EI 8073 - Bio Medical Instrumentation

UNIT - I → Fundamentals of Bio Medical Engineering.

→ Cell & its structure
→ Resting & Action potential
→ Nervous system & its fundamental.
→ Basic components of Bio Medical System.
→ Cardio Vascular System
→ Respiratory system.
→ Kidney & Blood Flow.
→ Bio Mechanics of Bone
→ Bio Mechanics of soft tissue.
→ physiological signals & Transducer.
→ Transducer.
    → Selection criteria.
    → piezo electric
    → ultrasonic Transducer.
→ Temperature Measurement
→ fibre optic temperature sensor.

Cell and its Structure

The cell is the basic structural, functional, biological unit of all is known as organism.

→ cell is the smallest unit of life. Cells are often called the building blocks of life!'

→ The study of cell is called cell biology,

100 trillion cells → Human body.

80 billion → Human brain.

25 trillion → RBC.

→ cells can be either Eukaryotic or prokaryotic.

→ cell have many structure inside of them called organelles.

Organelles:

→ It helps the cell to stay alive.

→ All cells have the ability to reproduce new cells whenever the cells of a particular types are destroyed further in all cells, O_2 combine with carbohydrates, Fat (or) protein to release the energy required for cell function.

Each cell consist of a centrally Located nucleus surrounded by the cytoplasm (cell body)

Each cell consist of Nucleus is separated from the surrounding fluids by a cell membrane.

The substance that make up the cell → Protoplasm

protoplasm are (water, electrolytes, protein, Lipids & Carbohydrate.

Water: - principal fluid medium
- concentration is between 70-85 %.

Electrolyte:
- potassium
- Magnesium
- phosphate
- Sulphate
- bicarbonate
- Small quantities of Sodium, calcium & chloride.

protein:
- 10-20 %
- It is divided into

a) Structural
→ Long filament
→ composed of polymers
→ provide contractile Mechanism of muscle

b) globular (enzymes)
→ globular
→ enzymes
→ catayze reaction provide cellular function.

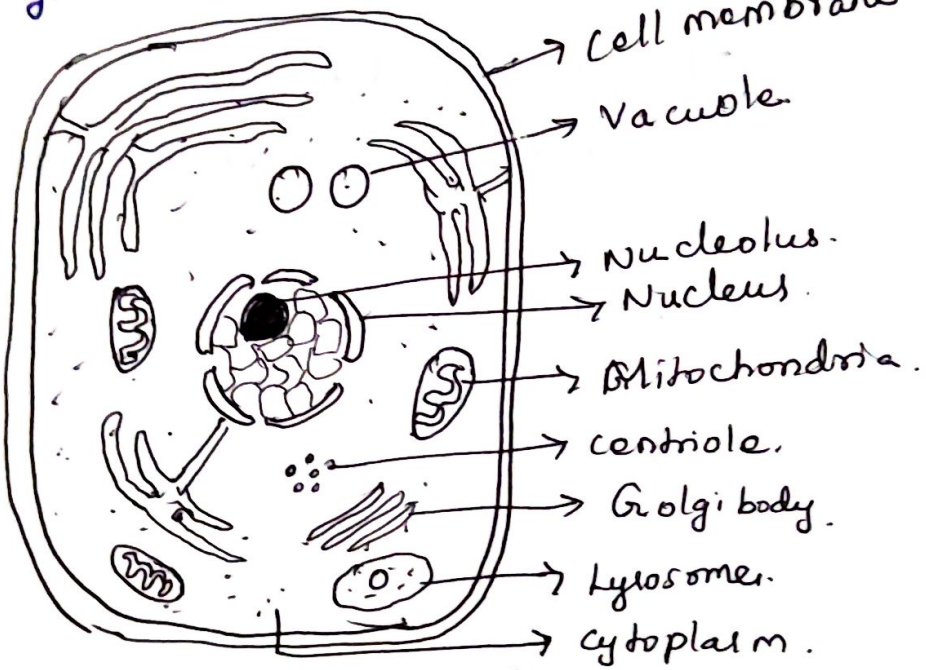
Lipids :-

Soluable in Fat Solvents & insoluble in Water.

phospholipids and cholestrerol - form membranous barriers separating the intracellular compartments.

Carbohydrates :-

- Stored in the cell in the form of glycogen
- Supply energy & present in the form of glucose.



Organelles :

highly organised physical structures.

cytoplasm :

- filled with cytosol
- minute & Large particle of organelles dispersed.

Ribosomes :-

- minute granular particles
- composed of ribonucleic acid (RNA) & proteins

Lysosomes

- vesicular organelles.
- provide intracellular digestive System

- remove unwanted substances

Mitochondria :

- power houses of the cell.
- It contain Deoxyribonucleic acid (DNA)

DNA :-

- control the centre of the cell

Nucleus contain large quantities of DNA called genes.

Genes ist reproduce themselves, splits by a special process called mitosis to form two daughter cells.

Nucleolus :

- inside the nucleus
- contain large amount of RNA & proteins.

Size of cells → 5 - 10 micrometer

Enormous DNA - Larger cell size.

DNA grows due to increased production of RNA & cell proteins.

Transport of ions through cell membrane.

In cell membrane there are two fluid.

a) Extra cellular fluid

→ Fluids lies outside the cell membrane

→ It contain large quantities of → sodium
→ Small amount of potassium

b) Intracellular fluid

→ Fluids lies inside the cell membrane.

→ concentration of potassium ion is more than sodium ion.

- concentration of phosphates & proteins are more in intracellular fluid.

- concentration of chlorides is more in the extracellular fluid.

	Extracellular Fluid	Intracellular Fluid.
Na^+	142 millimol / Litre	10 millimol / Litre
K^+	4 millimol / Litre	140 millimol / Litre
phosphates	1.3 millimol / Litre	25 millimol / Litre
proteins	2 g/dl	16 g/dl.
Chlorides.	103 millimol / Litre	4 millimol / Litre.
Glucose.	90 mg/dl	0-20 mg/dl.
pH	7.4	7

Cell membrane consist of a lipid bilayer with Large No. of protein molecules.

→ It constitutes a barrier for the movement of the water soluble soluble substance between the extracellular & intracellular fluid regions.

→ Transport of the substances through the cell membrane occurs by diffusion (passive transport) & Active transport.

Diffusion:

Diffusion take place either through intermolecular spaces in the membrane or in combination with a carrier protein.

Active transport:

When a cell membrane moves molecules or ions uphill against a concentration gradients.

- Sodium ions, potassium ion, calcium ion, chloride ions & most of the amino acids - transported through cell membranes.

Two types

a) primary Active transport

b) Secondary Active transport.

primary Active transport :-

Energy is derived directly from the breakdown of adenosine triphosphate (ATP) (or) some other high energy phosphate compound.

Secondary Active transport:

Energy is derived secondarily from ionic concentration gradients.

Both depend upon carrier proteins that penetrate through the membrane.

1.2. Resting and Action potential

Bioelectric potential:

The ionic voltage produced as a result of the electrochemical activity of certain special type of cell are known as Bioelectric potential.

Bioelectric potential are generated due to

- nerve conduction
- brain activity
- Heart beat
- muscle activity etc.

There are two type of Bio potential

→ Action potential

→ Resting Potential.

Resting potential

The membrane potential measured when an equilibrium is reached with a potential difference across the cell membrane negative on the inside and positive on the outside is called resting potential

Characteristic of Resting potential.

→ Resting potential is maintained constant.

→ It strongly depends on the temperature.

Resting potential → -60 - 100mV.

Goldman's equation

$$V_R = -\frac{kT}{q} \ln \left[\frac{P_K[K^+]_i + P_{Na}[Na^+]_i + P_{Cl}[Cl^-]_o}{P_K[K^+]_o + P_{Na}[Na^+]_o + P_{Cl}[Cl^-]_i} \right]$$

Where,

0 - outside the cell

i → inside the cell

V_R → Resting potential

K - Boltzman constant

T - Temperature in Kelvin.

P_K - permeability of potallium ion

P_{Cl} - permeability of chloride ion.

P_{Na} - permeability of Sodium ion.

$[K^+]$ $[Na^+]$ $[Cl^-]$ - concentration of potallium, Sodium - chloride.

Nernst equation.

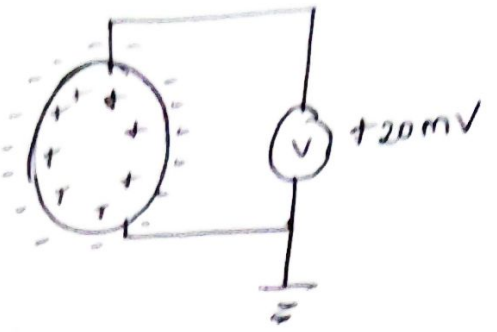
If $P_{Na} = 0$, $P_{Cl} = 0$.

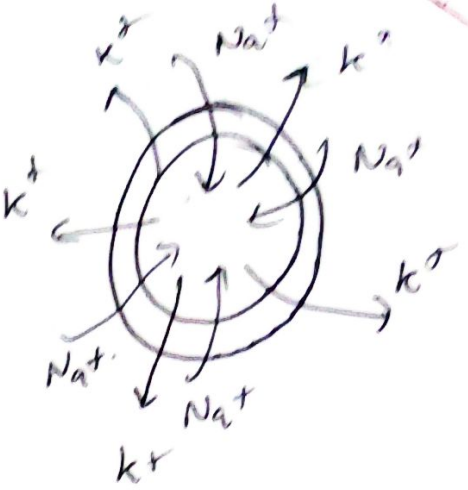
$$\therefore V_R = -\frac{kT}{q} \ln \left[\frac{P_K[K^+]_i}{P_K[K^+]_o} \right]$$

$$= -94.9 \text{ mV}.$$

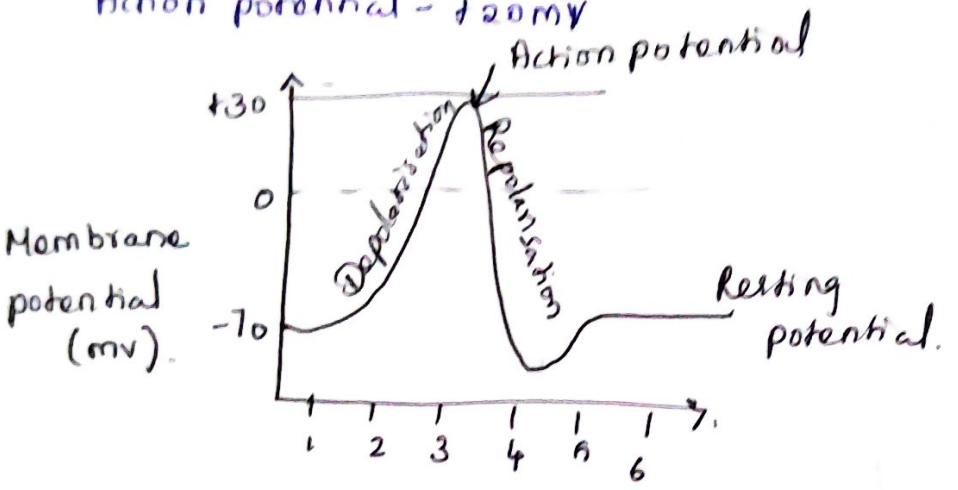
Action Potential

When a stimulus is applied to the cell at resting potential stage, there will be a high concentration of positive ion inside the cell and negative ion outside the cell. This is called Action potential.





Action potential - +20mV



→ It follows All-or-Nothing Law.

The method of excitation of cells (or) intensity of the stimulus, which is assumed to be greater than the threshold of stimulus, the action potential is always the same for any given cell. this is known as all-or-Nothing Law.

→ The process take place from Resting to Action potential is known as Depolarisation.

→ The process take place from Action potential to Resting potential is known as Repolarisation.

→ The rate at which an action potential moves down a fiber (or) its propagate from cell to cell is called propagation rate.

Absolute Refractory period:

The time duration in which the cell can't respond to any new stimulus it called absolute refractory period. period ⇒ 1ms

Relative Refractory period:

During which another action potential can be triggered but a high stimulus is required to reinitiate the action potential & subsequent contraction of muscle. period : several ms.

1.3 Nervous System & its fundamental.

→ Nervous system governs the rapid events like muscular contraction & secretion of the most of the glands in the body.

→ It ensures the smooth functioning of various system in the body.

→ It works through a system of nerves.

→ Nerves act as tiny electric wire.

Sensory Nerve:

It carry the information gathered by the sensory organs to the brain.

→ Thus they serve as message carriers for the brain.

Motor Nerve:

It carry the order from the brain to muscle & glands.

Mixed nerve:

It perform the function of both sensory nerve and motor nerve.

ie) they carry signals from brain to other sense orga and sense organ to brain.

Nervous System → coordinate the function of organs.

The Nervous system consist of

- Central Nervous System
- peripheral Nervous System.

Central Nervous system :-

It is made up of brain & the spinal cord

peripheral Nervous System:-

It consist of all the nerves & group of neuron outside the brain & spinal cord.

Central Nervous System:

the brain stem continues directly into the spinal cord. It consist of 10^{10} neurons.

The brain consist of

- Cerebrum
- Cerebellum
- brainstem.

Cerebrum:

Cerebrum consist of two hemisphere. the hemisph are

are divided into → frontal Lobe
→ parietal Lobe
→ occipital Lobe
→ temporal Lobe.

Frontal Lobes :

It is responsible for intelligence, constructive imagination & abstract thought. The outer layer of brain is called cerebral cortex. The area in the cerebral cortex is responsible for sight, hearing, touch & control of the voluntary muscles of the body.

Temporal Lobes :

→ The upper side of the temporal lobe contain hearing center.

→ It is important for storage process in the long term memory.

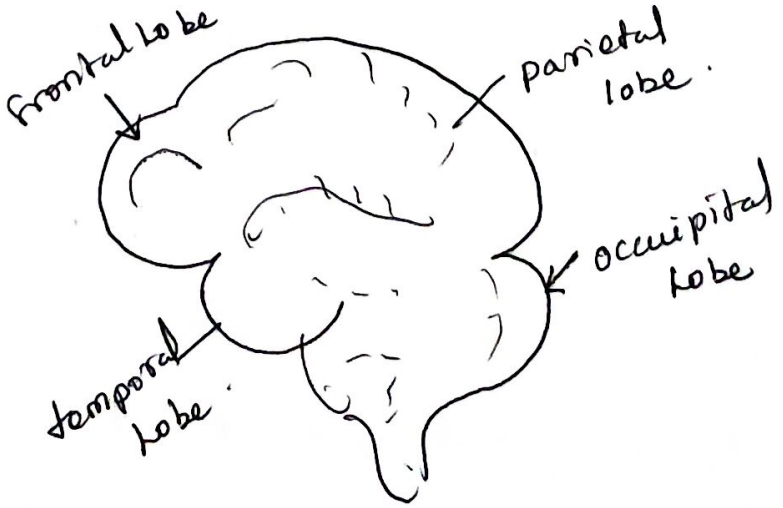
Occipital Lobe :

→ Back side of the brain.

→ visual centre is situated.

→ Motor centre in the cerebral cortex corresponding to a certain body movement which can be elicited by electrically stimulating the brain surface.

In the anterior part of the parietal lobe contain Sensory center where sensory nerves are terminated.



Cerebellum:-

→ It consist of two hemisphere

→ they regulate the coordination of muscular movement elicited by the cerebrum.

→ It is a balance center.

In brain stem, diencephalon, which consist of thalamus & hypothalamus & medula oblongata.

Thalamus → is a relay station for sensory pathways to the cortical sensory center of the cerebrum.

Hypothalamus → consist of center for temperature regulation, metabolism, fluid regulation, appetite, thirst, Sleep, Feeling & emotions.

Medulla oblongata → contains center for regulating the working of the heart & Lungs.

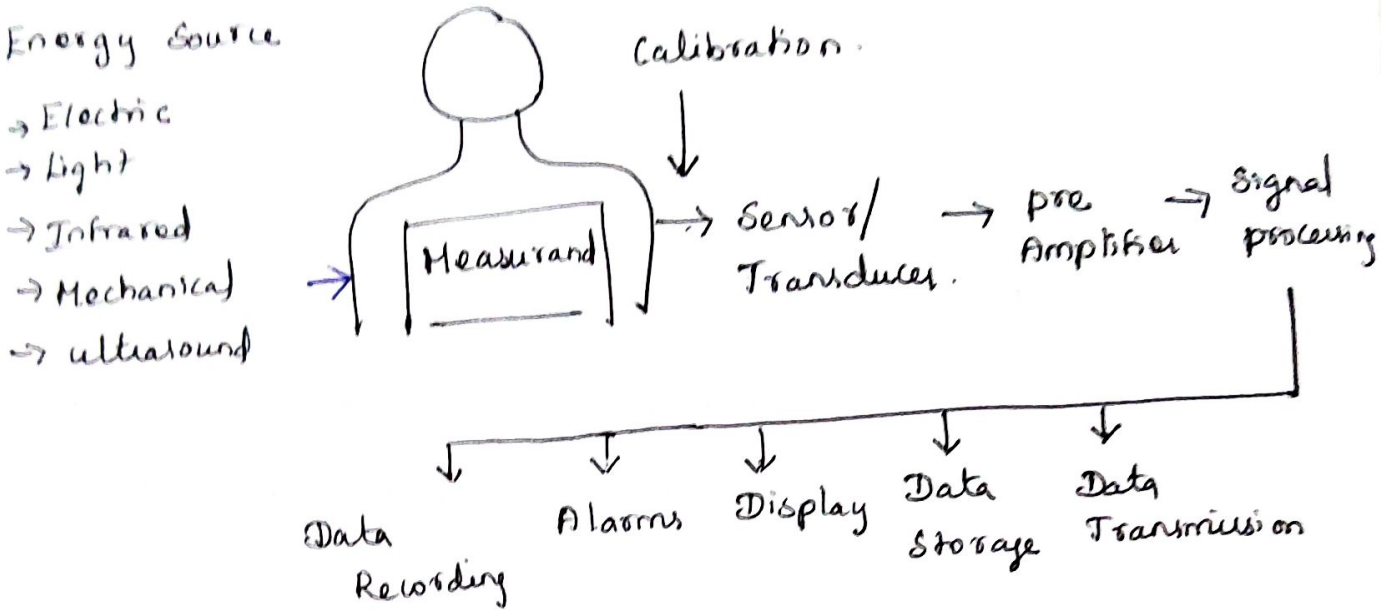
The brain consist of a system of cavities called Ventricles. the ventricles contain cerebrospinal fluid which helps to resist the stresses due to acceleration

Spinal cord:

→ It is the downward continuation of the medulla oblongata & is protected by the spinal cord canal.

→ It runs through the vertebral column or through the back bone. the working of the entire body is linked with it. It is connected to a

Basic components of Bio Medical System.



Measurand → the physical quantity or condition that the instrumentation system measures is called measurand.

Transducer / sensor → A transducer is a device that convert one form of energy to another.

sensor is also used in Medical Instrumentation System.

Signal conditioner → It converts the output of the transducer into an electrical quantity.

Display system →

It provides a visual representation of the quantity as a displacement on a scale

Alarm System:-

→ with upper & Lower adjustable threshold to indicate when the measurand goes beyond preset Limit.

Data storage:

→ to maintain the data for future reference.

→ It may be a hard copy on a paper or on magnetic (or) semiconductor memories.

Data transmission:-

→ using standard interface connections so that information obtained may be carried to other parts of an integrated system.

→ Calibration is necessary at regular interval during their operation.

Measurement in the medical field is classified into

→ In vivo

→ In vitro.

In vivo → Measurement is made on or within the living organism itself.

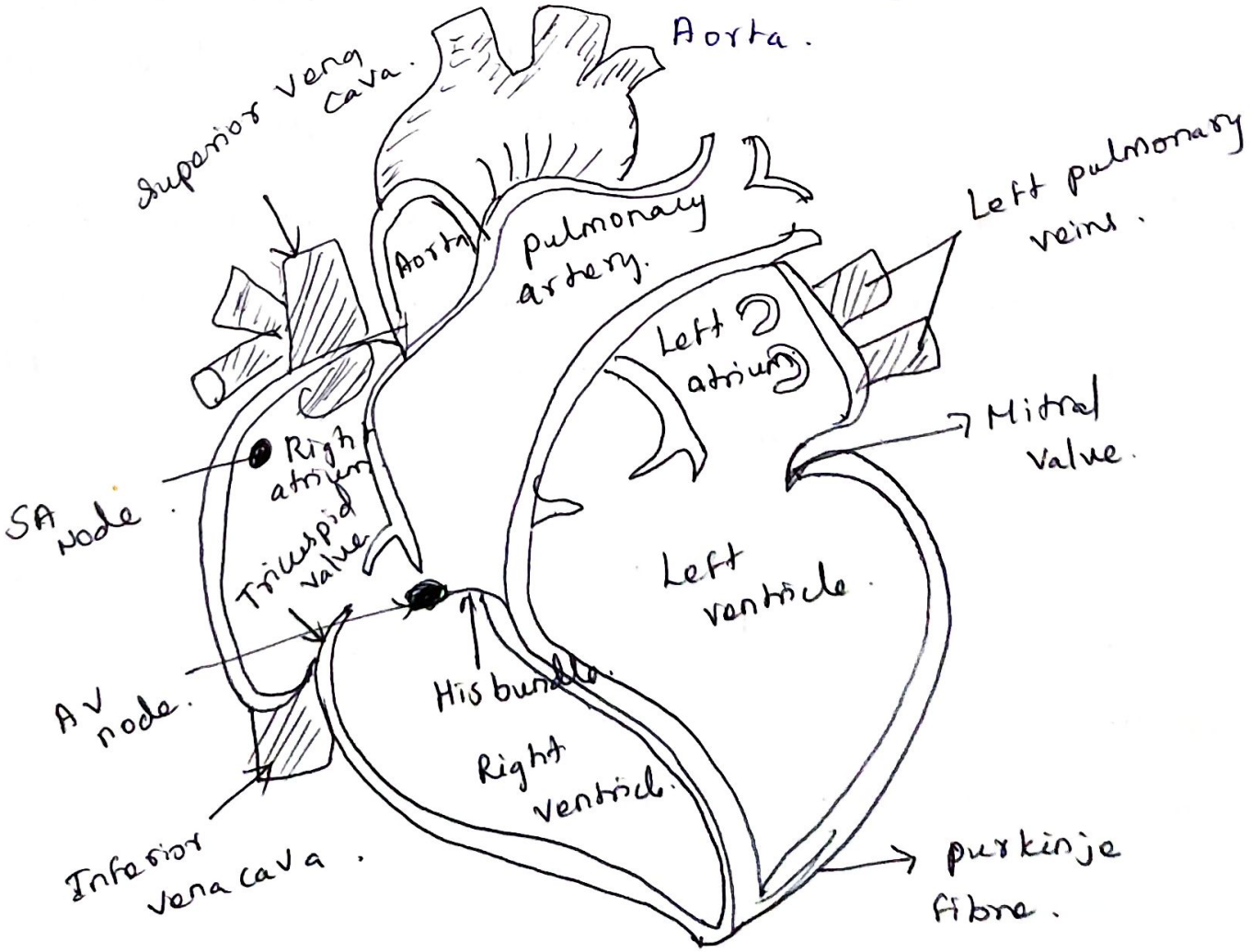
In vitro → Measurement is made outside the body.

Cardio Vascular System

→ It is a closed hydraulic system, which performs the essential service of transportation of oxygen, carbondioxide, numerous chemical compounds & the blood cells to maintain optimum environment for cellular function.

The heart has Four values.

→ Tricuspid Valve → between right Atrium & ventricle
→ Bicuspid Valve → between Left atrium & Ventricle
→ pulmonary Value → at the right ventricle
→ Aortic Value → between Left ventricle & Aorta.



The heart wall consist of 3 Layer.

→ pericardium → outer layer of heart
→ myocardium → middle layer
→ endocardium → inner layer.

The blood is carried to the various part of the body through blood vessels. There are three type of Blood Vessels.

→ Arteries. (carry oxygenated blood away from the heart)
→ Veins (carry deoxygenated blood towards the Heart)
→ capillaries (smallest & Last Level of blood vessels).
→ 800,000 km of capillaries in human being. that includes all the arteries veins which carry blood.

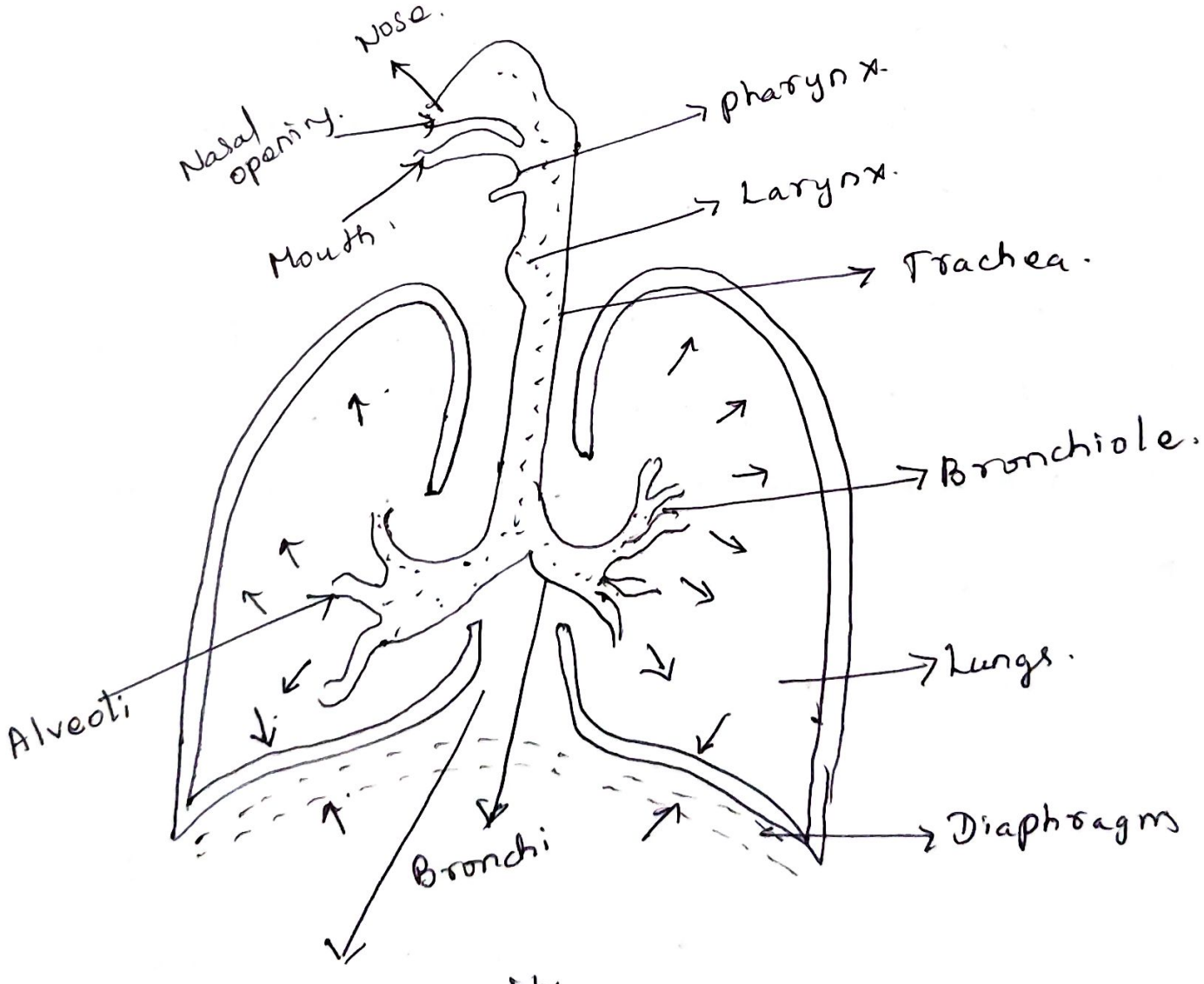
→ In pulmonary circulation, the venous blood flows from the right ventricle through the pulmonary artery to the lungs, where it is oxygenated & gives off carbon dioxide.

→ In systemic circulation, the blood is forced through blood vessels which are elastic. The blood flow from left atrium to the left ventricle & it is pumped through aorata & its branches.

Respiratory System :-

→ Respiration is the process of supplying oxygen to and removing carbondioxide from the tissues.

→ These gases are carried in the blood, oxygen from the lungs to the tissue & carbondioxide from the tissue to the lungs.



The lungs are connected to the outside environment through a passage way comprising

→ nasal cavities
→ pharynx
→ Larynx
→ Trachea.
→ Bronchi
→ Bronchioles.

→ oxygen is taken into the blood from the incoming air & carbondioxide is transferred from the blood to the air under the control of pneumatic pump.

→ Thus the blood circulation forms the Link in the supply of oxygen to the tissues & in the removal of gaseous waste products of metabolism.

under normal condition,

250 ml of O_2 are taken up.

250 ml of CO_2 are given out by the body.

Exchange of gases take place 15 - 20 breath/min

Mechanics of Bone :-

→ Bones protect the vital organs & help to support the body.

→ Body is composed mainly of collagen, (or) ossein, fibers and bone cells called osteocytes. There are two types of bone tissue.

- → cortical bone
- → cancellous bone.

Types of Bones

- → Flat (Skull, Scapula)
- → Irregular (vertebrae)
- → Long bones (Femur).
- → Short. (wrist, ankle)

Force, Displacement & Stiffness.

$$\text{Stiffness} = \frac{\text{Force}}{\text{Displacement}}$$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}.$$

$$\text{Elastic Modulus} = \frac{\text{Stress}}{\text{Strain}}.$$

Elastic Modulus (GPa) of common materials in Orthopaedics

Stainless steel - 200

Titanium - 100

Cortical bone - 7 - 21

Bone cement 2.5 - 3.5

Cancellous Bone 0.7 - 4.9.

Load to Failure

→ continuous application of force until the material breaks

→ common mode of failure of bone & reported in the implant literature.

Fatigue Failure

→ cyclical sub threshold Loading may result in Failure due to Fatigue

→ common mode of failure of orthopaedic implants & fracture fixation constructs

Material properties of Bone.

→ Anisotropic

Mechanical properties dependent upon direction of Loading

→ Viscoelastic.

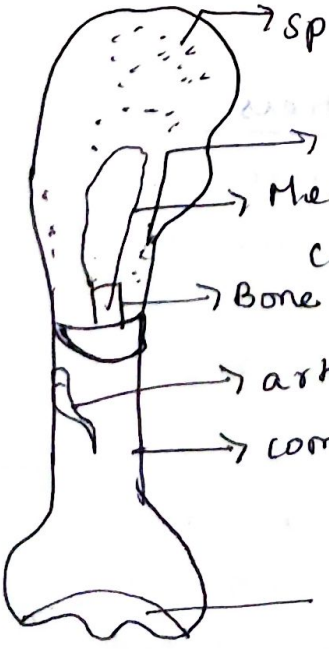
Stress-strain characteristics dependent upon rate of applied strain (time-dependent)

Stress at failure cortical Bone

compression $< 212 \ N/m^2$

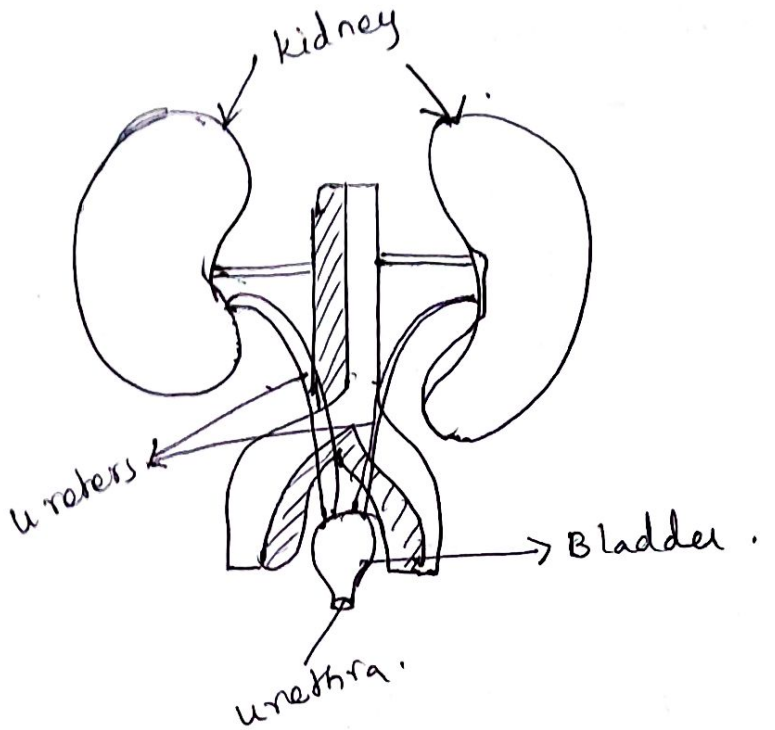
Tension $< 146 \ N/m^2$

Shear $< 82 \ N/m^2$.



dney & Blood Flow

Kidney are two bean - shaped organs, each about the size of fist. they are Located just below the rib cage, one on each side of your spine.



→ Each of your kidney is made up of about a million filtering unit called nephrons.

→ Each nephron includes a filter called the glomerulus & a tubule.

→ the nephrons work through a two step process
  → the glomerulus. filters your blood &
  → the tubule returns needed substances to your blood & remove waste.

→ Larger molecules, such as proteins & blood cells, stay in the blood vessel.

Bio Mechanics of soft Tissues

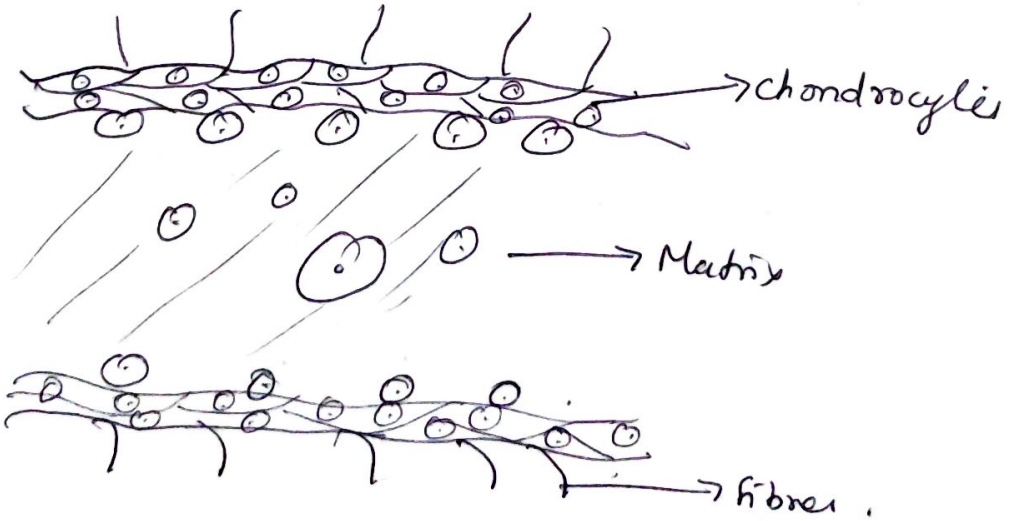
Soft tissues is found all over the body. It includes tissues that connect, support or surround other structures & organs in the body.

Types of soft tissues are.

- → Cartilage
- → Tendons
- → Ligaments
- → Muscles

Cartilage:

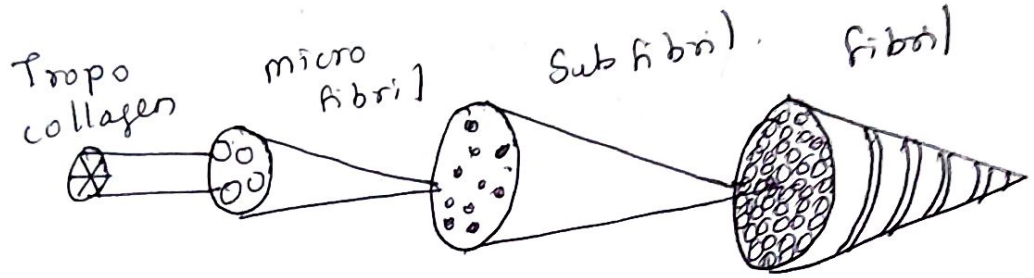
- → Flexible connective tissue
- → Avascular
- → Made up of 3 basic structure
  - → Matrix
  - → chondrocyte
  - → fibres.



Tendons & Ligaments.

→ They are both composed of collagen & elastin fibers with a structural hierarchy.

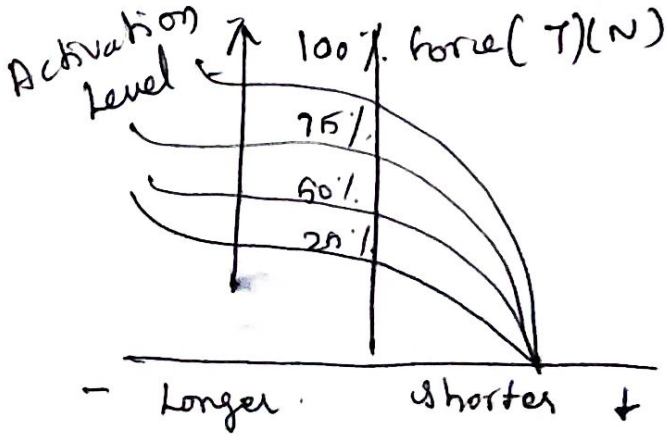
→ tendons connect the muscle to bone & Ligaments connect bone to bone.



Muscles:

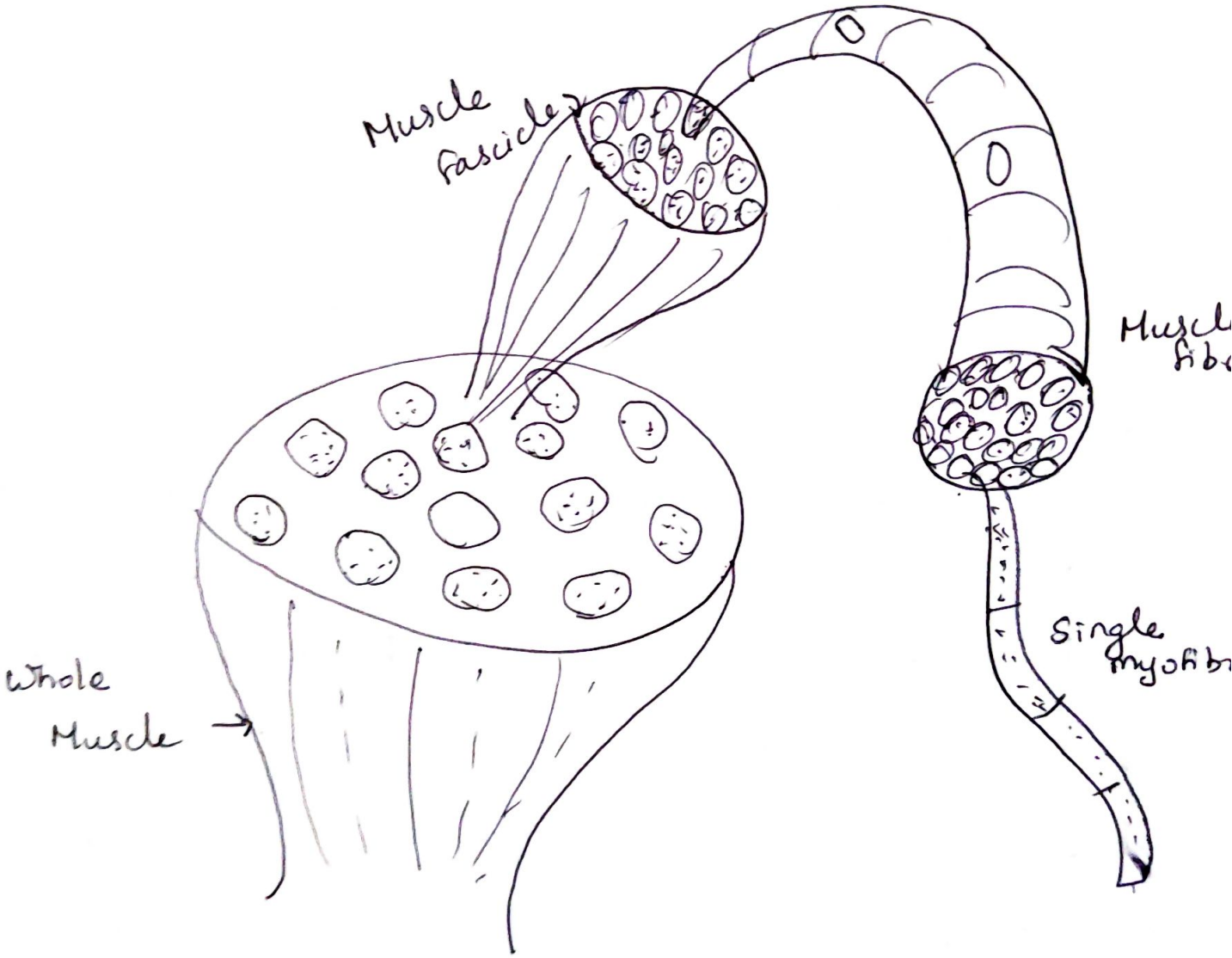
→ the functional units that produces motion at a joint consist of two discrete units, the muscle belly & the tendon that binds the muscle belly to the bone.

→ the muscle belly consist of the muscle cells or fibers that produce the contraction & the connective tissue encasing the muscle fibres.



→ force is greater during lengthening than during contraction

→ Smaller the force, greater the velocity.



→ Movement of body.

→ Maintenance of posture & body position.

→ Movement of substance inside the body.

→ Generation of body heat.

physiological signal & Transducer.

Transducer is a device which convert one form of energy into other form.

classification of Transducer:

1) Active & passive transducer
2) physical or chemical principles.
3) Application.

Signals from cardio Vascular System

Blood pressure → freq : dc to 200 Hz.
→ unbonded wire strainguage.

Blood flow → Rate : 0 - 300 ml/s.
freq : 0 - 100 Hz.

cardiac output → freq : 0 - 60 Hz.

Heart rate → 25 - 300 beats/min.
Normal human heart rate at rest.
→ 60 - 90 beats/min
Normal foetal heart rate
→ 110 to 175 beats/min.

phonocardiogram (heart sounds) → freq : 20 - 2000 Hz

oximetry : freq range 0-60Hz.

Signals from Respiratory System.

→ Respiration rate.
→ pneumotachogram.
→ Tidal volume.
→ minute ventilation.
→ Gases in expired air.

physical quantities

→ Temperature
→ Galvanic skin Resistance.
→ plethysmogram.
→ Tocogram.

Transducer - selection criteria.

→ Accuracy
→ precision
→ Resolution
→ sensitivity
→ span
→ offset.
→ Drift.
→ Linearity
→ threshold.
→ Noise
→ Hysteresis
→ Saturation
→ conformance
→ Repeatability
→ Input Range.
→ Transfer function.
→ Response time
→ Settling time.

Piezo electric Transducer.

→ It convert displacement or pressure into an electric voltage variable.

→ It is based on piezo electric effect. If a varying potential is applied to the proper axis of the crystal, it will change the dimensions of the crystal thereby deforming it. This effect is called piezo electric effect.

Material

→ Rochelle salt

→ Ammonium dihydrogen phosphate

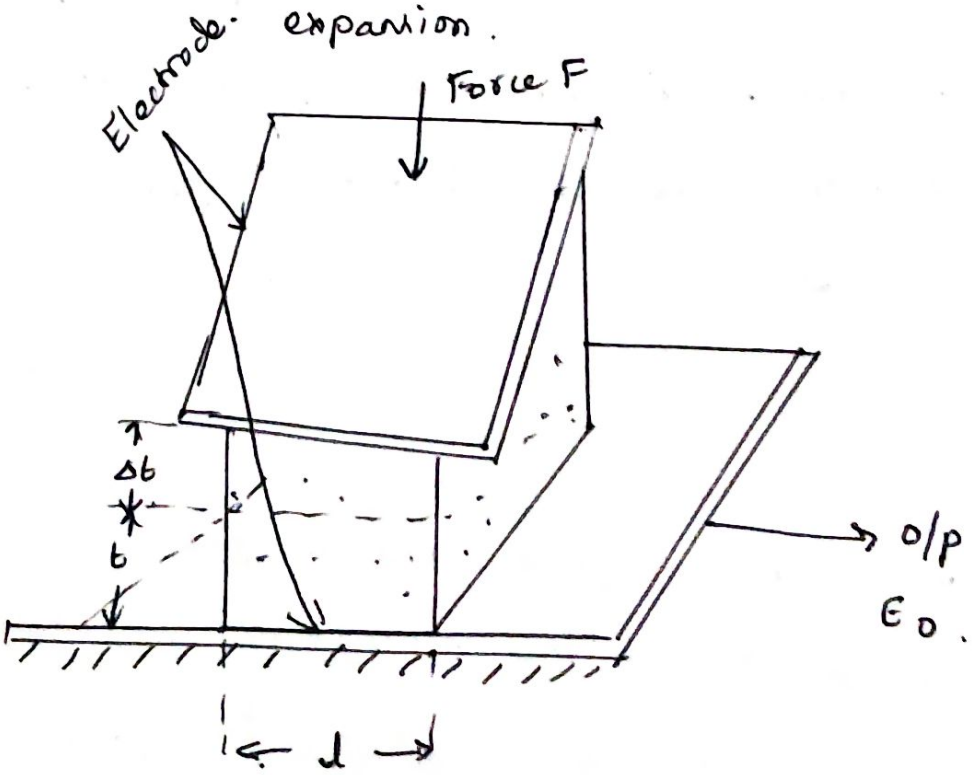
→ quartz & ceramics A & B.

The mode of motion depends on

→ shape of body

→ Location of electrode.

→ thickness, expression, transverse expansion.



$$E = Q/C$$

Q = charge in coulomb

E - voltage

C - capacitance

$$Q = d \times F \text{ coulomb}$$

d - charge sensitivity of crystal.

F = Applied force N.

properties of piezo electric crystal.

(i) Stability

(ii) High o/p sensitivity

(iii) Humidity are the desirable properties.

Ultrasonic Transducer:

It is used to produce high frequency ultrasonic waves. Frequency are greater than 20000 Hz. These transducer are divided into 2 type.

→ Magnetostrictive ultrasonic transducer.

→ piezoelectric ultrasonic transducer.

(i) Magnetostrictive ultrasonic transducer:

→ When a ferromagnetic rod is placed in a magnetic field along the magnetization, there is a change in length of the rod. This phenomenon is called Magnetostriction.

It depends on

→ Nature of material

→ degree of Magnetization

→ Temperature

→ Length of rod increase or decrease.

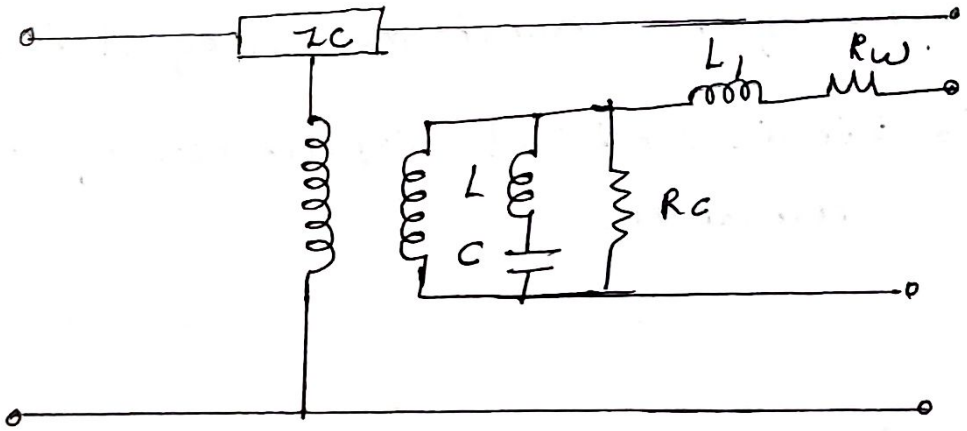
Frequency of rod $f = \frac{1}{2l}\sqrt{\frac{E}{P}}$

Where,

l - Length of rod.

E - Young's modulus

P - Density of the rod.



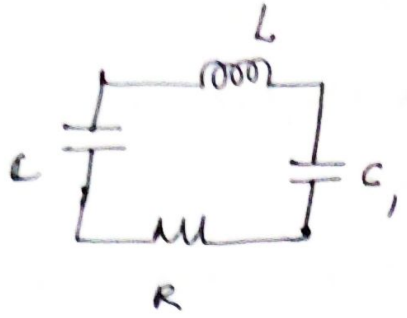
Equivalent circuit of Magnetostrictive Transducer.

piezo electric ultrasonic transducer

ultrasonic waves produced in quartz by inverse piezo electric effect.

→ If we apply an ac voltage along X axis of the crystal, then the corresponding compression or tension is produced along the Y axis of the

crystal. This is called inverse piezoelectric effect.



The production of ultrasonic wave at resonance in the transducer can be represented by as an electro Mechanical (or) voltage - force Transformer.

$$h = \frac{\text{Stress developed.}}{\text{Applied charge density}} \quad V/m.$$

Turns ratio of that transformer is equal to $1 : hC_o$.

$C_o \rightarrow$ Static electrical capacitance of the transducer.

Temperature Measurement :→ fibre optic temperature sensor.

→ The elevated temperature in the range of $42 - 45^\circ$ (or) higher for cancer treatment by electro magnetic energy, either in the radio frequency (or) microwave frequency ranges pauses a difficult temperature measurement problem.

→ Sensor such as thermistor or thermocouples require metallic components & connecting wires

UNIT - II

Non Electrical Parameter Measurement & Diagnostic Procedure.

→ Measurement of blood pressure
→ Cardiac output
→ Heart rate
→ Heart Sound
→ pulmonary function measurement
→ Spirometer
→ photo plethysmography
→ Body plethysmography
→ Blood gas Analyser
→ pH of Blood
→ Measurement of blood P_{CO_2}, P_{O_2}
→ finger tip oximeter
→ ESR
→ GSR measurement.

Measurement of Blood pressure.

Blood is pumped by Leftside of heart into aorta which supplies it to the arteries. Due to Load resistance at the arteries, blood loses most of its pressure & return to its heart at low pressure & return at a low pressure via the veins.

Right side of the heart pumps it to the pulmonary vein, which operates at a lower pressure

the maximum pressure reached during cardiac out is called systolic pressure.

the minimum pressure occuring at the end of the ventricular relaxation is termed as diastolic pressure.

Pulse pressure = Difference between systolic & diastolic values.

Haemodynamic pressure values are.

Arterial System = 30 - 300 mm of Hg
Venous System = 5 - 15 mm of Hg
Pulmonary System = 6 - 25 mm of Hg.

the most frequently monitored pressure are
→ Arterial pressure
→ Venous pressure.

Blood Pressure Measurement:

1) Direct Measurement
2) Indirect Measurement.

1) Direct Measurement using Catheters:-

A catheter or a needle type probe is inserted through a vein (or) artery to the area of interest. Two types of probes can be used. one type is catheter tip probe in which sensor is mounted on the tip of the probe & the pressure exerted on the sensor are converted to the

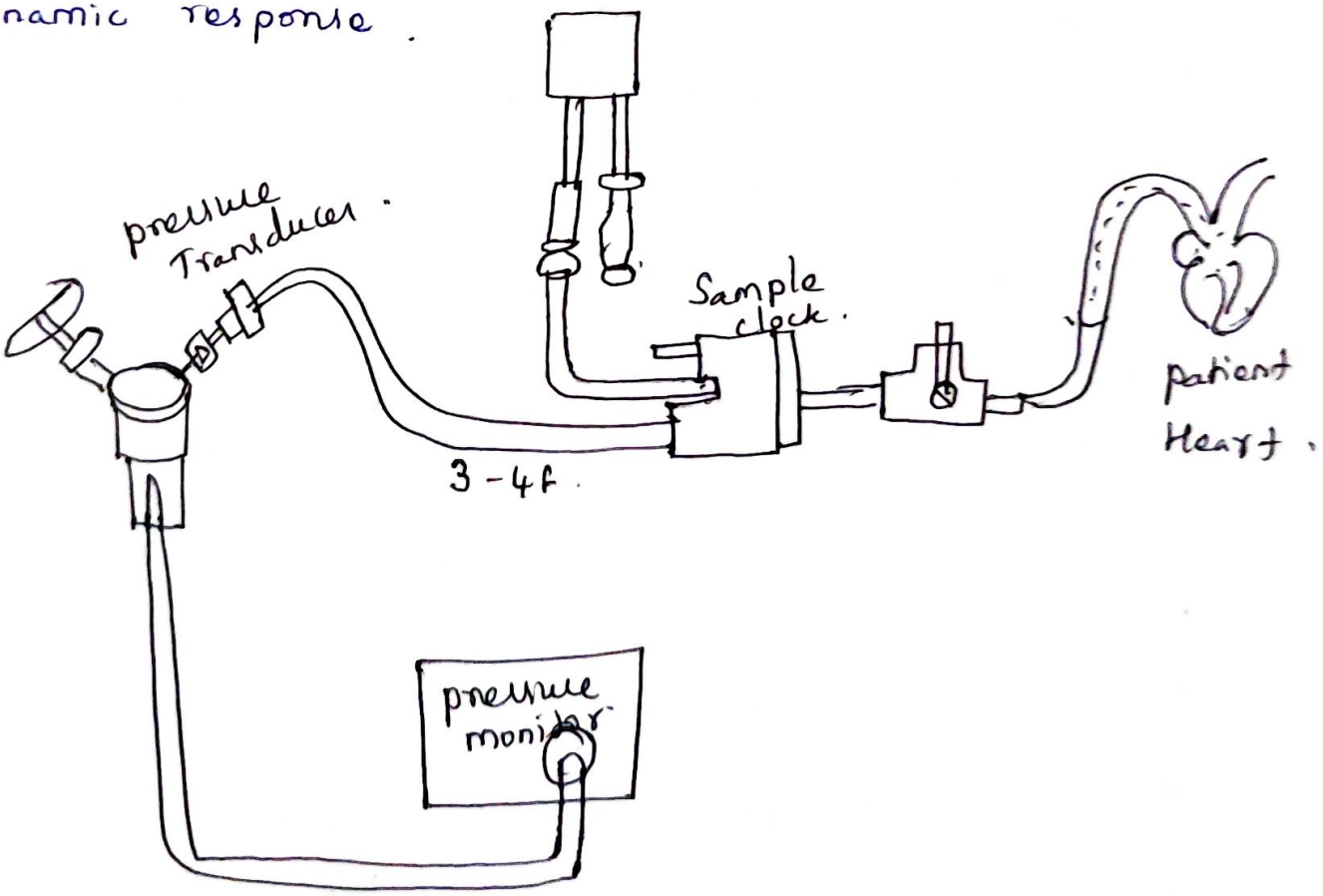
the proportional signal.

→ the other is the fluid filled catheter type which transmit the pressure exerted on its fluid filled column to an external transducer.

→ this transducer converts the exerted pressure to the electrical signals.

→ the electrical signals can be amplified & displayed or recorded.

→ catheter tip probes provide the maximum dynamic response and avoid acceleration. artefacts whereas the fluid filled catheter type systems require careful adjustment of the catheter dimension to obtain an optimum dynamic response.



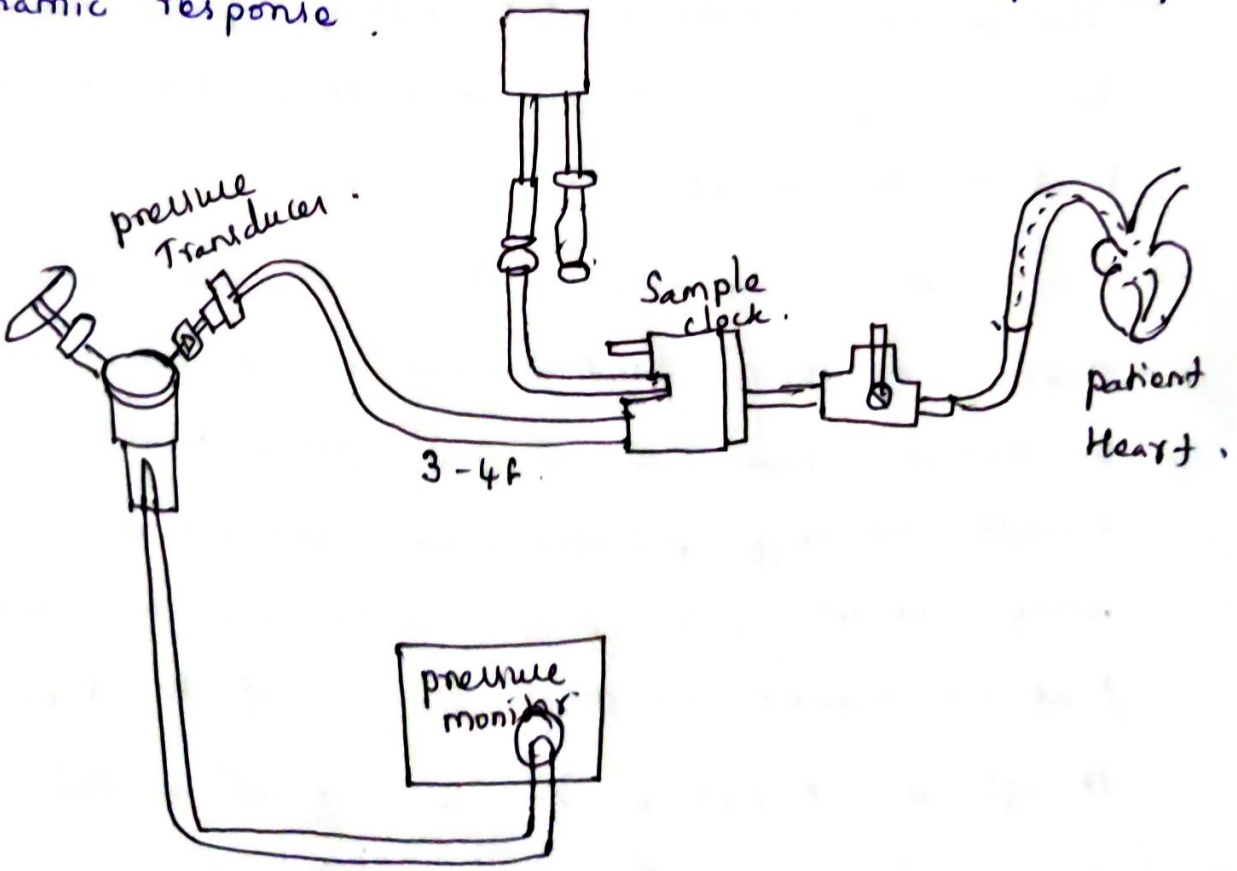
the proportional signal.

the other is the fluid filled catheter type which transmit the pressure exerted on its fluid filled column to an external transducer.

→ this transducer converts the exerted pressure to the electrical signals.

→ the electrical signals can be amplified & displayed or recorded.

→ catheter tip probes provide the maximum dynamic response and avoid acceleration artefacts whereas the fluid filled catheter type systems require careful adjustment of the catheter dimension to obtain an optimum dynamic response.



(ii) Indirect Method:

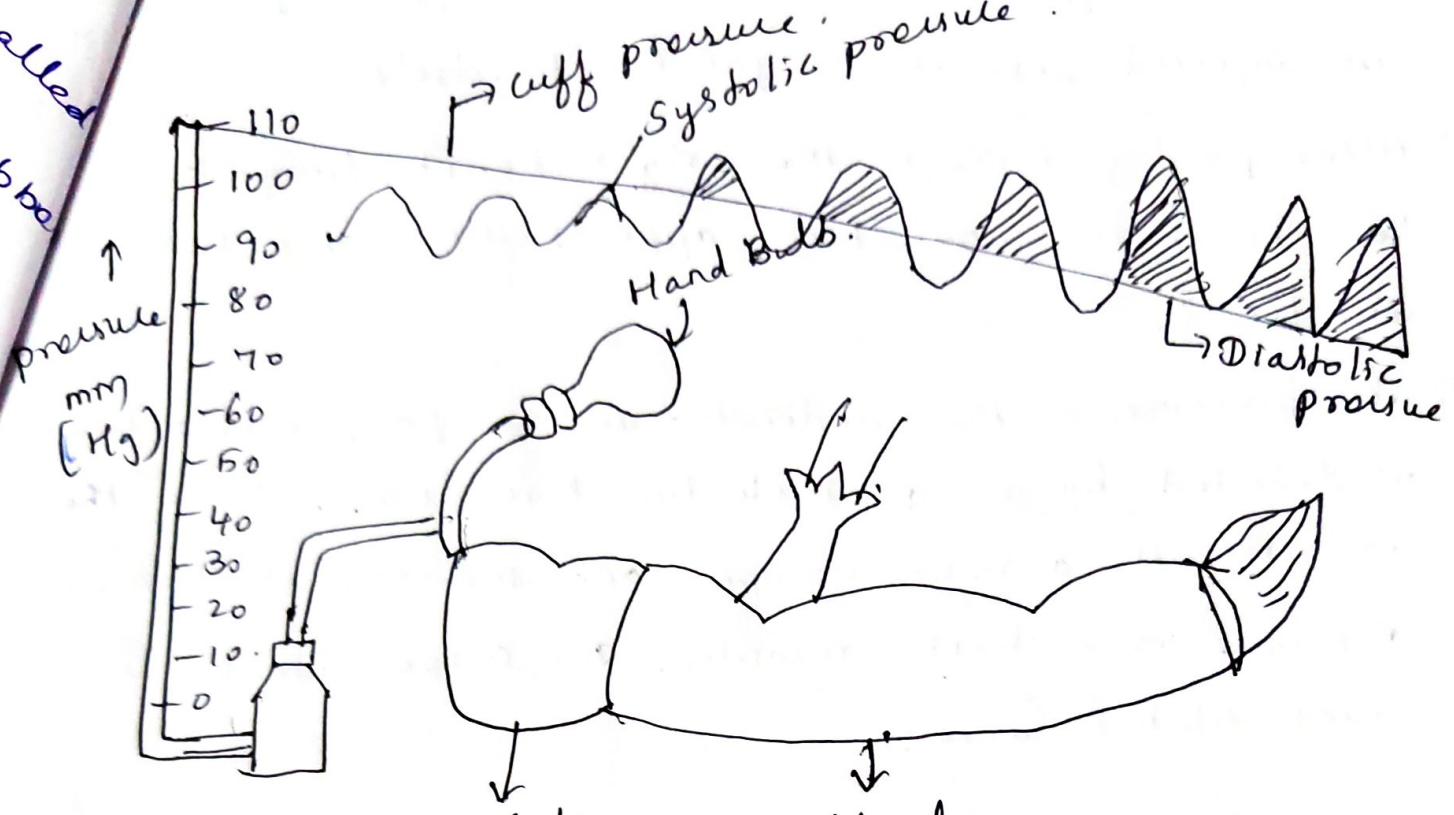
→ It is used by physician requires a device called Sphygmomanometer. It consist of an inflatable rubber bladder called the cuff, a rubber squeeze, ball pump and value assembly & a manometer.

→ The cuff is wrapped around the patient's upper arm at a point about midway between the elbow & shoulder. The stethoscope is placed over an artery to the cuff.

→ The cuff is inflated so that the pressure inside the inflated bladder is increased to a point greater than the anticipated systolic pressure.

→ This pressure compresses the artery against the underlying bone causing an occlusion that shuts off the flow of blood in the vessel.

→ The operator then slowly releases the pressure in the cuff (= 3mm Hg/s) and watches the pressure gauge or mercury column, when the systolic pressure first exceeds the cuff pressure, the operator begins to hear some crashing, snapping sounds in the stethoscope that are caused by the first jets of blood pushing through the Korotkoff sounds continue as the cuff pressure diminishes, becoming less loud as the blood flow through the occlusion becomes smoother.



Cardiac Output:

There are three method for measuring cardiac output. They are

→ Indicator dilution method

→ Dye dilution method

→ thermal dilution method.

(i) Indicator dilution method:

→ The volume flow of fluid (blood) from the heart can be estimated by introducing a known amount of indicator & measuring the concentration upstream & downstream of injection.

→ the indicator can be injected at a constant rate or as a bolus. But if indicators at a constant rate most of it will recirculate and this prevents estimation of concentration efficiently.

→ In the bolus type of injection, a small quantity of is injected into the right heart itself.

→ After passing through the right heart, Lungs & the Left heart the indicator appears in the arterial circulation.

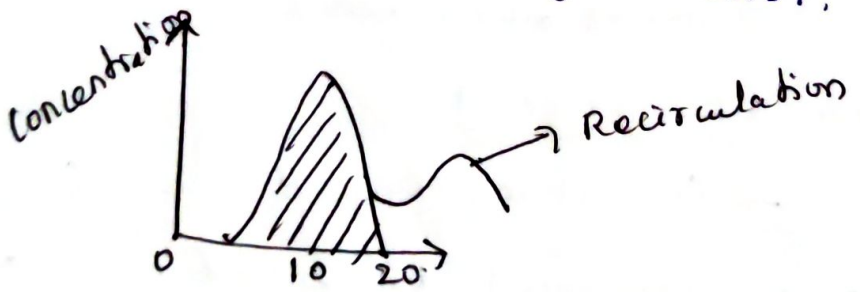
→ The presence of the indicator in the peripheral artery is detected by a photoelectric transducer. Since the indicator is a radio isotope and the concentration is displayed on a chart recorder. The curve obtained is called dilution curve.

$$Q = (M * 60) / \text{area under the curve in l/min}$$

Where,

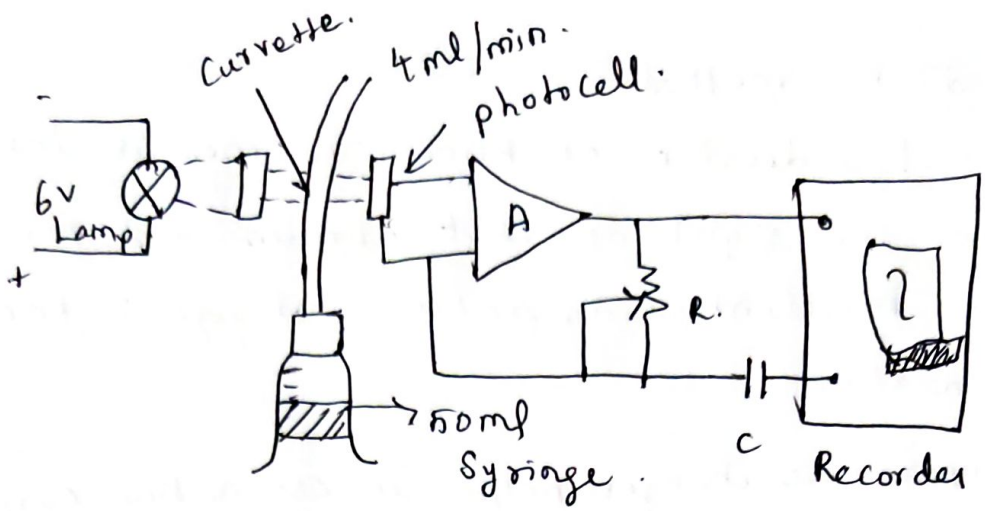
Q - Cardiac output

M - amount of indicator.



(ii) Dye Dilution method:

The indicator is used as dye. Indocyanine green (or) cardiogreen dye is commonly used. The dye is used to record the dilution curve. The concentration of the dye is measured with the help of infrared photocell.



The dye is needed in very small quantities of up to 5mg The dye is injected and the dye pass through circulation.

→ The Blood is drawn from the radial or femoral artery by a motor driven syringe through a cuvette.

→ A radiation source illuminates the cuvette from one side & the detector photocell receives the scattered Laser.

→ The curve is made of disposable polyethylene tube. there is an interference filter with a peak transmission of 805 nm which permit only infrared radiation to be transmitted.

→ The syringe which draws blood has a volume of 50ml/min The output of the photocell is connected to a Low drift amplifier. It has a high input impedance & Low output impedance.

→ A potentiometric recorder record the amplifier output signal on a recording paper at a speed of 10mm/s. After recording the dilution curve, Saline is injected to flush the dye out of the circulating blood.

(iii) thermal dilution method:

A thermal indicator of known volume is introduced into either the right or left atrium and this will produce a resultant temperature change in the pulmonary artery or aorta.

→ the temperature changes helps in estimating cardiac output

Cardiac output = (a constant * [Blood temperature - injectate temperature) / (area under the dilution curve).

Dextrose solution at a temperature of 18°C - 28°C

Blood temperature is measured over a range of 30°C - 40°C

Heart Rate

The No. of heart beats per unit time is measured as the heart rate. The heart rate is based on the No. of contraction of the ventricle.

→ the heart rate may be too fast (tachycardia) or too slow (bradycardia).

→ Heart rate can be measured from the ECG signal either by the average or instantaneous time interval between two successive R peaks.

e technique used to calculate the heart rate include.

1) Average calculation :-

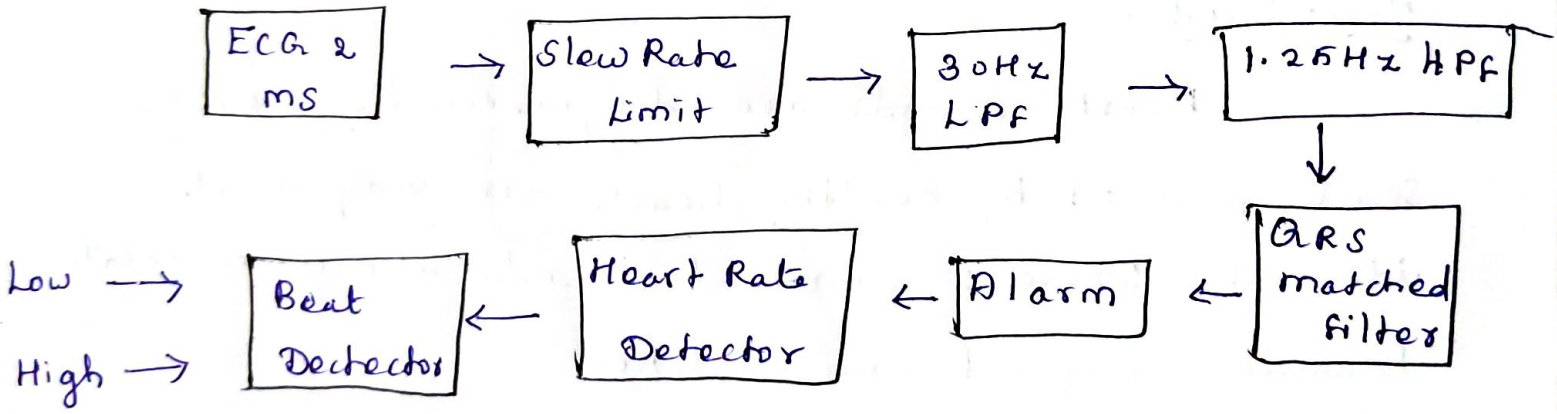
Average rate in beats/min is calculating by counting the No. of pulses in a given time.

2) Beat to Beat calculation :-

Time between two consecutive pulses & converting this time into beats/min (60/T).

3) Combination of heart beats - to beat calculation with average technique. This is done based on a four or six beats average.

→ Average heart rate meters.
→ Instantaneous heart rate meters



→ ECG is sampled every 2ms. Two adjacent 2ms samples are averaged and the result is a train of 4 ms samples.

→ In order to remove unnecessary high frequency components of the signal, 30 Hz. Butterworth filter is used.

→ Any dc offset with the signal is removed by a high pass filter.

→ The clamped and filtered ECG waveform is finally passed through a QRS matched filter.

→ This beat detector recognizes QRS complexes. If this value exceeds a threshold value, a heartbeat is counted.

Each beat → inhibitory period (200ms) → No heart beat is detected.

→ The inhibitory period is also kept varied as an inverse function of the high rate limit, with lower high rate limit giving longer inhibitory periods.

Heart Sound :-

Heart sounds are diagnostically useful. Sounds produced by healthy hearts are very much identical. Whereas abnormal sounds always correlate to specific physical abnormalities.

→ The heart sounds may be due to movement of heart wall, closure of walls, flow of blood, Leakage of blood etc.

Instrument are

→ Acoustical stethoscope.
→ Electronic stethoscope.
→ Phonocardiograph.

Phonocardiograph :-

It is an instrument used for detecting & recording the sounds connected with the pumping action of the Heart.

→ It helps in indicating heart rate & rhythmicity of heart beat, η of pumping of Blood, value action etc.

→ It consist of a microphone, an amplifier & the recorder.

Two types of microphones

1) Crystal

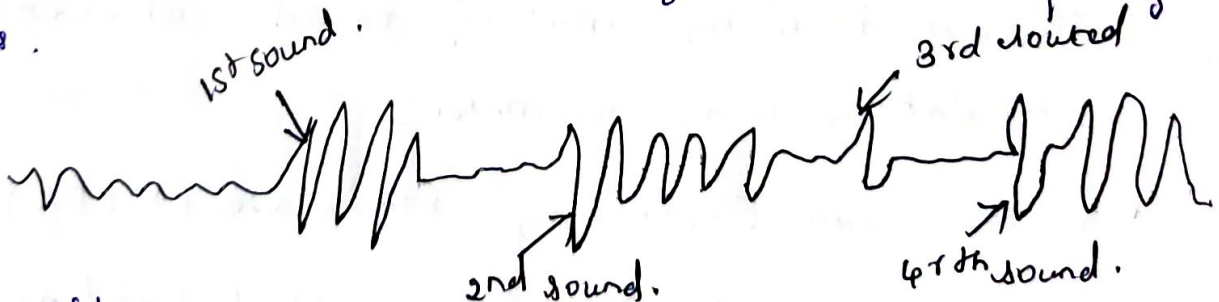
2) Dynamic.

→ Crystal consist of a piezo electric material which generates potentials when subjected to Mechanical stresses due to heart sounds.

→ Dynamic consist of a moving coil having a fixed magnetic core inside it.

Frequency → 20 - 2000 Hz.

→ filter permits the selection of suitable frequency bands.



1st sound → closure of mitral & tricuspid valves.

→ relaxation of atria or contraction of ventricles.

→ 30 - 100 Hz, t = 50 - 100 ms.

2nd sound → higher in pitch.

t = 25-50ms

f = 100Hz.

→ Sound is produced due to closure of aortic & pulmonary veins.

3rd sound → Inflow of blood to ventricles.

4th sound → produced due to the contraction of the artia.

Pulmonary function Measurement.

Measurement of pulmonary function is important as far as diagnosing problems related to respiratory System that arise either due to organic (or) environmental issues. pulmonary function measurement include.

1) Maximum Voluntary Measurement (MVV) :- This is done by making deep and rapid breathing on a spirometer.

2) Forced Expiratory Volume in 1 second (FEV_1)
This is done by making rapid inhalation - exhalation on a spirometer.

3) Maximum Expiratory Flow Rate (MEFR)
this is done by forcible inhalation/exhalation measured on a pneumotachometer.

Intra alveolar pressure → this measure pressure in the alveolar ac by a body plethysmograph.

5) Blood gas Measurement → this measures partial pressure of Blood O_2 & blood CO_2 using blood gas analyzer.

Spirometer

The process of measurement of the amount (volume) of air that can be inhaled and exhaled is called spirometry.

It is a tool used for arresting condition such as.

→ Asthma
→ pulmonary fibrosis
→ chronic obstructive pulmonary disease.

Spirometer is a special device that registers the amount of air a subject inhales or exhales into or out of lungs. The output produced by a spirometer is called a kymograph trace (or) spirogram.

→ Spirograms are tracing (or) recording of the information obtained from the spirometric test.

There are two type of spirometers.

→ Volume spirometer
→ Flow spirometer.

Volume spirometer → Record the amount of air

exhaled or inhaled within a certain time (Volume).

Flow spirometer:-

That measures how fast the air flows in or out as the volume of air inhaled or exhaled increases (Flow).

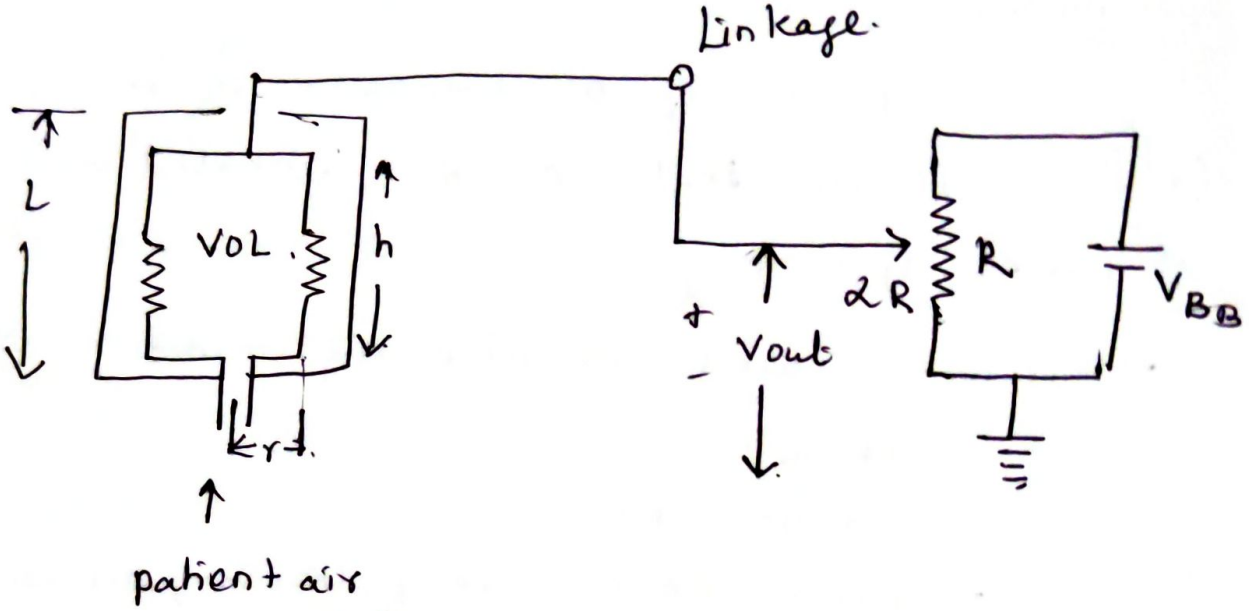


fig: Spirometer

The volume change information in the chamber or water tank in proportion to the lung capacity can be converted to corresponding electrical signal by the usage of appropriate transducer like bellows element (or) piston operated devices.

$$\alpha = \frac{V_{out}}{V_{BB}} = \frac{V_{OL}}{V_{OLmax}}$$

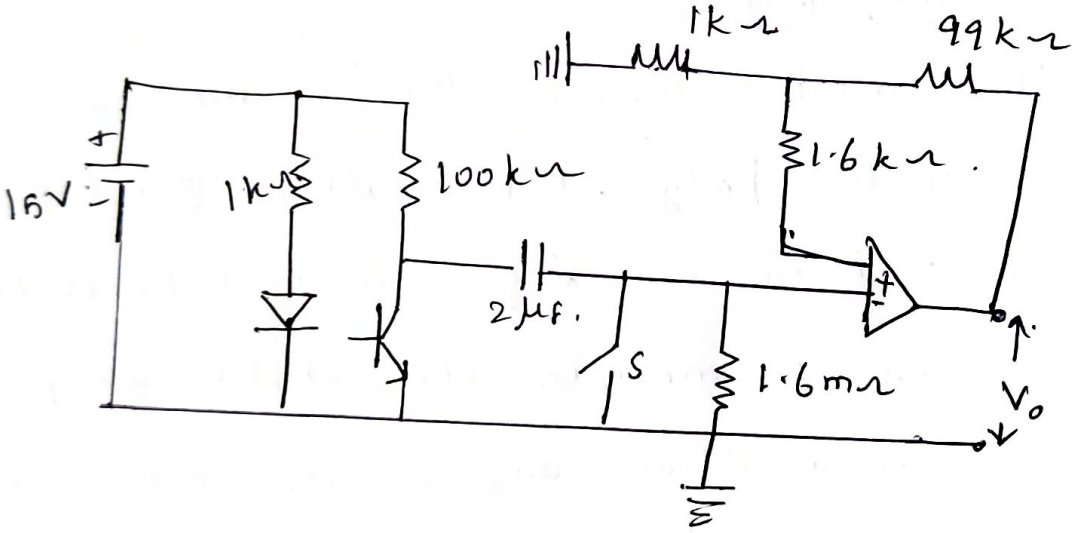
$$V_{OL} = \frac{V_{out}}{V_{BB}}.$$

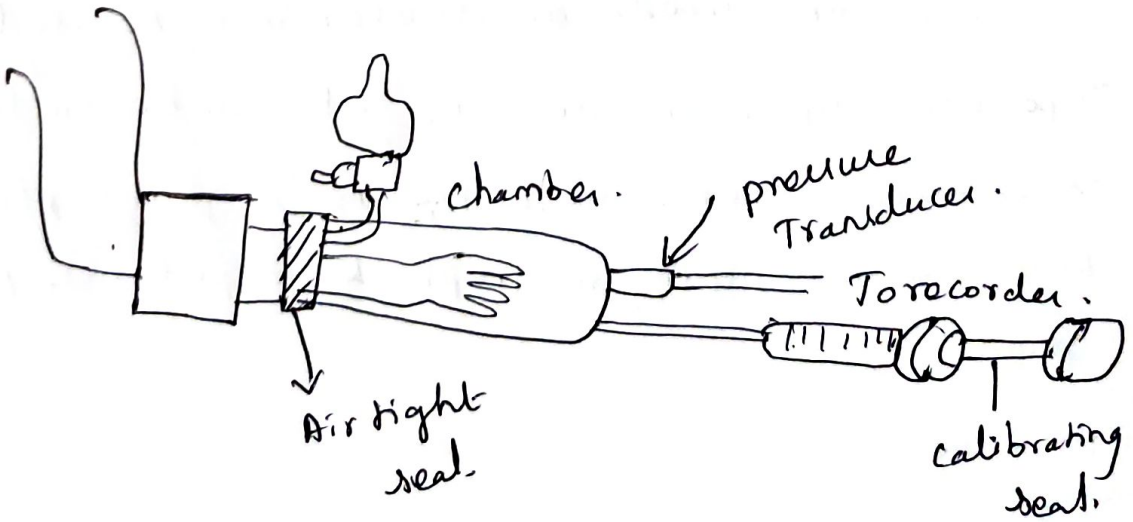
Photo plethysmography :-

It is the determination of blood flow in a part of the body by measurement of volume changes in the part.

→ It is also called pseudoplethysmography is constructed using photo detector & light source.

→ the light source is a (LED) light emitting diode and photo detector is a photoresistor type which is excited by a constant current source (CCS).





→ Blood flow through the thumb during each cons... contraction of the atrium blood volume also cha... aiding a change in optical density of blood.

→ The change in intensity is calibrated interms of blood flow.

→ The volume change at the photo resistor is amplified Sampled, filtered & displayed in terms of blood flow.

Body plethysmography :-

It is used to measure the volume changes in any part of the body. that results from the pulsation of blood occuring with each heart beat.

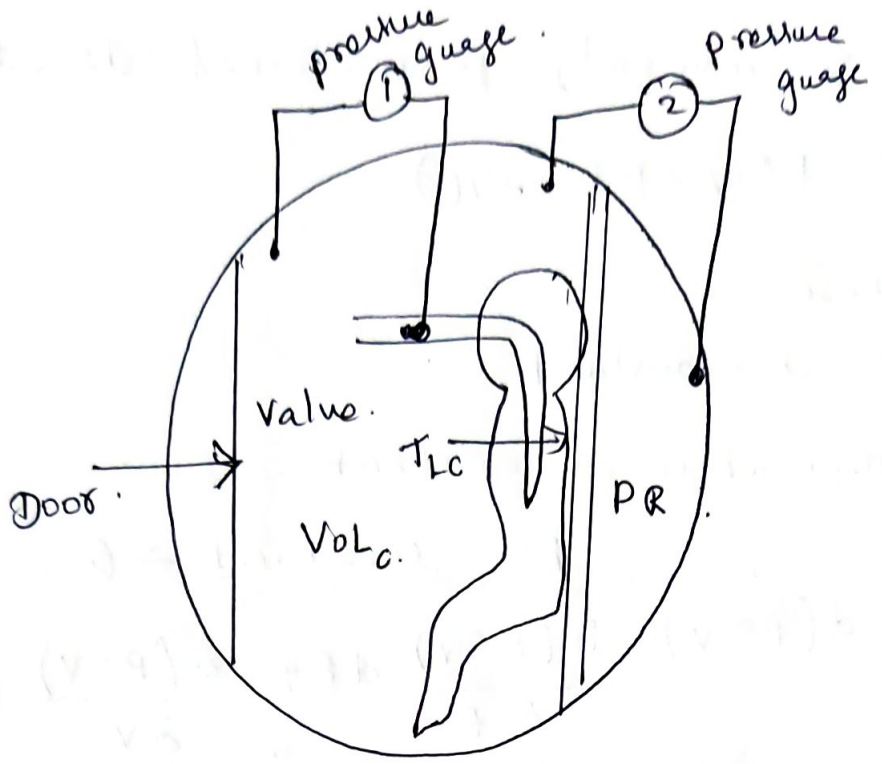
→ It is used to measure the total lung capacity.

→ Sensor such as strain gauge, photo electric sensors, capacitive or impedance sensor can be used. Depending upon the sensor, it can be called as capacitance plethysmograph, strain gauge plethysmograph photo electric plethysmograph & impedance plethysmo graph.

principle :-

It is depend on Boyle's Law

At a given temperature, the pressure of a given.



Procedure:-

→ mouth piece value is closed when the patient is sitting inside the sealed chamber. the patient is asked to make breathing motions.

→ change in pressure reading in the pressure gauge (1) which reads out dP_T is noted down.

Similarly change in pressure reading in the pressure gauge (2) which reads out dP_C is also noted.

$$TLC = V_C \cdot \left[\frac{dP_C}{dP_T}\right]$$

mass of gas is inversely proportional to its

$$P * V = KT \rightarrow (1)$$

Where,

K - constant.

When temperature is constant

$$PV = \text{constant} \rightarrow (2)$$

$$d(P*V) = \frac{\partial (P*V)}{\partial P} dP + \frac{\partial (P*V)}{\partial V} dV = 0 \rightarrow (3)$$

$$V\,dP + P\,dV = 0 \rightarrow (4)$$

$$\frac{dP}{dV} = -\frac{P}{V} \rightarrow (5)$$

In the body,

$$\frac{d\,TLC}{d\,P_T} = -\frac{TLC}{P_T} \rightarrow (6)$$

Where,

TLC - thorax volume

P_T - thorax pressure

In the chamber,

$$\frac{dV_c}{dP_c} = -\frac{V_c}{P_c}$$

$$\therefore TLC = -V_c \frac{dP_c}{dP_T}$$

Blood gas Analyzer :-

It is used to measure the pH, partial pressure of carbon dioxide (PCO_2), and partial pressure of oxygen (PO_2) of the body fluid with special reference to the human blood.

Types of blood gas measurement.

(i) Acid-Base balance
(ii) Blood pH measurement
(iii) Blood PCO_2 "
(iv) Blood PO_2 "

pH of Blood :-

It helps to identifying chemical balance of the body.

Extracellular fluid → 7.35 - 7.45

pH exceeds 7.45 → body is considered to be in the state of alkalosis.

below 7.35 → acidosis.

Three physiological Mechanism.

→ buffering of chemical.
→ Respiration
→ Excretion into the urine by kidney.

pH → measures of hydrogen ion concentration in a solution.

$$pH = -\log(H^+).$$

Nernst equation is given by

$$E = E_0 + 2.3026\ RT/F \log C_u$$

Where,

E - Electrode potential

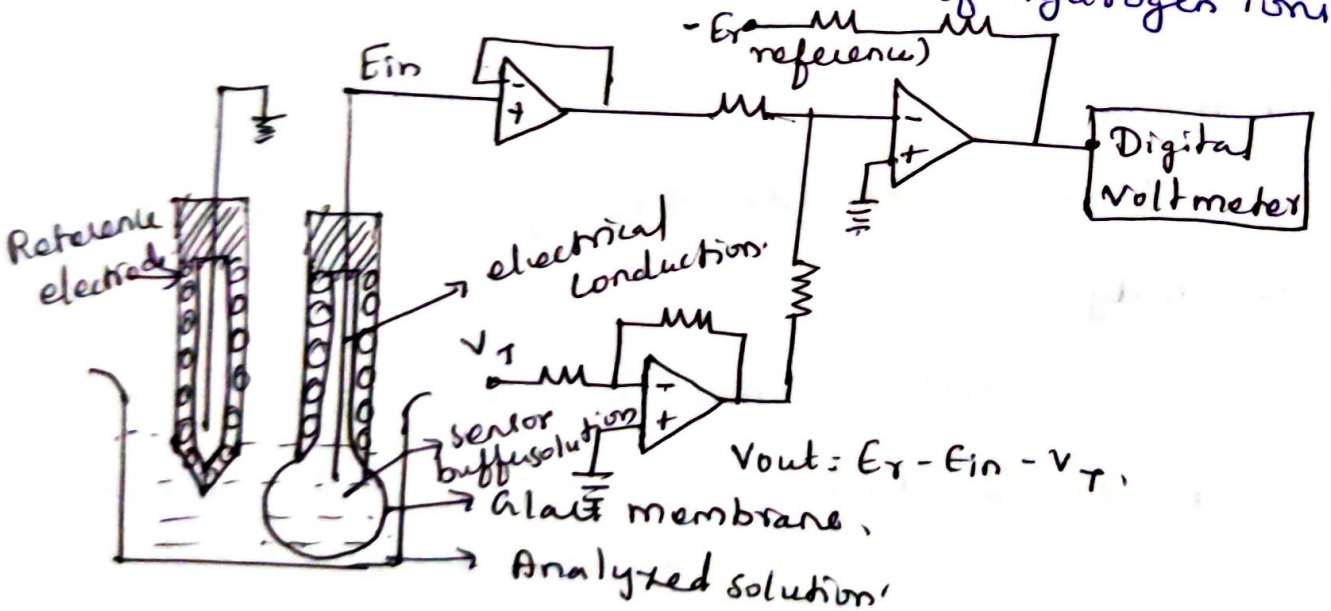
E_0 - Standard potential.

R - Gas constant.

T - Temperature.

F - Faraday constant.

C_u - concentration of hydrogen ions.



The pH measuring Silver / Silver chloride & reference calomel electrode is connected to a small pool of kcl through a porous pin.

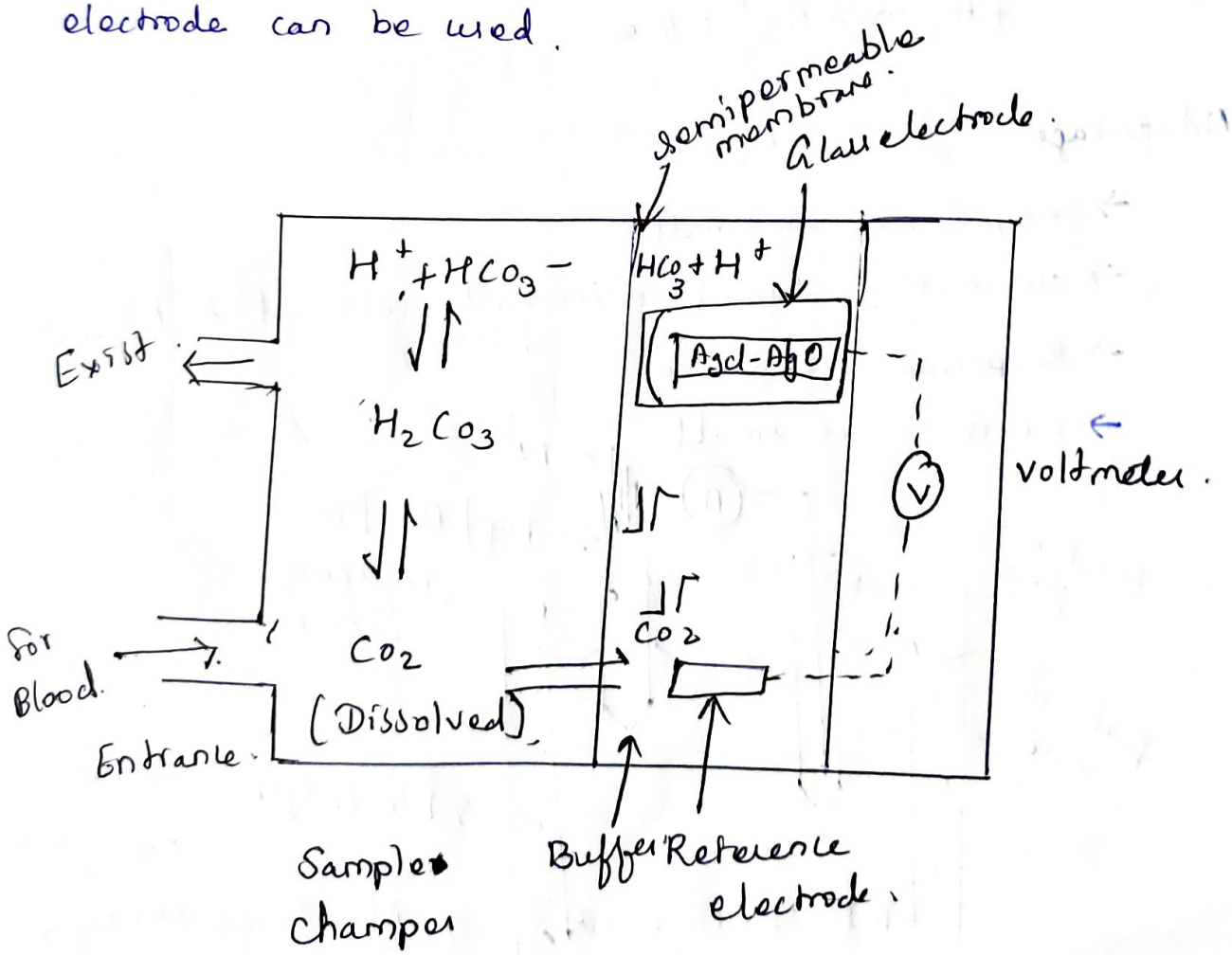
$T = 38°C$.

Measurement of Blood PCO_2

The blood PCO_2 is the partial pressure of carbon of blood anaerobically.

PCO_2 = Barometric pressure - Water Vapour Pressure * ($\%CO_2$/100).

The PCO_2 electrode consist of a standard glass electrode used as pH measurement electrode. The electrode is enclosed by a permeable rubber membrane. A thin film of water surrounds the glass electrode in between the rubber membrane, Instead of silver / silver chloride electrode a calomel electrode can be used.



Measurement of blood pO_2.

The partial pressure of O_2 in the blood or plasma indicates the extent of O_2 exchange between the lungs & blood & normally, the ability of the blood to adequately perfuse the body tissues with O_2.

Electrode → clark O_2 electrode.

→ It consist of platinum cathode

→ silver / silver chloride anode.

Reaction occurs at the anode & cathode

Cathode $O_2 + 2H_2O + 4e^- \rightarrow 4OH$.

Anode $4Ag \rightarrow 4Ag^+ + 4e^-$

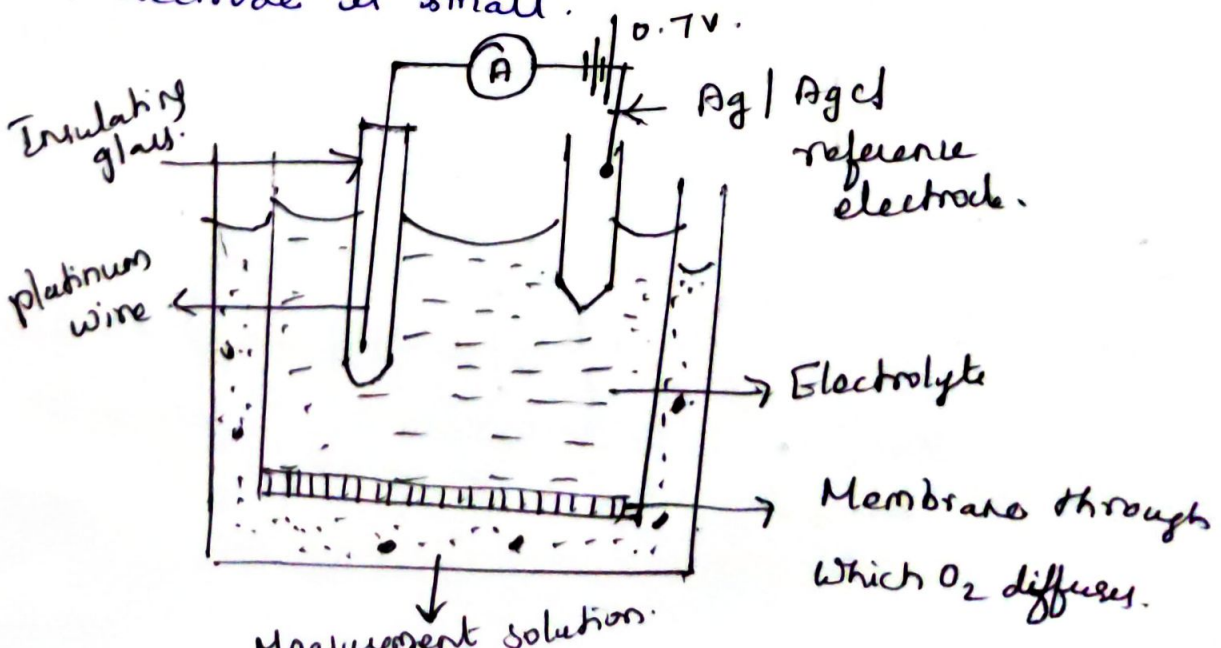
Advantage:

→ Sample size is small.

→ current produced is linearly related to pO_2.

→ Response time is low.

→ electrode is small.



ngertip Oximeter.

Oximetry is a technique that helps in measuring the amount of O_2 in a patients (or) subject blood.

$$\text{Oxygen saturation} = \frac{[HbO_2]}{[HbO_2] + [Hb]}$$

Where,

$[HbO_2]$ → concentration of Oxygenated hemoglobin.

$[Hb]$ - concentration of De oxygenated hemoglobin

Types of oximetry:-

There are two types of oximetry namely

(1) In vivo oximetry.

(2) In vitro oximetry.

In vitro oximetry:-

In this technique O_2 saturation in blood is measured by taking blood out of the body & the measurement process is done at a later time in the lab under anaerobic condition.

In vitro oximetry:-

In this technique O_2 saturation in blood is measured while the blood is still flowing in the circulatory system.

There are two types of measurement principles namely

a) Transmission method

b) Reflection method.

According to Beer-Lambert Law, When a beam of light radiation is passed through a medium, the rate of decrease of intensity of radiation with the thickness of the medium is proportional to the intensity of the incident radiation.

$$I = I_0^{-kcb}$$

where,

I_0 → Intensity of original incident light

k → Absorption coefficient.

c → concentration.

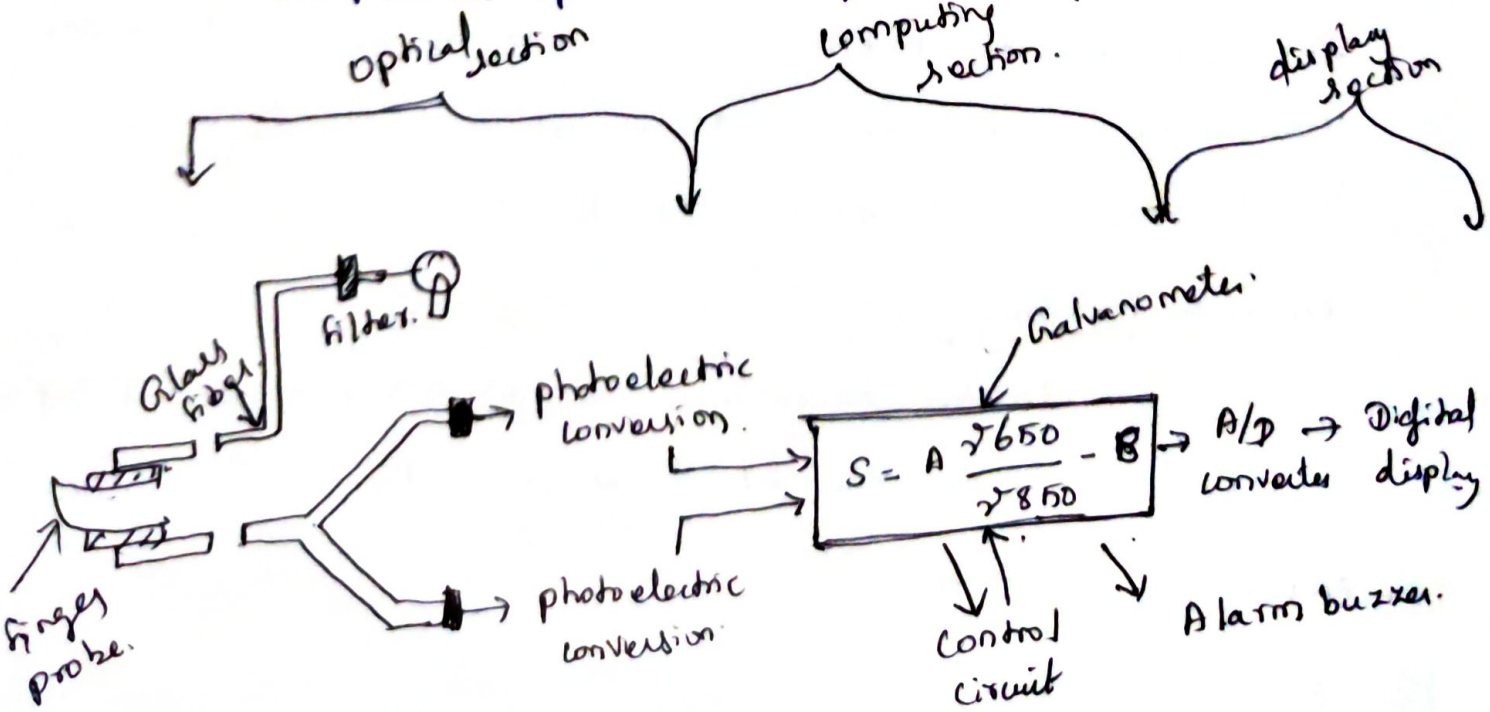
b → thickness of the medium.

Advantage:

→ No need of rubbing of skin

→ Subject variability.

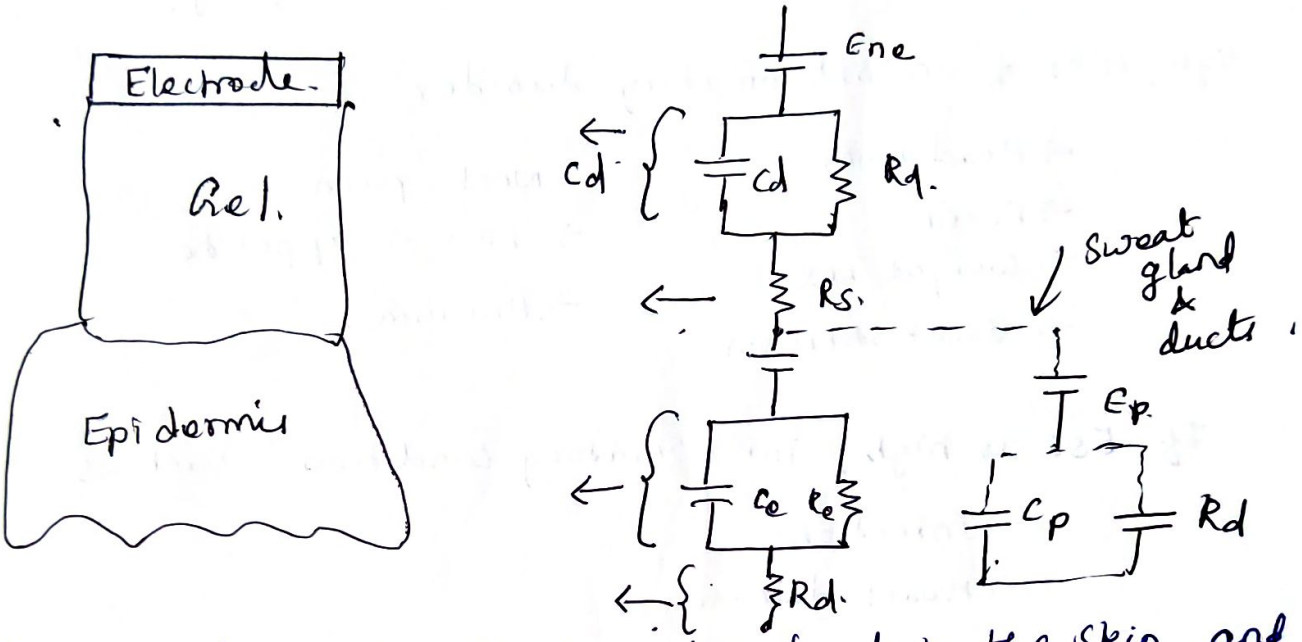
→ Simplified operational procedure.



Name of

GSR measurement.

Galvanic Skin Response (GSR) also known as electro dermal response (EDR), Psychogalvanic reflexes (PGR) or skin conductance response (SCR) and it is a method of measuring the electrical resistance of the skin.



GSR is conducted by attaching two leads to the skin, and acquiring a base measure. There are two ways to perform a GSR.

(i) In active GSR :-

Current is passed through the body with the resistance measured.

(ii) In passive GSR :-

Current generated by the body itself is measured.

→ GSR measurement is one component of polygraph devices.

→ Silver | Silver chloride electrodes are used to measure GSR.

ESR measurement.

An erythrocyte sedimentation rate (ESR) is a type of blood test.

Inflammation is part of your immune response system. It can be reaction to an infection or injury.

Symptoms of an inflammatory disorder.

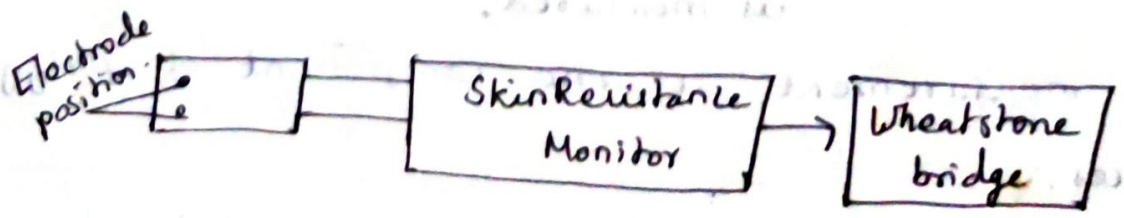
- → Head aches
- → Fever
- → Weight Loss
- → Joint stiffness.
- → Neck pain
- → Loss of appetite
- → Anemia.

If ESR is high, inflammatory condition such as.

- → Infection.
- → Heart disease.
- → kidney disease.
- → Vascular disease.

Sometimes ESR can be slower than normal, A slow ESR indicates a blood disorder such as.

- → polycythemia.
- → Sickle cell anemia.
- → Leukocytosis, an abnormal increase in white blood cell.



UNIT - III

Electrical Parameters Acquisition and Analysis.

- → Electrode
- → Limb electrode
- → Floating electrode
- → pregelled disposable electrode.
- → micro electrode
- → needle electrode
- → surface electrode.
- → Amplifier.
- → pre amplifier
- → differential amplifier
- → chopper amplifier
- → Isolation Amplifier.
- → ECG
- → EEG
- → EMG
- → ERG.
- → Lead System & recording method.
- → Typical waveform
- → Electrical safety in medical environment
- → Shock Hazards.
- → Leakage current
- → Instruments for checking Safety parameter of biomedical equipment.

Electrode:

→ Electrode help in picking up electrical signals.

Types of electrodes:

(i) Micro electrodes: These electrodes are used to measure biopotential within a single cell.

a) Metal micro electrode
b) micropipet.

(ii) Depth & Needle: These electrodes are used to measure biopotential at highly localized extra cellular region.

a) Depth
b) Needle.

(iii) Surface electrode:- These electrode are used in measuring potentials available from the surface of the skin:

a) Metal plate
b) Suction cup
c) Adhesive tape.
d) multipoint
e) Floating

Limb electrode:

- It is used for recording ECG.
- It is made up of german silver, nickel silver (or) nickel plated steel.

→ Rectangular (or) circular surface electrode.

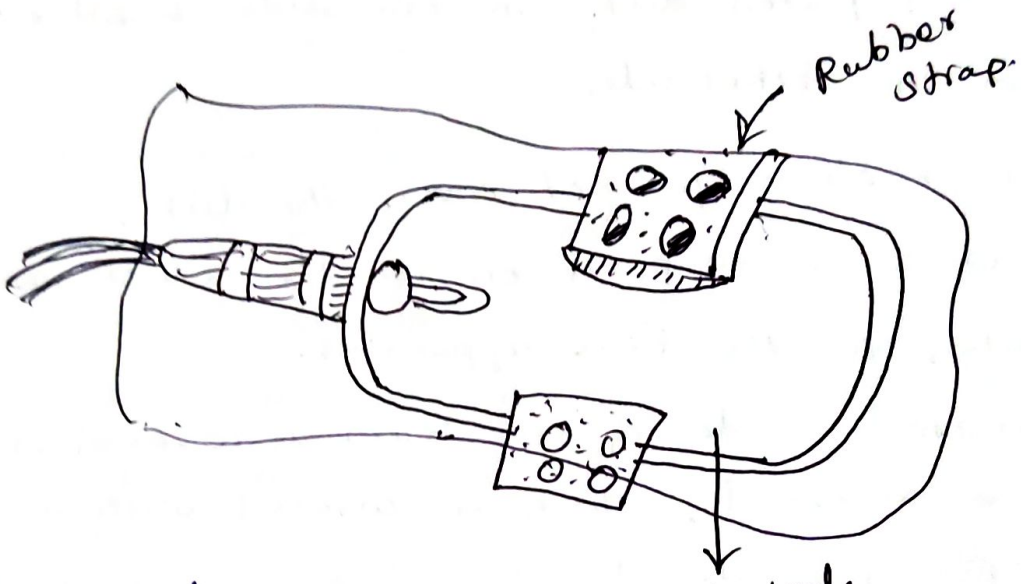
R = 2 - 5 kΩ

F = 10Hz.

→ the electrodes are held in position by elastic straps.

→ they are reusable

→ It is preferred during surgery.



Floating electrode:

the metal electrode is not in contact with the body, hence motion artifact is avoided.

→ It is also known as top-hat electrode.

→ electrode element is surrounded by electrolyte gel inside the cavity.

→ electrode disk is made up of silver metal & coated with silver chloride.

Pregelled Disposable electrode. (Adhesive tape ele

→ When surface electrode are used., the pres applied on it across the body squeezes the gel a electrode paste out.

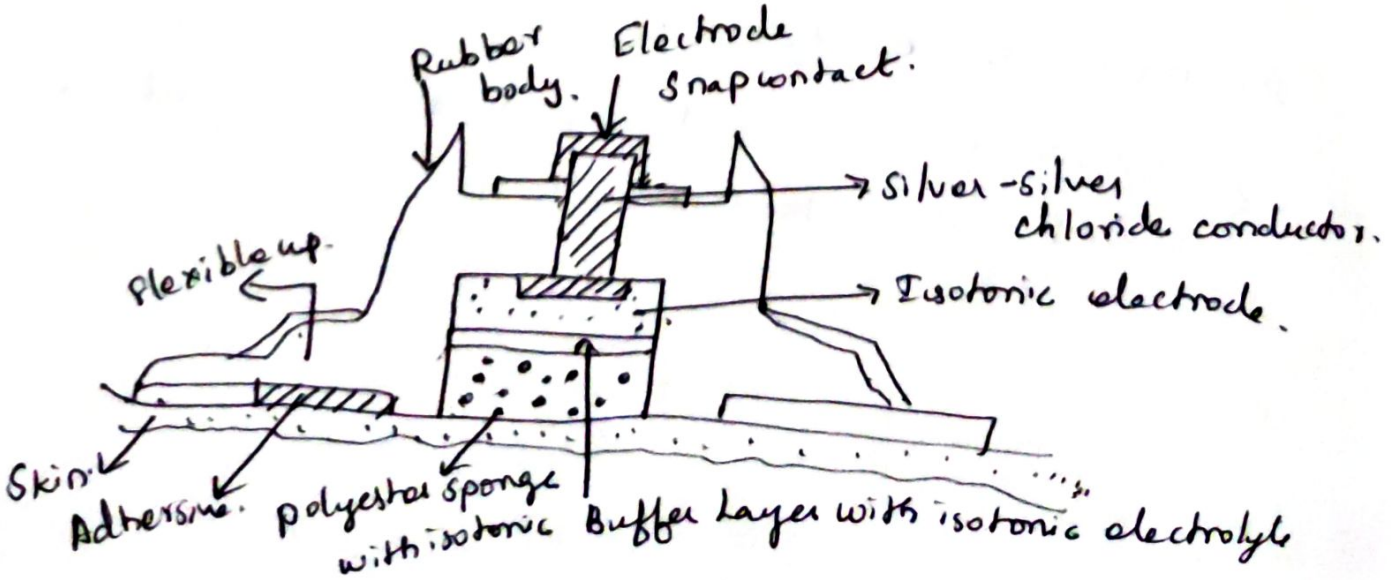
→ It consist of Large disk of plastic foam mater with silver plated disk on one side & silver p Snap on the other sides

→ Layer of electrolyte gel covers the disk.

→ Lead wire is snapped on to the electrode & connected to the ECG apparatus.

→ the electrode side of the foam is covered with an adhesive material, which is covered with a protective foil material.

→ To apply this electrode, the skin is cleaned, the protective material is removed & pressed again the patient.



Micro electrode:-

It is used to measure potential near or within the single cell.

diameter = 0.5 - 5 μm.

There are two type of micro electrodes.

→ Metal micro electrode

→ Non metal micro electrode (or) micro pipet.

Metal micro electrode:

→ These electrodes are made of fine tungsten or Stainless steelwire.

→ etched metal wire is then supported by a large metallic shaft.

The bio electric potential measured the difference in instantaneous potential of the measuring micro electrode & reference electrode.

bioelectric potential $E = E_A + E_B + E_C$.

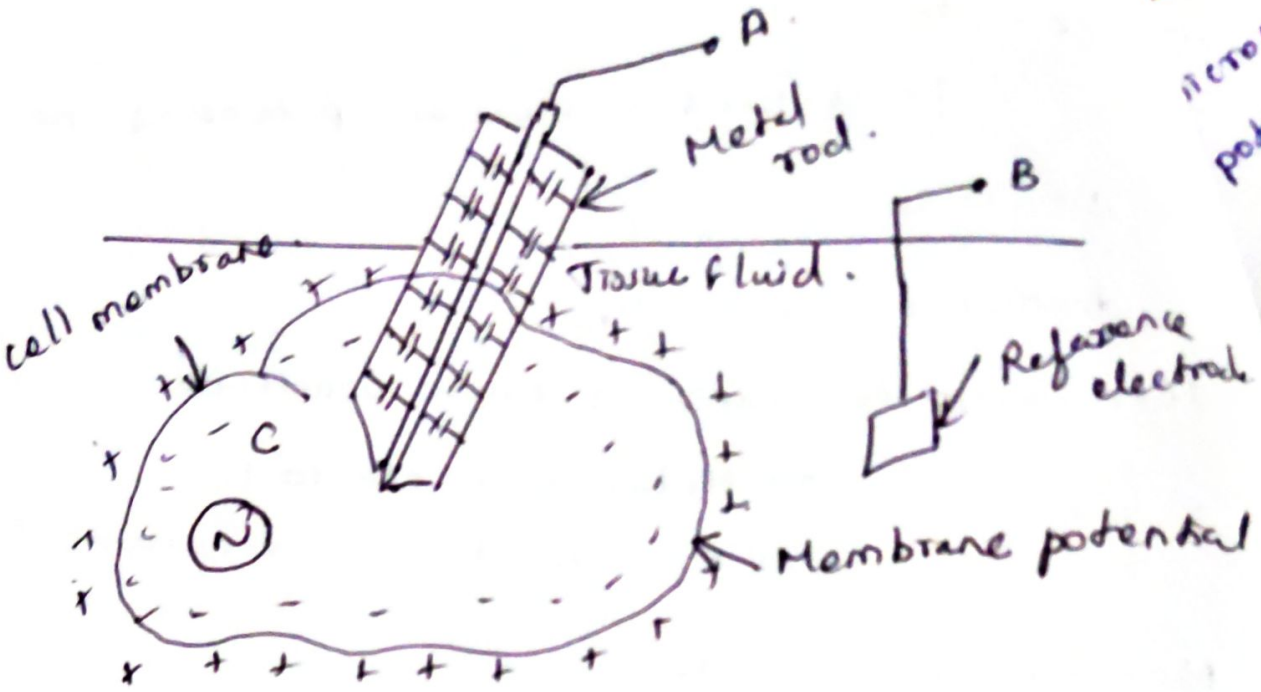
Where,

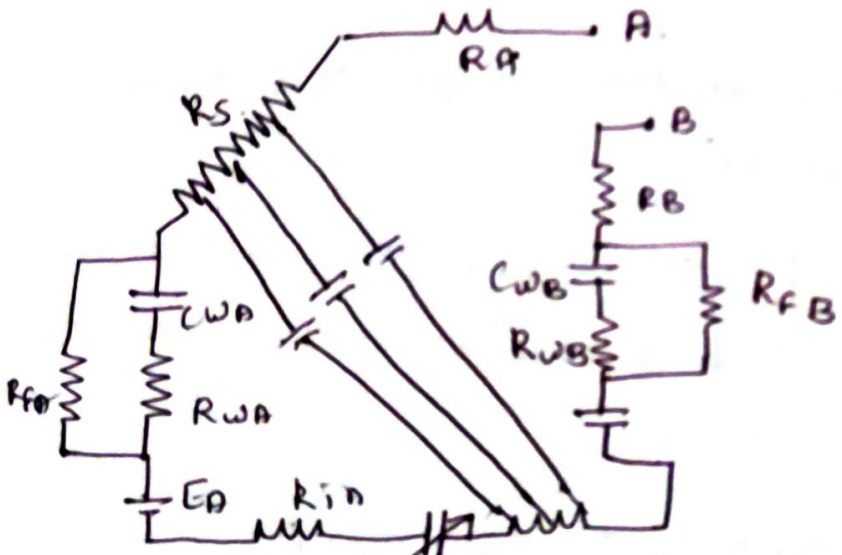
E → bio potential.

E_A → metal electrode - electrolyte potential at the micro electrode tip.

E_B → Reference electrode.

E_C → variable cell membrane potential.





Micropipet :- (Non metal micro electrode)

→ It consist of a glass micropipet whose tip's diameter is about 1 μm.

→ A thin, flexible metal wire made of silver, Stainless steel (or) tungsten is inserted into the stem of the micropipet.

→ one end of the metal wire is mounted to a rigid support and other free and through the stem of

micropipet is resting on the cell to pick up bio electric potential.

Bioelectric potential $E = E_A + E_B + E_C + E_D$.

Where,

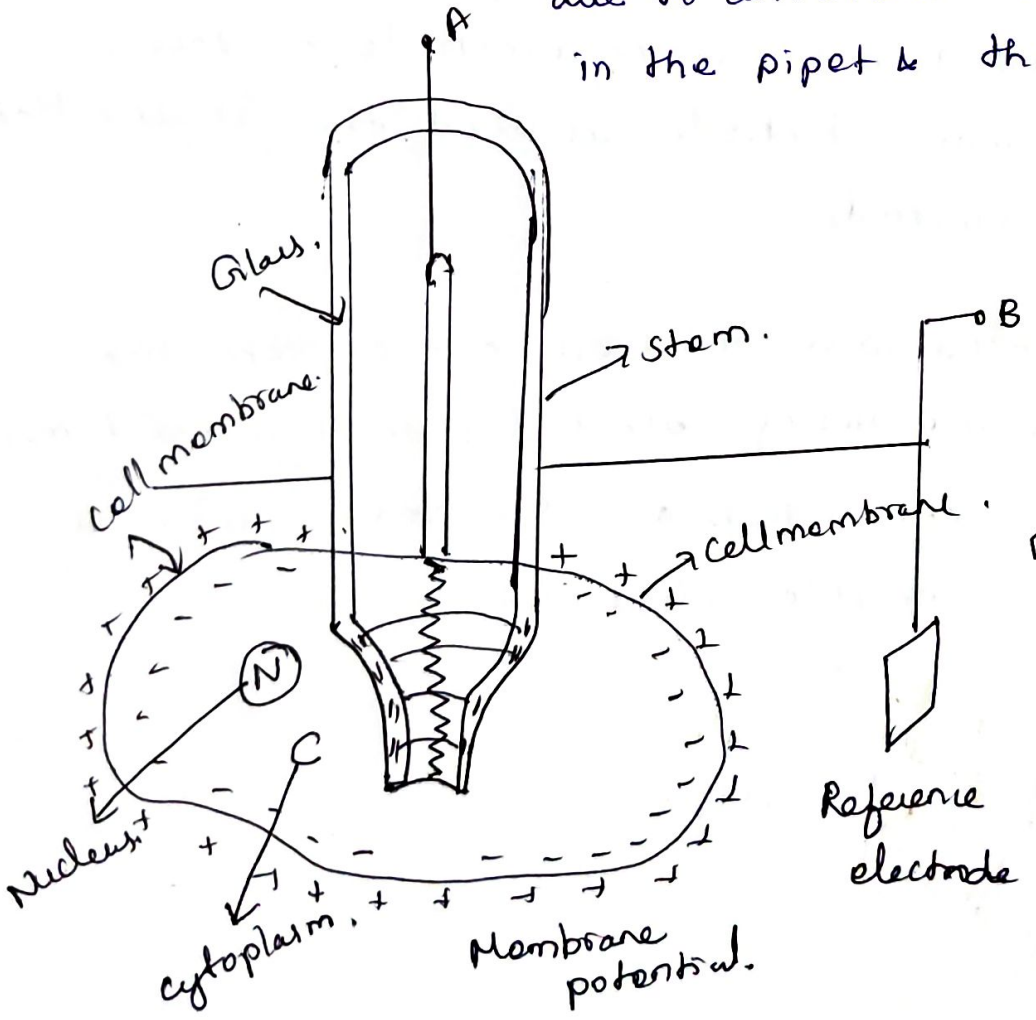
$E \rightarrow$ Bioelectric potential.

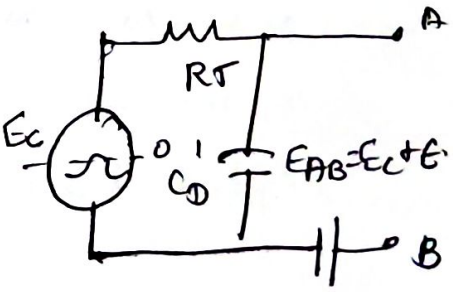
$E_A \rightarrow$ potential between the metal wire & electrolyte filled in the micropipet.

$E_B \rightarrow$ potential between the reference electrode & the extra cellular fluid.

$E_C \rightarrow$ Variable cell membrane potential.

$E_D \rightarrow$ potential existing at the tip due to different electrolyte present in the pipet & the cell.





Needle electrode:-

The needle electrode is used to measure action potential of peripheral Nerves.

→ It is used to make a Lumen through which a short Length metal wire is inserted.

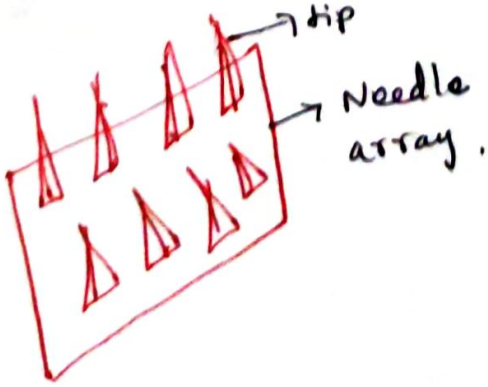
→ This short Length metal wire is bent at one end and inserted through the Lumen into the muscle

→ This wire picks up the electrical activity of the biological System.

→ Monopolar electrode
→ Bipolar electrode.

→ one wire is used as a measuring electrode & other separate reference electrode is used. then it is called as monopolar electrode

→ If two insulated wire are used, one as reference and other as measuring electrodes through the Lumen of the needle then such an electrode System is called bipolar needle electrode.



urface electrode :-

→ Simplest of all surface electrodes.

→ It consist of a metallic conductor in contact with the skin.

→ Types of surface electrodes

1) Metal plate electrode (Limb electrode)

(2) Adhesive tape electrode (pregelled Disposable electrode)

(3) Floating electrode

(4) Suction cup electrode

(5) Multipoint electrode.

Suction cup electrode :

→ It consist of hollow metallic cylindrical electrode that makes contact with the skin at its base

→ Lead wire is attached to it.

→ Rubber bulb is squeezed & placed on the body the bulb releases & applies suction against the skin, thus holding the electrode to the body.

→ It is used in ECG Limb electrod.

Multipoint electrodes:

→ It contain 1000 fine active contact points

→ Active surface area is very small.
very low resistance.

→ This electrode can be used under any environmental condition

→ It is a very pratical electrode for ECG measurement.

Amplifier:

Amplifier is a device which amplifies or increase an input of current or voltage.

→ Most of bio electric signals are of very low amplitude thus requiring amplification.

Types of Amplifier

→ Differential Amplifier
→ operational "
→ Instrumentation "
→ chopper "
→ Isolation "

Need of Bio Amplifier:

→ voltage gain should be more than 100db
→ high input impedance
→ CMRR should be more than 80db

...ro Amplifier (or) Instrumentation Amplifier.

It consist of 3 operational amplifier.

The first two amplifiers are working at the non inverting mode but the inverting terminal are not grounded.

→ The feedback loops are connected with the inverting terminal.

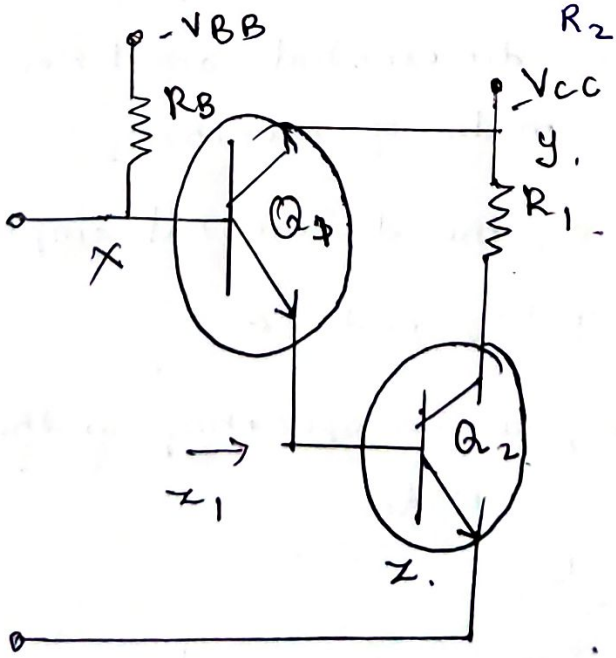
→ The third operational amplifier will act as a differential amplifier.

→ common mode voltage gain is unity.

$$V_0' = \left[1 + \frac{aR_1}{R_1}\right] V_1 - \frac{aR_1}{R_1} V_2$$

$$V_0'' = \left[1 + \frac{aR_1}{R_1}\right] V_2 - \frac{aR_1}{R_1} V_1$$

$$V_{out} = (V_0'' - V_0') \frac{bR_2}{R_2}.$$



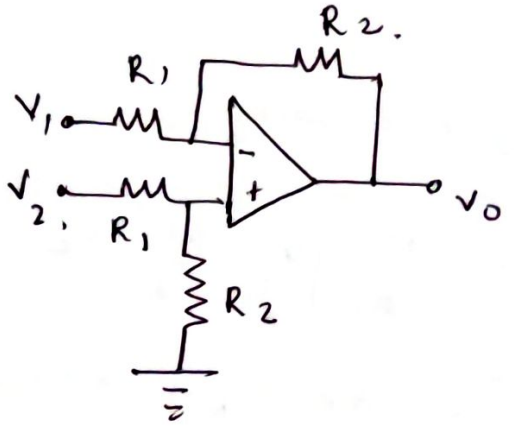
Differential Amplifier.

A differential amplifier produces an output voltage ie voltage is proportional to the difference between the voltage applied to the two input terminals. There are three different modes of operation.

→ Single ended mode

→ Differential mode

→ common mode.



(i) Single ended mode:

When either V_1 or V_2 is equal to zero, the operation of the differential amplifier is known as single ended mode of operation.

if $V_1 = 0$, the differential amplifier is operating in the non inverting mode &

if $V_2 = 0$, it is operating in the inverting mode.

(ii) Differential mode:-

Two inputs signals are equal but have opposite polarity at every instant of time

$$V_1 = -V_2 = V_0$$

$$\therefore V_0 = \frac{R_2}{R_1}(V_2 - V_1)$$

$$V_0 = \frac{R_2}{R_1} V_0$$

(iii) Common mode

The input voltage appearing at the input terminal 1 and 2 are identical both in amplitude & phase at every instant of time & circuit is said to be operating in the common mode.

$$V_1 = V_2 = V_{cm}$$

$$V_0 = 0$$

These input signals are called common mode signal.

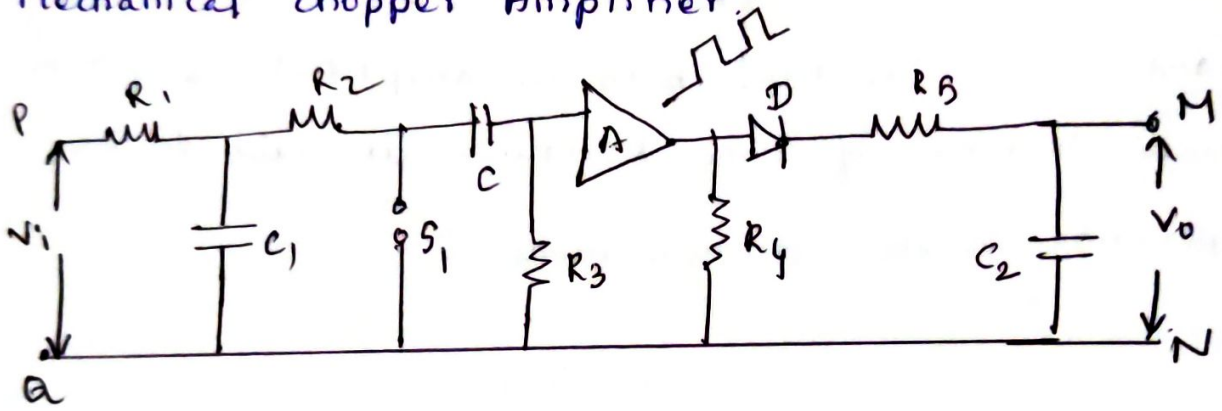
Chopper Amplifier:-

chopper amplifier solves the problems of drift in a amplifier. the name chop means to sample the data. the amplifier circuit samples the analog signal. so it is known as chopper Amplifier.

Types of chopper Amplifier.

→ Mechanical chopper Amplifier.
→ Non Mechanical chopper Amplifier.
→ Differential chopper Amplifier.

(i) Mechanical chopper Amplifier.



S_1 → electromagnetically operated switch or relay

A → Ac amplifier.

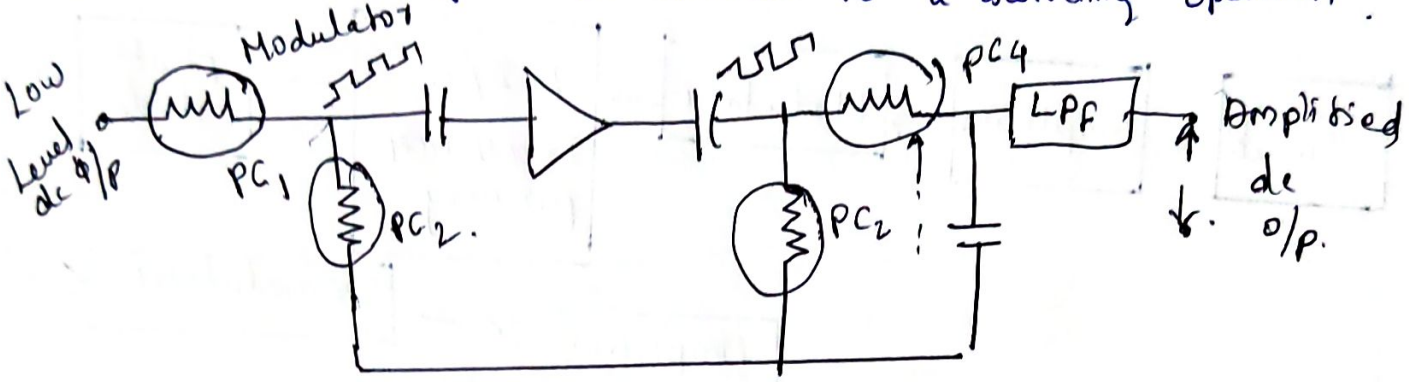
Q → reference term.

→ When chopper S_1 is closed, Amplifier input terminal connects to Q, the entire circuit is short circuited so input voltage is zero.

→ When chopper S_1 is open, Ac amplifier starts receiving the signal from P terminal. The amplifier input varies between zero & input voltage.

Non Mechanical chopper Amplifier.

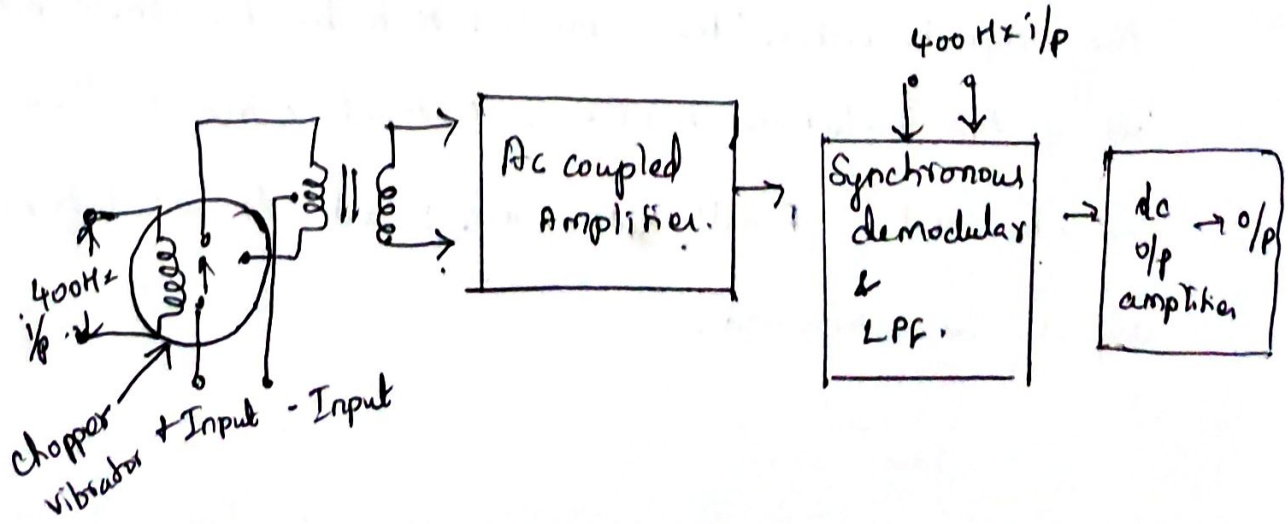
It uses photodiodes (or) photo conductor for modulation and demodulation. When light is no incident on the photodiode current flows through the circuit. ∴ When light falls on the photo sensor, the resistance become low, So the current flows through the sensor. This system is similar to a switching operation.



(iii) Differential chopper Amplifier.

→ It is used in EEG.

→ It has a transformer. A chopper vibrator connects the input of the transformer. Ac coupled amplifier provides the gain. The output from this amplifier goes to the filter & demodulator block. finally an amplified Dc output signal is obtained.

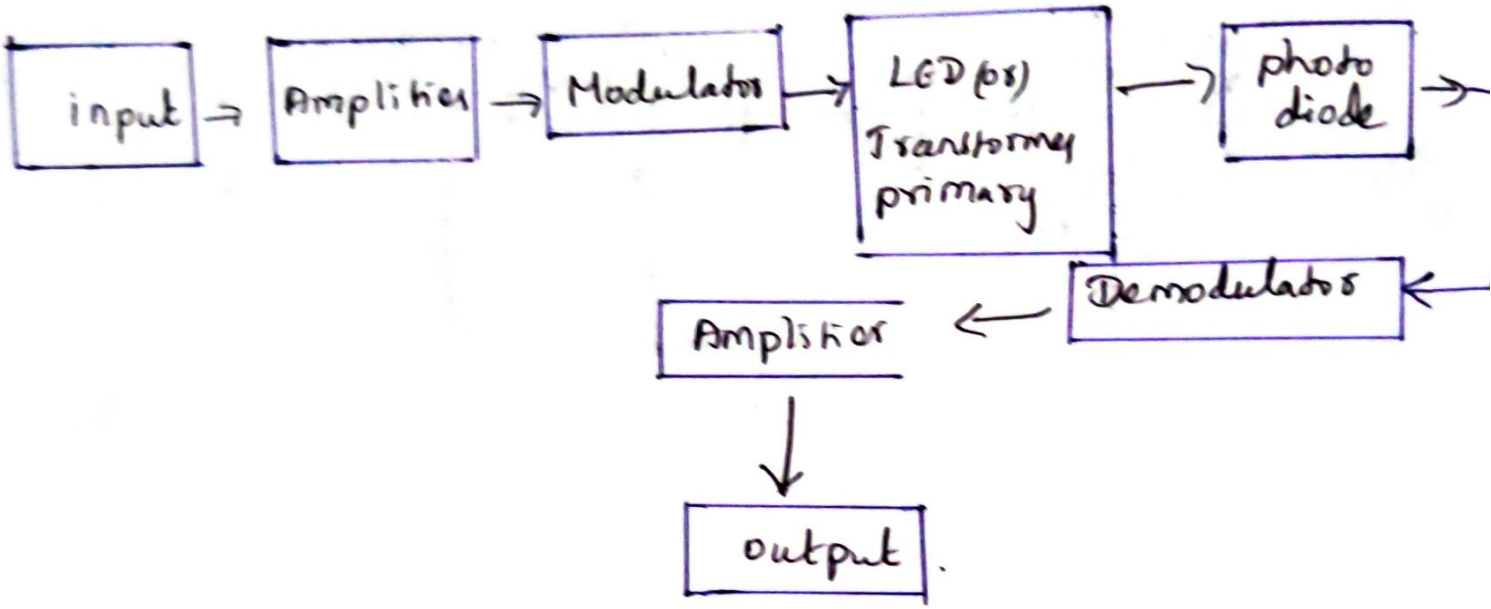


Isolation Amplifier:

→ It is used in ECG recording

→ It provide insulation between the patient connector & the ac power main line cord.

→ It is used to protect hospital patients.



A isolation amplifier increases the input impedance of the patient monitoring system. It also helps to Isolate the patient from the device. The electrical signals are obtained with electrode. After amplification the signals enters the modulation block. When either it go to isolation barrier, optical cable or Transformer can be used. Finally the amplified demodulator signal is obtained.

There are two types of isolation Amplifier.

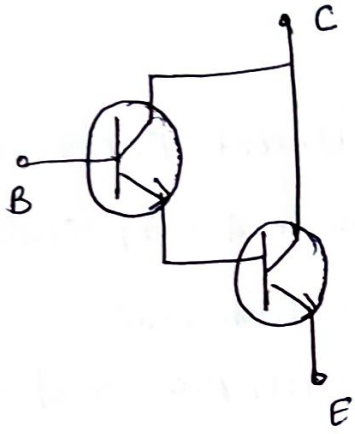
→ Darlington pair

→ Boost Trapping circuit.

(i) Darlington pair.

It is an isolation amplifier which provides high impedance with high current gain.

input impedance $Z_i = \beta^2 Z_o$.



(ii) Boost Trapping circuit.

It is also used as isolation amplifier.

The feedback developed is proportional to the values of R_1, R_2 in series & R_3 in series. The resistor R_4 is used to limit the current flowing through Q_2.

Voltage gain = 0.9. The current & power gain are high.

ECG System :-

The Electrocardiography (ECG) is an instrument, records the electrical activity of the heart.

ECG wave consist of

→ P wave

→ QRS complex

→ T wave.

ECG Lead System

there are four different ECG Lead System.

→ Bipolar Limb Lead (or) Standard Lead System

→ Augmented Limb Lead.

→ chest Lead (or) pre cordial System

→ Frank Lead System (or) corrected orthogonal Lead System.

Bipolar Limb Lead :-

In bipolar Limb Lead system ECG is recorded with two electrode at a time.

Right arm → White colour electrode.

Left arm → Black colour electrode

Right Leg → Green colour electrode

Left Leg → Red colour electrode.

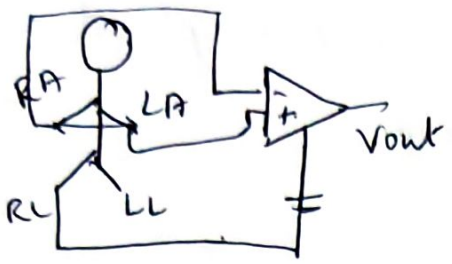
Right Leg electrode is used as reference electrode

there are 3 different Lead

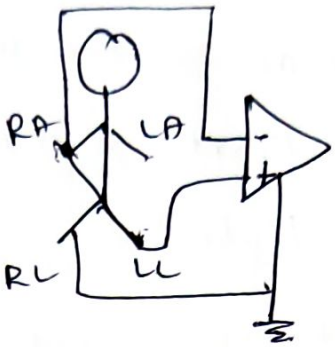
→ Lead I

→ Lead II

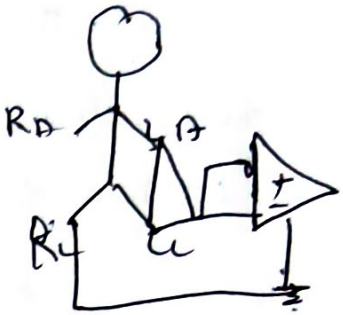
→ Lead III.



Lead I.



Lead II



Lead III

2) Augmented unipolar Limb leads

→ It is introduced by wilson.

→ A pair of limb electrodes is tied up with a large Resistor to make the central reference electrode & the third limb electrode is the measuring electrode.

aVR – augmented voltage RA

aVL – augmented voltage LA

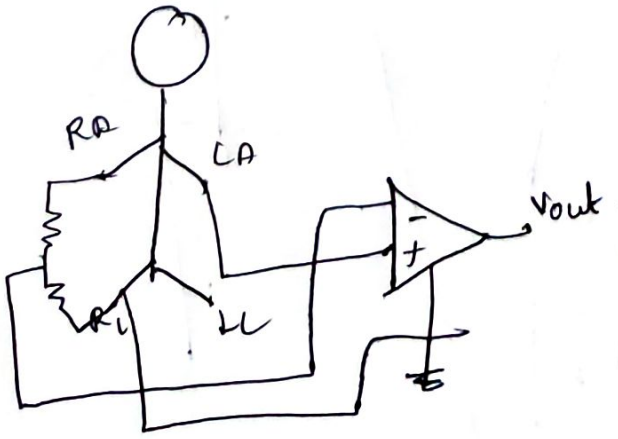
aVF – augmented voltage foot.

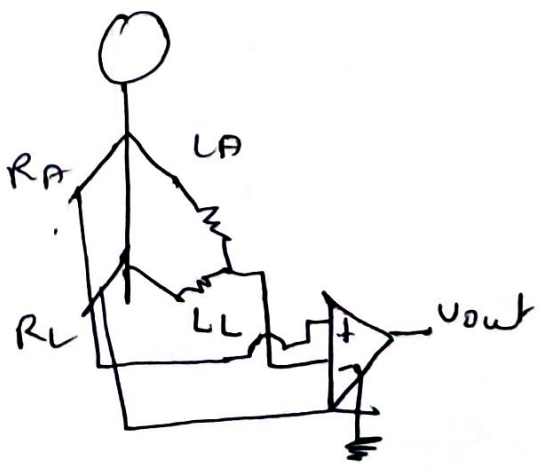
By kirchoff's Law.

$$aVR = -V_1 - V_3/2$$

$$aV_L = V_1 - V_3/2$$

$$aV_F = V_2 - V_2/2.$$





3) chest Lead

If there are two are more electrode placed in chest, close to the Heart. 6 chest Leads

Location of chest Leads

* V_1 - 4th intercoastal space at right sternal margin

V_2 - 4th intercoastal space at Left sternal margin

V_3 - midpoint of V_2 & V_4.

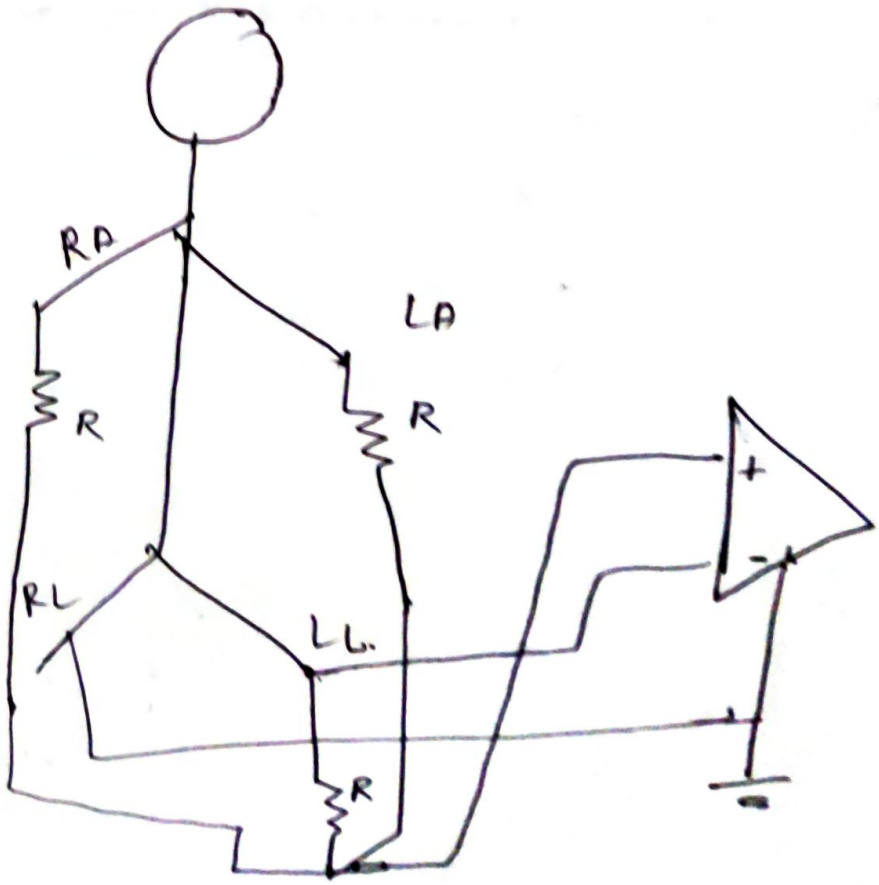
V_4 - 5th intercoastal space at mid-clavicular line

V_5 - Same Level as V_4 - anterior auxiliary line

V_6 → Same Level as mid auxillary line.

RA - Right arm
LA - Left arm
RL → Right Leg
LL → Left Left

R → Resistance.



ECG recording setup.

It consist of the following blocks

→ Defibrillator Protection circuit.

The one end of the electrode leads are connected along RA, LA, chest, LL of the patient. The other end of electrode passes through defibrillator protection circuit.

→ Lead selection Logic.

This block helps to select the type of electrode lead system.

→ Calibration circuit.

Calibration is a process that helps to eliminate error in the system.

→ pre Amplifier

An instrumentation amplifier & a differential amplifier with high gain & high CMRR is used as pre-Amplifier

→ power Amplifier.

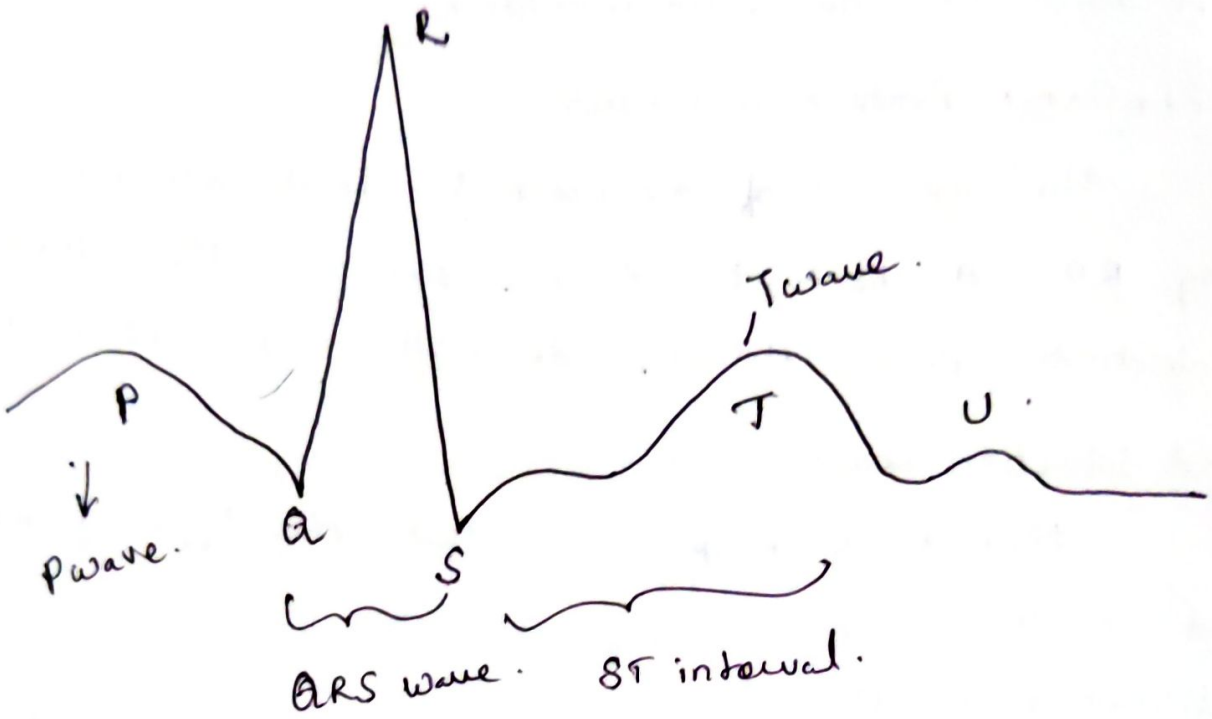
The output unit is driven with Power Amplifier.

→ Feedback Network:

Feedback network is used to provide damping to the pen motor.

→ output display unit:

Either a CRO or a pen chart recorder act as the output device.



P wave → due to depolarisation of atria.

Amplitude → 0.25 mV

time → 0.12 - 0.22 (s)

R wave → due to repolarization of atria & ventricle contraction.

(QRS wave) complex

→ 1.6 mV

→ 0.07 - 0.1 (s).

T wave → due to relaxation of myocardium.

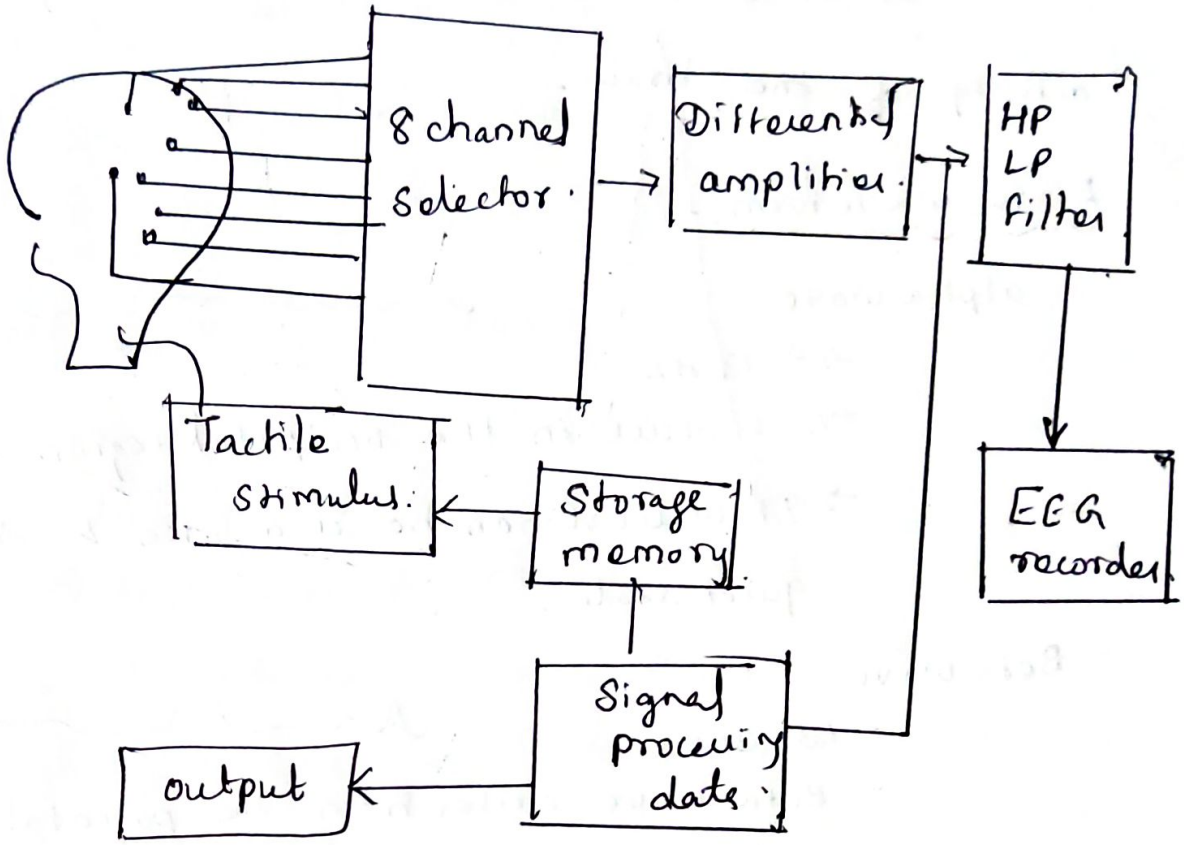
→ 0.1 - 0.5 (mV).

→ 0.05 - 0.15

ST interval → contraction of ventricles.

U wave → due to slow expansion of purkinje fibers.

EG recording setup :-



→ Here 21 electrode system is used. These electrode are connected to 8-channel selector. The output from 8-channel connector goes to the differential amplifier bank.

→ Differential amplifier is made of preamplifier. that are used to reduce noise.

→ The output obtained from differential amplifier is connected with signal processing unit.

→ After further processing, the display units display the data.

→ This systems helps to record the potential generated from the sensory part of the brain.

EEG → Electroencephalograph.

It is an instrument for recording the electrical activity of the brain.

EEG waveform:-

alpha wave 

→ 8-13 Hz.

→ It occur in the occipital region of a person.

→ It occur when he is awake & stay in quiet state.

Beta wave:- 

- 13-30Hz.

- Beta wave arises from the parietal & frontal region of cerebrum.

→ Mental activity of a person like tension, results in excited beta wave.

theta wave:- 

→ 4-8 Hz.

→ arises from the parietal & temporal region of cerebrum.

Delta waves:- 

→ 0.5-4 Hz.

→ occurs during deep sleep in premature babies for every 2 to 3 seconds.

→ occurs in cortex of the brain.

Electromyography:

Electromyograph is an instrument used for recording the electrical activity of the muscles to determine whether the muscle is contracting or not.

Block diagram of EMG machine.

The amplitude of the EMG signal depend upon

→ type & placement of electrode

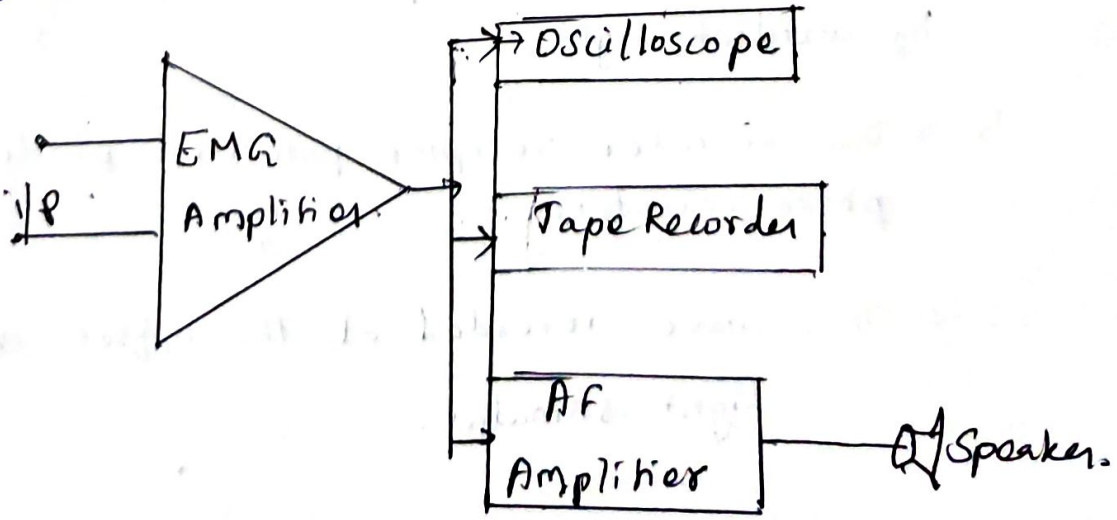
→ degree of muscular exertions.

→ The needle electrode in contact with a single muscle fibre will pick up spike type voltage whereas the surface electrode pick up many overlapping spikes.

EMG signal range - 0.1 - 0.5 mV.

f = 10 kHz.

High frequency signal can't be recorded in conventional pen recorder. Therefore, they are usually displayed on the CRT screen.



ERG: Electro retinography.

the process of recording & interpreting the ele... activity of eye is called electro retinography.

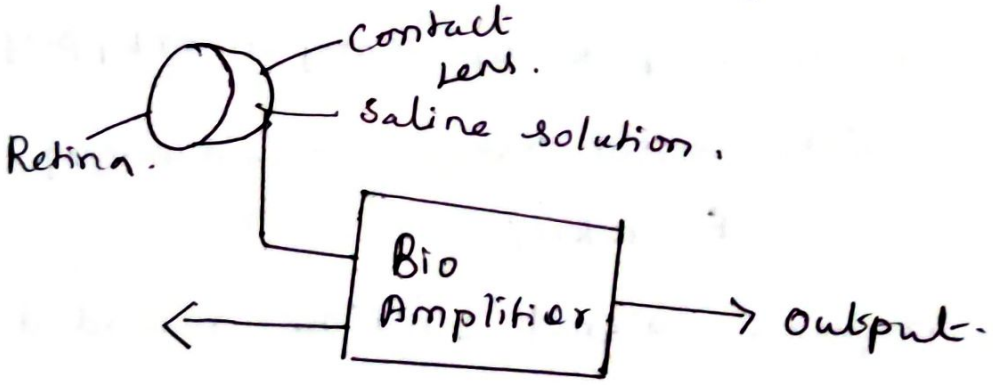
→ unipolar type of measurement is followed for ERG

ERG → 0-1mV.

→ measuring electrode is Ag / Ag cl electrode is placed in a saline filled contact lens, attached to the eye.

→ the reference electrode is placed in the cheek.

→ the potential is amplified & then recorded on a hea... sensitive paper by a heated stylus.



A → Response due to early receptor potential generate... by incident light.

B → Due to later receptor potential produced by photo receptors.

C to D → wave recorded at the offset of the light stimulus.

Electrical Safety in medical environment: Shock Hazards Leakage current - Instruments for checking Safety parameters of biomedical equipments.

Let go-current :-

It is defined as the maximal current at which the subject can withdraw voluntarily.

Let go current → 6 mA.

Many devices have a metal chassis and cabinet that can be touched by the medical attendants & patients. If they are not grounded, then an insulation failure or short circuits results & Leads to macroshock or microshock.

Microshock:

A physiological response to a current applied to the surface of the heart that result in unwanted stimulation Like muscle contraction or tissue injury is called microshock.

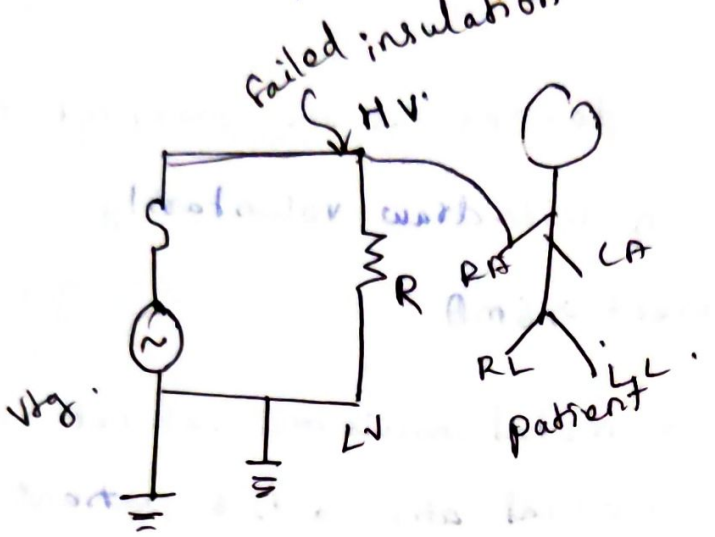
→ microshock is caused when current in excess of 10 mA.

Microshock Hazard:-

(i) Leakage current.

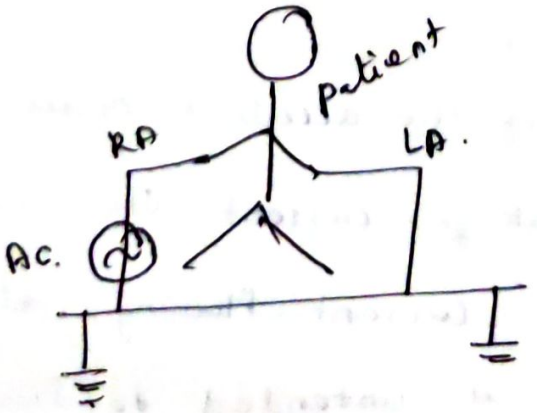
Most of the accidents occur due to improper grounding & Leakage current. The Leakage current is an extraneous current flowing along a path other than those which is intended to flow.

Leakage current may be caused due to Resistive, Inductive (or) capacitive couplings with the mains Some electronic equipment.



e) Static Electricity :-

Static electricity may be dangerous to people and sensitive equipment having integrated circuits. Sparks from static electricity could ignite flammable gases, causing an explosion, Shocks from static electricity could cause cardiac arrest if applied to a pacemaker catheter. Carpet used on the floor are a source of static electricity build up.



Interruption of Power.

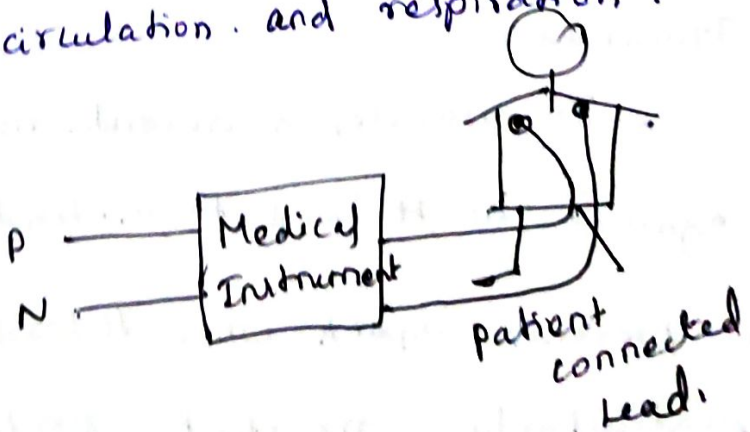
Interruption of electrical power to life support equipment can be hazardous. If a delay occurs before emergency power is brought into operation, the failure of a respirator, monitor, defibrillator pacemaker or other life support equipment can be fatal.

Macro shock:-

A physiological response to a current applied to the surface of the body that produces unwanted or unnecessary stimulation like muscle contraction or tissue injury is called macro shock.

Macroshock hazards:-

Macroshocks occur with two wire system. with two wire equipment it is always dangerous to get between the hot H & neutral N wires. If the patient touches H & N wire simultaneously with two limbs then the current are flowing directly through vital organs of circulation and respiration.



Devices to protect against electrical Hazards:-

Several devices are available to protect patients from Health care coworkers from Hazardous electrical current. some of the devices include.

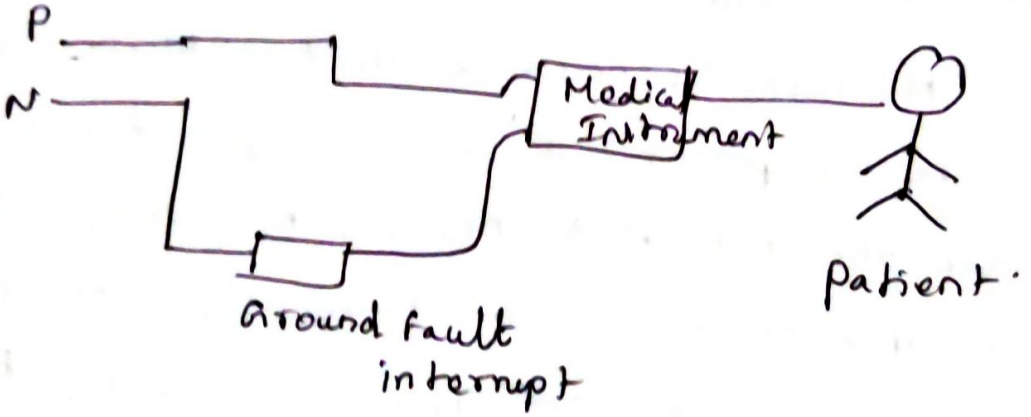
(1) Ground fault interrupter.

(2) Isolation Transformer

(3) Line isolation monitor

(1) Ground fault interrupter:-

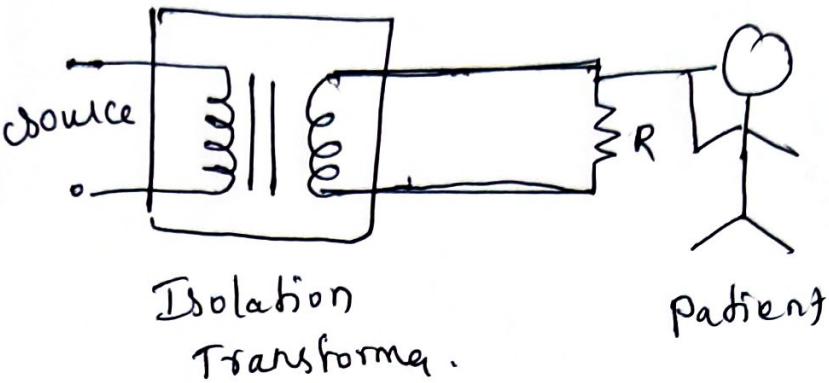
It protects against a shock that occurs if a person touches the hot lead with one hand & the ground with other.



(2) Isolation Transformer.

→ It provides a seconds means of protecting against an H. Lead to G-Lead macro shock.

→ It also prevents spark when H leads touches a ground particularly important protection



(3) Line isolation Monitor :-

It putrelatively Large impedance from either secondary Lead through an ammeter to ground of the isolation transformer. It currents draws 2 - 5 mA. The alaram indicates that the backup system failed. and the equipment is no Longer isolated.

UNIT - IV

Imaging Modalities & Analysis

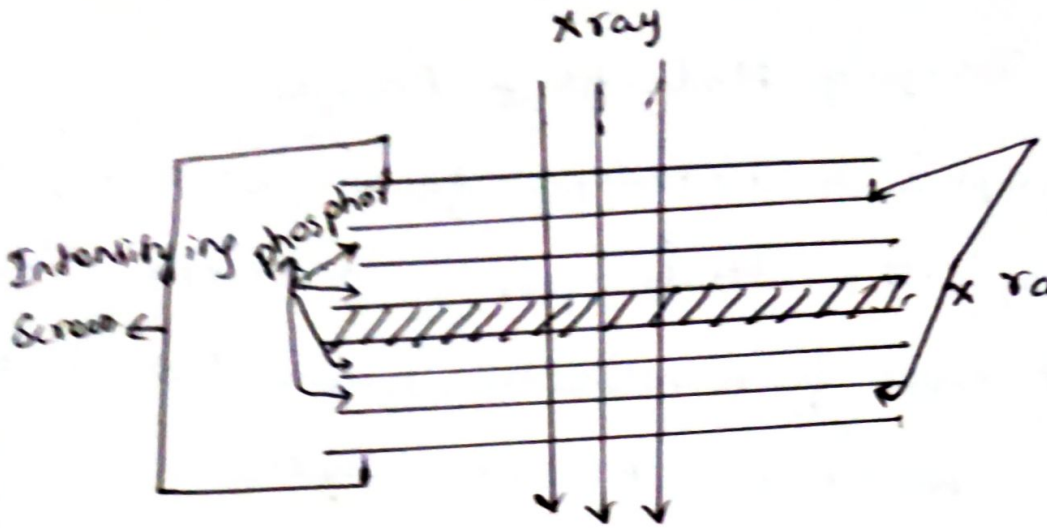
Radio graphic & fluroscopic techniques, computer tomography, MRI, ultrasonography, endoscopy, Thermography, Different types of Biotelemetry systems, Retinal imaging. Imaging Application in BioMetric systems.

4.1 Radiographic & Fluroscopic Techniques.

Radiography	Fluroscopy.
→ X ray images are developed by photosensitive film	→ X ray images are developed by photoelectric effect & Fluroscopic principle
→ High Resolution	→ Fair resolution
→ dose is Low	→ dose is high.
→ Efficiency is more	→ Efficiency is less compared to Radiography.

Radiography :-

To improve the density & resolution of the image, we are going for intensifier.



the various type above and below the X-ray film in the image intensifier. Intensifying Screen are used since the X-ray film is relatively insensitive to X ray.

High Z-Screen :-

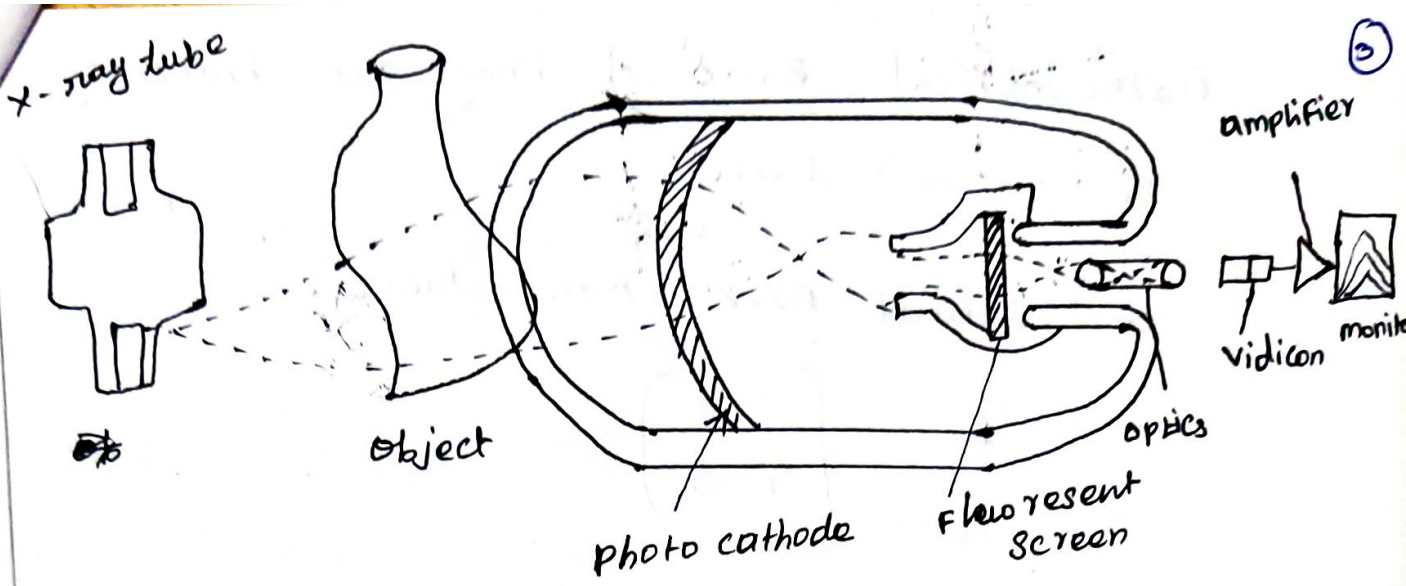
Capture more amount of X-ray.

phosphor → introduce secondary visible Light radiation by scattering process.

Silver bromide grain → absorbs secondary Radiati and preserve the X-ray image.

Fluoroscopy :-

Fluorescent screen → converts X ray photon into Light photons.



The emitted photo electrons are accelerated & focussed on a small output fluroscent screen.

the amplified image passes through the collimating optical system & then to the video camera combined with a television system.

→ Fluroscopy image can be recorded on the video disc for a detailed examination performed later & to reduce the patient dose.

Computer tomography :-

When an x-ray is passed to the body by using multidirectional scanning of the object, Multiple data are collected. computer perform the calculation.

Mathematical Basis of image construction.

Analysis involved are.

Step 1: Actual Attenuation values.

$$\begin{bmatrix} 2 & 0 \\ 1 & 3 \end{bmatrix}$$

Step 2: Adding row → 1st estimation

$$\begin{bmatrix} 2 & 2 \\ 4 & 4 \end{bmatrix} \rightarrow (1)$$

Step 3: 2nd estimation → Adding column

$$\begin{bmatrix} 3 & 3 \\ 3 & 3 \end{bmatrix} \rightarrow (2)$$

Adding 1 & (2).

$$\begin{bmatrix} 2 & 2 \\ 4 & 4 \end{bmatrix} + \begin{bmatrix} 3 & 3 \\ 3 & 3 \end{bmatrix} = \begin{bmatrix} 5 & 5 \\ 7 & 7 \end{bmatrix} \rightarrow (3)$$

Step 4: 3rd estimation

The values are measured along the North east diagonal

$$\begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix} \rightarrow (4)$$

④ + ③

$$\begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix} + \begin{bmatrix} 5 & 5 \\ 7 & 7 \end{bmatrix} = \begin{bmatrix} 7 & 6 \\ 8 & 10 \end{bmatrix}.$$

Step 5 : 4th estimation.

The values are measured along N-W diagonal.

$$\begin{bmatrix} 5 & 0 \\ 1 & 5 \end{bmatrix}$$

$$\begin{bmatrix} 7 & 6 \\ 8 & 10 \end{bmatrix} + \begin{bmatrix} 5 & 0 \\ 1 & 5 \end{bmatrix} = \begin{bmatrix} 12 & 6 \\ 9 & 15 \end{bmatrix} \rightarrow ⑥.$$

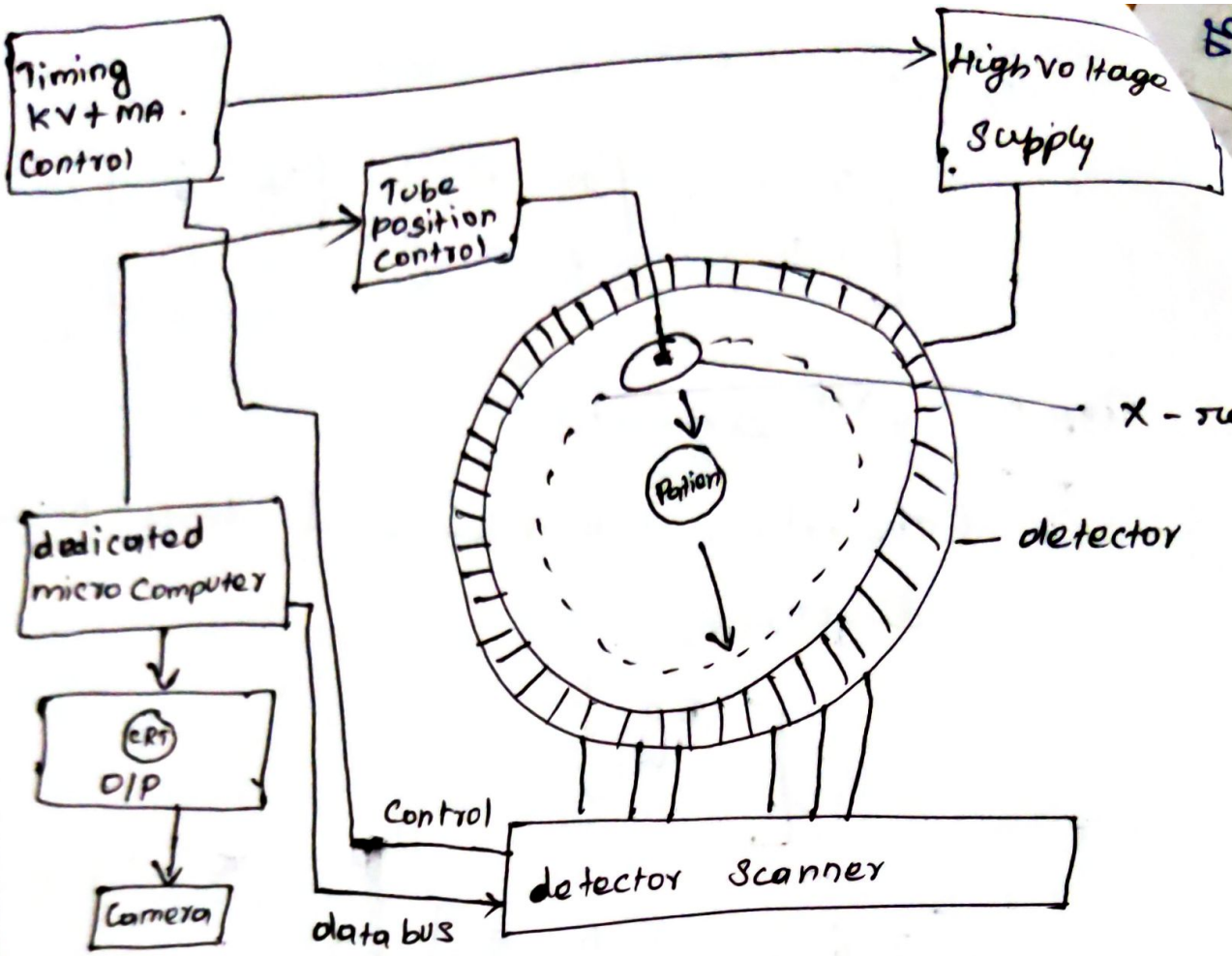
Step 6 :- Sub ⑥ with 6

$$\begin{bmatrix} 6 & 0 \\ 3 & 9 \end{bmatrix}$$

$$\div 3$$

$$\begin{bmatrix} 2 & 0 \\ 1 & 3 \end{bmatrix}$$

Thus the image can be calculated.



→ the timing beam current & voltage are controlled by the computer through control bus.

→ High voltage supply is given to the detector

→ X-ray is passed to the patient from X-ray to be only small amount of the X-ray are absorbed by the patient. Remaining X-rays are absorbed by the detector.

→ It has 1000 radiation.

→ X ray photons are converted into Scintillation.

→ the detector Scanner absorb the image & data are stored in the computer & the output are displayed in the CRT.

The hard copy of the image are taken by using a camera. thus computer are used for scanning. so it is called CT scanner.

Application:-

- Central Nervous System
- Thorax
- Neck
- orthopedics.

MRI (Magnetic Resonance Imaging).

Advantage:-

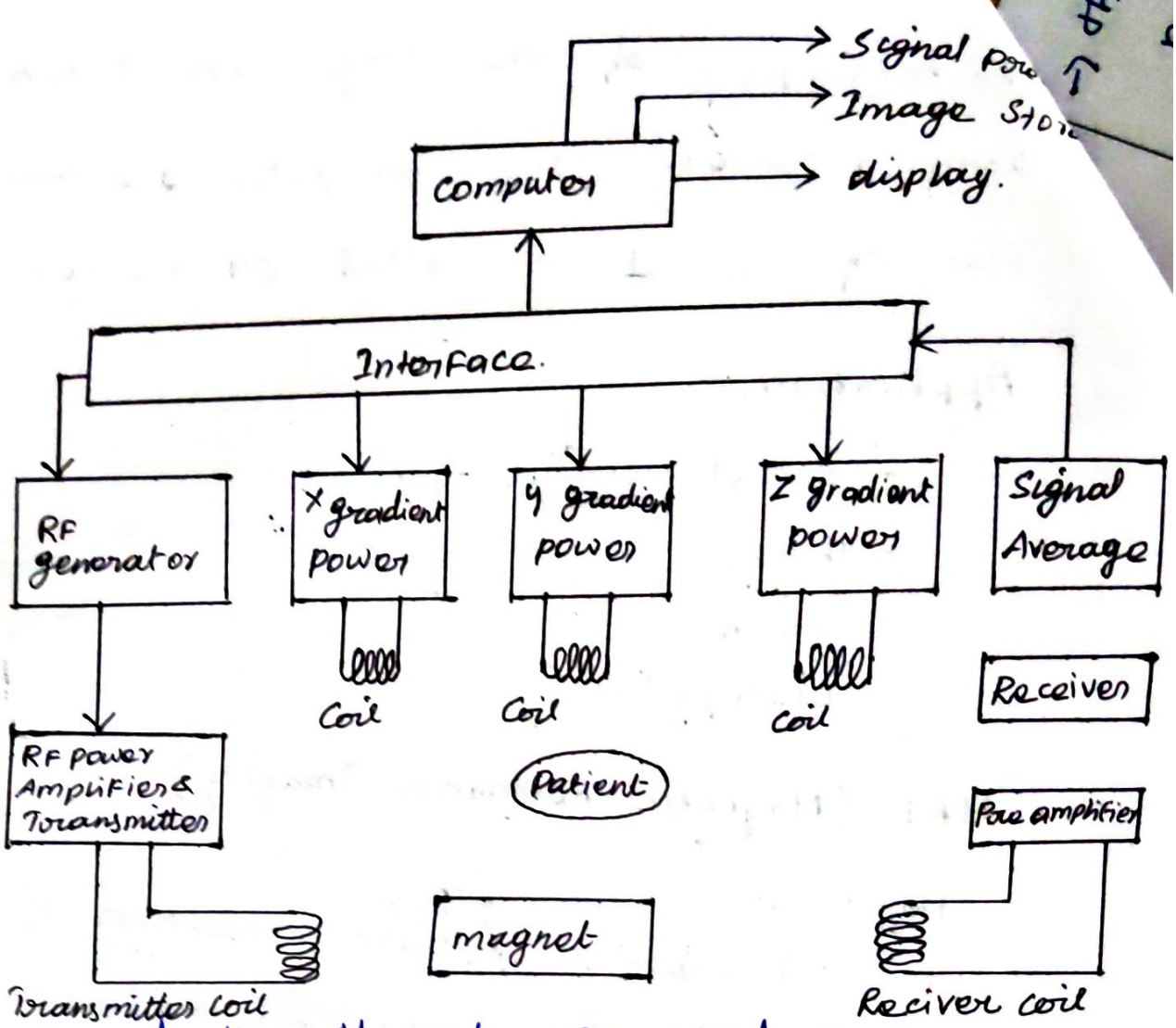
1) Superior contrast resolution.
2) Absence of harmful radiation.

Magnetic Resonance Imaging technique uses RF region of the electromagnetic spectra to provide an image.

It is spinning & Nuclear Magnetic moment is associated with it.

Magnetic moment is depend upon.

→ Mass
→ charge.
→ rate of spin of the nucleus.



→ Super conducting Magnets are used in MRI System. the super conducting Magnetic coil are cooled to helium Liquid temperature and can produce very high Magnetic field.

→ Signal to Noise & image quality are better. gradient coil control the Magnetic field. in different direction.

→ patient is kept in the gradient space.

→ the gradient Magnetic field is controlled by computer & that field can be positioned.

→ the transmitter provides the R.F. signal pulses.

→ the received NMR signal is picked up by the Receiver coil & it fed into the Receiver for signal processing.

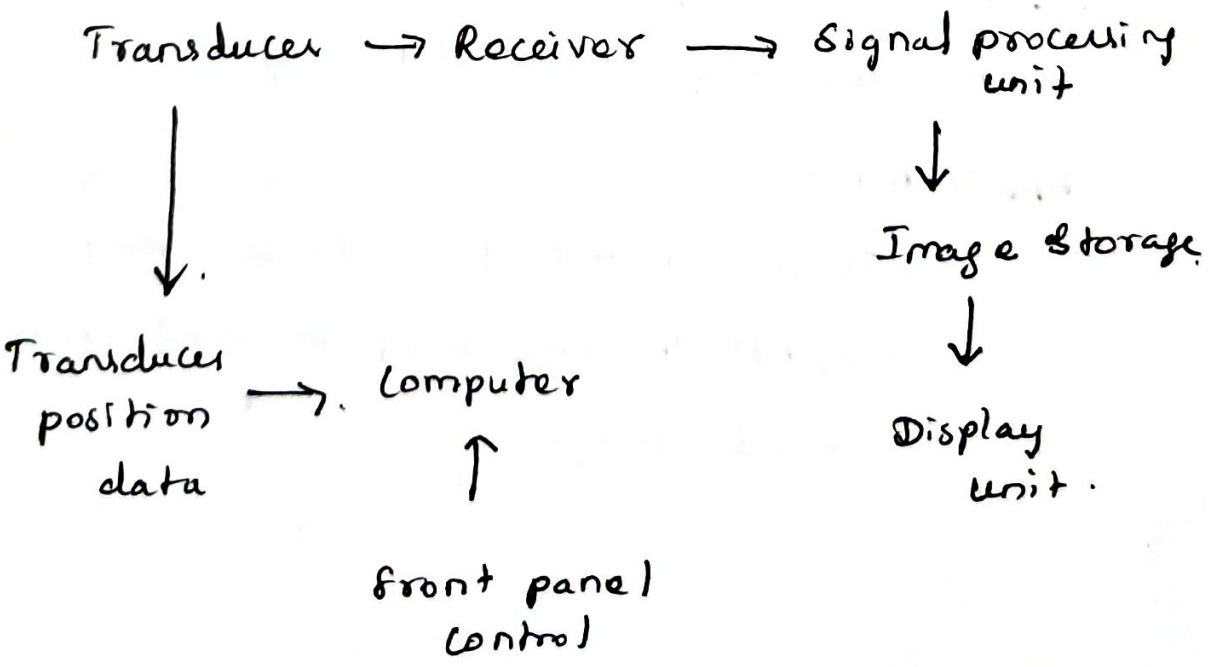
→ The image is constructed by the computer and its displayed on the TV screen.

ultrasonography:

It is a technique by which ultrasonic energy is used to detect the state of the internal body organs.

ultrasonography finds the application in

→ Neurology
→ cardiology
→ gyneology



→ the ultrasonic image forming system consi
of so many peripheral sub-units such as
(transducer data, Receiver panel control,
display unit, image storage & signal
processing unit).

→ computer is the heart of the system.
Signal processing unit receives information from
transducer data through computer & also
receives transducer signal from Receiver.

→ Receiver sensitivity is controlled by control bus.

→ proper gain compensation is calculated.

→ It is difficult to carry out direct real time
image processing.

∴ thus the digital real time scanner are used
for displaying ultrasound image.

Application:-

→ It is used to find any brain Tumor.

→ ophthalmology used to find foreign
object in eye.

Endoscopy:

The endoscopes (or) fiberoscopes are designed using Low quality, large diameter & short Length silica fiber.

There are two types.

→ Flexible

→ Rigid.

→ It is used to illuminate the inner structure.

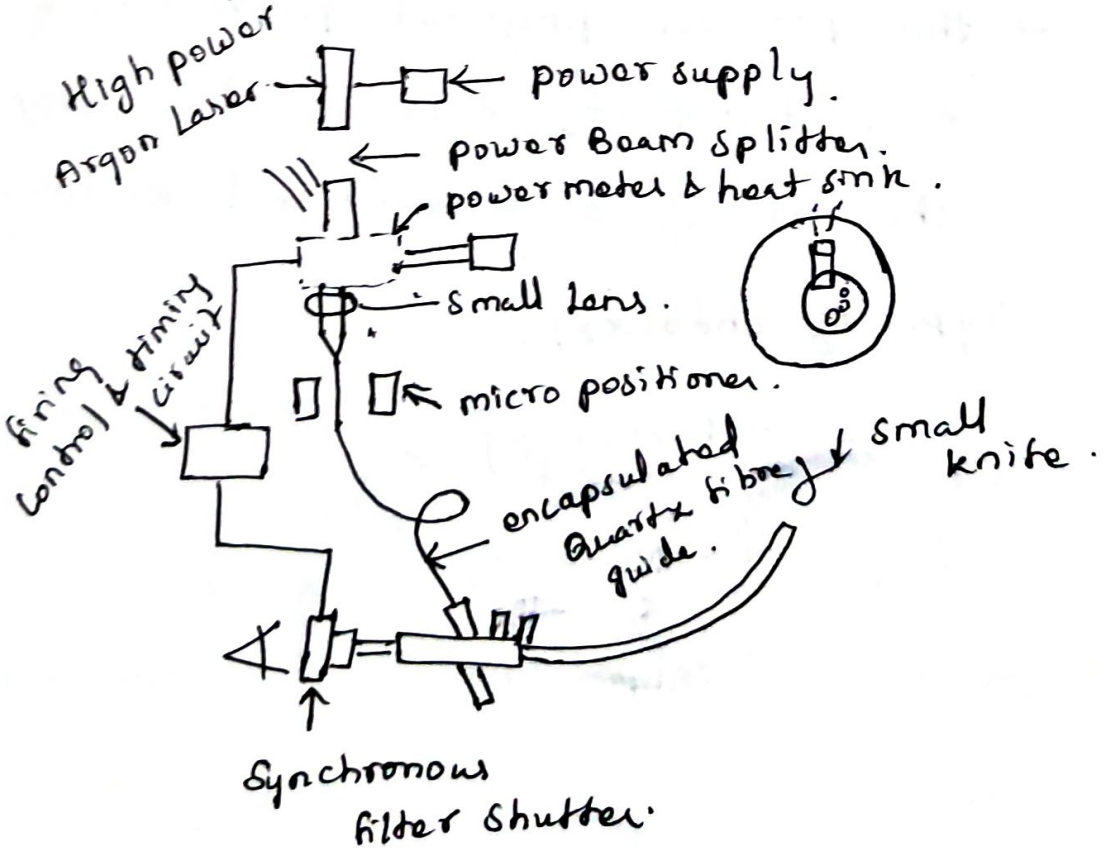
→ It is used to collect the reflected Light from that area.

Application:-

→ Retinal detachment

→ detect Foreign body infection.

→ diagonise tumors etc.



the argon ion Laser are very useful in coagulation of blood vessels, since its green Light is highly absorbed by the Red Blood Vessels & haemoglobin. The absorption of green Light results in the photocoagula of the blood protein & micro hemostasis.

→ It has the ability to do coagulation without affecting the surrounding healthy tissue.

→ the high power beam is transmitted to the flexible quartz wave guide by triggering an electronically controlled solenoid.

→ this provides physical protection & enables easy transport through the biopsy channel of a conventional endoscopy.

Types of endoscopy:

→ Arthoscopy

→ colonoscopy

→ colposcopy.

Thermography :-

Thermography is the process of Recording true thermal images of the surface of object under study.

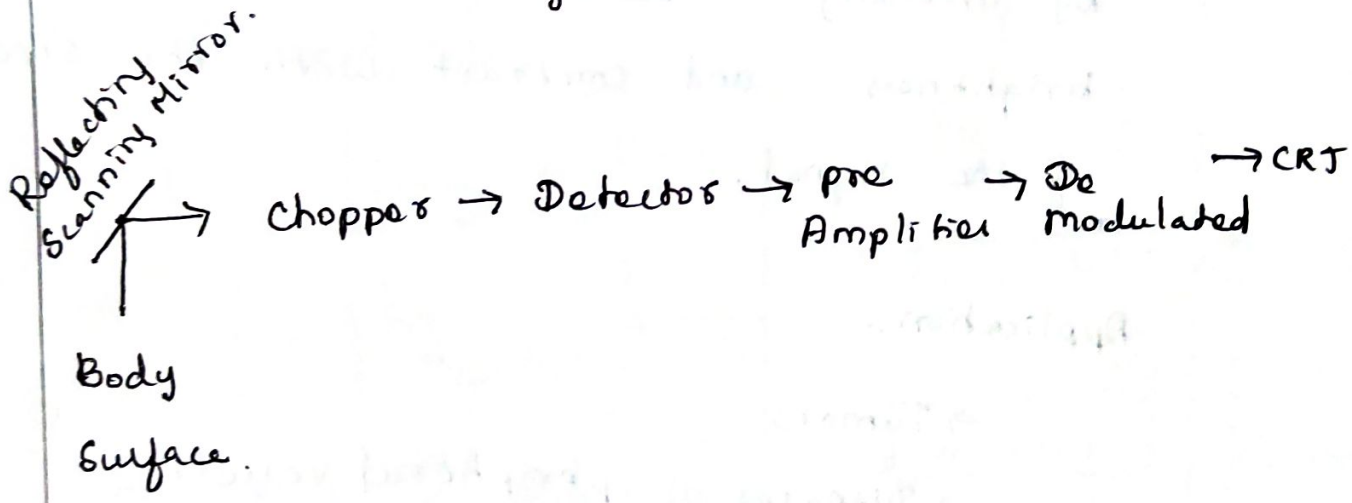
Types.

→ Infra Red thermography

→ Liquid crystal thermography.

→ Microwave thermography.

Infra Red thermography :-



→ Every thermographic equipment provided with a special infrared camera that scans the object & display unit for displaying the thermal picture on the screen.

→ the camera used to focuses the collected infrared radiation onto the chopper.

→ the chopper disc interrupts the infrared beam so that ac signals are produced & amplified, then demodulated.

→ the demodulated signals are given to the cathode ray tube in synchronization with scanning mechanism.

→ the signals are displayed on the screen by intensity modulation which control brightness and contrast with the strength of the signal.

Application:-

→ Tumors
→ Diseases of peripheral vessels.
→ Burns & perthiones
→ Skin grafts & organ transplantation.

Factors design:

- choice of detector
- parameters of the optimal system
- Scanning Mechanism
- Method of data presentation.

① Different types of Biotelemetary Systems.

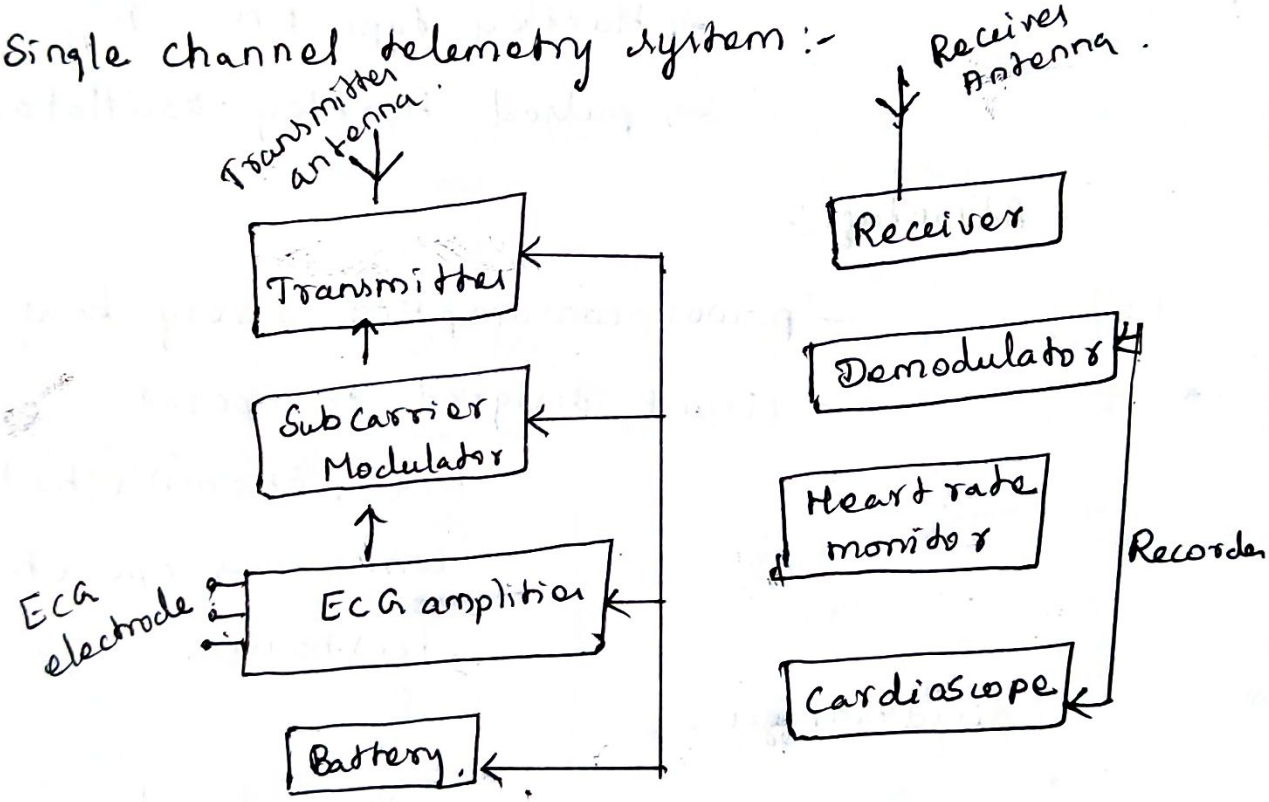
Biotelemetary is the use of the telemetry methods in order to remotely observe, document & measure certain physiological functions in human beings.

Categories of Biotelemetary measurement.

→ single channel telemetry system

→ Multi channel telemetry system.

Single channel telemetry system :-



→ Transmitter broadcast the biopotential over a limited range to a remotely located receiver which detects the radio signal & recovers the signal for further proces.

Radio frequency → 100 kHz - 300 MHz.

→ Amplitude modulation is not adoptable bec the signal amplitude will be raised & introdu serious error between transmitter & receiver.

→ frequency modulation or pulse modulation techniqu are used to transmit the bio signal. the following methods.

→ Tunnel diode FM transmitter.
→ Hartley type FM "
→ pulsed Hartley oscillator.

Advantage:-

- power consumption is very Low.
- circuit designed to operate on 5.4V, 350mAh battery to give continuous operation for few hours.

disadvantages:

- Large error is produced.
- Interference can be generated.

Multichannel telemetry system.

Signals are to be transmitted simultaneously is difficult in single channel.

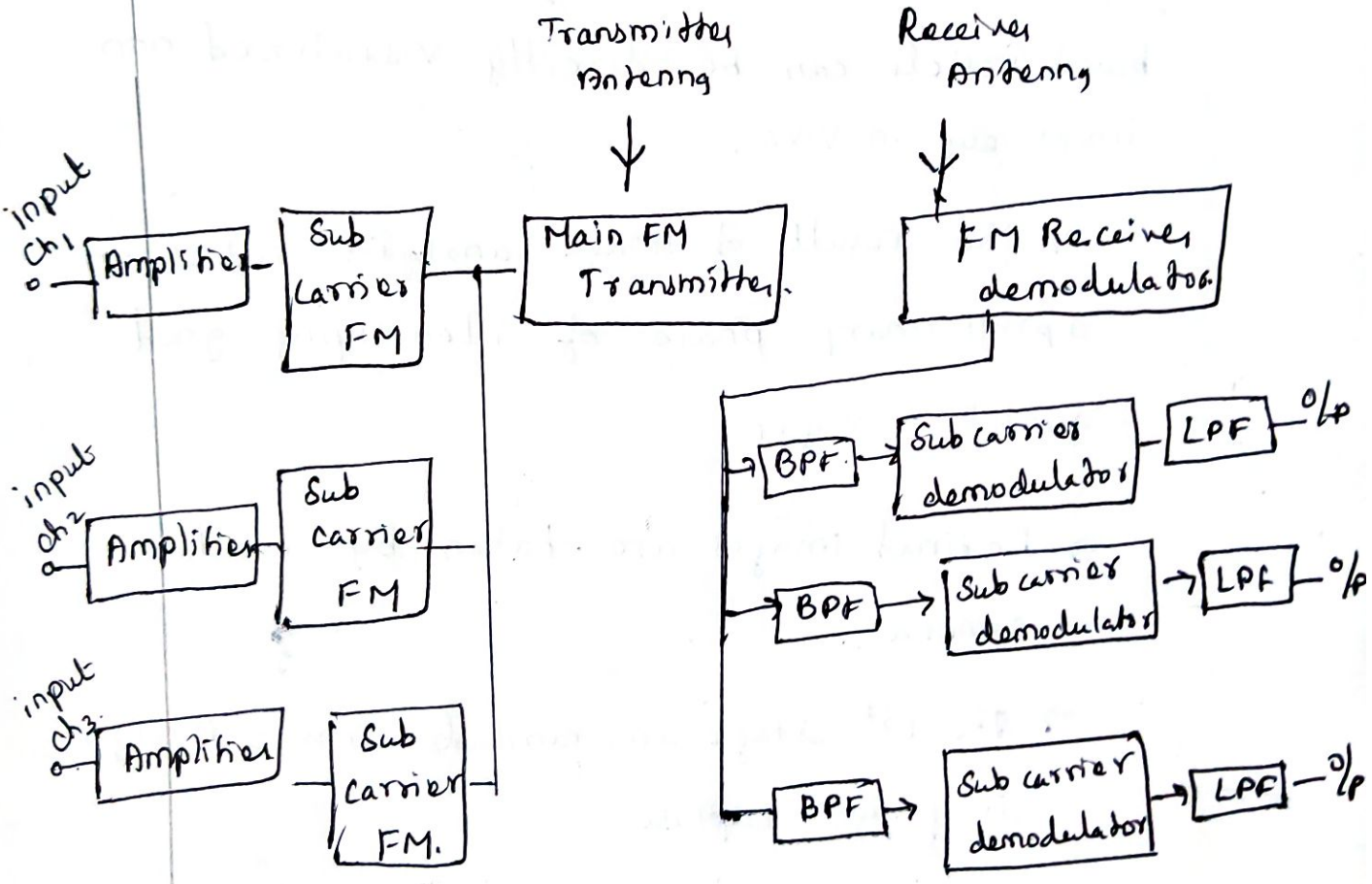
There are two type of Multiplexing. they are

→ FDM (Frequency division Multiplexing)

→ TDM (Time division Multiplexing)

FDM (Frequency Division Multiplexing).

→ Each signal is frequency modulated on the sub carrier frequency. these modulated sub carrier frequencies are then combined to modulate the main RF carrier.



→ At the receiver side the modulated sig will be separated by the proper band pa filter after the 1st discrimination.

→ the frequency of the sub carriers has to be carefully selected to avoid interference.

∴ an extract signal without any noise is obtained by using Low pass filter.

Retinal imaging :-

→ Retinal is the only location where blood vessels can be directly visualized non invasively in vivo.

→ the result of image analysis relies on a preliminary phase of identifying good quality images.

→ Retinal images are taken by Fundal camera.

→ The 1st stage in fundal image Analysis is image capture.

→ the digital camera operates in the same fashion as conventional camera but instead of having film, digital camera use an image sensor.

Imaging Application in Biometric System.

→ X ray (CT scan)

→ Sound (ultra sound)

→ MRI

→ Endoscopy

→ OCT.

→ PET

→ SPECT.

UNIT-V

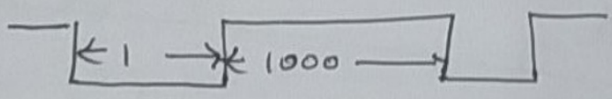
Life Assisting, Therapeutic & Robotic devices.

pacemaker, defibrillator, Ventilator, Nerve & Muscle Stimulators, Diathermy, Heart Lung Machines, Audiometer Dialysis, Lithotripsy, ICCU patient Monitoring System - Nano Robots, Robotic Surgery, Orthopodic prosynthoses fixation.

pacemaker:

pacemaker is an electrical pulse generator for starting or maintaining the normal heart beat.

pacemaker pulse.



there are two type

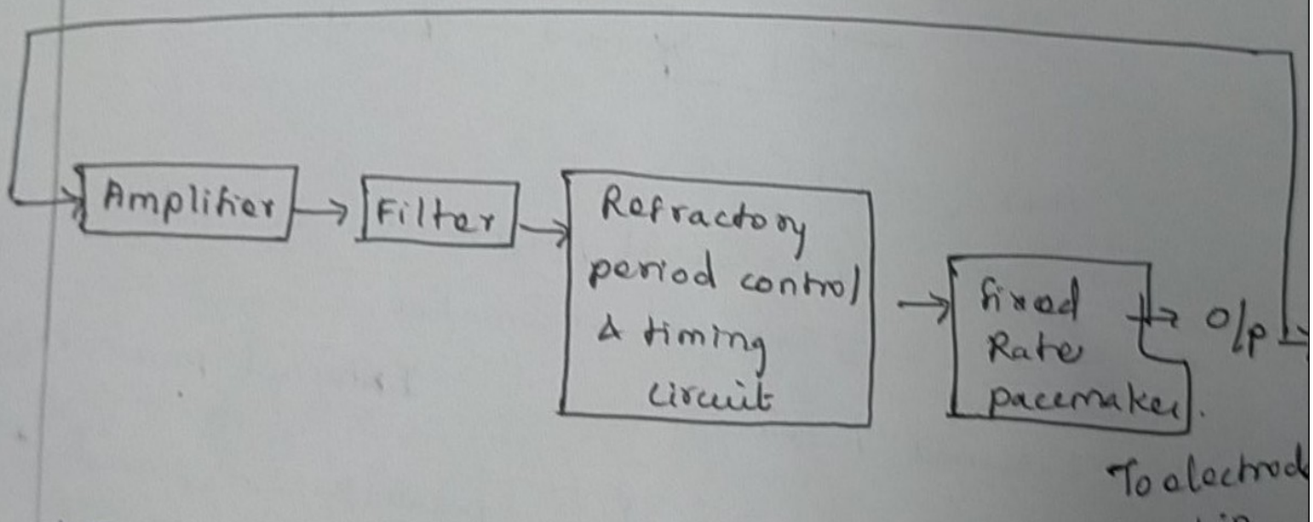
→ External pacemaker.
→ Internal pacemaker.

External pacemaker	Internal pacemaker.
→ pacemaker is placed outside the body.	- pacemaker is placed inside the body.
→ It doesn't require open chest surgery.	- It requires an open chest Surgery
→ temporary heart beats irregularities.	- permanent heart damage.

- pain do not arise	→ pain arise.
→ Battery can be easily replaced	→ Battery can be repla by surgery.

Different Modes of operation :-

1) Ventricular asynchronous pacemaker
2) Ventricular synchronous pacemaker.
3) Ventricular inhibited pacemaker.
4) Atrial Synchronous pacemaker
5) Atrial Sequential ventricular inhibited pacemaker.



→ If the intrinsic heart rate falls below the preset rate, the pacer. will automatically operate synchronously at its present rate to pace the heart.

→ ventricular triggered pacing is used less frequently than inhibited pacing

→ pulse generator is connected through wire & electrod to both the artria & ventricles.

Defibrillator:

A defibrillator is an electronic device that creates a sustained myocardial depolarisation of a patient heart in order to stop ventricular fibrillator (or) Atrial fibrillation.

The instrument for administering the electric shock is called defibrillator.

Different type of defibrillator:-

(1) Internal defibrillator

(2) External defibrillator.

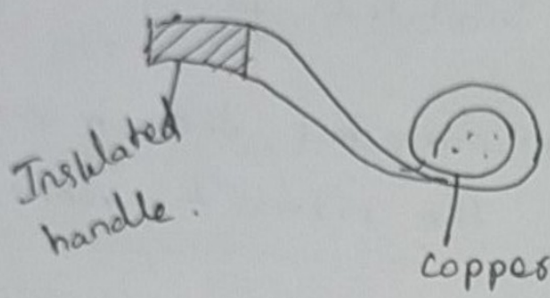
Internal defibrillators:-

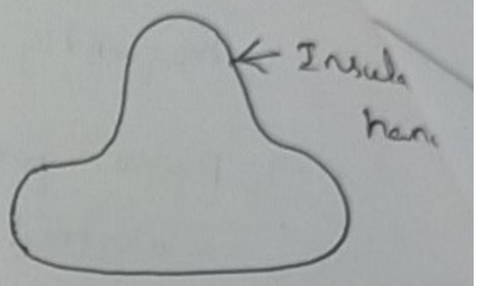
It is used when the chest is opened, Here Large spoon shaped electrodes with insulated handle are used.

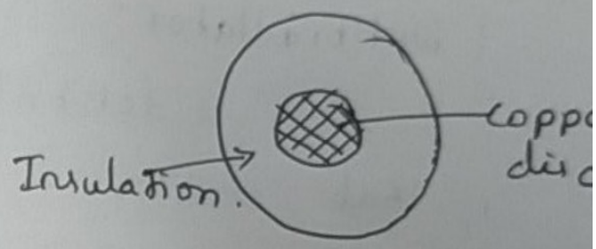
Range → 50V - 1000V

impedance - 50Ω

Energy - 15 - 50 J.







e) External defibrillator.

External defibrillator is used on the chest using paddle shaped electrode.

Range. → 1000V - 6000V -

impedance - 100Ω.

I → 10-60A.

Defibrillator can be divided into 6 types.

→ Ac defibrillator

→ Dc defibrillators

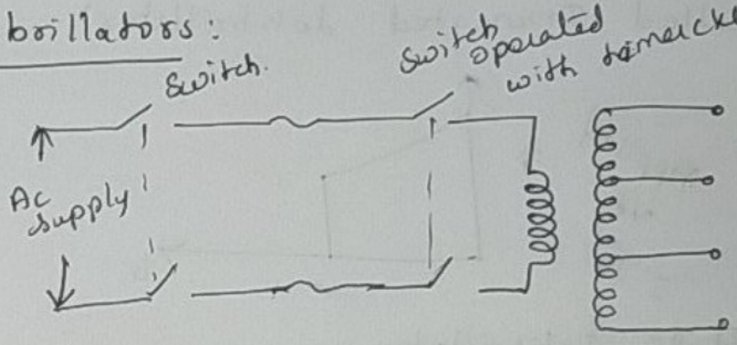
→ Synchronized dc defibrillator.

→ Square pulse defibrillator.

→ double Square pulse.

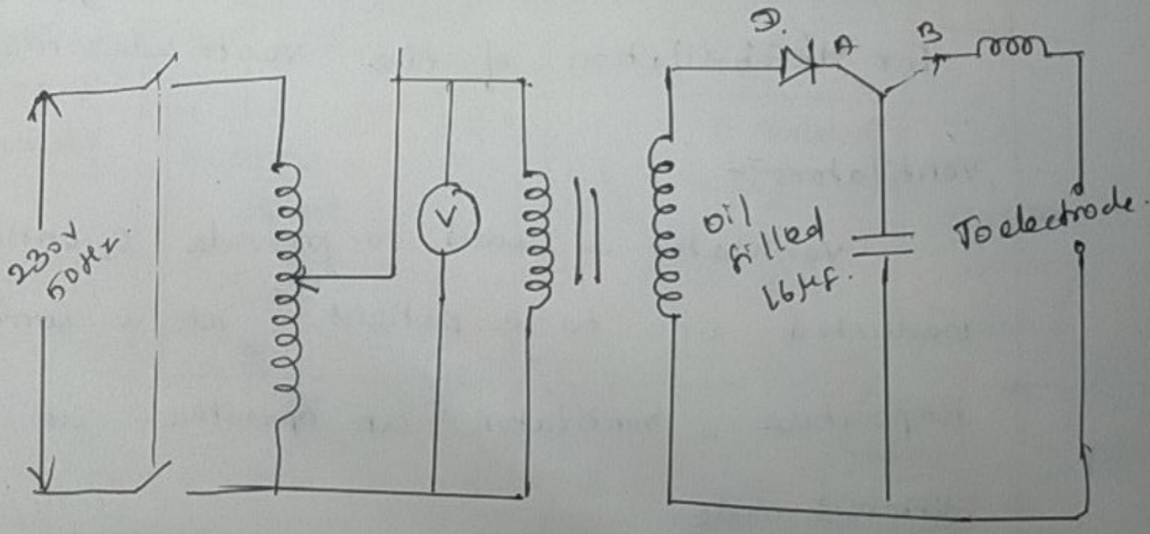
→ Biphasic Dc defibrillators

Ac defibrillators:



It produce atrium fibrillation while arresting the ventricular fibrillation. the current not only cause a violet contraction of the thoracic muscles.

Dc defibrillator:-



Energy - 100 J

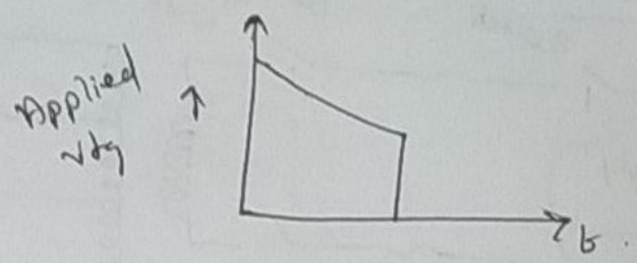
Duration - 5ms - 10mA

$$\text{Energy} = \frac{1}{2}CV^2$$

$$= 288 \text{ J}.$$

some energy can be applied to the heart with Low current Level. such defibrillators.

are called Truncated defibrillator.



Biphasic DC Defibrillator:

It is similar to the double square pulse defibrillator such that it deliver pulses alternatively in opposite direction. this type of waveform is found to be more efficiency. For defibrillation of the ventricular muscles.

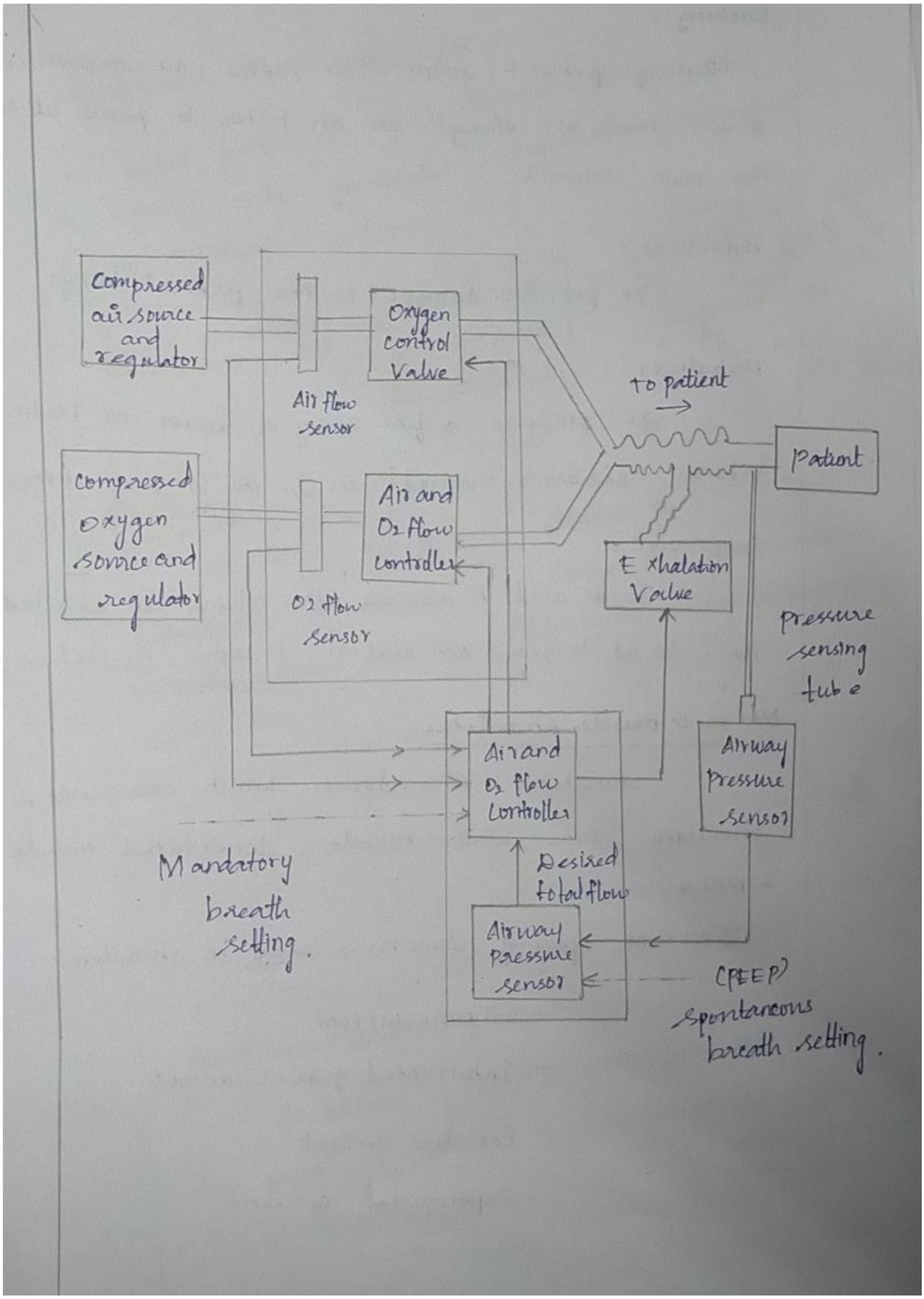
Ventilators:-

Ventilator is used to provide O_2 enriched, medicated air to a patient at a controlled temperature. ventilator can operates in different mode.

→ controlled breathing
→ Assisted breathing.
→ Assist control mode.

The ventilator treatment gives the following.

1) Adequate Ventilation.
2) Elimination of Respiratory work.


Compressed air source and regulator
Air flow sensor
Oxygen control Valve
To patient
Patient
compressed oxygen source and regulator
Air and O2 flow controller
O2 flow Sensor
Exhalation Valve
pressure sensing tube
Air and O2 flow Controller
Airway Pressure Sensor
Mandatory breath setting.
Desired total flow
Airway Pressure sensor
(PEEP) Spontaneous breath setting.

Working :-

→ During patient inspiration, the air compressor draws room air through an air filter & passes it to the main solenoid.

Humidifier :-

It provides damage to the patient lungs.

Nebulizer :-

It produces a fine spray of water or Medication into th. patient's inspired air in the form of aerosols

Spiromater :-

It is used to measure the volume of exhaled air. so as to give an alaram to stop excitation.

Nerve & muscle Stimulator

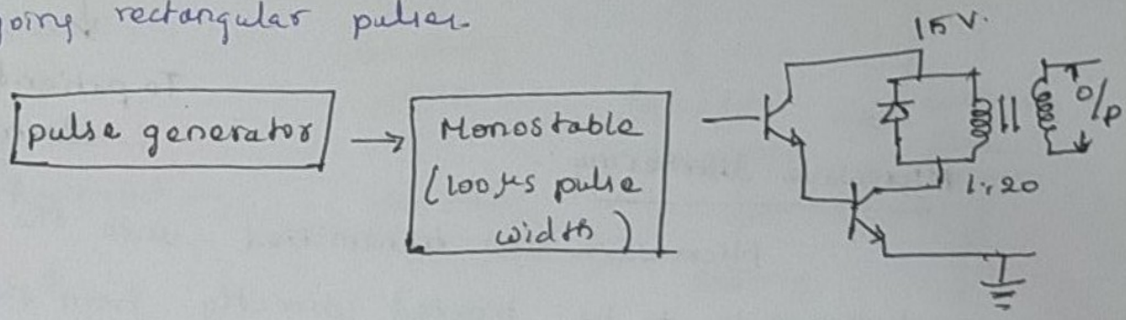
Stimulator are device which are used to stimulate innervated muscle, denervated muscle & Nerve.

Different types of waveform used in stimulator

- Galvanic current
- Interrupted galvanic current
- faradic current
- Exponential current

pheripheral Nerve stimulator.

the pulse generator which determines the pulse repitition rate generates repetitive negative going rectangular pulses.



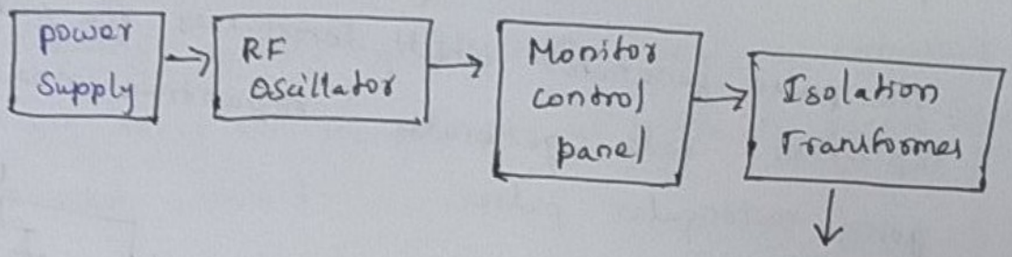
Diathermy:

It is the treatment process by which cutting, coagulation of tissues are obtained. there are various electro surgery techniques using diathermy unit.

1) Fulguration.
2) desiccation
3) Electrotemy
4) Coagulation
5) Blending

Short wave diathermy:-

RF pulses of 65 μs with interval between the pulses of 1600 μs. the depth of penetration is correctly adjusted.



Microwave diathermy :-

Microwave are transmitted into the portion of the body to be treated directly from the director of the unit. Normally Magnetrons are used to produce microwaves.

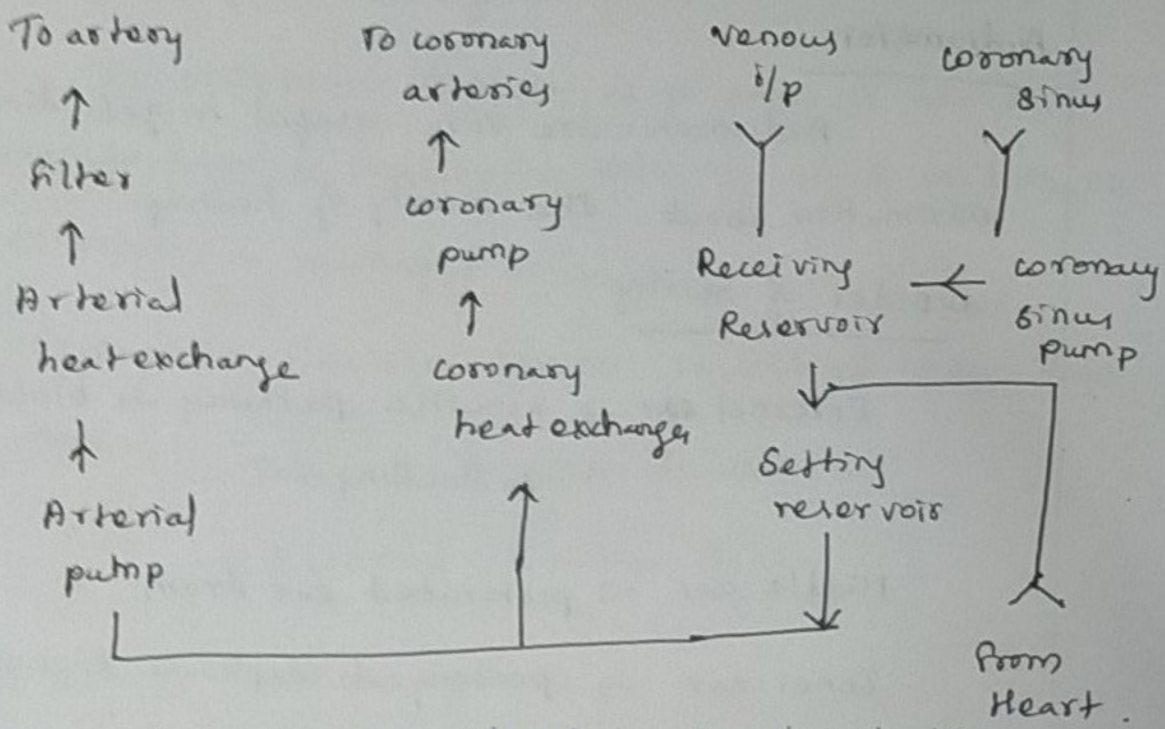
Heart Lung Machines

To provide extra corporeal circulation with a special Machine called Heart lung Machine.

Mechanical Function of heart :-

1) Un oxygenated blood → Right side of the heart at 0 - 5 mm Hg.
2) Right side of the heart → pumped Lung.
3) Lung → Left atrium of the heart (Receiving chamber)
4) Left Atrium → Left ventricle. (powerful chamber).
5) Ventricle ejects → Aorta pressure 100 - 150 mm Hg.

Heart pump about 5 Litre of blood



Lungs and Heart are replaced by the heart the oxygenator & blood pump respectively.

the collected venous blood is directly into a receiving reservoir of the heart Lung Machine by gravity drainage.

The accumulated blood in the operating field is also collected & pulled into the receiving reservoir by suction device.

In the oxygenator, the blood is exposed to Atmospheric O_2.

Systematic circulation is maintained by returning this arterial oxygenated blood to a major artery. the blood pumped through them.

Audiometer:

Audiometer are very useful to get diagnostic information about the acuity of hearing.

disorder of hearing:

External ear → acoustic pathway is blocked due to swelling.

Middle ear → perforated ear drum.

Inner ear → prolonged exposure to noise or due to acoustic injury.

pure tone & speech audiometer.

Audiometer is an electronic acoustic instrument for measuring human hearing level.

pure tone audiometer → obtain air conduction, bone conduction threshold of hearing which are used to diagnoise the amount of hearing loss.

Speech audiometer.

It is used to identify the speech reception threshold.

Screening audiometer → identify the threshold of hearing

orthopedic prosthesis fixation:-

An orthopedic implant is a medical device manufactured to replace a missing joint or bone or to support a damaged bone.

orthopedic fixation devices classified into two type

→ Internal fixation device

→ External fixation devices.

External fixation systems:-

Externally fixation systems comprise specially designed frames, clamps, rod, rod-rod coupling, pin, post etc.

the following treatment application.

→ open & closed fracture fixation.

→ correction of bony or soft tissue deformity

→ Limb lengthening.

Method of fixation.

- Direct Mechanical fixation.

→ passive "

→ Bone cement fixation.

→ Biological fixation

→ Direct chemical bonding.

Types of material :-

Material such as composite, metal, polyme ceramic are used.

Dialysers :

Both acute & chronic renal failures can be treated successfully by a dialysis.

There are three process.

→ diffusion

→ osmosis

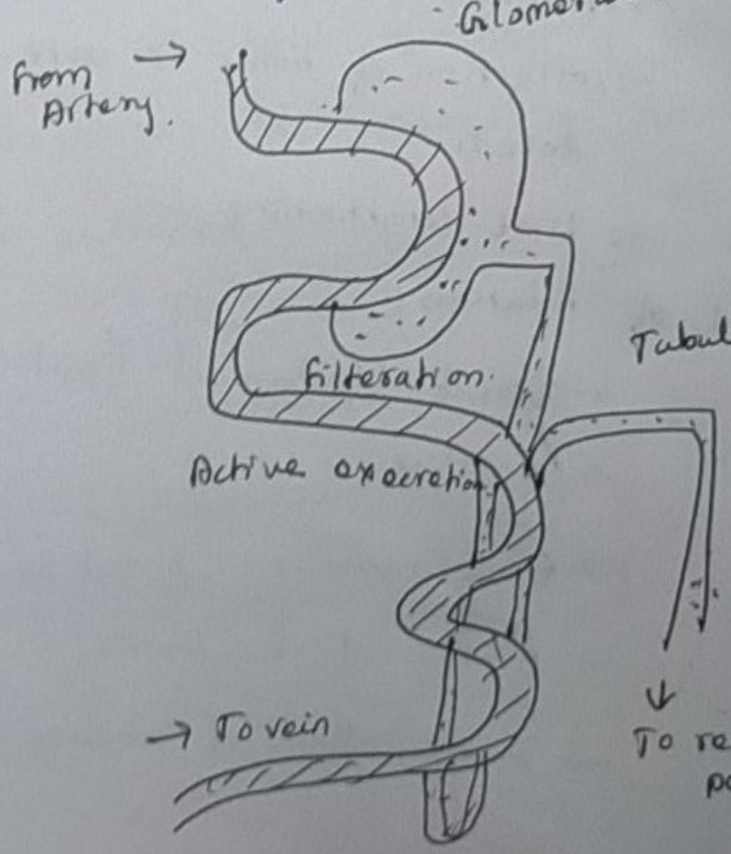
→ ultra filtration.

There are two type of dialyser

→ hemodialyser

→ peritonical dialyser.

Blood is purified by an artificial kidney machine called hemodialyzer.



working:

→ double lumen catheter is inserted into the femoral vein. there should be perfect protection against bacterial infection.

→ Arterio venous shunt is opened & connected to the dialyser

→ dialysate is an electrolyte

→ Blood leak detector to detect the rupture of a membrane.

Lithotripsy:

Shock wave Lithotripsy machines currently in the market vary in terms of several operational factors such as the energy source, the focusing system & stone localization system.

the Main component of Lithotripsy.

→ Focused shock wave source

→ monitor

→ patient table

→ X-ray generator.

the 3 basic type of shock wave source are.

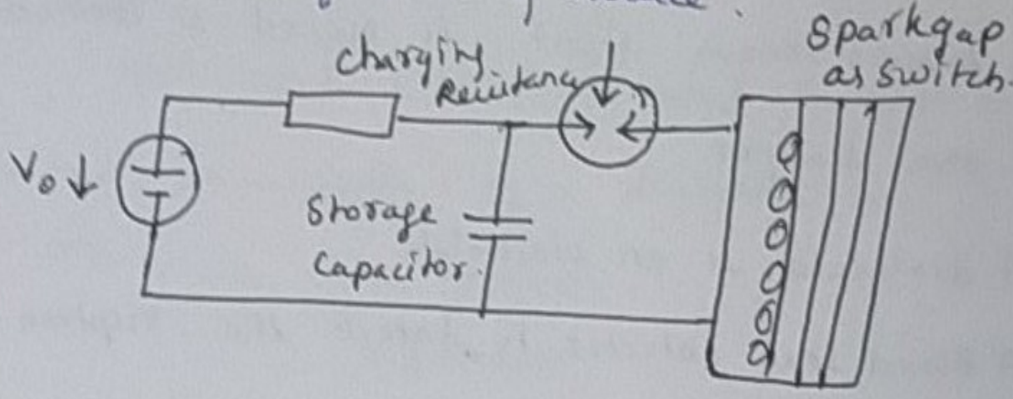
- plasma explosion method
- electromagnetic system
- piezo ceramic system.

Excitation source are

→ Ellipsoidal reflector

→ Focusing with an acoustic Lens.

→ Self focusing source.



ICCU patient monitoring System

ICCU → intermediate coronary care unit

It is used to monitor the patient recovered from Heart attack. patient monitoring systems are used for measuring continuously & automatically the important physiological parameter of patient.

objectives of patient Monitoring.

1) organizing
2) correlating
3) processing
4) providing
5) Ensuring.
6) proper parameter

Robotic Surgery.

Robotic surgery or robot assisted surgery allows doctor to perform many types of complex procedure with more precision, flexibility & control than is Possible with conventional techniques.

Robotic surgery is a method to perform surgery using very small tools attached to the robotic arm.

Anesthetics

Antiseptics

Anticoagulation

Antibiotics

Analgesic.

Modern Surgery

↓

Minimally invasive Surgery

↓

Imaging & Robotics.

Computer assisted Surgery.

Robotics used in Surgery

ie) Accuracy + Predictability + Repeability = Quality

→ Surgeon makes small cuts to insert the instrument

→ Surgeon sits on the computer station & direct the movement of Robots.

→ A thin tube with camera is attached to the end of it allows the surgeon to view the enlarged 3D image of a patient body.

→ The Robot matches the doctor's hand movement to perform the procedure using tiny instrument.

→ It is similar to Laproscopic surgery.

Robotic surgery may be used for a No. of different procedures including.

1) corona artery bypass

2) cutting away cancer tissue.

3) kidney transplant

4) open heart surgery.

precaution:

Before:

- patient can't have food for 8 hours ~~abdy~~ before the surgery
- patient need to cleanse their bowels with enema.
- patient insisted to stop taking aspirin.

After:-

- patient will be taken to a room after the procedure.
- Depending upon the type of surgery, patient should stay in the hospital.

Risk factors:

- Reaction to medicine
- Breathing problem
- Bleeding Infection.

Adv:

- fast recovery
- Less pain & bleeding
- Less effect of infection.

disadv:

- more expensive
- take longer time to perform.
- many hospital don't have accu.