved require that the central computer be utilized.

4(a) Discuss various types of electrodes used in biomedical instrumentation

Microelectrodes:

Microelectrodes are electrodes with tips sufficiently small to penetrate a single cell in order to obtain readings from within the cell.

Microelectrodes are generally of two types: metal and micropipet.

Metal microelectrodes are formed by electrolytically etching the tip of a fine tungsten or stainless-steel wire to the desired size. Then the wire is coated almost to the tip with an insulating material.

Some electrolytic processing can also be performed on the tip to lower the impedance. The metal-ion interface takes place where the metal tip contacts the electrolytes either inside or outside the cell

The micropipet type of microelectrode is a glass micropipet with the tip drawn out to the desired size [usually about 1 micron in diameter].

The micropipet is filled with an electrolyte compatible with the cellular fluids. This type of microelectrode has a dual interface.

One interface consists of a metal wire in contact with the electrolyte solution inside the micropipet, while the other is the interface between the electrolyte inside the pipet and the fluids inside or immediately outside the cell.

A commercial type of microelectrode is shown in the following Figure

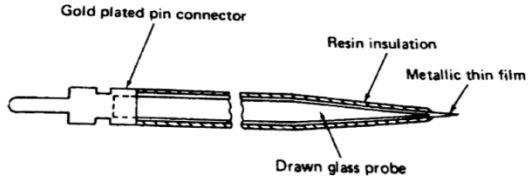


Fig : Commercial microelectrode with metal film on glass

In this electrode a thin film of precious metal is bonded to the outside of a drawn glass microelectrode.

The manufacturer claims such advantages as lower impedance than the micropipet electrode, infinite shelf life, repeatable and reproducible performance, and easy cleaning and maintenance.

The metal electrolyte interface is between the metal film and the electrolyte of the cell

Microelectrodes, because of their small surface areas, have impedances well up into the megohms. For this reason, amplifiers with extremely high impedances are required to avoid loading the circuit and to minimize the effects of small changes in interface impedance.

Needle Electrodes:

To reduce interface impedance and, consequently, movement artifacts, some electroencephalographers use small subdermal needles to penetrate the scalp for EEG measurements. These needle electrodes, shown in the following Figure 4.13, are not inserted into the brain; they merely penetrate the skin. Generally, they are simply inserted through a small section of the skin just beneath the surface and parallel to it.

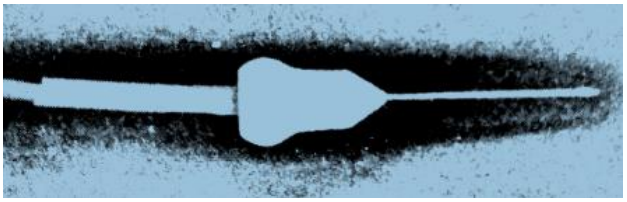


Fig : Subdermal needle electrode for EEG

Needle electrodes for EMG- consist merely of fine insulated wires, placed so that their tips, which are bare, are in contact with the nerve, muscle, or other tissue from which the measurement is made. The remainder of the wire is covered with some form of insulation to prevent shorting.

Wire electrodes of copper or platinum are often used for EMG pickup from specific muscles. The wires are either surgically implanted or introduced by means of a hypodermic needle that is later withdrawn, leaving the wire electrode in place. With this type of electrode, the metal-electrolyte interface
takes place between the uninsulated tip of the wire and the electrolytes of the body, although the wire is dipped into an electrolyte paste before insertion in some cases.

The hypodermic needle is sometimes a part of the electrode configuration and is not withdrawn. Instead, the wires forming the electrodes are carried inside the needle, which creates the hole necessary for insertion, protects the wires, and acts as a grounded shield. A single wire inside the needle serves as a unipolar electrodey which measures the potentials at the point of contact with respect to some indifferent reference. If two wires are placed inside the needle, the measurement is called bipolar and provides a very localized measurement between the two wire tips.

Needle electrodes and other types of electrodes that create an interface beneath the surface of the skin seem to be less susceptible to movement arti facts than surface electrodes, particularly those of the older types. By making direct contact with the subdermal tissue or the intercellular fluids, these electrodes also seem to have lower impedances than surface electrodes of comparable interface area.

Body Surface Electrodes

Although any type of surface electrode can be used to sense EGG, EEG, or EMG potentials, the larger electrodes are usually associated with EGG, since localization of the measurement is not important, whereas smaller electrodes are used in EEG and EMG measurements.

The earliest bioelectric potential measurements used immersion electrodes, which were simply buckets of saline solution into which the subject placed his hands and feet, one bucket for each extremity.

As might be expected, this type of electrode (following Figure) presented many difficulties, such as restricted position of the subject and danger of electrolyte spillage.

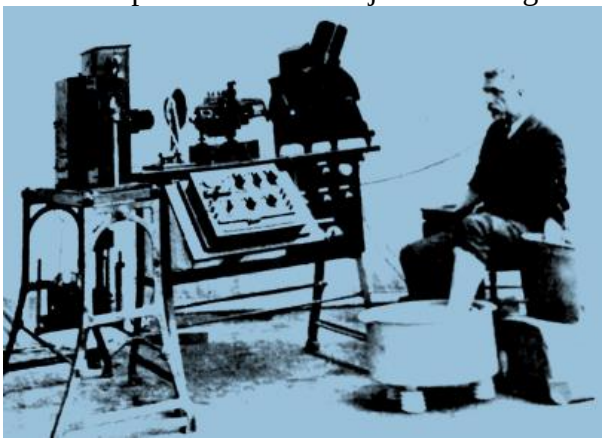


Fig : ECG measurement using immersion electrodes

A great improvement over the immersion electrodes were the plate electrodes, first introduced about 1917. Originally, these electrodes were separated from the subject's skin by cotton or felt pads soaked in a strong saline solution. Later a conductive jelly or paste (an electrolyte) replaced the soaked pads and metal was allowed to contact the skin through a thin coat of jelly. Plate electrodes of this type are still in use today. An example is shown in the following Figure .

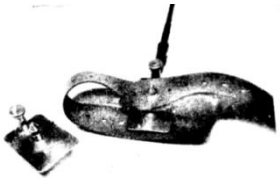


Fig : Metal plate electrode

Another fairly old type of electrode still in use is the suction-cup electrode shown in the following Figure .

Fig : Suction cup electrode

In this type, only the rim actually contacts the skin.

One of the difficulties in using plate electrodes is the possibility of electrode slippage or movement. This also occurs with the suction-cup electrode after a sufficient length of time.

All the preceding electrodes suffer from a common problem. They are all sensitive to movement, some to a greater degree than others. Even the slightest movement changes the thickness of the thin film of electrolyte between metal and skin and thus causes changes in the electrode potential and impedance. In many cases, the potential changes are so severe that they completely block the bioelectric potentials the electrodes attempt to measure.

Later, a new type of electrode, the floating electrode, was introduced in varying forms by several manufacturers. The principle of this electrode is to practically eliminate movement artifact by avoiding any direct contact of the metal with the skin. The only conductive path between metal and skin is the electrolyte paste or jelly, which forms an electrolyte bridge. Even with the electrode surface held at a right angle with the skin surface, performance is not impaired as long as the electrolyte bridge maintains contact with both the skin and the metal. The following Figure shows a cross section of a floating electrode,

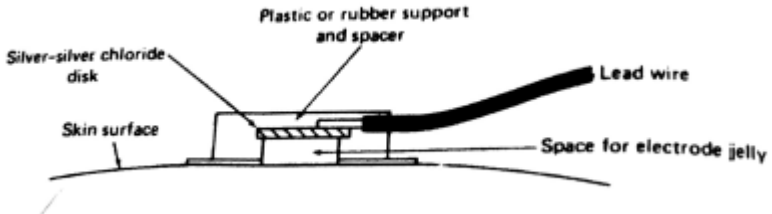


Fig : Diagram of floating type skin surface electrode

and the following Figure shows a commercially available configuration of the floating electrode.

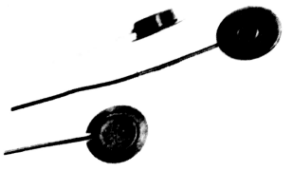


Fig : Floating skin surface electrode

Floating electrodes are generally attached to the skin by means of two sided adhesive collars (or rings), which adhere to both the plastic surface of the electrode and the skin.

Following Figure shows an electrode in position for biopotential measurement.

Fig : Application of floating type skin surface electrode

Various types of disposable electrodes have been introduced in recent years to eliminate the requirement for cleaning and care after each use.
Primarily intended for ECG monitoring, these electrodes can also be used for EEC and EMG as well.

Special types of surface electrodes have been developed for other applications. For example, a special ear-clip electrode (following Figure) was developed for use as a reference electrode for EEG measurements.

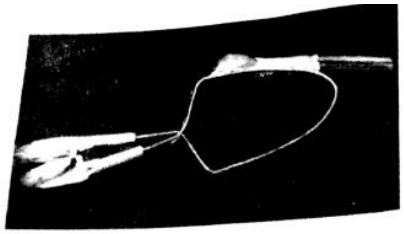


Fig : Ear-clip electrode

Scalp surface electrodes for EEG are usually small disks about 7 mm in diameter or small solder pellets that are placed on the cleaned scalp, using an electrolyte paste.

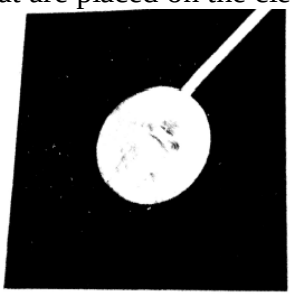


Fig : EEG scalp surface electrode

4(b) With neat sketch draw and explain the block diagram of ECG machine

ECG Recorder Principles :

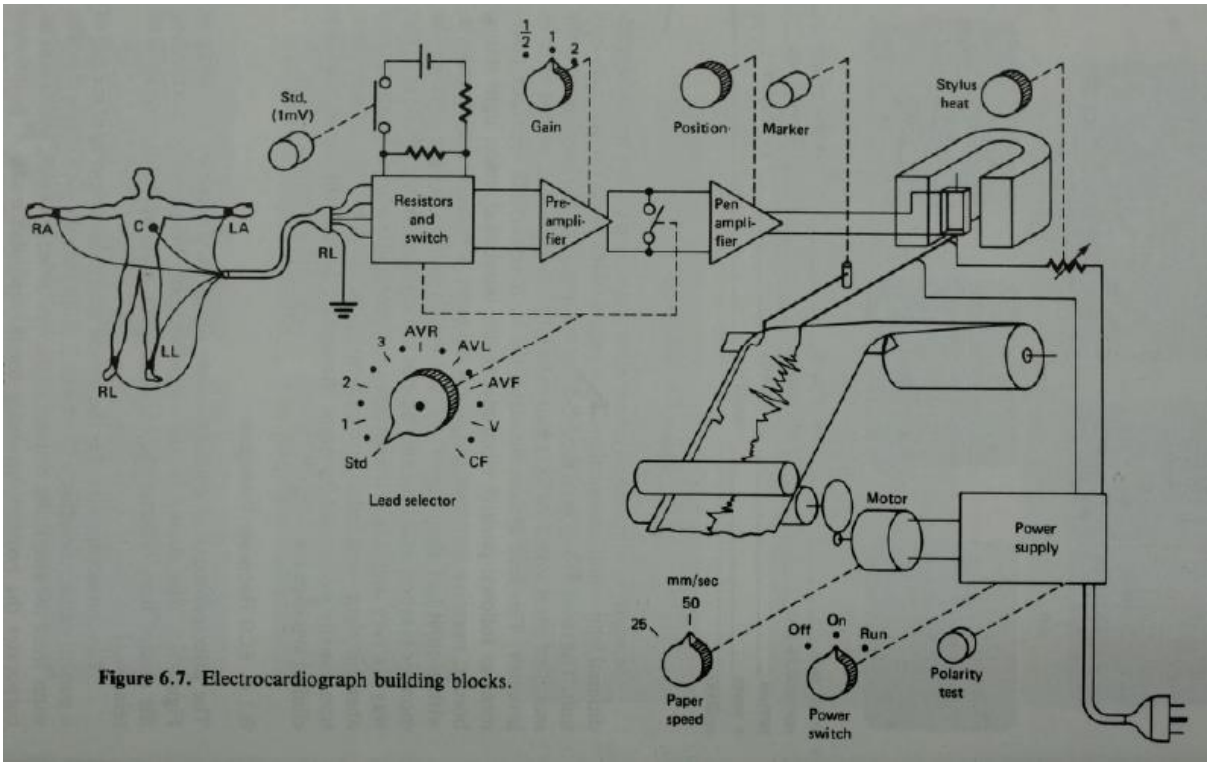


Fig : Electrocardiograph building blocks.

The building blocks of an ECG recorder along with the front panel controls are shown in the above fig.

The wires from the electrodes connect to the lead selector switch, which also incorporates the resistors necessary for the unipolar leads.

A pushbutton allows the insertion of a standardization voltage of 1 mV to standardize or calibrate the recorder.

From the lead selector switch the ECG signal goes to a preamplifier, a differential amplifier with high common-mode rejection.

By means of standardization adjustment, the sensitivity of the ECG recorder can be set so that the standardization voltage of 1 mV causes a pen deflection of 10 mm.

The preamplifier is followed by a dc amplifier called the pen amplifier, which provides the power to drive the pen motor that records the actual ECG trace.

All modern ECG recorders use heat-sensitive paper, and the pen is actually an electrically heated stylus, the temperature of which can be adjusted with a stylus heat control for optimal recording trace.

5(a) Write a short note on Electromyographic measurements

Myography :

Myography is a study of muscular contraction and a myograph is an apparatus for recoding the mechanical effects of a muscular contraction.

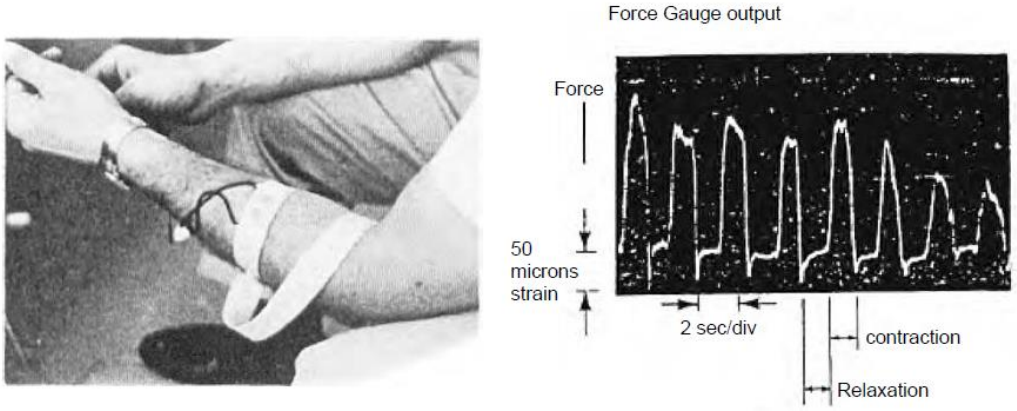


Fig : Shows how a myograph with a strainage is used.

A myograph may simply consist of a displacement transducer or a force transducer mechanically coupled to the muscle under investigation. As shown is the above Fig., an elastic strip is paced around the muscle concerned and a strain gauge is bonded to this elastic strip. Muscular contraction causes a tension increase in the elastic strip with resulting resistance change in the strain gauge. The muscular contraction may be initiated voluntarily or produced by electrical stimulation. The output form a recording system, a series of muscular contractions over a 20sec. period is also shown in the above figure

Electromyography :

The myography records are for the study of muscular contraction, the EMG records the electric effects of such a contraction. Muscular contraction is caused by depolarization of the muscle fibers. The depolarization produces action potentials as discussed in earlier chapters. This muscular action potential is known as the electromyogram or EMG. An electromyogram will be produced in a muscle where the muscle contraction is caused either by voluntarily muscle action or by electrical stimulation of the muscle.

Electromyography with Voluntary Muscular Action

A typical system of recording the electromyography produced by voluntary muscle action is shown in the following Fig.

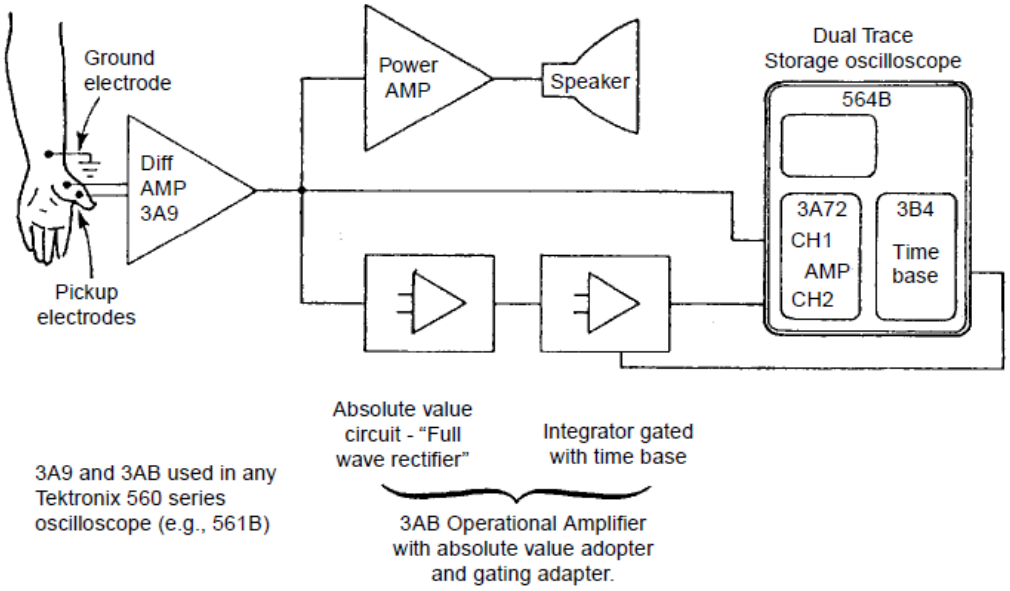


Fig : Shows an electromyograph system

The muscle action potential is picked up by a needle electrodes inserted into the muscle or by surface electrodes placed over the muscle concerned . Then the signal is

amplified by a suitable differential amplifier. The EMG can then be detected audibly by using a speaker in conjunction with an audio amplifier. The EMG may also be displayed directly on an oscilloscope or this may be converted to an absolute integral and then displayed on an oscilloscopes.

5(b) Discuss in detail about EEG and 10-20 system

Electroencephalography is the measurement of the electrical activity of the brain.

Since clinical EEG measurements are obtained from electrodes placed on the surface of the scalp, these waveforms represent a very gross type of summation of potentials that originate from an extremely large number of neurons in the vicinity of the electrodes.

EEG potentials have random-appearing waveforms with peak-to-peak amplitudes ranging from less than 10 μV to over 100 μV. Required bandwidth for adequately handling the EEG signal is from below 1 Hz to over 100 Hz.

Electrodes for measurement of the EEG are surface or subdermal needle electrodes.

The ground reference electrode is often a metal clip on the earlobe.

A suitable electrolyte paste or jelly is used in conjunction with the electrodes to enhance coupling of the ionic potentials to the input of the measuring device.

To reduce interference and minimize the effect of electrode movement, the resistance of the path through the scalp between electrodes must be kept as low as possible.

Placement of electrodes on the scalp is commonly dictated by the requirements of the measurement to be made.

In clinical practice, a standard pattern, called the 10-20 electrode placement system, is generally used.

This system is so named because electrode spacing is based on intervals of 10 and 20 percent of the distance between specified points on the scalp.

The 10-20 EEG electrode configuration is illustrated in the following Figure.

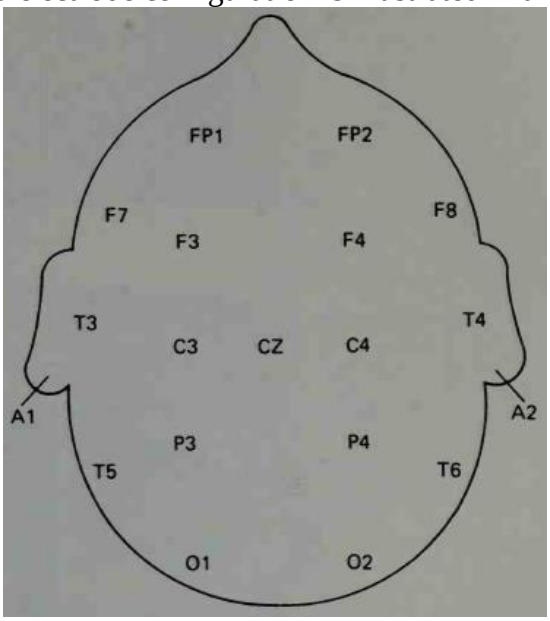


Fig : 10 - 20 EEG electrode configuration

6(a) With neat sketch explain the blood flow measurement by Ultrasonic blood flow meter

In an ultrasonic blood flow meter, a beam of ultrasonic energy is used to measure the velocity of flowing blood.

This can be done in two different ways.

In the transit time ultrasonic flow meter, a pulsed beam is directed through a blood vessel at a shallow angle and its transit time is then measured.

When the blood flows in the direction of the energy transmission, the transit time is shortened. If it flows in the opposite direction, the transit time is lengthened.

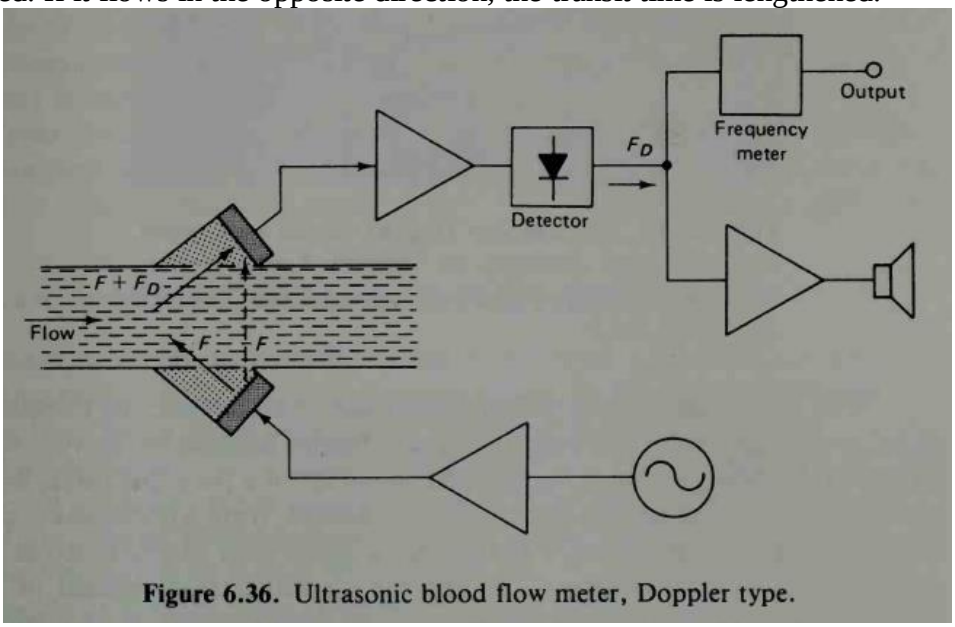


Figure 6.36. Ultrasonic blood flow meter, Doppler type.

Fig : Ultrasonic Blood flow meter, Doppler type

More common are ultrasonic flow meters based on the Doppler principle.

The Doppler effect (or the Doppler shift) is the change in frequency of a wave in relation to an observer who is moving relative to the wave source

An oscillator, operating at a frequency of several megahertz, excites a piezoelectric transducer (usually made of barium titanate).

This transducer is coupled to the wall of an exposed blood vessel and sends an ultrasonic beam with a frequency F into the flowing blood.

A small part of the transmitted energy is scattered back and is received by a second transducer arranged opposite the first one.

Because the scattering occurs mainly as a result of the moving blood cells, the reflected signal has a different frequency due to the Doppler effect.

Its frequency is either $F + F_D$ or $F - F_D$, depending on the direction of the flow.

The Doppler component F_D is directly proportional to the velocity of the flowing blood.

A fraction of the transmitted ultrasonic energy, however, reaches the second transducer directly, with the frequency being unchanged.

After amplification of the composite signal, the Doppler frequency can be obtained at the output of a detector as the difference between the direct and the scattered signal components.

With blood velocities in the range normally encountered, the Doppler signal is typically in the low audio frequency range.

Because of the velocity profile of the flowing blood, the Doppler signal is not a pure sine wave, but has more the form of narrow-band noise.

Therefore, from a loudspeaker or earphone, the Doppler signal of the pulsating blood flow can be heard as a characteristic " swish—swish—."

When the transducers are placed in a suitable mount (which defines the area of the blood vessel), a frequency meter used to measure the Doppler frequency can be calibrated directly in flow-rate units.

Unfortunately, Doppler flow meters of this simple design cannot discriminate the direction of flow.

More complicated circuits, however, which use the insertion of two quadrature components of the carrier, are capable of indicating the direction of flow

6(b) With a neat sketch explain the blood pressure measurement using Electrosphygmomanometer

Automatic indirect blood pressure measuring device utilizes a pressure transducer connected to the sphygmomanometer cuff, a microphone placed beneath the cuff (over the artery), and a standard physiological recording system on which cuff pressure and the Korotkoff sounds are recorded.

The pressure cuff is automatically inflated to about 220 mm Hg and allowed to deflate slowly.

The microphone picks up the Korotkoff sounds from the artery near the surface, just below the compression cuff.

The pressure reading at the time of the first sound represents the systolic pressure; the diastolic pressure is the point on the falling pressure curve where the signal representing that last sound is seen.

This instrument is actually only semiautomatic because the recording thus obtained must still be interpreted by the observer.

False indications—caused, for instance, by motion artifacts — can often be observed on the recording.

Fully automated devices use some type of signal-detecting circuit to determine the occurrence of the first and last Korotkoff sounds and retain and display the cuff pressure reading for these points, either electronically or with mercury manometers that are cut off by solenoid valves.

An early example of an automatic blood pressure meter is the programmed electrosphygmomanometer PE-300, illustrated in the following Figure in block diagram.

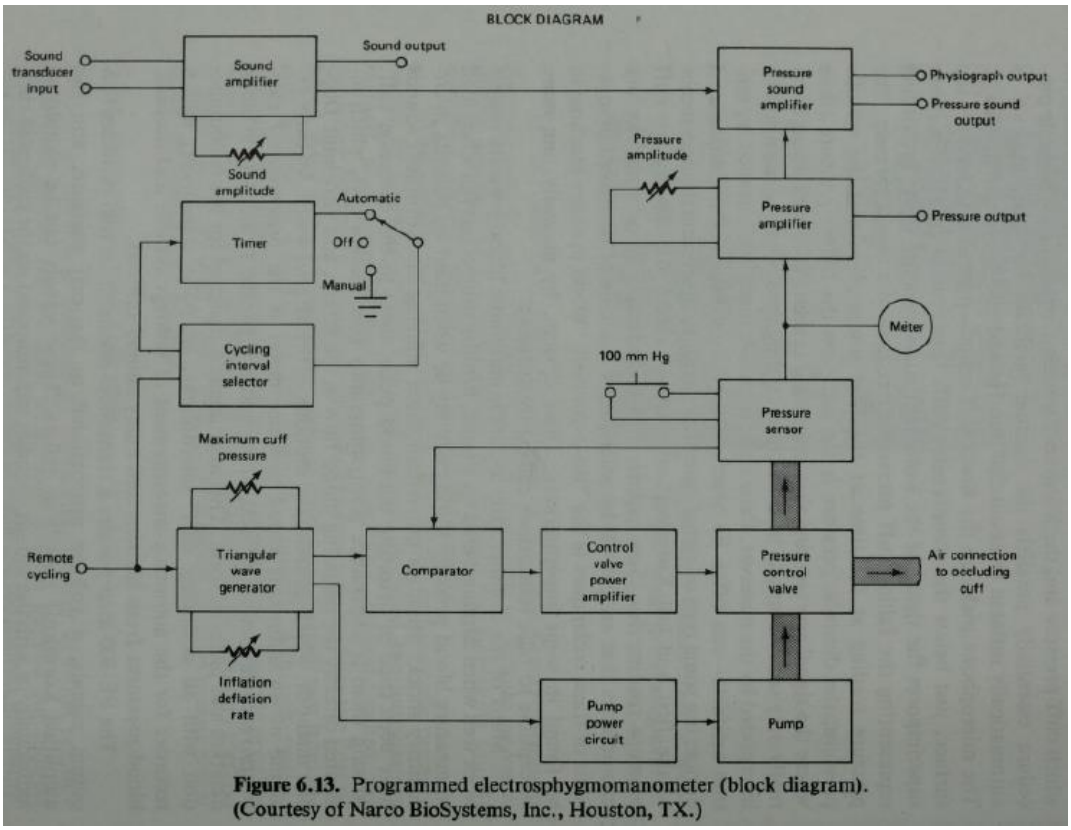


Figure 6.13. Programmed electrosphygmomanometer (block diagram). (Courtesy of Narco BioSystems, Inc., Houston, TX.)

This instrument is designed for use in conjunction with an occluding cuff, microphone, or pulse transducer, and a recorder for the automatic measurement of indirect systolic and diastolic blood pressures from humans and many animal subjects.

The PE-300 incorporates a transducer-preamplifier that provides two output signals, a voltage proportional to the cuff pressure, and the amplified Korotkoff sounds or pulses. These signals can be monitored individually or with the sounds or pulses superimposed on the calibrated cuff recorder. The combined signal can be recorded on a graphic pen recorder.

The self-contained cuff inflation system can be programmed to inflate and deflate an occluding cuff at various rates and time intervals.

Equal and linear rates of cuff inflation and deflation permit two blood pressure determinations per cycle.

The PE-300 can be programmed for repeat cycles at adjustable time intervals for monitoring of blood pressure over long periods of time.

Single cycles may be initiated by pressing a panel-mounted switch. Provision is also made for remote control via external contact closure.

The maximum cuff pressure is adjustable, and the front-panel meter gives a continuous visual display of the cuff pressure.

7(a) Explain the techniques used to measure the cardiac output.

Cardiac Output measurement :

Cardiac output is the quantity of blood delivered by the heart to the aorta per minute. It is a major determinant of oxygen delivery to the tissues.

Obviously, problems occur when the supply of blood from the heart is unable to meet the demand.

A fall in cardiac output may result in low blood pressure, reduced tissue oxygenation, acidosis, poor renal function and shock.

Stroke volume of blood pumped from the heart with each beat at rest varies among adults between 70 and 100 ml,while the cardiac output is 4 to 6 liters/min.

The direct method of estimating the cardiac output consists in measuring the stroke volume by the use of an electromagnetic flow probe placed on the aorta and multiplying it by the heart rate. The method involves surgery and, therefore, is not preferred in routine applications.

Another well known method for measuring cardiac output is the Fick's Method, which consists in determining the cardiac output by the analysis of the gas-keeping of the organism. Even this method is rather complicated, difficult to repeat, necessitates catheterization and, therefore, cannot be considered as a solution to the problem, though it is practised at many places even now. The most popular method group is the one applying the principle of indicator dilution.

1.Indicator dilution method :

Indicator dilution principle states that if we introduce into or remove from a stream of fluid a known amount of indicator and measure the concentration difference upstream and downstream of the injection (or withdrawal) site, we can estimate the volume flow of the fluid.

The method employs several different types of indicators. Two methods are generally employed for introducing the indicator in the blood stream, viz: it may be injected at a constant rate or as a bolus.

The method of continuous infusion suffers from the disadvantage that most indicators recirculate, and this prevents a maxima from being achieved.

In the bolus injection method, a small but known quantity of an indicator such as a dye or radioisotope is administered into the circulation.

It is injected into a large vein or preferably into the right heart itself. After passing through the right heart, lungs and the left heart, the indicator appears in the arterial circulation. The presence of an indicator in the peripheral artery is detected by a suitable (photoelectric) transducer and is displayed on a chart recorder. This way we get the cardiac output curve shown in Fig. 12.1. This is also called the dilution curve.

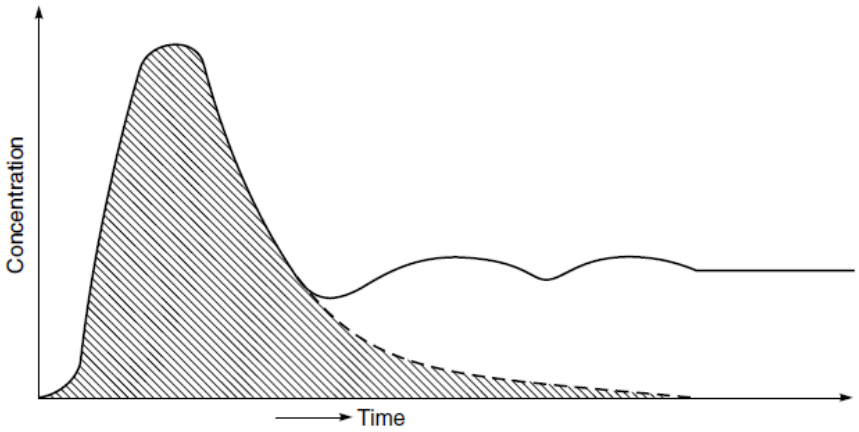


Fig : The run of the dilution curve

The run of the dilution curve is self-explanatory.

During the first circulation period, the indicator would mix up with the blood and will dilute just a bit.

When passing before the transducer, it would reveal a big and rapid change of concentration.

This is shown by the rising portion of the dilution curve.

Had the circulation system been an open one, the maximum concentration would have been followed by an exponentially decreasing portion so as to cut the time axis as shown by the dotted line.

The circulation system being a closed one, a fraction of the injected indicator would once again pass through the heart and enter the arterial circulation.

A second peak would then appear. When the indicator is completely mixed up with blood, the curve becomes parallel with the time axis. The amplitude of this portion depends upon the quantity of the injected indicator and on the total quantity of the circulating blood.

For calculating the cardiac output from the dilution curve, assume that
M = quantity of the injected indicator in mg
Q = cardiac output

$$\text{then} \quad Q = \frac{M}{\text{average concentration of indicator per litre of blood for duration of curve} \times \text{curve duration in seconds}} \cdot \text{l/s}$$

$$= \frac{M \times 60}{\text{area under the curve}} \text{ l/min}$$

Suppose that 10 mg of the indicator was injected and the average concentration as calculated from the curve was 5 mg/l for a curve duration of 20 s; then Q = 6 I/min.

2.Dye dilution method :

The most commonly used indicator substance is a dye.

Fox and Wood (1957) suggested the use of Indocyanine green (cardiogreen) dye which is usually employed for recording the dilution curve.

This dye is preferred because of its property of absorbing light in the 800 nm region of the spectrum where both reduced and oxygenated haemoglobin have the same optical absorption.

While using some of a the blue dyes, it was necessary to have the patient breathe oxygen.

The concentration of cardiogreen can be measured with the help of infra-red photocell transducer.

Dye cuvettes of as small volume as 0.01 ml are available.

The procedure consists in injecting the dye into the right atrium by means of a venous catheter.

Usually 5 mg of cardiogreen dye is injected in a 1 ml volume. The quantity used may be 2.5 mg in the case of children.

A motor driven syringe constantly draws blood from the radial or femoral artery through a cuvette.

The curve is traced by a recorder attached to the densitometer.

After the curve is drawn, an injection of saline is given to flush out the dye from the circulating blood.

There are problems relating to the use of the indicator indocyanine green. It has been experimentally determined that above a dye concentration of approximately 20 mg/ml of blood, the optical density rises less with an increase in dye concentration than below this level (Chamberlain,
1975).

Thus for optimum accuracy, the amount of dye chosen for injection should result in dye curves whose peak concentration is less than 20 mg/ml.

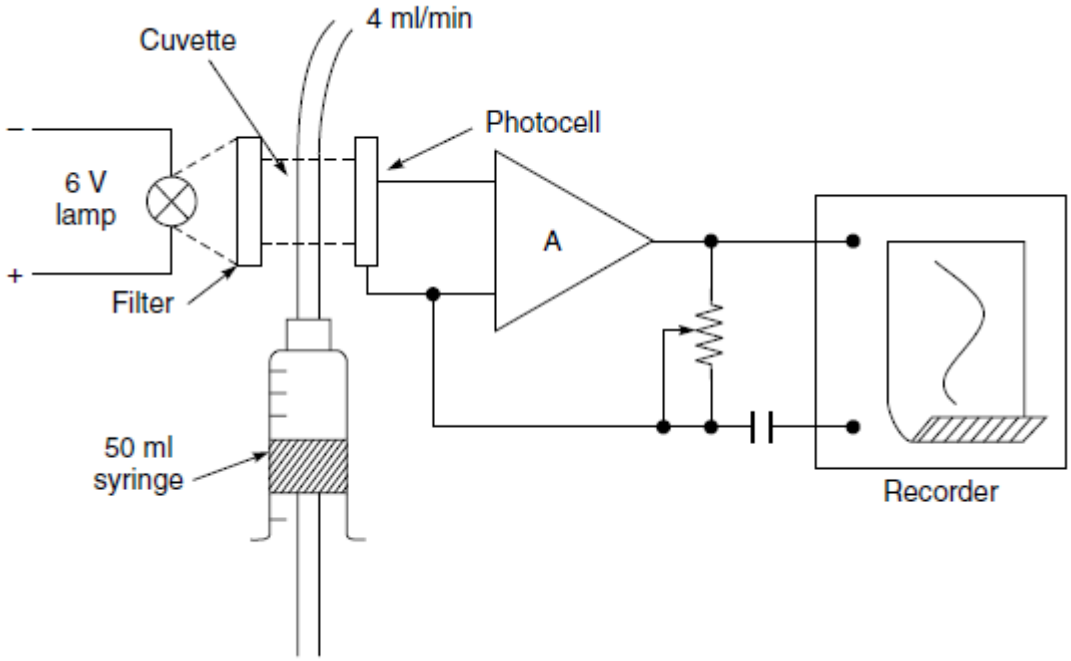


Fig : Diagrammatic representation of a **densitometer** for quantitative measurement of dye concentration

The above Figure shows a diagrammatic representation of a densitometer which can be used for the quantitative measurement of dye concentration.

The photometric part consists of a source of radiation and a photocell and an arrangement for holding the disposable polyethylene tube constituting the cuvette.

An interference filter with a peak transmission of 805 nm is used to permit only infrared radiation to be transmitted.

This wavelength is the isobestic wavelength for haemoglobin (Jarlov and Holmkjer, 1972) at various levels of oxygen saturation.

In order to avoid the formation of bubbles, the cuvette tubing should be flushed with a solution of silicone in ether.

A flow rate of 40 ml/min is preferred in order to get as short a response time as possible for the sampling catheter.

The sampling syringe has a volume of 50 mi/min. The output of the photocell is connected to a low drift amplifier. It has a high input impedance and low output impedance.

The amplification is directly proportional to the resistance value of the potentiometer R. A potentiometric recorder records the amplifier signal on a 200 mm wide recording paper and a paper speed of 10 mm/s.

In the recording of dye dilution curves, it is generally necessary that the densitometer be at some point removed from the site of interest.

A catheter is used to transport the blood containing dye from the sampling site, inside the cardiovascular system, to the densitometer located outside the body.

Sampling through the catheter densitometer system distorts the concentration time curve.

First, the velocity of flow within the catheter is not uniform, which causes the dye to mix within the tube as it travels downstream.

The mixing is a function of the flow rate and the volume of the sampling system, the viscosity of the sampled fluid and the shape of the configuration of the sampling tube.

The second source of distortion is the measuring instrument itself, which may not have response characteristics fast enough to record instantaneous dye concentration as it actually occurs in the lumen.

Distortion is very important when the indicator dilution method is used to measure volume since it is the measurement of the mean transit time of an indicator from the point of injection to the point of sampling, which is of interest.

To reduce distortion, computer software based corrections have been devised.

3.Thermal Dilution Technique :

A thermal indicator of known volume introduced into either the right or left atrium will produce a resultant temperature change in the pulmonary artery or in the aorta respectively, the integral of which is inversely proportional to the cardiac output.

$$\text{Cardiac output} = \frac{\text{"a constant"} \times (\text{blood temp.} - \text{injectate temp.})}{\text{area under dilution curve}}$$

A multi-lumen thermistor catheter (Pulmonary Artery Catheter), also known as the Swan-Ganz catheter is shown in the following fig.

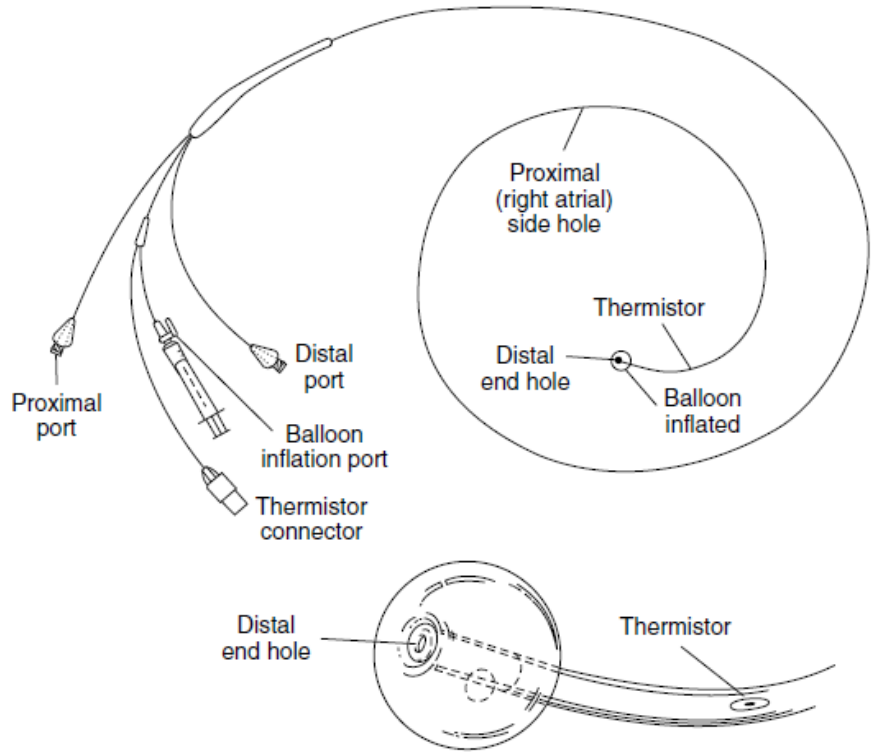


Fig : Swan-Ganz Catheter - A 4-lumen catheter.

A Swan - Ganz Catheter is usually 110 cm in length.

A balloon surrounds the tip of the catheter. The balloon is inflated during catheter insertion to carry the tip through the heart and into the pulmonary artery.

Catheter is marked at 10cm increments from the tip to aid insertion.

Usually there are four ports in the PA Catheter.

First is the **proximal infusion port**, its lumen terminates 30 cm from the tip of the catheter. This opening lies in the right atrium when the tip is in the pulmonary artery. This port measures the right atrial pressures i.e., central venous pressure. This port can also be used to give fluids and drugs.

The second is the **distal pulmonary artery port**. Its lumen terminates at the tip of the cathter. When in position this port is used to measure pulmonary artery presuure.

The third is the **balloon inflation port**. The balloon of the cathter is checked by inflating 1.5 ml of air using the syringe. The balloon is used to guide the cathter into pulmonary artery by the balloon floating technique. The balloon is also used to wedge the pulmonary artery to measure the pulmonary capillary wedge pressure which is an indirect measurement of left atrial pressure.

The fourth is the **thermistor.** Its lumen terminates four centimeters proximal to the tip of the catheter. It is used to measure cardiac output using thermo dilution technique.

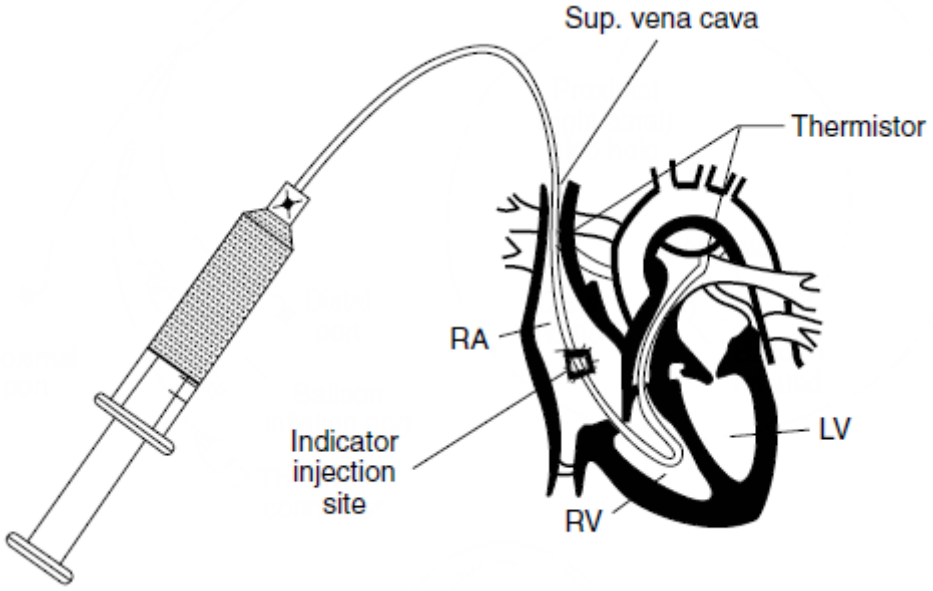


Fig : ***Cardiac output thermal-dilution set-up***

The above Figure shows a typical cardiac output thermal dilution set up.

A solution of 5% Dextrose in water at room temperature is injected as a thermal indicator into the right atrium.

It mixes in the right ventricle, and is detected in the pulmonary artery by means of a thermistor mounted at the tip of a miniature catheter probe.

The injectate temperature is also sensed by a thermistor and the temperature difference between the injectate and the blood circulating in the pulmonary artery is measured.

The reduction in temperature in the pulmonary artery (due to the passage of the Dextrose) is integrated with respect to time and the blood flow in the pulmonary artery is then computed electronically by an analog computer which also applies correction factors.

A meter provides a direct reading of cardiac output after being muted until integration is complete so as to avoid spurious indications during a determination.

4.Impedance Technique :

The technique used for the measurement of cardiac output by the impedance method is illustrated in the following Fig. 12.7.

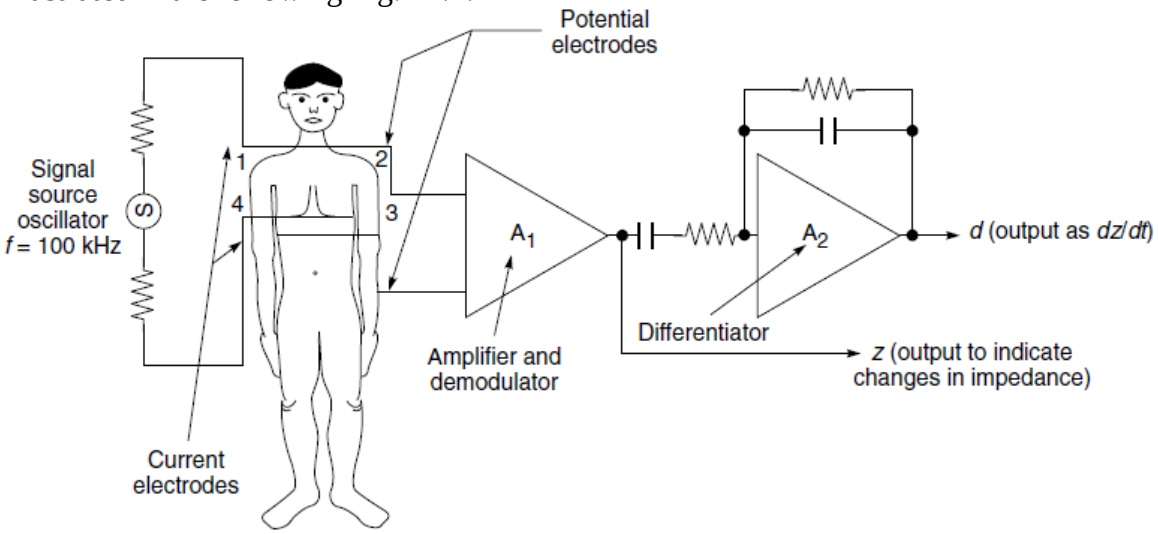


Fig. : Technique of measuring cardiac output by impedance changes (after Hill and Thompson, 1975; by permission of Med. & Biol. Eng)

If p is the resistivity, the resistance of the thorax between two sensing electrodes (2 and 3) is given by R0

$$R_0 = \frac{\rho L}{A}$$

where L is the separation between the electrodes and A is the cross-sectional area of the thorax.

Assuming that with each ejection of stroke volume dV, the resistance decreases by dR, it can be derived that

$$dV = -\rho \left[\frac{L^2}{R_0^2}\right] dR$$

R can be replaced by Z if an ac signal is used for transthoracic impedance measurement, thus giving

$$dV = -\rho\,(L^2/Z_o^2)\,dz.$$

In this relationship, dV is the stroke volume in ml, r is the resistivity of the patient's blood in ohm-cm and dz is the decrease in Zo during a particular systolic ejection.

The stroke volume is given by the product of the initial rate of change of impedance and the time the aortic and pulmonic valves open, i.e., $dz = T(dz/dt)_{max}$ where $(dz/dt)_{\max}$ corresponds to the peak negative value of dz/dt found during systole and T is the interval between $dzldt = 0$ and the second heart sound.

The equation used by Kubicek *et al* (1966) for stroke volume can be expressed as

$$dV = -\rho \left[\frac{L^2}{Z_0^2}\right] \cdot T \cdot \left[\frac{dz}{dt}\right]_{\max}$$

The value of p is related to the patient's haematocrit and for normal values, a blood resistivity of 150 ohm-cm can be assumed.

For experimentally calculating the stroke volume, a constant current at 100 kHz is applied between electrodes 1 and 4. The resulting voltage fluctuations occurring across the thorax coincident with cardiac activity are detected at the inner pair of electrodes 2 and 3.

The basal impedance between these electrodes is found to be about 25 ohm and this diminishes by about 0.1 ohm with each systole. The voltage signal due to changes in impedance is amplified and demodulated to obtain Z.

The $dzldt$ is calculated using a differentiator. A two-channel recorder is used to record dz/dt and the phonocardiogram.

For each beat the maximum value of the dz/dt at systole is noted as is the ejection time from the moment the dz/dt tracing crosses the $dz/dt = 0$ line at the commencement of systole until the onset of the second heart sound.

The method of measuring cardiac output from transthoracic impedance plethysmograms has several advantages in clinical use, especially in monitoring each stroke volume non-invasively.

For this reason, there have been many correlation studies of cardiac-output values between those measured by this method and those by other methods such as indicator dilution, Fick and pressure-gradient methods.

7(b) Explain the blood flow measurement by Thermal Convection method

Blood Flow measurement by thermal convection :

A hot object in a colder-flowing medium is cooled by thermal convection.

The rate of cooling is proportional to the rate of the flow of the medium.

This principle, often used to measure gas flow, has also been applied to the measurement of blood velocity.

In one application, a thermistor in the bloodstream is kept at a constant temperature by a servo system.

The electrical energy required to maintain this constant temperature is a measure of the flow rate.

In another method an electric heater is placed between two thermocouples or thermistors that are located some distance apart along the axis of the vessel.

The temperature difference between the upstream and the downstream sensor is a measure of the blood velocity.

A device of the latter type is sometimes called a thermostromuhr (literally, from the German"heat current clock").

Thermal convection methods for blood flow determination, although among the oldest ones used for this purpose, have now been widely replaced by the other methods described in this chapter.

8(a) What is a pacemaker? Explain the various modes of pacemaker in detail.

A device capable of generating artificial pacing impulses and delivering them to the heart is known as a pacemaker system (commonly called a pacemaker) and consists of a pulse generator and appropriate electrodes.

Pacing Modes:

Several pacing techniques are possible with both internal and external pacemakers.

They can be classed as either competitive and noncompetitive pacing modes as shown in the following Figure.

The noncompetitive method, which uses pulse generators that are either ventricular programmed or programmed by the atria, is more popular.

Ventricular-programmed pacemakers are designed to operate either in a demand (R-wave-inhibited) or standby (R-wave-triggered) mode, whereas atrial-programmed pacers are always synchronized with the P wave of the ECG.

The first (and simplest) pulse generators were fixed-rate or asynchronous (not synchronized) devices that produced pulses at a fixed rate (set by the physician or nurse) and were independent of any natural cardiac activity.

Asynchronous pacing is called competitive pacing because the fixed-rate impulses may occur along with natural pacing impulses generated by the heart and would therefore be in competition with them in controlling the heartbeat.

This competition is largely eliminated through use of ventricular or atrial programmed pulse generators.

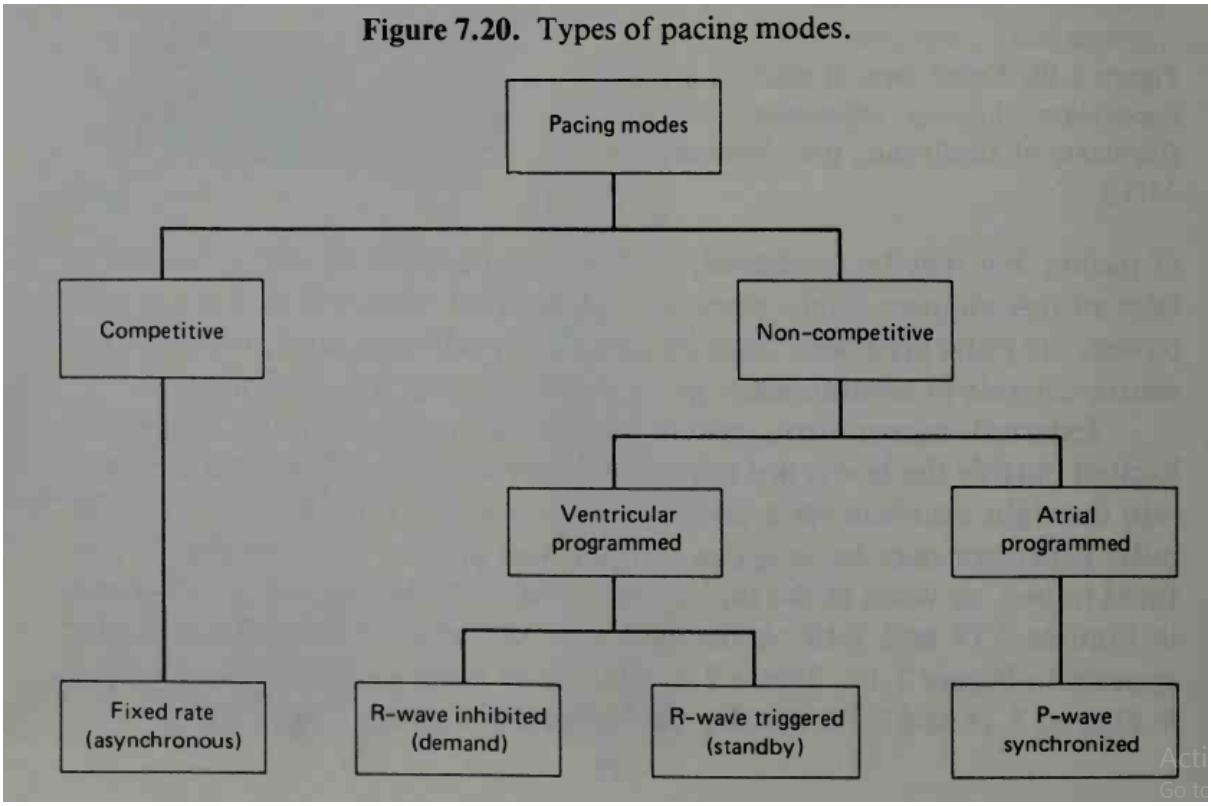
Fixed-rate pacers are sometimes installed in elderly patients whose SA nodes cannot provide proper stimuli.

They are also used temporarily to determine the amplitude of impulses needed to pace or capture the heartbeat of a patient prior to or during the implantation of a more permanent unit.

The amplitude at which capture occurs is referred to as the pacing threshold.

While the implantable fixed-rate units tend to fail less frequently than the more sophisticated demand or standby pacers, their battery life (if the batteries are not rechargeable) is generally shorter because they are in constant operation

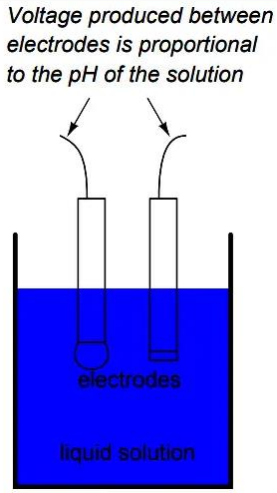
Figure 7.20. Types of pacing modes.



8(b) Explain the reference and pH electrodes

pH Electrodes:

The most common approach to measure pH is the use of a specially-prepared electrode designed to allow hydrogen ions in the solution to migrate through a selective barrier, producing a measurable potential (voltage) difference proportional to the solution's pH:



These two electrodes generate a voltage directly proportional to the pH of the solution. At a pH of 7 (neutral), the electrodes will produce 0 volts between them. At a low pH (acid) a voltage will be developed of one polarity, and at a high pH (caustic) a voltage will be developed of the opposite polarity.

Measurement Electrode

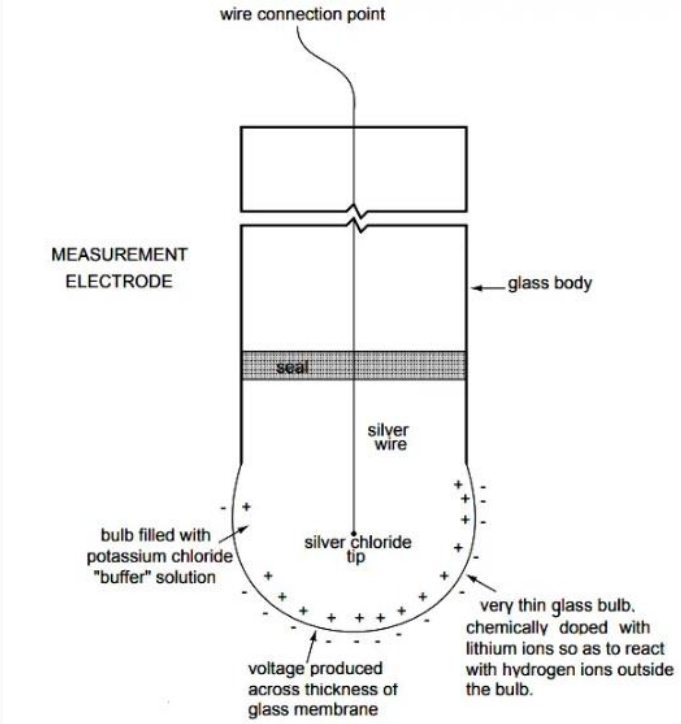
A design constraint of pH electrodes is that one of them (called the measurement electrode) must be constructed of special glass to create the ion-selective barrier needed to screen out hydrogen ions from all the other ions floating around in the solution.

This glass is chemically doped with lithium ions, which is what makes it react electrochemically to hydrogen ions. This presents a major problem if our intent is to measure the voltage between the two electrodes. The circuit path from one electrode contact, through the glass barrier, through the solution, to the other electrode, and back through the other electrode's contact, is one of extremely high resistance.

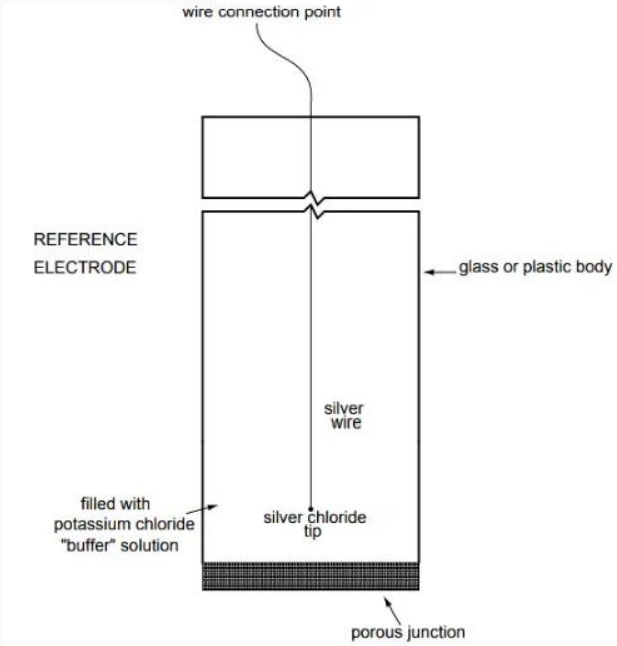
Reference Electrode

The other electrode (called the reference electrode) is made from a chemical solution of neutral (7) pH buffer solution (usually potassium chloride) allowed to exchange ions with the process solution through a porous separator, forming a relatively low resistance connection to the test liquid.

Here is an illustration of the measurement electrode's construction. Note the thin, lithium doped glass membrane across which the pH voltage is generated:



Here is an illustration of the reference electrode's construction. The porous junction shown at the bottom of the electrode is where the potassium chloride buffer and process liquid interface with each other:



The measurement electrode's purpose is to generate the voltage used to measure the solution's pH. This voltage appears across the thickness of the glass, placing the silver wire on one side of the voltage and the liquid solution on the other.

The reference electrode's purpose is to provide a stable, zero-voltage connection to the liquid solution so that a complete circuit can be made to measure the glass electrode's voltage. While the reference electrode's connection to the test liquid may only be a few kilo-ohms, the glass electrode's resistance may range from ten to nine hundred mega-ohms, depending on electrode design.

9(a) Write short note on Magnetic Resonance Imaging in Medical Imaging

The basic components of an NMR imaging system are shown in the following Fig. These are:

• *A magnet,* which provides a strong uniform, steady, magnet field *B*0;
• *An RF transmitter,* which delivers radio-frequency magnetic field to the sample;
• *A gradient system,* which produces time-varying magnetic fields of controlled spatial nonuniformity;
• *A detection system,* which yields the output signal; and
• *An imager system,* including the computer, which reconstructs and displays the images.

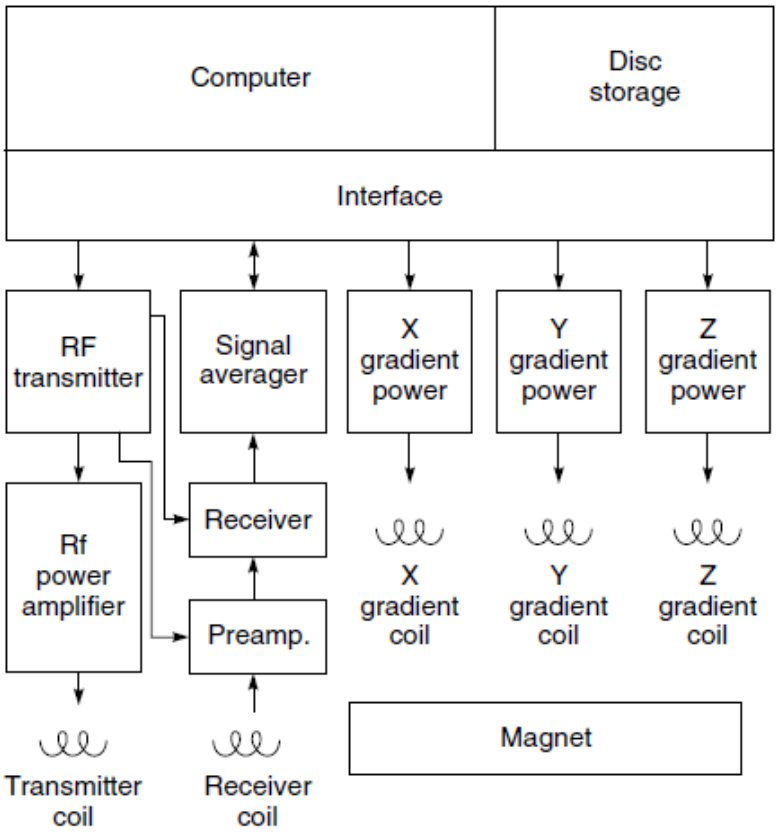


Fig : ***Sub-systems of a typical NMR imaging system***

The imaging sequencing in the system is provided by a computer. Functions such as gates and envelopes for the NMR pulses, blanking for the pre-amplifier and RF power amplifier and voltage waveforms for the gradient magnetic fields are all under software control. The computer also performs the various data processing tasks including the Fourier transformation, image reconstruction, data filtering, image display and storage. Therefore, the computer must have sufficient memory and speed to handle large image arrays and data processing, in addition to interfacing facilities.

Nuclear magnetic resonance (NMR) tomography uses magnetic fields and radio frequency signals to obtain anatomical information about the human body as cross-sectional

images in any desired direction and can easily discriminate between healthy and diseased tissue.

NMR images are essentially a map of the distribution density of hydrogen nuclei and parameters reflecting their motion, in cellular water and lipids.

The total avoidance of ionizing radiation, its lack of known hazards and the penetration of bone and air without attenuation make it a particularly attractive non-invasive imaging technique.

CT provides details about the bone and tissue structure of an organ whereas NMR highlights the liquid-like areas on those organs and can also be used to detect flowing liquids, like blood.

A conventional X-ray scanner can produce an image only at right angles to the axis of the body, whereas the NMR scanner can produce any desired cross-section, which offers a distinct advantage to and is a big boon for the radiologist.

9(b) Write a detailed note on diathermy and its applications

The use of frequencies near 30 MHz for heating is called short-wave diathermy. Long wave diathermy, at frequencies near 10 KHz was used, but this has become obsolete. In 1951, a mode of diathermy that use microwaves of a frequency of 2450 MHz was introduced. Microwaves are used in radar and in microwave ovens.

Heat from diathermy penetrates deeper into the body than radiant and conductive heat. It is thus useful for internal heating and has been used in the treatment of inflammation of the skeleton, bursitis, and neuralgia.

Applications of Short wave Diathermy

Short -wave diathermy is used in the treatment of bursitis, arthritis, traumatic injuries, strains, and sprains. However, it does have a limitation, when short-wave diathermy is used on muscle tissue surrounded by a fatty layer, a disproportionate amount of energy is lost in the fat.

While short- wave diathermy is a much better heater of deep tissue than the hot packs, or infrared lights, it is far from ideal because of the large amount of energy deposited in surface fatty layers. For this reason microwave diathermy is frequently employed.

Microwave diathermy :

The microwaves are produced in a special tube called magnetron and are then emitted from the applicator (antenna). The antenna is usually designed so that it can be placed several inches from the region to be treated. The microwaves from the antenna penetrate deep into the tissues, causing a temperature rise and deep heating. Microwave diathermy is used in the treatment of fractures, sprains, bursitis, injuries to tendons, and arthritis. The frequency used in microwave is 2450 MHz.

(OR)

Diathermy in surgical applications :

In modern surgery, the use of high frequency surgery currents offer a number of important advantages. The simplified method of hemostatis saves valuable time since bleeding can be arrested immediately by touching the spot briefly with the blade of a lancet or coagulation electrode. Blood vessels with a lumen of up to 1 mm can be quickly and efficiently sealed by grasping the vessel with hemostatic forceps and then touching the forceps with an electrode. As the forceps are removed immediately after this procedure, the operating field is kept clear. With high frequency coagulation a homogeneous coagulation zone is formed that gradually merges into the adjacent tissue, thus avoiding the danger of hemorrhage.

Electric cutting permits particularly elegant and effortless surgery. The electrode virtually melts through the tissue, instantaneously sealing capillary and lymphatic vessels to

prevent contamination by bacteria and resorption of toxic tissue products. Moreover, “cutting” or “tearing” surgery is possible with the cutting electrode, depending upon whether the high frequency is switched “on” or “off”. The degree of coagulation of the cut surface can be varied by selecting a suitable current intensity and cutting speed from a smooth and fine incision to a separation of tissue with coagulated edges.

Now a days therefore, a high frequency (H.F.) equipment is regarded as standard in a theatre.

In addition to its use as therapeutic procedure, diathermy is also an established surgical tool and then it works as 1.5 – 3 MHz. Insertion of pointed electrode, energizing produces high local current densities. As blood vessels, using surgical diathermy units, are cut, they may be sealed by passing diathermy currents through an electrode or forceps to the ends of the vessel. By using a surgical scalpel as the active electrode, the various tissues can be sealed as they are cut, to allow for ‘bloodless surgery’. Current methods by treatment for ‘Parkinson’s disease’ necessitate the destruction of localized sections of brain tissue which may be accomplished by a controlled amount of heating or cooling (cryogenic probes). Laser beams are also used for precise coagulation of the brain surface and other tissues.

Surgical Diathermy units in the operating room for tissue and coagulation consist basically of a power radio-frequency oscillator. Typically, assuming a patient tissue load of 150 Ω, a maximum power output of 200 to 500W would be available at some 1.75 Mc/s.