MOHAMED SATHAK AJ COLLEGE OF ENGINEERING ENGINEERING COLLEGE

DEPARTMENT OF ELECTRONICS & COMMUNICAITON ENGINEERING

EC8073 – MEDICAL ELECTRONICS

III YEAR, V SEM

By

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MSAJCE

EC8073 MEDICAL ELECTRONICS L T P C
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OBJECTIVES:

The student should be made:

- To gain knowledge about the various physiological parameters both electrical and non-electrical and the methods of recording and also the method of transmitting these parameters
- To study about the various assist devices used in the hospitals
- To gain knowledge about equipment used for physical medicine and the various recently developed diagnostic and therapeutic techniques.

UNIT I ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING 9

Sources of bio medical signals, Bio-potentials, Bio potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics

UNIT II BIO-CHEMICAL & NON ELECTRICAL PARAMETER MEASUREMENT 9

pH, PO2, PCO2, Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.

UNIT III ASSIST DEVICES 9

Cardiac pacemakers, DC Defibrillator, Dialyser, Ventilators, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems.

UNIT IV PHYSICAL MEDICINE AND BIOTELEMETRY 9

Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry.

UNIT V RECENT TRENDS IN MEDICAL INSTRUMENTATION 9

Telemedicine, Insulin Pumps, Radio pill, Endomicroscopy, Brain machine interface, Lab on a chip.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student should be able to:

- ✓ Know the human body electro- physiological parameters and recording of bio-potentials
- ✓ Comprehend the non-electrical physiological parameters and their measurement – body temperature, blood pressure, pulse, blood cell count, blood flow meter etc.
- ✓ Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and ventilators
- ✓ Comprehend physical medicine m`ethods eg. ultrasonic, shortwave, microwave surgical diathermies , and bio-telemetry principles and methods
- ✓ Know about recent trends in medical instrumentation

TEXT BOOK:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007. (UNIT I – V)

REFERENCES:

1. Khandpur, R.S., "Handbook of Biomedical Instrumentation", TATA Mc Graw-Hill, New Delhi, 2003.
2. John G.Webster, "Medical Instrumentation Application and Design", 3rd Edition, Wiley India Edition, 2007
3. Joseph J.Carr and John M.Brown, "Introduction to Biomedical Equipment Technology", John Wiley and Sons, New York, 2004.

UNIT- I

ELECTRO- PHYSIOLOGY AND BIO-POTENTIAL RECORDING

The origin of Bio–potentials, Biopotential Electrodes, Biological Amplifiers, ECG, EEG, EMG, PCG, EOG, lead system, and Recording Methods, Typical Wave forms and signal characteristics.

SOURCES OF BIOELECTRIC POTENTIAL

The body generates their own monitoring signals which convey useful information about the function they represent. These signals are the bioelectric potential. Bioelectric potential are actually ionic voltage produced as a result of electrochemical activity of certain special type of cells.

Resting and Action Potential

The concentration of sodium ions inside the cell becomes much lower than outside. Since the sodium ions are positive, the outside of the cell is more positive than inside.

To balance the electric charge, potassium ions which are positive enters the cell causing a higher concentration of potassium on inside than on outside.

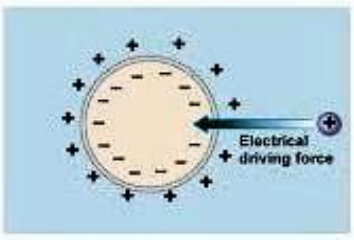


Fig 1.1: Polarized cell with its resting potential
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

This charge cannot be achieved. However Equilibrium is reached with a potential difference across the membrane, negative on inside and positive on outside. This membrane potential is called the resting potential of the cell.

Characteristics of Resulting Potential

The resting potential is maintained as a constant until some kind of disturbance upsets the equilibrium. It is strongly depending on temperature. It is given as negative and various from 60 to 100mA. The resting potential _V'of a cell can be written as

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

Where k – Boltzmann's constant

T- Absolute Temperature of cell q- Change of electron

Pk, P_{Na}, P_{Cl}- Permeability of K, Na, & Cl ions

$[K^+]$, $[Na+]$, $[Cl^-]$ –Concentration of K, Na & Cl ions

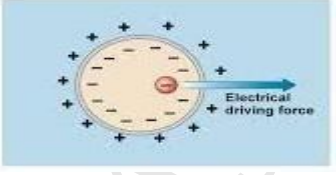


Fig 1.2: Depolarized cell with action potential

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

When the passage of sodium ions is stopped, there is no ionic current and hence the membrane reverts back to the original condition. By an active process called a sodium pump, sodium ions are quickly transported to the outside of cell and the cell is in its resting potential. This is called repolarization.

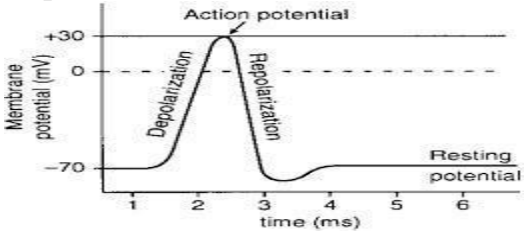


Fig 1.3: waveform of the action potential

[Source: Leslie Cromwell - Biomedical instrumentation and measurement],

DESIGN OF MEDICAL INSTRUMENT

To design any medical instrument, the factors to be considered are

1. **Accuracy:** ccuracy is the closeness with which an instrument reading approaches the true value of variable being measured.
2. **Frequency Response:** It is the response of the instrument for various frequency components present in a physiological signal.
3. **Hysteresis**: Hysteresis error occurs due to mechanical friction.
4. **Isolation:** Electrical isolation is made for electrical safety and to avoid any interference between different instruments.
5. **Linearity:** It is defined as the degree to which variations in the output of an instrument follow input variations
6. **Sensitivity:** It is the ability of an instrument to detect even a very small change that is taking place in the input.
7. **Signal to Noise (S/N) ratio:** It should be high to get reliable information about input.
8. **Simplicity:** It is an essential one to eliminate the human errors
9. **Stability:** It is the ability of the instrument to produce constant output for a given input.
10. **Precision:** It is the measure of the reproducibility of the measurements.

COMPONENTS OF BIO- MEDICAL INSTRUMENT SYSTEM:

The clinical laboratory instrument is used to investigate the pH value and concentration of various radicals present in the body fluids and to count blood cells in the blood sample. Each switch position connects an instrument for measurement, for monitoring, diagnosis, therapy or surgery with signal processor.

Transducer transforms the physiological signal like temperature, pressure or bio-potential into an electrical form.

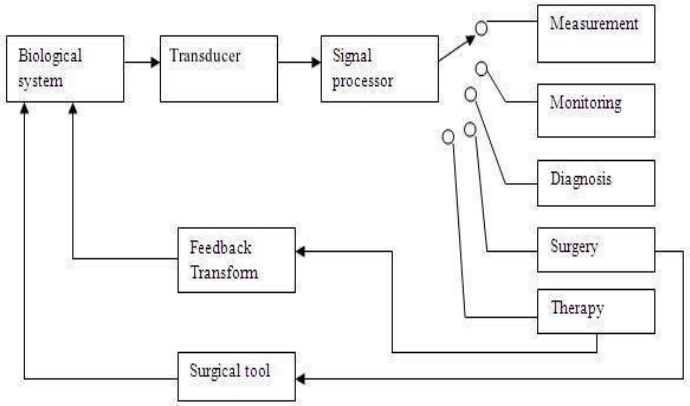


Fig 1.4: Block Diagram of a Generalized Bio-Medical Instrument System
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

PHYSIOLOGICAL SIGNAL AMPLIFIERS

The biomedical pre- amplifier should satisfy the following condition

1. The voltage gain should be more than 100 db to amplify the biosignal properly to drive the recorder.
2. It should have low frequency response.
3. The gain and frequency response should be uniform throughout the required bandwidth.
4. There is no drift in the amplifier.

The biosignal amplifiers are designed with operational amplifiers as the basic unit.

Isolation Amplifier

Isolation amplifiers are used to increase the input impedance of the monitoring system in order to isolate the patient from biomedical instrument. They are called pre- amplifier isolation circuits. High quality isolation amplifiers are required so that any electrical faults cannot result in electrical shock to the patient.

Darlington pair: It is an isolation amplifier which provides high input impedance with high current gain. θ_1 and θ_2 are connected in

common emitter mode. The input impedance is given by Zi = β Z ; β - Current amplification factor. The emitter of θ_1 is connected to base of θ_2 and both collectors share a common lead P_L. This results in high input impedance. R_B is chosen so that both stages operate in active region X, Y, and Z are the external terminals.

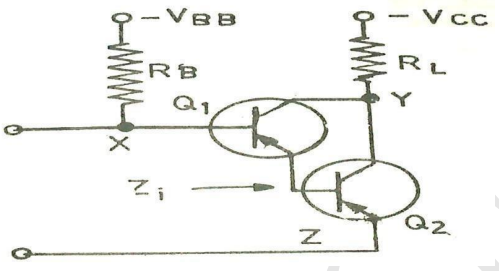


Fig 1.5: Darlington Pair [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Bootstrapping circuit: is also used as isolation amplifier to get very high input impedance. A feedback network is connected between the emitter of θ_2 and collector of θ_1. The feedback voltage increases the signal level at input which in turn increases the input impedance. R is used to limit the current flowing through θ_2.

ECG Isolation Amplifier Circuit

The signals from the different leads are given to LPF. This filtering reduces the interference caused by electron surgery and radio frequency emission. The filter circuit is following by high voltage and over voltage protection circuit so that amplifier can withstand large voltage. Now the signals are fed into lead selected switch and then the output is given to a d.c amplifier.

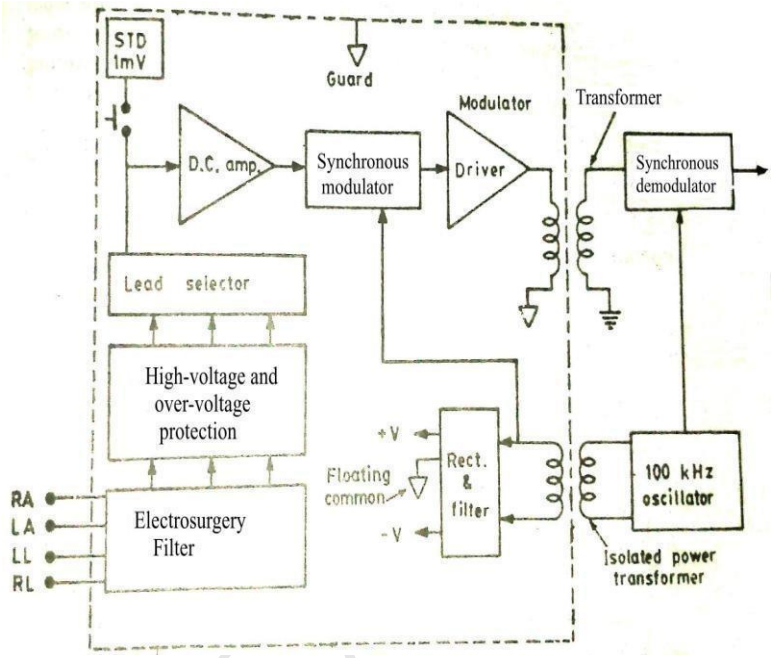


Fig1.6: Block Diagram of Transformer Coupled ECG Isolation Amplifier Circuit

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Medical Preamplifier Design. (Instrumentation Amplifier):

It has very high input impedance. It consists of op-amps. First two are working at non-inverting mode but their inverting terminals are not grounded. The third op-amp will act as a differential amplifier.

By this configuration we can get high stability high fidelity high CMRP and high input impedance. By virtual ground concept, inverting terminal of op-amp 1 is fed by a voltage V_2 through R_2 and inverting terminal of op-amp 2 is fed by a voltage V_1 through R_1. The common mode signal at input will lead to zero voltage drop

across variable resistor R_1. The common mode voltage gain is unity. Thus most of common mode signals will be rejected by third op-amp. V_o^1 is the output of first op-amp and V_0^{11} is the output of second op-amp.

Gain calculation

$V_0^1 = (1 + aR_1/R_1) V_1 - (aR_1/R_1) V_2$

$V_0^{ll} = (1+aR_1 / R_1) V_2 - (aR_1 / R_1) V$

$1\ V_{out} = (V_0^{ll} - V_0^{l}) bR_2 / R_2$

$V_{out} = (1+ 2a) (V_2 - V_1)$

b Net gain is (1+2a) b

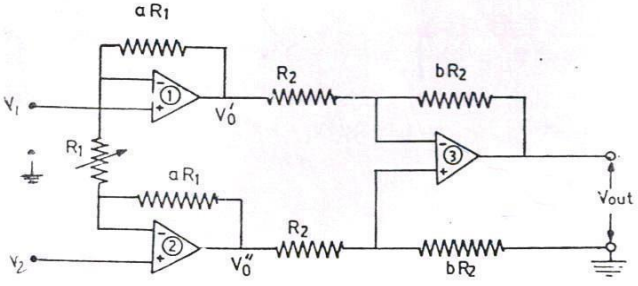


Fig1.7: Medical Preamplifier Bridge amplifiers:
[Source: Leslie Cromwell- Biomedical instrumentation and measurement]

They are used to measure the magnitude of biosignal parameters in terms of current or voltage. They are also measured in terms of frequency.

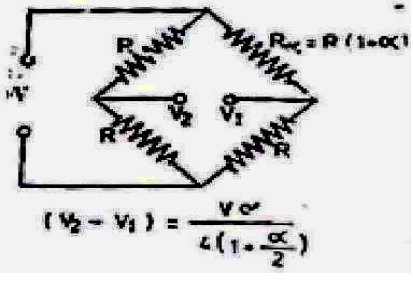


Fig 1.8: Bridge Amplifier for Voltage Readout
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

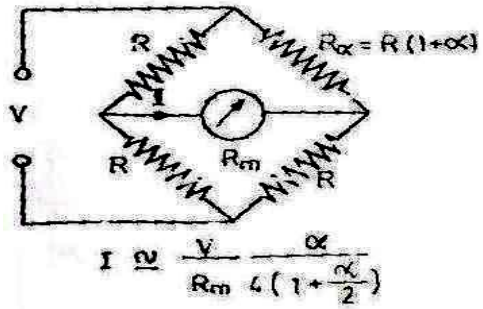


Fig1.9: Bridge Amplifier for Current Readout
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

In both bridge, the unbalance is measured by measuring the unbalance voltage or unbalance current. It is a measure of fractional change _α'in resistance of transducer Rα. Using op-amp, the unbalance voltage or current can be amplified.

Chopper Amplifier:

The chopper is used to convert low frequency signal into a high frequency signal. The modulated high frequency signal is amplified and finally the amplified signal is demodulated and filtered to get low frequency signal. Chopper amplifier has no drift. Chopper amplifiers are available in the form in the form of mechanical and non-mechanical chopper.

i) Mechanical Chopper Amplifier:

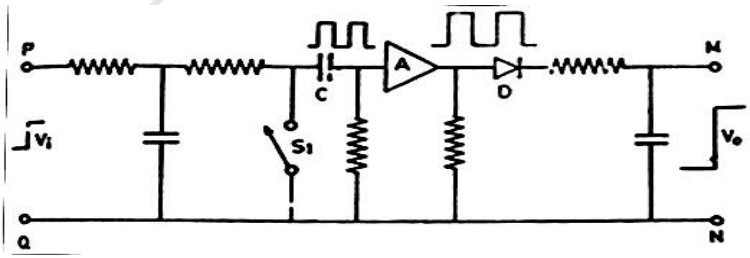


Fig 1.10: Chopper amplifier using a mechanical switch
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Chopper S_1 is an electromagnetically operated switch or relay. S_1 connect the input terminal of amplifier _A'to reference

terminal _Q'which is connected to ground. When the amplifier input terminal is connected with Q, it is short circuited and the input voltage is zero. When S_1 is open, the amplifier receives the signal voltage from P.

ii) Non mechanical Chopper Amplifier:

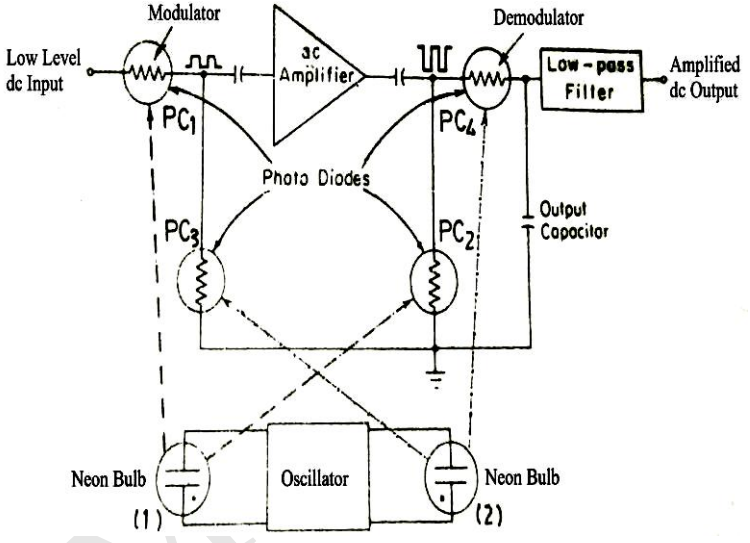


Fig 1.11: Non Mechanical Photoconductive Chopper Amplifier
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Photoconductors or photodiodes are used as non mechanical chopper for modulation and demodulation. When there is no incident light on photoconductor, its resistance is high and hence it is in RB and no current flows through it. When there is incident light on photoconductor, its resistance is very low and hence it is in FB and current flows through it. Thus it can act as a switch by means of incident light.

ELECTRODES

Electrodes are used to pick up the electrical signals of the body. They transfer the bioelectric event to the amplifier. The type of electrode to be used depends upon the bioelectric generator.

Half Cell Potential (or) Electrode Potential:

The voltage development at an electrode – electrolyte interface is designated as the half cell potential. In metal solution interface, an electrode potential results from two processes.

1. The passage of ions from metal into solution
2. The combination of metallic ions in solution with electrons in metal to from atoms of metal.

The net result is the creation of charge gradient, the spatial arrangement of which is called the electrical double layer. Electrodes in which no net transfer of charge occurs across the metal electrolyte interface are called as perfectly polarized electrodes.

Fig shows the electrical equivalent circuit of a surface electrode when it is in contact with body surface. The electrode-electrolyte interface resemble a voltage source having half cell potential _E_{hc}'which is developed due to charge gradient and a capacitor _C_d'(i) parallel with a leakage resistance _R_d'.

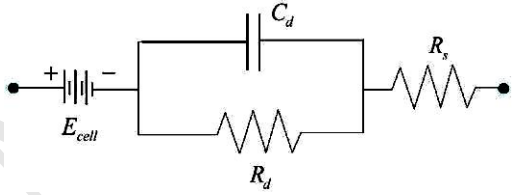


Fig 1.12: surface electrode equivalent circuit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

E_{hc} - half – cell potential

C_d – electrode capacitance

R_d – leakage resistance

R_S – Series electrolyte and skin resistance

The series resistance _R_S'represents the series electrolyte and skin resistance under equilibrium conditions. The impedance of the equivalent circuit can be written as

$$Z \quad R_S \quad = \quad \frac{R_d}{1 - j2\,fC_d\,R_d}$$

The value of voltage and impedance depend on the

electrode metal, its area, electrolyte, charge density and frequency of current. The electrode potential is measured with reference to hydrogen electrode placed in electrolyte near metallic electrode. The half cell potential development can be expressed by Nernst equation as

$$E_{hc} = \frac{RT}{nF} \ln \frac{C_1}{C_2} \cdot \frac{f_1}{f_2}$$

Where R – Gas Constant

T – Absolute Temperature
F – Faraday Constant
N – Valency of Ion

C_1, C_2 – Concentration of selected ion on two sides of membrane

f_1, f_2 – Activity coefficients of ion on two sides of membrane.

Purpose of Electrode paste:

The outer skin of the body is highly non- conductive and will not establish a good electrical contact with an electrode. The skin should be washed and rubbed to remove some of the outer cells. The electrode paste decreases the impedance of contact and also reduces the artifacts resulting from movement of electrode.

Electrode Material:

The electrode, electrode paste and body fluids can produce a battery like action causing ions to accumulate on the electrodes. This polarization of electrode can affect the signal transfer.

Types of Electrodes:

These are three types of electrodes

Micro electrodes (Intracellular Electrodes):

These are used to increase the bioelectric potential within a single. It is divided into metallic and non metallic. The microelectrodes should have smaller diameter and during insertion of electrode into the cell, there will not be any damage to the cells.

They are formed by electrolytically electing the tip of a fine tungsten or stainless steel wire to a fine point. This technique is known as electro pointing. The metal microelectrodes are coated almost to the micro tip with a material.

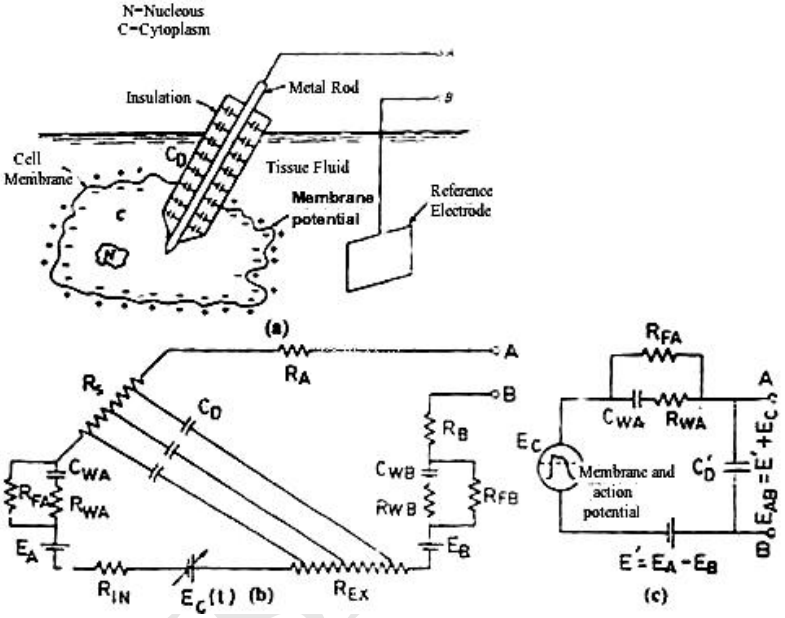


Fig 1.13: Metal Microelectrode [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The impedance of microelectrode tip is inversely proportional to the area of the tip and frequency. When the electrode output is couple with an amplifier, the low frequency components of the bioelectric potentials will be attenuated if the input impedance of the amplifier is not high.

ii) Micropipet

It consists of a glass micropipet tips diameter is about1 micrometer. The micropipette is filled with an electrolyte usually 3M Kcl which is compatible with the cellular fluids.

E_A is the potential between metal wire and electrolyte filled in the micropipette

E_B is the potential between the reference electrode and the extracellular fluid.

E is variable membrane potential

E_D potential existing at the tip due to different electrolytes present in the pipet and the cell

$$E = E_A + E_B + E_D$$

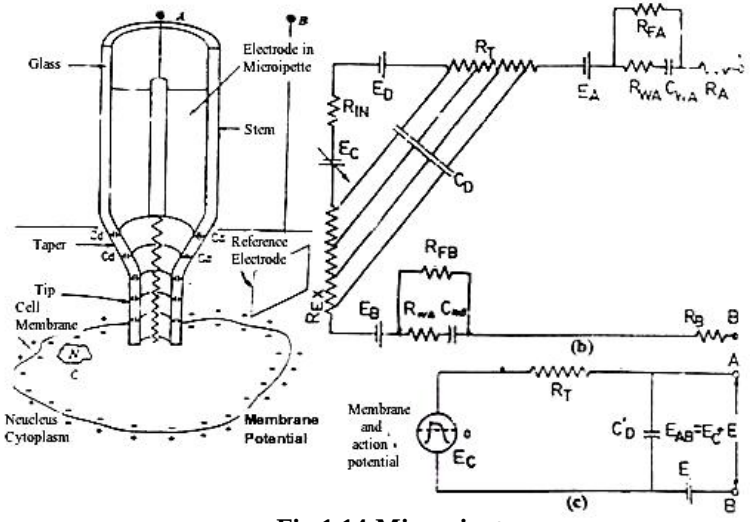


Fig 1.14:Micropipet

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Depth and Needle Electrodes

These are used to measure the bioelectric potentials of the highly localized extracellular regions in brain or bioelectric potentials from specific group of muscles.

i) Depth Electrode

These are used for study the electrical activity of the neutrons in superficial layers of the brain. Normally each electrode consists of a bundle of Teflon insulated platinum (90%) iridium (10%) alloy wires, bonded to a central supporting stainless steel wire which can act as indifferent electrode by an insulating varnish.

ii) Needle electrode

These are used to record the peripheral nerve‘s action potentials (Electro neurography). The needle electrode resembles a medium dropper or hypodermic needle.

Surface Electrode

Generally large area surface electrodes are used to sense ECG potentials and smaller area surface electrodes are used to sense EEG and EMG potentials.

i) Metal plate Electrodes

Rectangular and circular plates from German silver, nickel silver or nickel plated steel are used as surface electrodes in the case of ECG measurement.

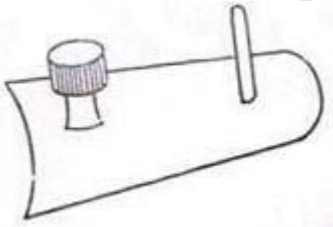


Fig 1.15: Metal plate Electrodes [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

ii)Suction Cup Electrode

It is more practical and is well suited for attachment to flat surfaces of the body and to regions where the underlying tissue is soft. Although physically larger this electrode has a small area because only the rim is in contact with the skin.

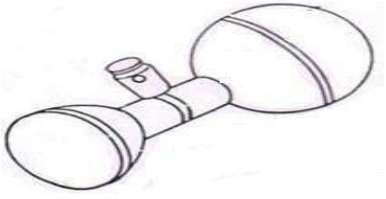


Fig 1.16: Suction Cup electrode [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

iii) Adhesive Tape Electrode

The pressure of the surface electrode against the skin may square the electrode pasted. To avoid this problem, adhesive tape electrode is used.

Fig 1.17: Adhesive tape electrode [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

iv) Multipoint Electrode

It is a very practical electrode for ECG measurements and it contains nearly 1000 fine active contact points. By this a low resistance contact is established with the subject.

v) Floating electrode

Here, the metal does not contact the subject directly. The contact is made via an electrolytic bridge. By means of this electrode, movement artifact is eliminated. This is also called as liquid junction electrode.

BOIPOTENTIAL RECORDERS

The bio – potential recorder plays an important role in the biomedical instrumentation. ach doctor is performing his diagnosis based on the output from recorder.

Characteristics of Recording System:

i) **Sensitivity:** The sensitivity is the magnitude of input voltage required to produce a standard deflection in the recorded trace.

ii) **Linear:** a recorder is said to be linear if the pen deflection is proportional to the amplitude of input signal.

iii) **Frequency Response:** A recorder is said to have good frequency response when the sensitivity is constant for all the frequencies present in the signal.

ELECTRO CARDIO GRAPHY (ECG)

ECG deals with the study of electrical activity of heart muscles. Electrocardiogram is the recorded ECG wave. ECG is also called EKG is derived from the German Electro Kardio Gam.

i) Origin of Cardiac action potential:

Heart is divided into four chambers. The top two champers are atria and lower two champers are ventricles.

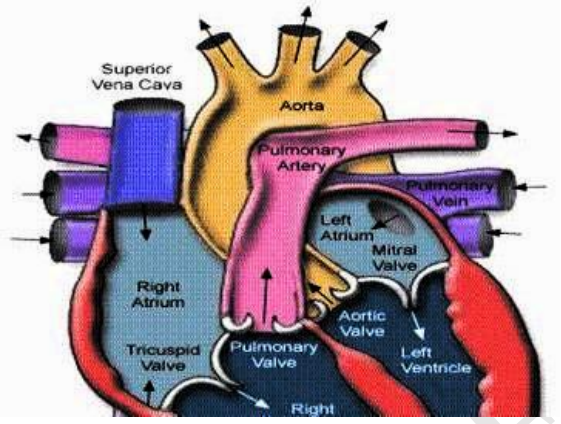


Fig 1.18: Cross Section of the Interior of the Heart Table

1.1Physiological Nature of ECG Waveform

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

	Origin	Amplitude mV	Duration sec
P Wave	Atrial depolarization or contraction		0.12 to o.22 (P-R interval)
R wave	Repolarisation of the atrial and the depolarization of theventricles	1.60	0.07 to 0.1
	Ventricular repolarisation (Relaxation of myocardium)	0.1 to 0.5	0.05 to 0.15 (S-T interval)
S-T interval	Ventricular contraction		
U wave	Slow repolarisation of the intraventricular (Purkinje fibers) system	< 0.1	0.2 (T-U interval)

The complete waveform is called electrocardiogram indicating important diagnostic features. If PR interval is more than 0.22 sec, AV (first heart attack) occurs. When QRS duration is more than 0.1 sec, the bundle block (severe heart attack) occurs.

(ii) Lead configuration

The electrode systems are

1) Bipolar limp leads (or) standard leads.
2) Augment unipolar limp leads.
3) Chest leads (or) precordial leads.
4) Frank lead system (or) corrected orthogonal leads.

1) Bipolar Limb leads – Standard leads I, II, and II

In standard leads, the potential are tapped from four locations of our body. They are i) right arm ii) Left arm iii) Right Leg and iv) Left leg.

Right leg electrode is acting as ground reference electrode. Fig.1.20 shows the standard bipolar limp lead positions and the corresponding wave patterns.

Lead I position – give voltage V_I, the voltage drop from left arm(LA) to right arm (RA)

Lead II position- gives voltage V_{II}, voltage drop from left leg (LL) to right arm (RA)

Lead III position – gives voltage V_{III}, voltage drop from left leg (LL) to left arm (LA)

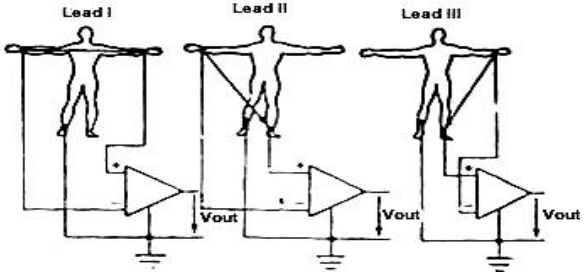


Fig 1.20: Standard Bipolar Limb Leads and the Corresponding ECG

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

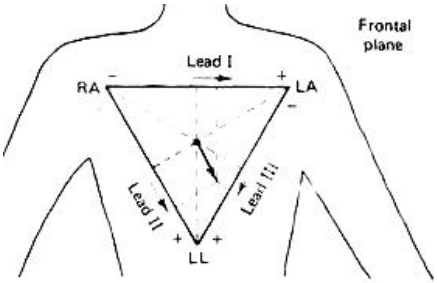


Fig 1.21: Einthoven Triangle
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]18

The closed path RA to LA to LL and back to RA is called the **Einthoven triangle**. Along the sides of this triangle, three projections of ECG vector are measured.

2) Augmented unipolar Limb leads

In this, the electrocardiogram is recorded between a exploratory electrode and the central terminal.

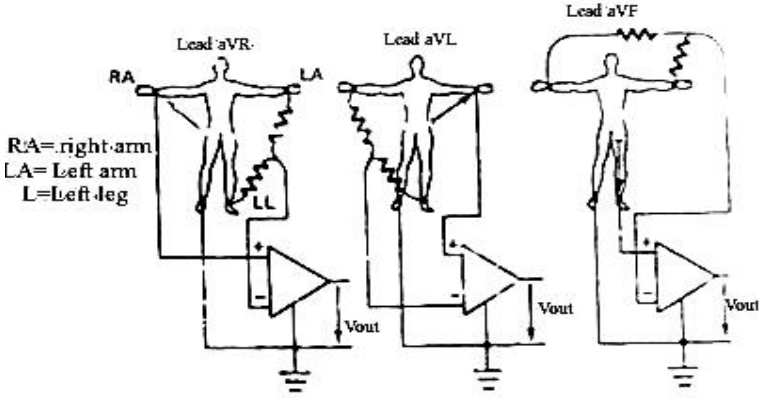


Fig.1.22: Augmented Unipolar Limb Leads [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

3) Unipolar Chest Leads

In this, exploratory electrode is obtained from one of the chest electrodes. The chest electrodes are placed on six different points on chest closed to the heart. By connecting three equal large resistances to LA, RA and LL a reference electrode or central terminal is obtained. This lead system is known as Wilson system. Electrocardiogram recorded from these 12 lead selections such that 3 standard bipolar leads, 3 augmented unipolar leads and 6 chest leads.

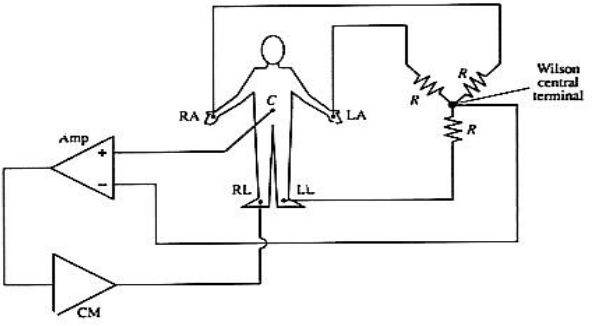


Fig.1.23: Unipolar Chest Leads [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The ECG potentials are measured with colour coded leads for easy reference.

4) Frank lead system:

The corrected orthogonal lead system (or) Frank lead system is used in vector cardiography. Here one can get the information from 12 leads. The state of the heart is studied three dimensionally.

iii) ECG Recording setup:

i) Patient cable and Defibrillator Protection Circuit

The patient cable connects the different leads from the limbs and chest to the defibrillator protection circuit. It consists of buffer amplifiers and over voltage protection circuit. Each patient lead is connected to one buffer amplifier.

ii) Lead selector switch

It is used to feed the input voltage from appropriate electrode to the preamplifier.

iii) Calibrator

A push button allows a standardization voltage of 1 mV to the preamplifier. This enables to observe the output on display unit. From lead selector switch, ECG signal goes to bio-amplifier.

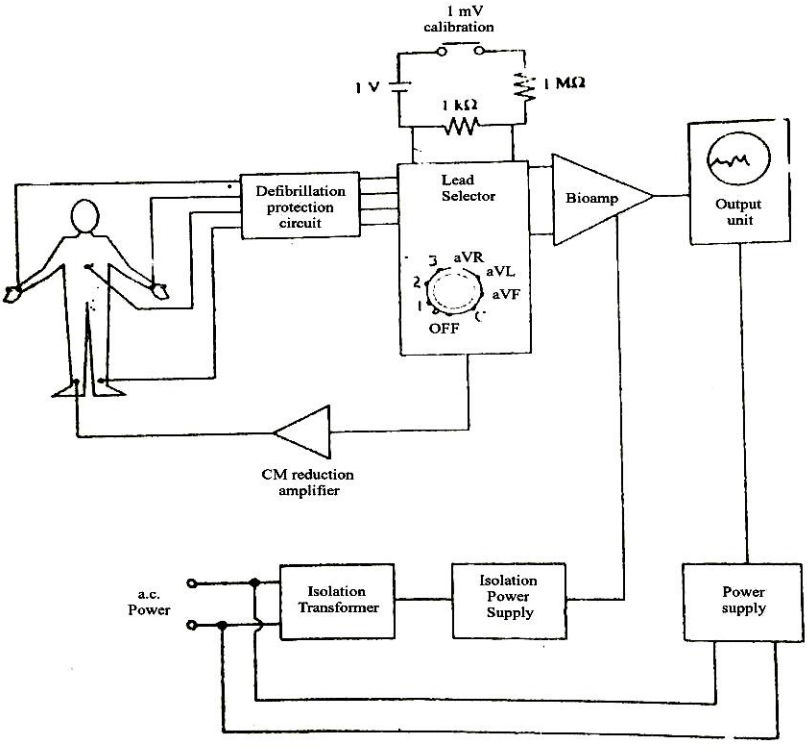


Fig1.24: ECG Recording

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Setup iv) Bio-Amplifier

The bio-amplifier consists of a preamplifier and power amplifier. The preamplifier should have high gain and high CMRR.

It consists of two power transistor such that their emitters are joined together and connected with R_L. When V_B is positive, Q_1 is FB and conducts while Q_2 is RB and remains off.

Output power pout = V_{out}^2 / R_L

Amplifier efficiency η = Pout / (pout +P_{loss})

To avoid the cross over distortion, an ideal non – inverting amplifier is inserted at the output. Since R_f is so large, it raise the gain and output voltage and thereby crossover distortion is eliminated. The effect control is provided by R_2 and gain adjustment is provided by R_S

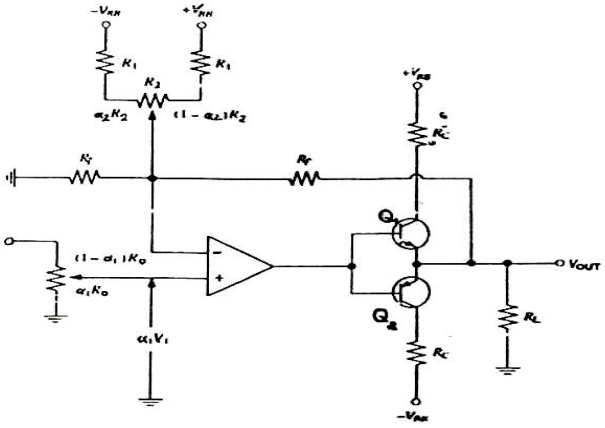


Fig.1.25: Push-Pull Power Amplifier with Crossover Compensation and Offset Control

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

v) Auxiliary Amplifier

The common mode signals can be reduced to a minimum level by adding an auxiliary amplifier between right leg lead and ECG unit.

vi) Isolation Tower Supply

It is used given power to the bio amplifier and hence the electrical safety for the patient is increased.

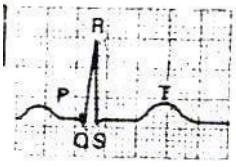
vii) Output Unit

In paper chart recorder, the power amplifier or pen amplifier supplies the required power to drive pen motor. Pen motor records the ECG trace on the wax coated heat paper. A position control is used to position the pen at the center on the recording paper.

viii) Power switch

The power switch of the recorder has three positions. In ON position the power to the amplifier is turned on. But the paper drive is not running. In RUN position, the switch makes the paper drive to run. In OFF position, ECG unit is in switched off condition. **Analysis of Recorded ECG Signals**

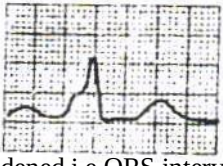
Fig. shows the analysis of different ECG signals.



Normal ECG

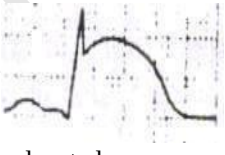
Here the PQ segment has prolonged conduction time i.e greater than 0.22second

Result: First degree AV block



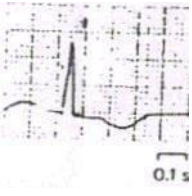
Here QRS complex is widened i.e QRS interval is greater than 0.1 second

Result: Bundle block

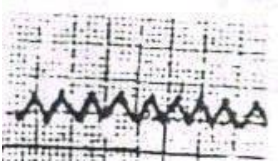


Here ST segment is elevated

Result: Myocardial infraction



Here ST segment is depressed and negative T wave is present Result: Coronary insufficiency



Here the train of pulses instead of PQRST waves

Result: Ventricular fibrillation which may lead to death if it is not properly corrected by defibrillator.

If the normal conduction system is disturbed, then the beat rate will be slower than the normal rate. This state s called heart block.

Vector cardiography

In electrocardiography, only the voltage generated by the electrical activity of the heart is recorded. In vector cardiography, the cardiac vector is displayed with its magnitude and spatial orientation.

Echocardiography

Echocardiography is a useful technique for diagnosis of heart diseases.. By changing the position of transducer, we can get reflections from the desired areas on the heart. An aqueous get is used to couple the transducer to the skin and the beam from the transducer. The time compensated signal amplifier is used to collect the low amplitude signals with same signal to noise ratio. Then these amplified signals are given to the cathode ray tube display unit.

A – Mode display

In amplitude mode or A - mode display, the echoes produce vertical displacements of a horizontal trace on the screen. The amount of vertical displacement is proportional to the strength of echo and the distance along horizontal trace represents the time taken by ultrasound to travel through tissue. Since the heart is moving,

echoes dance up and down during cardiac cycle.

B – Mode display

In brightness mode or B – mode display, the echoes are rotated through 90^0 towards the observer and so the echoes are presented as dots of light. The distance between dots represents the tissue depth. When echoes are from moving structure, dot's of light move back and forth.

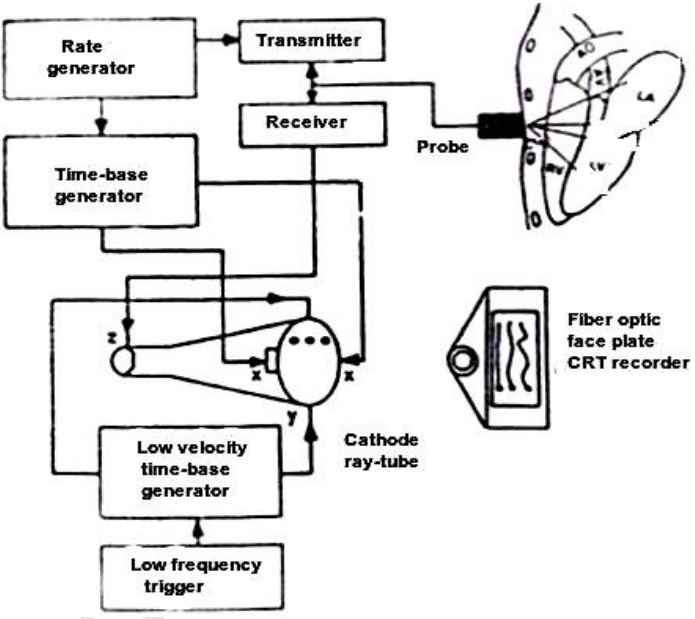


Fig.1.26: Block diagram of Echocardiograph and the typical Echocardiograms M – Mode display

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

In time – motion mode or m – mode Display, B – mode echo signal is recorded either by sweeping the oscilloscope screen or photographing the oscilloscope face on moving paper. In the conventional m – mode display time is on the x – axis distance on y – axis and intensity of echo is on z – axis

In echocardiogram the hill and valley regions indicate the working heart. A rapid b – mode scan of heart is known as real time

scan which is also called cross sectional or 2- D echocardiography.

PHONOCARDIOGRAPHY (PCG):

The graphic record of the heart sounds is called —Phonogram. Since the sound is from the heart, it is called phonocardiogram. The instrument used to measure the heart sounds is called phonocardiograph.

1) Heart sounds
2) Murmurs

Heart sounds have a transient character and are of short duration. Heart murmurs have a noisy characteristic and last for a longer time. Heart sounds are due to the closing and opening of valves whereas murmurs are due to turbulent flow of blood in the heart and large vessels.

Heart sounds

Heart sounds are classified into four groups based on their origin. They are

1) Valve closure sounds
2) Ventricular Filling sounds
3) Valve opening Sounds
4) Extra cardiac sounds

1) Valve Closure Sounds

The sounds occur at the beginning of systole (First heart sound) and the beginning of diastole (Second heart sound). The first heart sound is due to the closure of mitral and tricuspid valves. The second heart sound is due to the closure of aortic and pulmonary valves.

2) Ventricular filling sounds.

These sounds occur either at the period of rapid filling of the ventricles (Third heart sounds) or during the terminal phase of ventricular filling (ie) atrial contraction. These sounds are normally in audible.

3) Valve opening sounds

They occur at the time of opening of atrio – ventricular valves and semilunar valves.

4) Extra cardiac sounds

They occur in mid (or) late systole (or) early diastole. They are caused by thickened pericardium which limites ventricular distensibility.

Physical characteristics of sound

Heart sounds and murmurs are characterized by three physical properties. They are

1) Frequency

2) Amplitude

3) Quality

1) Frequency: All heart sounds and murmurs are made up of frequencies between 10 and 1000 Hz. They are divided into low, medium and high- pitch frequencies

i) Low range: 10 – 60 Hz. It is represented by the third and fourth heart sounds.

ii) Medium range: 60 – 150 Hz. It is represented by the first and second heart sounds.

iii) High range: 150 – 1000 Hz. It is represented by snaps, clicks and diastolic murmurs of aortic and pulmonary insufficiency.

1) Amplitude: Low frequency heart sounds have the biggest amplitude while the high frequency murmurs have small amplitudes.

2) Quality: quality depends upon the overtones (or) harmonics accompanying the fundamental frequency and applies to tones.

Origin of the heart sounds.

There are four separate heart sounds that occur during the sequence of one complete cardiac cycle.

1) First heart sound: It is produced by a sudden closure of mitral and tricuspid valves associated with myocardial contraction.

a) Timing: The low frequency vibrations occur approximately 0.05 sec after the onset of QRS complex of ECG.

b) Duration: It lasts for 0.1 to 0.12 sec.

c) Frequency : The first heart sound range from 30 – 50 Hz

d) Asculatory area: The first heart sound is best heard at the apex of the mid pericardium.

2) Second heart sound: It is due to the closure of semi lunar valves

(ie) the closure of aortic and pulmonary valves

a) Timing: The second heart sound start approximately 0.03 – 0.05 sec after the end of _T'wave of ECG.
b) Duration : 0.08 – 0.14 sec
c) Frequency : 250 Hz
d) Asculatory Area: It is best heard in the aortic and pulmonary areas.

3) Third heart sound: It arises as the ventricles relax and the internal pressure drops well below the pressure in atrium.

a) Timing: It starts at 0.12 – 0.18 sec after onset of second heart sound.
b) Duration : 0.04 – 0.08 sec
c) Frequency : 10 – 100 Hz
d) Asculatory Area: It is best heard at the apex and left lateral position after lifting the legs.

4) Fourth heart sound: Also called as atrial sound. It is caused by an accelerated flow of blood into the ventricles or due to atrial contraction. It occurs immediately before the first heart sound.

a) Timing : it starts at 0.12-0.18 sec after the onset of p-wave
b) Duration :0.03-0.06 sec
c) Frequency :10-50 Hz
d) Ausculatory Area: Because of its low frequency, it is inaudible

Heart murmurs

Murmurs are sounds related to non – laminar flow of blood in the heart and the great vessels.

They are distinguished from heart sounds such that

1) They have noisy character.
2) They have longer duration
3) They are high frequency components upto 1000 Hz.

Typical conditions in cardiovascular system which cause turbulence in blood flow.

1) Local obstructions to blood flow
2) Abrupt change in blood stream diameter.
3) Pathologic communication in cardiovascular system

4) Ruptured cardiac structures.
5) Valve insufficiency.

Transduction of heart sound

The sounds and murmurs originate from the heart which can be picked up from the chest using a stethoscope or by transduction of sound into electrical signals. The heart sounds are conducted from the heart to the cheat.

Recording setup:

The heart sounds are converted into electrical signals by means of a heart microphone. The electrical signals from microphone are amplified by a phonocardiographic preamplifier followed by

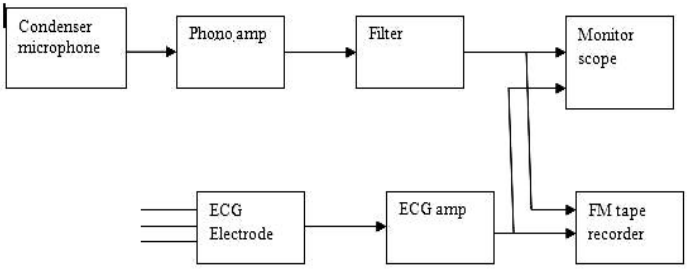


Fig.1.27: Block diagram of recording setup
[Source: Leslie Cromwell Biomedical instrumentation and measurement]

The electrodes are placed on the limbs to pickup the electrical activity of heart and these signals are amplified and recorded. This recorded ECG is used as a reference for PCG.

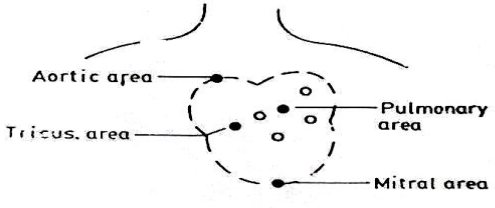


Fig1.28: Placement of Microphone on Different Areas of the chest for Recording PCG Heart Sound Microphone
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The conversion of heart sounds into electrical signals can be done using transducers. Via condenser microphone, moving coil microphone etc. The two main categories of microphones used in P G are

1) The air coupled microphone
2) The contact microphone.

In the first case, the movement of chest is transferred via on air cushion and presents low mechanical impedance to chest.

$$C = Q/V$$

The vibrations produced by chest wall change the position of diaphragm which results in the change in voltage across electrode. The developed dc voltage is in the order of few mV. Relationship between heart and function of cardiovascular system

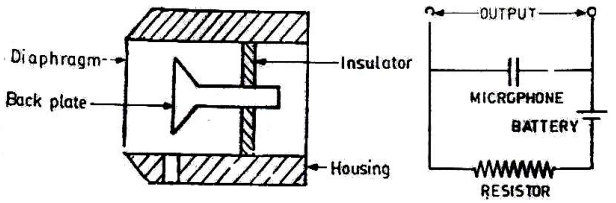


Fig 1.29: Condenser Microphone along with its Circuit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

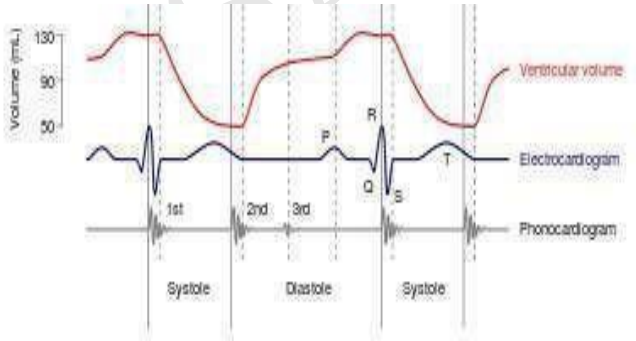


Fig 1.30: ECG waveform vs PCG
[Source: Leslie Cromwell - Biomedical instrumentation and measurement] waveform Medical Applications

Rheumatic Valvular Lesions

Valvular lesions results from rheumatic fever. Rheumatic

fever is an allergic disease in which heart valves are damaged. This can be detected by phonocardiograph.

Fig (a) shows the normal heart sounds

The valvular lesions cause the abnormal heart sounds as given below

1) The murmur of aortic steonosis
2) The murmur of aortic regurgitation
3) The murmur of mitral regurgitation
4) The murmur of mitral stenosis

Special applications of phonocardiogram

1) Fetal phonocardiogram
2) Esophageal phonocardiogram
3) Tracheal phonocardiogram

ELECTRO ENCEPHALO GRAPHY (EEG)

EEG deals with the recording and study of electrical activity of brain. The brain waves can be picked up and recorded by means of electrode attached to the skill of a patient. Brain waves are the summation of neural depolarization in the brain due to stimuli from five sense and thought process.

1) Anatomy of brain

The brain consists of three major parts such as cerebrum, cerebellum and the brain stem.

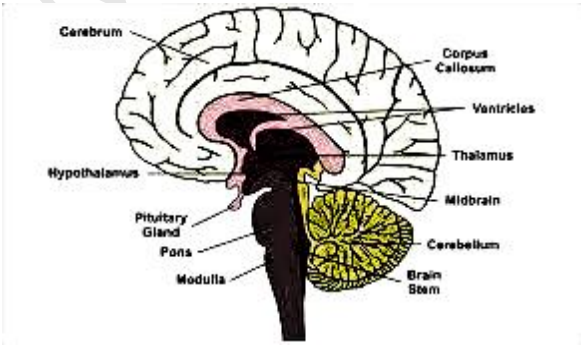


Fig 1.31: Internal structure of Human brain [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Cerebrum consists of two hemispheres and the hemispheres are divided into frontal lobe, parietal lobe, occipital lobe and temporal lobe.

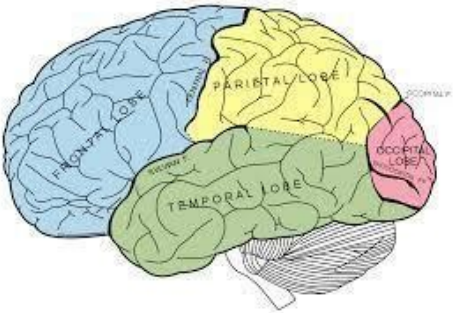


Fig 1.32: Human Brain
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

2) Action Potentials of Brain:

When the propagated action potential reaches the cell, the cell fires and thus a spike wave is produced. This firing spreads throughout the dendritic branches and causes the release of transmitter substances.

Inhibitory Post Synaptic Potential (PSP)

If the transmitter substance is inhibitory, membrane potential of receptor neuron increases in a negative direction. It is less likely to discharge; this induced potential charge is called an IPSP.

Excitatory Post Synaptic Potential (EPSP)

If the transmitter substance is excitatory, receptor membrane potential increases in a positive direction.

Evoked potentials

Evoked potential are the potentials developed in the brain as the responses to external stimuli like sound, light etc..

3) Brain waves

Brain waves are the recorded electrical potentials on the surface of brain. The intensity and patterns of electrical activity are determined by the overall level of excitation of brain.

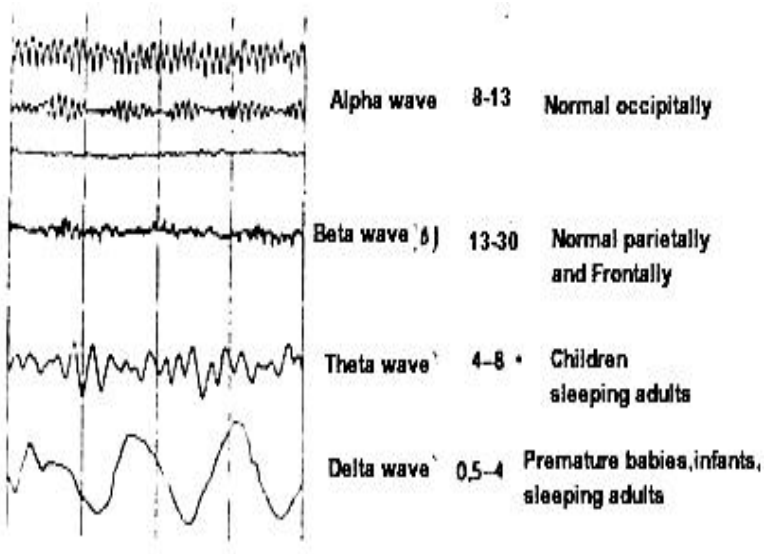


Fig 1.33: Brain Waves [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Alpha waves

Frequency: 8 – 13 Hz

Occurrence: They found in normal persons when they are awake in a quiet, state. They occur normally in occipital region. During step, these disappear

Beta waves

Frequency: 13 – 30 Hz

Occurrence: These are recorded from parietal and frontal regions of scalp two types: - Beta I – Inhibited by cerebral activity

Beta II – Excited by mental activity (tension)

Theta waves

Frequency: 4 – 8 Hz

Occurrence: These are recorded from parietal and temporal regions of scalp of children.

Delta waves

Frequency: 0.5-4Hz

Occurrence: These occur only in every 2 or 3 sec. These occur in deep

sleep in premature babies and in very serious brain disease.

4) Placement of electrode

In EEG, electrodes are placed in standard positions on skill in an arrangement called 10 – 20 system. The electrodes are arranged as follows.

1) Draw a line on the skull from the nasion, the root of nose, to the inion, ossification center on occipital lobe.

2) Draw a similar line from the left preauricular (ear) point to the right preauricular point.

3) Mark the intersection of two lines as Cz which is the midpoint of distance nasion and inion.

4) Mark points Fpz, Fz, Cz, Pz and Oz at 10, 20, 20, 20, and 10% of total nasion – inion distance.

5) Mark points T_3, C_3, Cz, C_4, and T_4 at 10, 20, 20, 20 and 10% of total distance between preauricular points.

6) Measure the distance between Fpz and Oz along the circle passing through T_3, and mark points as Fp_1, F_7, T_3, T_5, and O_1 at 10, 20, 20, 20 and 10% of this distance.

7) Repeat this procedure on right side and mark the positions as Fp_2, F_8, T_4, T_6, and O_2.

8) Measure the distance between Fp_1, and O_1 along the circle passing through C_3 and mark point as F_3, C_3, and P_3 at 25% intervals.

9) Repeat this procedure on right side and mark as F_4, C_4 and P_4.

10) Check that F_7, F_3, Fz,F_4 and F_8 are equidistant along transverse circle passing through F_7, Fz, and F_8 check that T_5, P_3, Pz,P_4, and T_6, are equidistant along transverse circle passing through T_5, P_z, & T_6

Pg_1 AND Pg_2 are nasopharyngeal electrodes and A_1 and A_2 are ear electrodes.

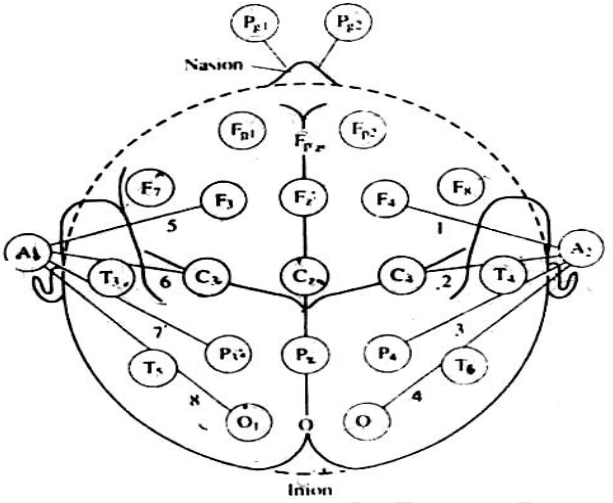


Fig 1.34: Placement of lectrodes on the Scalp for the EEG Recording
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Pg_1 AND Pg_2 are nasopharyngeal electrodes and A_1 and A_2 are ear electrodes. The electrode systems are used to facilitate the location of foci, (ie) cortical areas from which abnormal waves spread.

5) Recording Setup

In EEG recording setup, there are and drive amplifier whose gain can be increased by cascading several stages. The patient cable consists of 21 electrodes and is connected to the eight channel selector. The electrodes are attached to the channel selector in groups of eight called a montage of electrodes. The interference is reduced by employing differential amplifiers as preamplifiers.

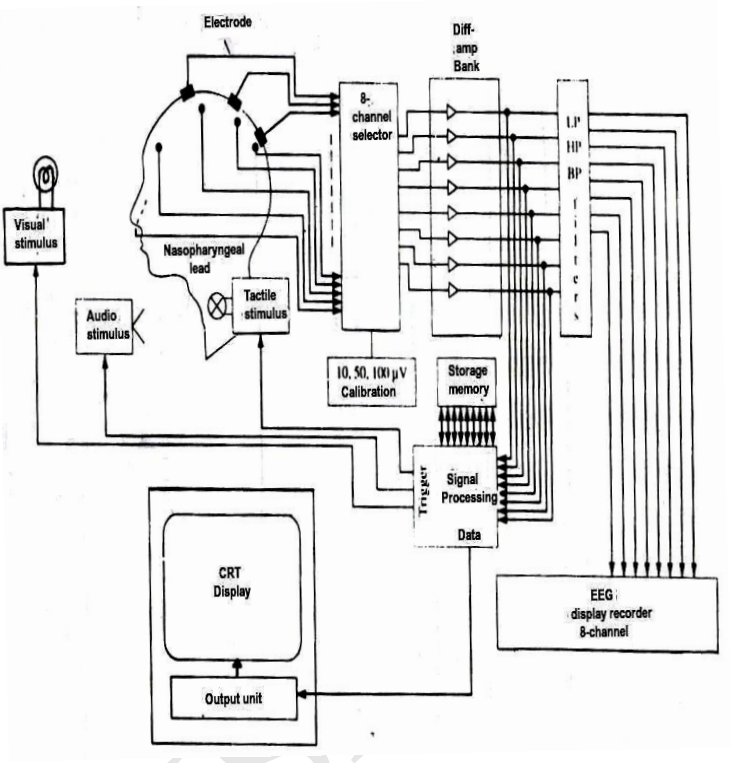


Fig 1.35: Fig: Modern EEG Unit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

EEG unit is covered with ferrous metal screen to reduce a,c interference.

The filter bank consists of appropriate filters to select different types of brain waves. Visual stimulus, Audio stimulus and tactile (touch) stimulus are used to record evoked potentials from sensory parts of brain. The time delay between stimulus and response can be measured in the signal processing unit.

6) Analysis of EEG

EEG helps physicians to diagnose the level of

consciousness, sleep disorders, brain death, brain tumors, epilepsy etc.

i) Level of consciousness

EEG changes with the level of consciousness. Diminished mental activity results in a lower frequency and large amplitude EEG wave.

REM means Rapid Eye Movement. REM sleep coincides with the periods of dreaming. EEG displays the characteristic features during the application of anaesthesia.

If the tumor displays the cortex and if it is large enough, the electrical activity will be absent since no electric potentials originate in the tumor. Thus a damped EEG over the cortex can be a sign of a tumor.

iii) Epilepsy

Epilepsy is a symptom for brain damage. It may due to defects in birth delivery or head injury during accident or boxing. It may also be due to brain tumor. Epilepsy is divided into two types.

1) Grandmal

2) Peritmal

1) Grandmal

Before grandmal attack, the patient recognizes a set of symptoms such that he sees a flash of light if grandmal arises from visual center .He hears a noise if it arises from acoustic center. It extends from few sec to several min

2) Peritmal

In peritmal attack, spike type waves are produced with a frequency 3 Hz. It lasts for 1– 20 sec.

Application

(i) Epilepsy – EEG is very helpful to find acuteness of epilepsy.

(ii) Anesthetic level – It is helpful to find the depth of intensity of anesthesia

(iii) Brain injury – If there is a scar on the cerebral cortex, it creates irrigative effect on the nearby healthy cortex. It is identified by EEG waveform.

(iv) Monitor during surgery – Doctor to find patient's conditions.

(v) Effect of Yoga – Identified by EEG for a normal person initially EEG in recorded.

The person has to do yoga for some time. After some period, once again EEG recorded for same person. Then it is compared with previous wave form different gives the effect of yoga.

ELECTRO MYO GRAPHY (EMG)

Electromyography is the science of recording and interpreting the electrical activity of muscle's action potential. The recording of peripheral nerve's action potentials is called electroneurography.

Recording Setup

The surface electrodes or needle electrodes pickup the potentials produced by the contracting muscle fibers. The surface of the skin cleaned and electrode paste is applied.

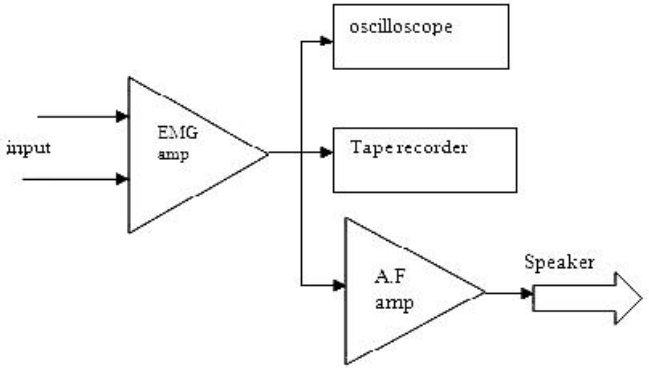


Fig 1.36: Block Diagram for EMG Recording Setup [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The needle electrode picks up the action potentials from selected nerves or muscle. Further to record the action potentials from a signal nerve, microelectrodes are used.

The amplitude of EMG signals depends upon the type and placement of electrodes used. Surface electrode picks up many overlapping spikes and produces an average voltage from various muscles.

The amplifier should have uniform frequency response, high CMRR and high input impedance. The signal is also recorded in the tape recorder for further reference.

Determination of conduction velocities in motor nerves.

The measurement of conduction velocity is used to indicate the location and type of nerve lesion.

The EMG electrode and stimulating electrode are placed at two points on the skin, separated by a known distance l_1. An electrical pulse is applied through the stimulating electrode. The latency is now measured as t_2 seconds. The conduction velocity is

$$U = l_1 - l_2 / t_1 - t_2$$

The conduction velocity in peripheral nerves is normally 50 m/s. when it is below 40 m/s, there is some disorder in nerve conduction.

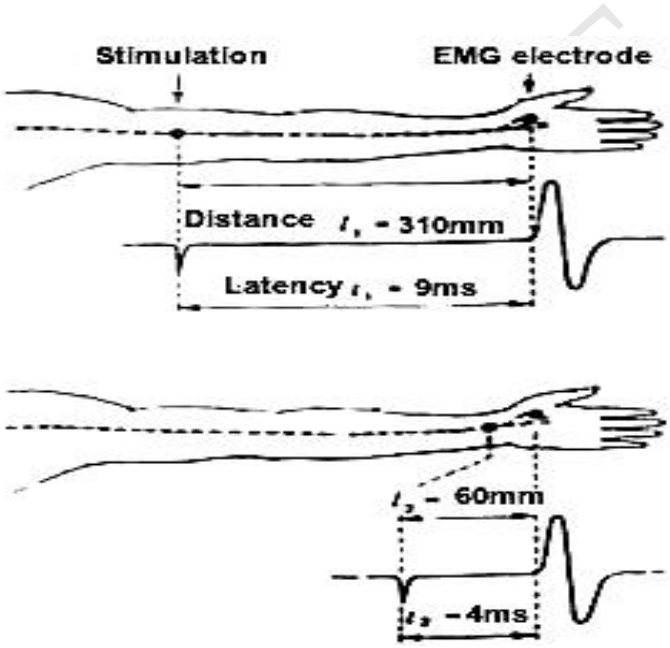


Fig 1.37: Determination of Conduction Velocity in a Motor Nerve [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

ELECTRO OCULO GRAPHY (EOG)

A recorder of corneal – retinal potentials associated with eye movements is called electrooculogram. It is simpler to recorder then electroretinogram.

The electrodes are placed as shown in Fig one pair of skin electrodes on either side of eye for recording of horizontal movement of eyes and another pair of electrodes on for head and checks for recording for vertical movement of eyes. This electrodes position methods reduces the cross coupling between the vertical and horizontal pair of electrodes.

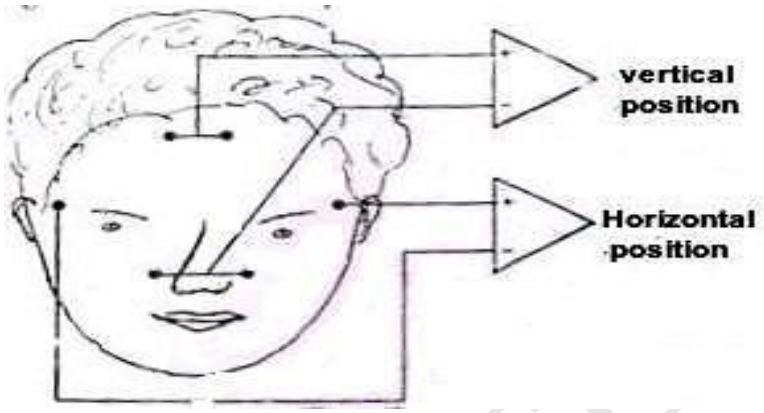


Fig 1.38: EOG measurement
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

A commonly observed artifact in EOG recording of vertical eye movements has being attributed to the motions of upper eyelid. Some diseases which affect the steady potential the eye can be studied using EOG.

i) The effect of certain drugs on the eye movement system can determined.
ii) The state of the semicircular canals is analysis by EOG.
iii) Diagnosis of the neurological disorders
iv) The level of anesthesia can be indicated by the eye movements.

UNIT II

BIO CHEMICAL NON ELECTRICAL PARAMETER MEASUREMENT

P^H,PO_2, PCO_2, $PHCO_3$, Electrophoresis, colorimeter, photometer, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, temperature, pulse, Blood cell counters, Blood pressure

CHEMICALELECTRODE

P^H Electrode:

Chemical balance of the human body in identified by the measurement of p^H content of blood and other body fluids. P^H is defined as the logarithmic of reciprocal of H^+ ion concentrations.

$$P^H = \log_{10} 1 /[H^+]$$

$$= - \log_{10} [H^+]$$

Neutral solution has a p^H value of 7. If $p^H < 7$, it is acidic, $p^H > 7$ it is basic.

Glass electrode advantages (over hydrogen electrode):

It is independent of oxidation – reduction potential. It is not necessary to pass the gas through the solution i.e equilibrium condition is reached rapidly.

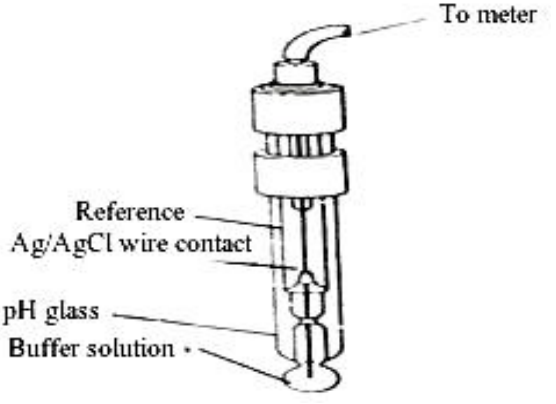


Fig 2.1: P^H Electrode
:[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The oxygen electrode is a piece of platinum wire embedded in an insulating glass holder with the end of the wire exposed to the electrolyte solution into which oxygen is allowed to diffuse through the membrane

Advantages

- The oxygen electrode is also used to monitor the partial pressure of oxygen in biological fluids.
- It is available in integrated version consisting of platinum electrode and reference electrode in the same enclosure called Clark electrode.

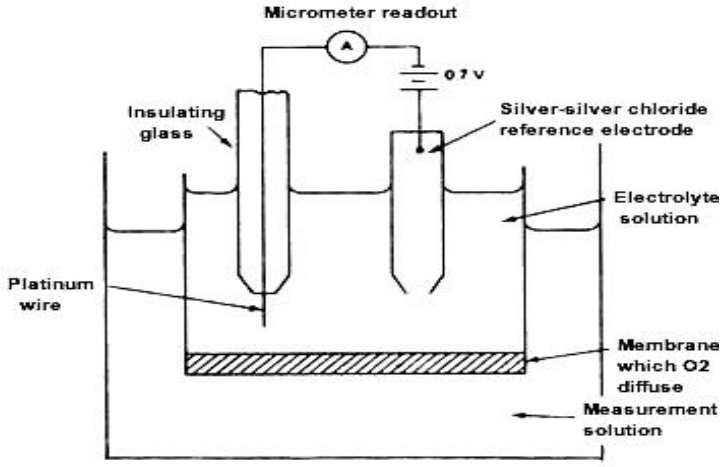


Fig 2.2: PO_2 Electrode [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

PCO2 Electrode:

It consists of a standard glass P^H electrode covered with rubber membrane permeable to CO_2.Between the glass surface and membrane there is a thin film of water. The solution under test contains dissolved CO_2 is presented to the outer surface of rubber membrane. After equilibrium P^H of aqueous film is measured by glass electrode and interpreted interms of PCO_2.

ELECTROPHORESIS

Devices based on electrophoretic principles are used in the

clinical laboratory to

- Measure the proteins in plasma, urine and CSF
- Separate enzymes into their component is enzymes
- Identify antibodies
- Serve in a variety of applications.

Basic Principle Definition

Electrophoresis may be defined as the movement of a solid phase with respect to a liquid (buffer solution)

Zone Electrophoresis

In this technique, the sample is applied to the medium. Under the effect of electric field, groups of particles that are similar in charge, size and shape migrate at similar rates.

(i) Magnitude of Charge

The mobility of a given particle is directly related to the net magnitude of particles charge. Mobility is defined as ―the distance in cm a particle moves in unit time per unit field strength expressed as voltage drop per centimeter‖.

$$\text{Mobility} = cm^2/(v.s)$$

(ii) Ionic strength of Buffer

The more concentrated the buffer, slower the rate of migration of particles.

(iii) Temperature

Mobility is directly related to temperature. The flow of current through the resistance of the medium produces heat. This heat has two important effects on electrophoresis.

(iv) Time:

The distance of migration is directly related to the time the electrophoresis takes.

(v) Types of Support Media.

A variety of support media such as paper, cellulose acetate starch gel, agar gel and sucrose are used in various electrophoretic applications.

Cellulose Acetate Electrophoresis

It is used extensively in clinical laboratories. The cellulose acetate strip is saturated with the buffer solution and placed in the

membrane holder (‘bridge‘).

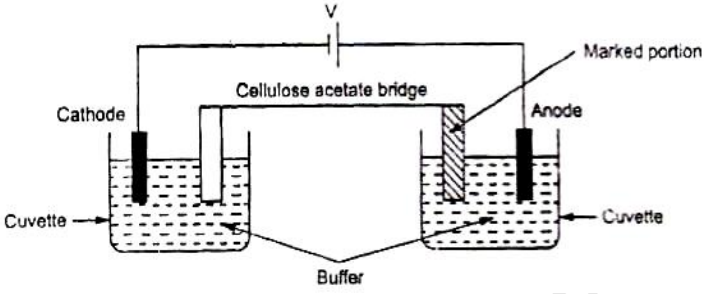


Fig 2.3: Cellulose Acetate Electrophoresis [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The current increases slightly and after 15-20 min, the electric voltage is removed. The membrane is dried in preparation for densitometry.

PHOTOMETERS AND COLORIMETERS

They are used to measure the transmitted and absorbed light as it passes through a simple. The colorimeter uses light absorption to determine blood proteins and iron levels.

$$\text{Transmittance } T = \frac{1}{I_0}$$

Where I_1 → Transmitted light intensity

I_0 → Incident light intensity

By measuring optical density or absorbance _A‘the concentration of given substance in the sample can be determined. When a diffraction grating or prism is used as a monochromator to get different spectral components or wavelengths is the colorimeter, and then it is called spectrophotometer. There are filter fluorometer and spectrofluoremeters depending on whether filters or monochromators are used to select the emission wavelength.

Filter Photometer (Colorimeter)

It is used to measure transmittance. Light from a halogen lamp is incident on a filter F. The divergent transmitted light is converted into two parallel beams by an optical arrangement.

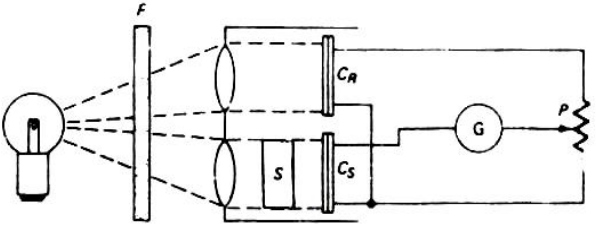


Fig 2.4: Filter Photometer [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

One beam falls on a reference selenium photoelectric cell C_R and other beam falls on a sample selenium photoelectric cell Cs after passing through sample in the cuvette. Without the sample, outputs from photoelectric cells are the same.

Spectrometer:

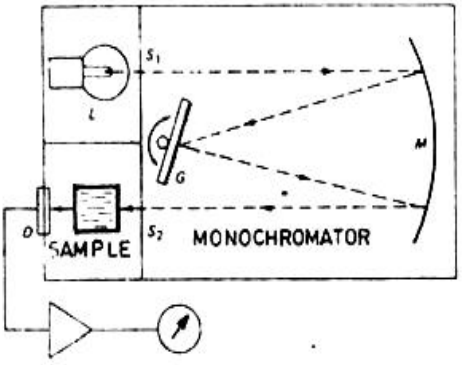


Fig 2.5: Spectrometer [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Light from a halogen lamp is passed through an entrance

slit s1 and incident on a concave reflector which focuses the light on a diffraction grating _G'to disperse light. The dispersed light is allowed to incident on the reflector. Then the light beam is directed to the sample through a narrow exit slit s2.

Flame Photometer:

A flame photometer is used to analyze urine or blood in order to determine the concentration of K, Na, Ca, and Li. Lithium is used as a calibration substance in analysis of other three substances. A known amount of lithium is added to the sample and the emitted light intensity is measured relative to that of lithium.

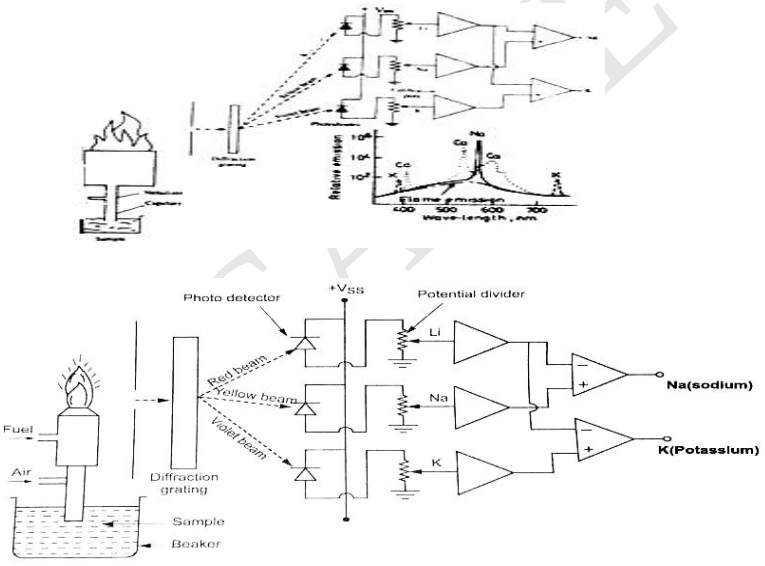


Fig 2.6: Flame Photometer [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

By this way, any error due to varying flame temperature is eliminated. Using an atomizer, liquid sample is sprayed into fine droplets by passing oxygen or air to it.

K : 4047 A^0, Na : 5890 A^0, Li : 6703 A^0

Separate photo detector is used for each channel. The photodetctor circuit consists of a reverse biased diode in which current flow increases as the intensity of light increases. Flame

photometer has many advantages such as fast response, high accuracy and lesser cost of equipment. But its sensitivity is smaller than fluorometer.

Filter Fluorometer:

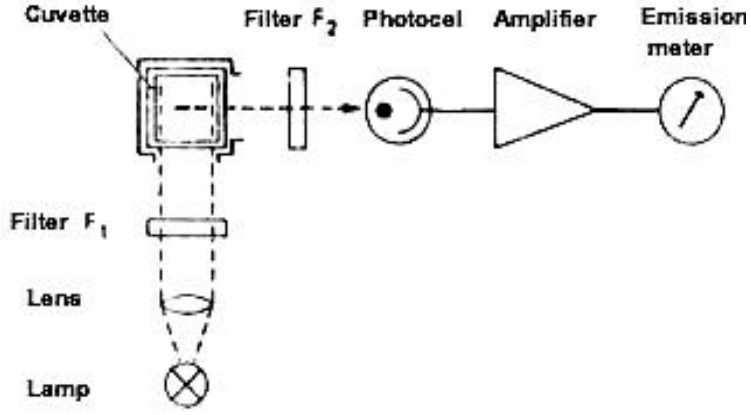


Fig 2.7: Filter Fluorometer [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Flurometer is carried out by illuminating the sample with a lower wavelength light, normally UV light and then measuring the fluorescent light intensity which is at higher wavelength. It is used only when the substances are available in lower concentration (eg) certain hormones and vitamins. Light from a light source is made parallel by a convex lens and passed through a filter F1.

Chromatography:

Chromatography is a technique used for separating closely related chemical substances. It is based on differences in the migration velocity of the substances between a stationary phase and a mobile phase. The difference is due to a difference in solubility in two phases. Depending upon the nature of mobile phase, there are

- Liquid chromatography which uses liquid mobile phase
- Gas chromatography which uses gas mobile phase.

Liquid chromatography is used to analyse amino acids and composition of drugs. Gas

Chromatography is used to anayse steroids and aromatic acids.

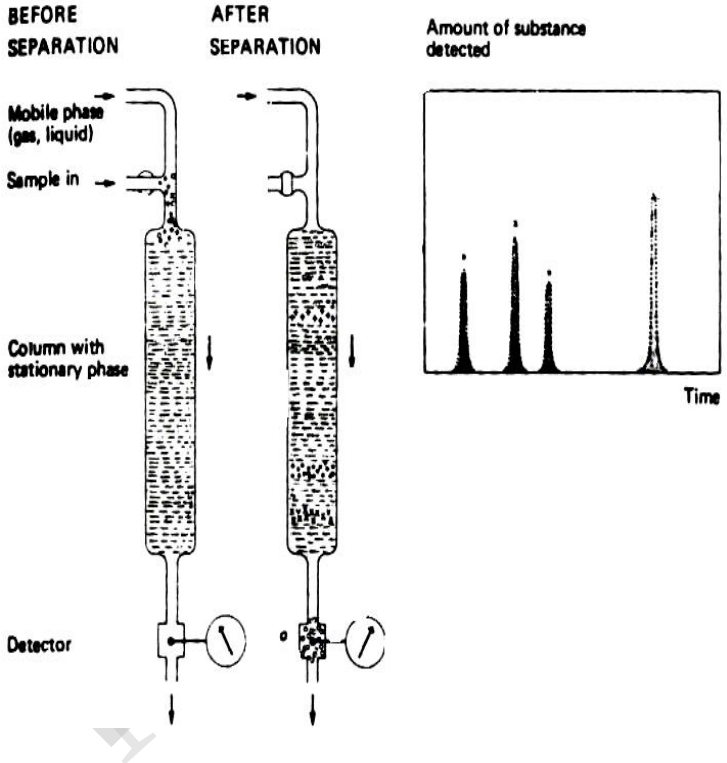


Fig. 2.8: Basic Principle of Chromatography [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The sample is added with the mobile phase gas or liquid flow. The components in the sample travel with different velocities depending on their solubility in the stationary phase.

Radionuclide methods for evaluating the function of various organs:

Radionuclide methods are used for the diagnosis of thyroid gland and real function. Thyroid gland takes up a large amount of iodine entering the body. Any disturbances of the thyroid cland

change the iodine uptakes. This fact is used to evaluate the degree of disturbance. An oral dose of I^{131} is given as sodium iodide. After 24 hours, the amount of radioactivity is measured by scintillation counter. Only the radiation emitted by I^{131} is counted by using a pulse height discriminator and counter.

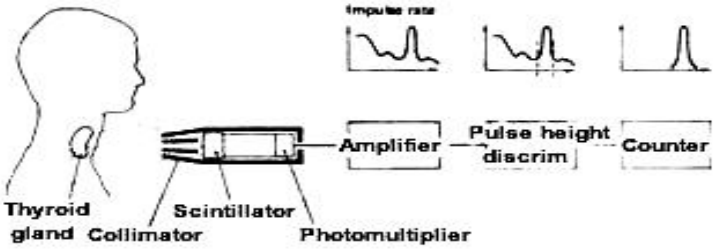


Fig 2.9: Radionuclide Methods for Evaluating the Thyroid Gland

Function [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

AUTOANALYZER (AUTOMATION OF CHEMICAL TESTS)

Most chemical tests consist of simple steps like pipetting, diluting and incubating. These are time consuming and require skilled technicians to avoid the errors. To replace the technicians by an automatic device, the first automatic analyse was found and still used at most hospitals.

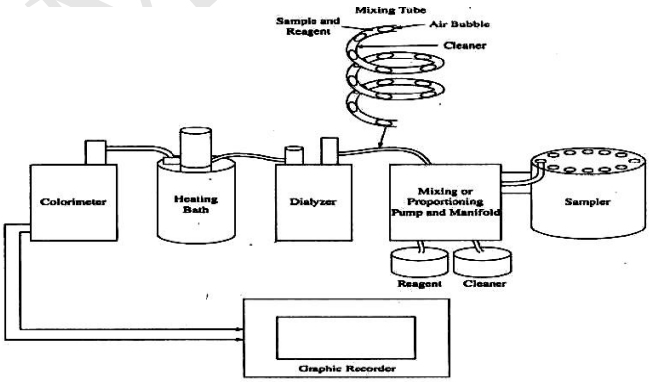


Fig 2.10: Continuous Flow Analyzer

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

BLOOD FLOW METERS

Blood flow meters are used to monitor the blood flow in various blood vessels and to measure the cardiac output .Electromagnetic flow meters

All blood flow meters are based on one of the following physical principle.

(1) Electromagnetic induction
(2) Ultrasound transmission or reflection
(3) Thermal convection
(4) Radiographic principles
(5) Indicator (dye or thermal) dilution

Magnetic Blood Flow Meter:

They are based on the principle of magnetic induction. When an electrical conductor is moved through a magnetic field, a voltage is induced in the conductor proportional to the velocity of its motion.

The voltage inducted in the moving blood column is measured with stationary electrodes located on opposite sides of blood vessel and perpendicular to direction of magnetic field.

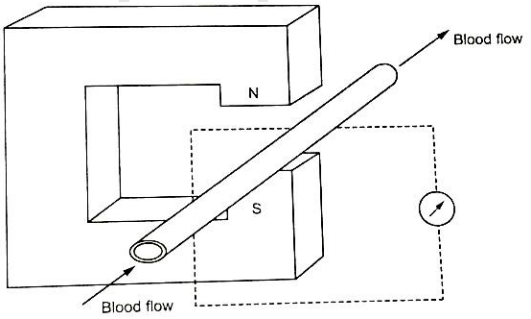


Fig 2.11: Magnetic Blood Flow Meter Principle [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The oscillator drives the magnet and provides a control signal for the gate, operates at a frequency between 60 & 400Hz.The gated detector makes the polarity of output signal reverse when the

flow direction reverses.

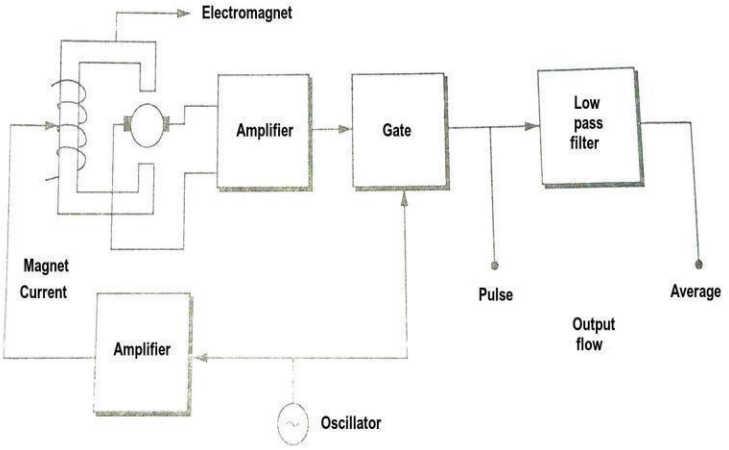


Fig 2.12: Block Diagram of Magnetic Blood Flow

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Meter Ultrasonic Blood Flow Meters:

In this, a beam of ultrasonic energy is used to measure the velocity of flowing blood. The two different ways are:

(i) Transmit time ultrasonic flow meter

(ii) Doppler type

Transmit Time Ultrasonic Flow Meter:

A pulsed beam is directed through a blood vessel at a shallow angle and its transit time is measured.

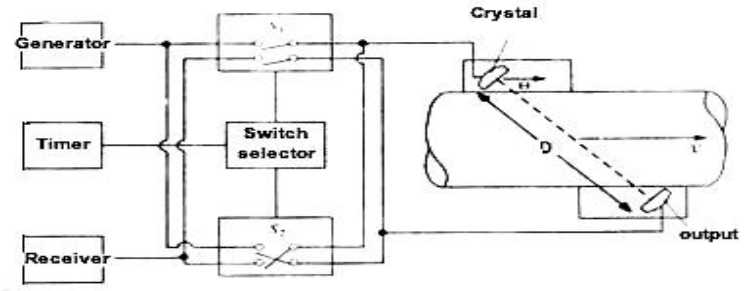


Fig 2.13: Transmit Time Ultrasonic Flow Meter

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

A piezoelectric crystal emits a pulse of ultrasound which propagates diagonally across the blood vessel. If the flow is in same direction as the pulse then the pulse reaches a receiving crystal situated on the opposite side wall of the blood vessel. Electronics circuit convert change in transits time to velocity.

D - Distance travelled by sound waves (or) Distance between transmitter and receiver ultrasonic waves.

T_D- Downstream transits time, V-velocity of blood flow, C-ultrasound velocity Ultrasonic velocity in downstream $C+V \cos\Theta = D/ T_D$

Ultrasonic velocity in up stream

$C - V \cos\Theta = D/T_U$

Difference in transist time

$\Delta T = T_U - T_D$

$V = \Delta T\ C / 2D \cos\Theta$

Thus blood flow velocity determining difference between upstream and downstream transit time.

Doppler type Ultrasonic Blood Flow Meter:

Ultrasonic flow meters are based on the Doppler principle.

An oscillator operating at a frequency of MHZ excites a piezoelectric transducer. This transducer is coupled to the wall of exposed blood vessel and sends an ultrasonic beam with frequency F into flowing blood.

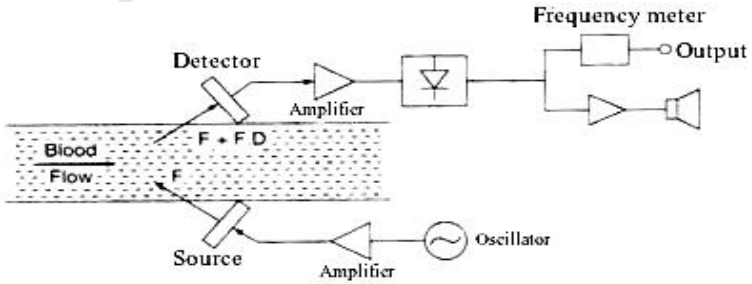


Fig 2.14: Doppler type Ultrasonic Blood Flow Meter [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Flick's Method:

This is based on the determination of cardiac output by the analysis of gas-keeping of the organism.

$I = C_A Q - C_V Q$

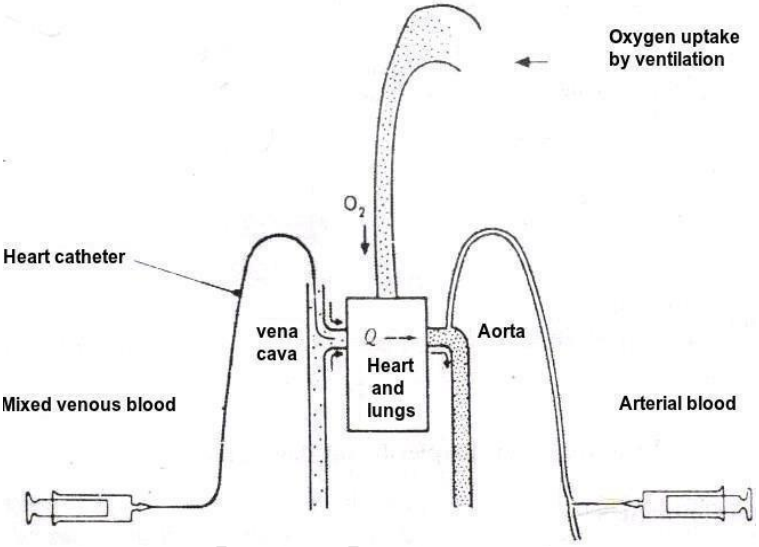


Fig: 2.15 Flick's Method

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Indicator Dilution Method:

This is based on the principle that if we introduce an indicator in the blood circulation and then measuring the concentration of indicator with respect to time. We can estimate the volume flow of blood. Let M mg of an indicator is injected into the right heart.

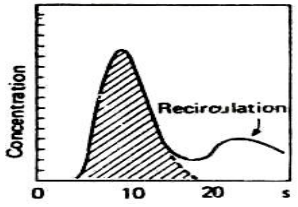


Fig. 2.16 Dilution Curve

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

During the first circulation period, the indicator would mix up with the blood in a small quantity. After that there is a rapid change of concentration. This is shows by rising portion of dilution curve. After reaching maximum, the concentration of indicator decreased exponentially.

Thermo Dilution Method

Now-a-days thermo dilution method is adapted to measure cardiac output.

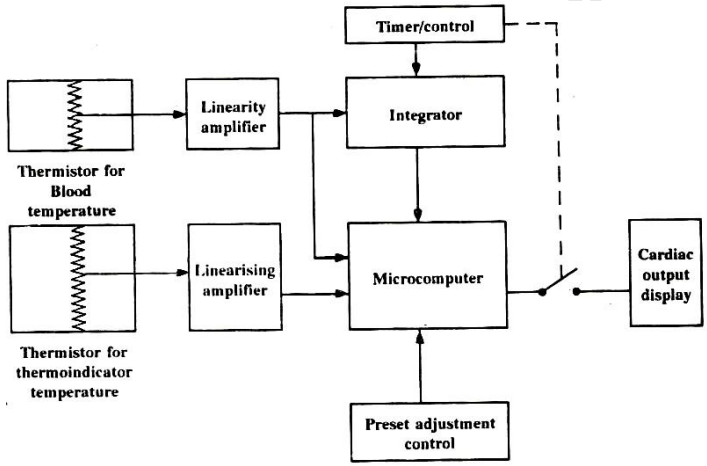


Fig. 2.17 shows the block diagram of thermo dilution system [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

A linear relation between temperature and resistance of the thermistor can be obtained by connected a parallel resistor with it. Then the line arising amplifier works. Integrator delivers the value of integral of blood temperature change over a given time. By feeding data about p, s, Q and thermal indicator, the computer can deliver the cardiac output in lit/min.

Measurement of cardiac output by impedance change.

By the impedance method, the cardiac output can be determined electronically. L probes method is adopted here.

The electrode pair 1 & 4 is used as current electrodes.

The electrode pair 2 & 3 is used to pick up the voltage across the thorax

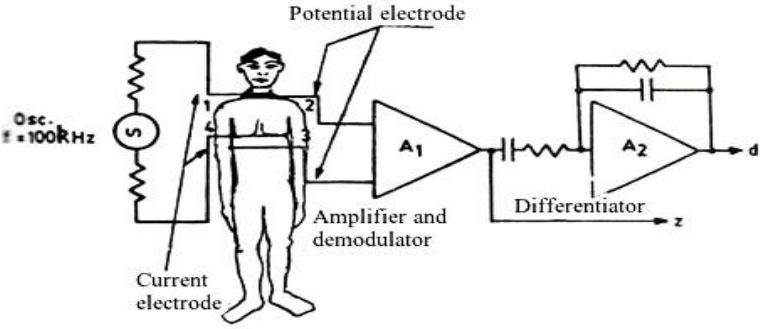


Fig 2.19: Measurement of Cardiac Output by Impedance Change
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Advantages of Cardiac Output Measurements.

Indicator dilution is more useful when there is no severe heart defect. Here the diagnostic information can be obtained from the changes in the shape of dilution curve.

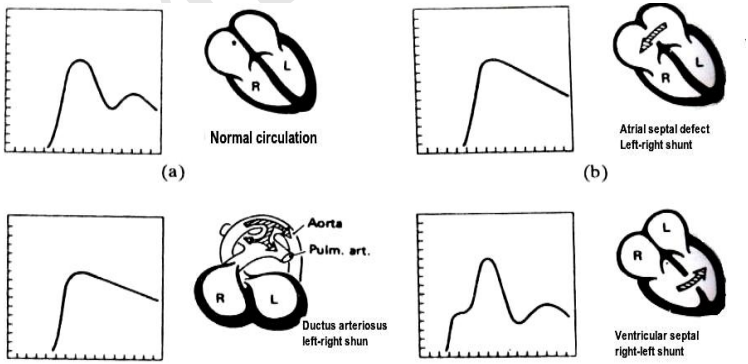


Fig. 2.20 shows the normal curve corresponding to normal circulation of blood.
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Fig (b) shows article output defect where blood flows internally

from left atrium to right atrium.
Fig (c) shows ductus arterisus. Here blood flows from aorta to pulmonary artery.

PULMONARY FUNCTION ANALYSIS (RESPIRATORY MEASUREMENT)

They are used to evaluate the state of lungs or respiratory process. The three basic types of measurement are ventilation, distribution and diffusion.

Ventilation:

Ventilation deals with the determination of the ability of body to displace air volume quantitatively and the speed with which it moves the air. Spirometers are used in the ventilation measurement.

Lung volumes and capacities

Pulmonary function analyzers are used to determine the lung volumes and capacities. These parameters depend on individual's physical characteristics and condition of breathing mechanism.

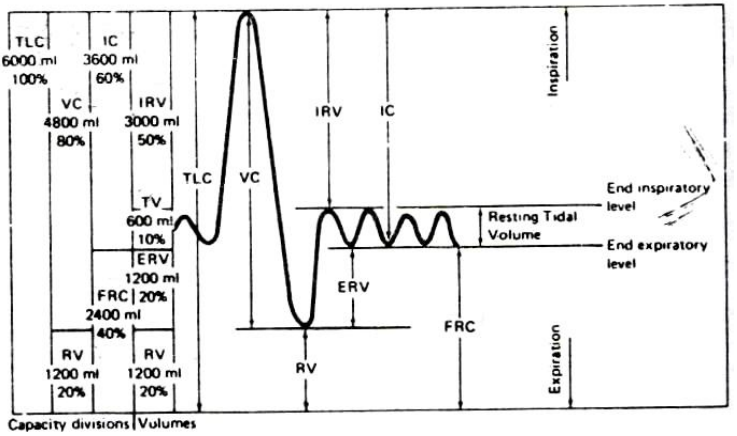


Fig 2.21 Lung Volumes and Capacities [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

IC→ Inspiratory Capacity. It is the volume of gas remaining in the lungs at the end of expiratory level. FRC→ Functional Residual Capacity. FVC and FEV are some of the forced

breathing tests used to assess the muscle power.

FVC → Forced Vital Capacity
FEV → Forced Expiratory Volume

FVC is the total amount of air that can forcibly be expired as quickly as possible after taking the deepest possible breath. FEV is the maximum amount of gas that can be expelled at the given time.

Spirometer:

It is used to measure the respiratory volume measurements. It is used to determine all lung volumes and capacities by measuring the gas inspired or expired during a given time involved. Fig. shows an electrical spirometer.

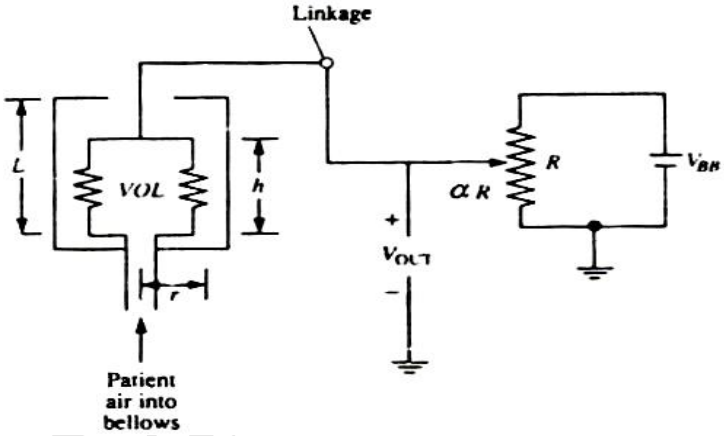


Fig 2.22: Spirometer

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

It consists of light weight bellows. Due to light weight, there is no airway resistance error.

Pneumotachograph using strain gauge:

Pneumotachograph is an instrument to measure the patient's air flow rate during respiration and vital air capacity of lung. Now-a-days strain gauge transducer is used to sense line air flow to get better accuracy. The airflow changes the resistance of strain gauge. Strain gauge is attached to a Wheatstone bridge & it

forms one arm of bridge.

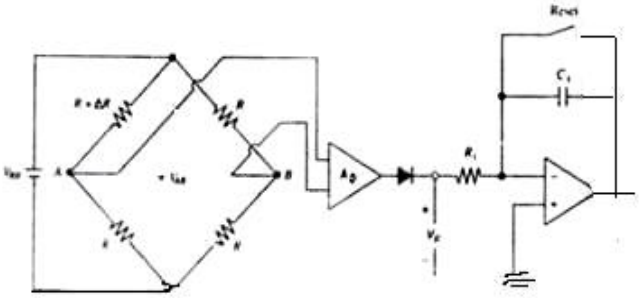


Fig 2.23 Pneumotachograph using Strain [Source: Leslie Cromwell - Biomedical instrumentation and measurement]**Gauge**

Procedure:

1. The volume of air exhaled by a patient is measured by first closing and then opening the reset switch. This set the initial charges on C1 to Zero and fixed Vout at Zero.
2. The patient is then asked to exhale through pneumotach mouthpiece. Hence resistance change R in strain gauge is proportional to airflow F.
3. VF is a function of time. V_F is given to the integrator and V_{out} is proportional to volume of air expired from time o to_t'seconds.
4. After the patient has stopped exhaling V_{out} remains constant in proportion to the total volume of air expired until the most switches is closed.

Gas Analyzer:

Determine composition of inspired & expired gas and to access lung function.

Infrared gas analyzer:

CO_2 concentration can be evaluated by its infrared absorption. One is filled with non absorbing gas such as nitrogen, other with sample. The difference in optical absorption detected between the 2 cells is a measure of absorption of sample at a

particular wave length. Infrared CO_2 analyzer which makes use of a non dispersive infrared analysis technique. In this technique

selective wavelength which is highly absorbed by gas in used accuracy of measurement.

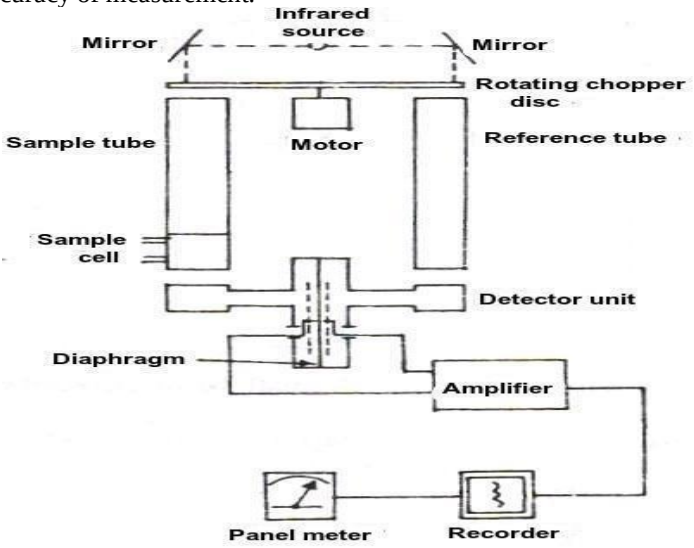


Fig 2.24 Gas Analyzer

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Infrared source operates at a temperature of about 815 C and it can deliver to a mirror. If the mirror have two beam with same intensity. There is a high speed rotating chopping disc which includes each beam twice per motion. The chopped lights are passing through the reference and samples tubes.

PULSE RATE MEASUREMENT

Each time the heart muscle contracts blood is ejected from ventricles and a pulse of pressure is transmitted through the circulatory system. This pressure pulse can be felt by placing the finger tips over the radial artery in the wrist or some other location where an artery seems just below the skin. The timing and ware shape of pressure pulse provide valuable diagnostic information. The pulse pressure and waveforms are indicators for blood pressure and flow. Instruments used to detect the artinal pulse and pulse pressure waveforms in the extremities are called plethysmographs. Plethysmograph techniques respond to a change in the volume of

blood as a measure of blood pressure.

Photoelectric Method:

It is the most commonly used method to measure the pulsatile blood volume changes. Two commonly used methods are,

i) Reflectance Method ii)
Transmittance Method

(a)Transmittance Method:

A light emitting diode (LED) and photo resistor are mounted in an enclosure that fits over the tip of patient‘s finger. Light is transmitted through finger tip and resistance of photo resistor is determined by the amount of light reaching it.

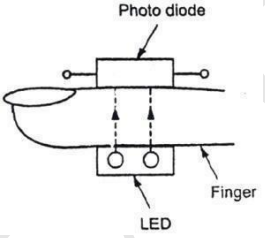


Fig 2.25 Transmittance Method [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

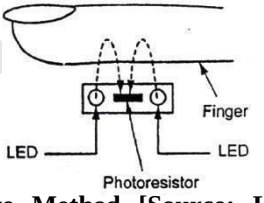


Fig 2.26 Reflectance Method [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The photoresistor is placed adjacent to exciter lamp. Part of light rays emitted y LED is reflected and scattered from the skin & tissues and falls on photoresistor.

TEMPERATURE MEASUREMENT:

Two types of temperature measurement can be obtained from the body. Systematic, surface temperature.

Systematic temperature

Temperature of the internal regions of the body. Usually heat is generated by the active tissues of the body & heat is lost by the body to the environment, between temperatures of body is maintained carefully.

Systematic Body Temperature Measurement:

Mercury thermometer is used for temperature measurement. It is inexpensive to use. When continuous temperature recording thermocouple or thermister used.

Thermocouple:

A junction of 2 dissimilar metals produces an o/p voltage, which is proportional to temperature at that junction.

Thermistor:

It is a temperature sensing device. Its resistance varies with temperature. This is mostly proffered in the biomedical field compared with thermocouple. Thermister can be manufactured in various shapes. In this relationship between resistance change & temperature in non – linear. Resistance of thermister is given by

$$R_t = R_r e^{+\beta(1/T_1 - 1/T_0)}$$

R_t = resistance at temperature T_t

R_r = resistance at temperature to (ref temperature)

T_1 = Temperature at which measurement is taken T_0 = Ref temperature

β = Temperature coefficient (range 3000 -4000)

Sp circuit are used to overcome nonlinear characteristics of thermister Sp circuit consists of 2 matched thermister.

Problem in thermister:

Self heating this problem overcome by limiting current used in measure power dissipation of thermister is maintained mV range to overcome this problem. Thermister problem is should be chosen based on resistance change sensitivity.

Skin temperature measurement:

Skin temperature is not constant throughout body varied from 30^0C-35^0C. Various factors affect skin temperature

How fat covers over capillary area.

How skin portion is exposed to ambient temperature. Blood circulation pattern beneath skin

Probes used – small, flat thermister probe is used.

Infrared thermometer – Device used to measure skin temperature. It is used to identity spots in which blood circulation is poor

BLOOD CELL COUNTER

The blood cells have important functions in our body. The red blood cell is used for transport of oxygen and carbon-di-oxide.

When the haemoglobin in the blood decreses, anemia is produced.

The number of red blood cells can be counted using a microscope, but the microscopic counting is time consuming. Now-a-days automatic red blood cell counters are used.

Automatic Red Blood Cell Counter:

This method us based on the fact that red cells have a higher electrical resistivity than the saline solution in which they are suspended. Fig (1) shows the automatic blood cell counter using electronic circuitry.

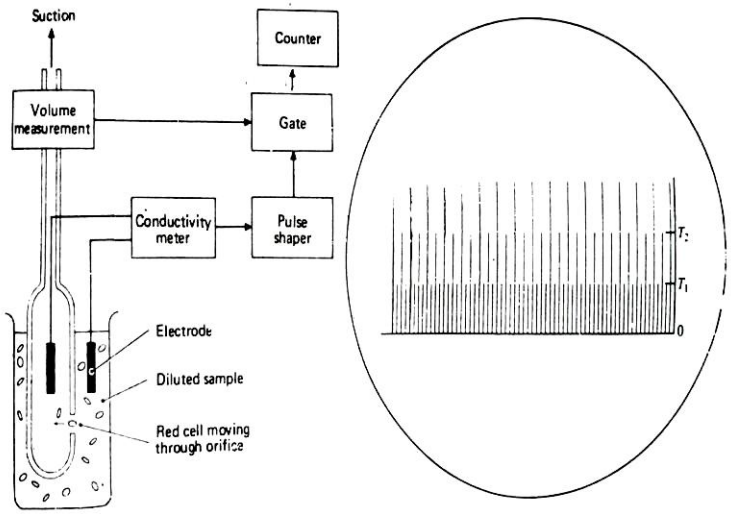


Fig 2.26: Automatic Red Blood Cell Counter [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Operation

The threshold is first set to zero and the counter output is given by the total number of particles (WBC_S + RBC_S + platelets) per litre. Then the threshold is set to T_1 and the counter gives the total number RBC_S and WBC_S per litre. After that the threshold is set to T_2 and the counter reads the total number of WBC $_S$ per litre.

Laser Blood Cell Counter:

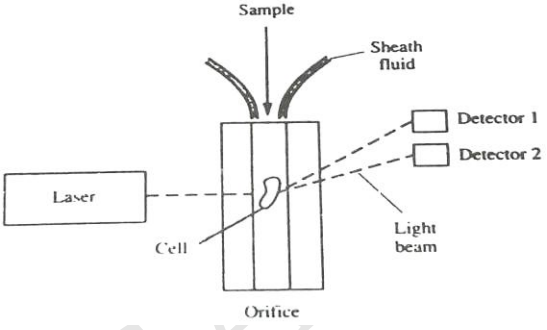


Fig 2.27: Laser Blood Cell Counter [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

This is a modern technique which gives the number of RBCs, WBCs and Platelets, hematocrit and concentration of haemoglobin. The basic Principle is that the angle of scattered light intensity is different for different sized particles. The sample blood is heavily diluted to reduce the number of particles counted to one at a time.

BLOOD PRESSURE MEASUREMENT.

Pressure is defined as force per unit area p = F / A

P = pressure in pascal,

F= force,

A=Area

Pressure is increased by increasing the applied force or by decreasing the area.

Hydrostatic Pressure: . If the force in a system under pressure is not varied then pressure is known as Hydrostatic pressure

Hydrodynamic Pressure: If the force in a system under pressure is varied then pressure is known as Hydrodynamic pressure

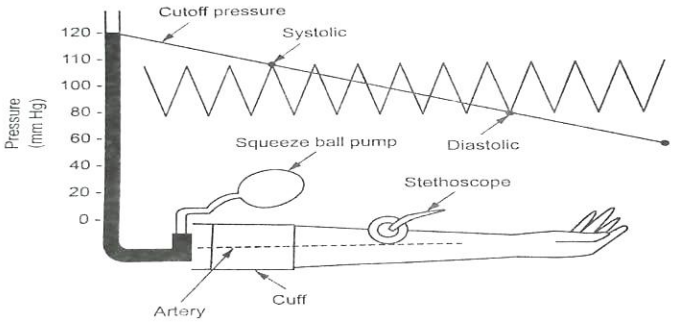
Methods:

1. Indirect method using sphygmomanometer
2. Direct method

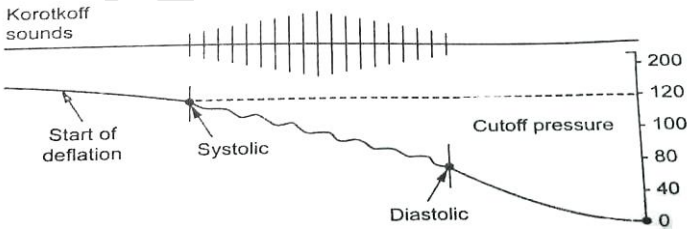
Indirect Method using Sphygmomanometer:

In this method Sphygmomanometer is used to measure blood pressure indirectly. It consists of inflatable rubber bladder which is known as cuff, rubber squeeze ball pump & valve assembly. Pressure is measured using manometer with mercury column.

Procedure to use Sphygmomanometer: Cuff is wrapped around the patient's upper arm at a point midway between elbow & shoulder. Stethoscope is placed over as artery distal to the off, because at this place, brachial artery comes close to surface.



a) **Oscillometric method** [Source: Leslie Cromwell - Biomedical instrumentation and measurement]



b) **Oscillometric in cuff pressure**

Fig 2.28 Indirect method using sphygmomanometer [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Then doctor slowly reduces the pressure in the cuff & he watches the mercury column when the systolic pressure exceeds the cuff pressure. Then doctor can hear some crashing, snapping sound through stethoscope. This sound is known as korotkoff sound.
Advantages

- Method is very simple
- Painless techniques
- There is no hazardous surgical procedure involved. Disadvantages

Effective result depend on the fact how accurately doctor read pressure values when koratkoff sound is heard.

Direct method

Direct method of blood pressure is used when accurate blood pressure reading. If we want to know blood pressure in deep region indirect method is not useful.so direct method is used.

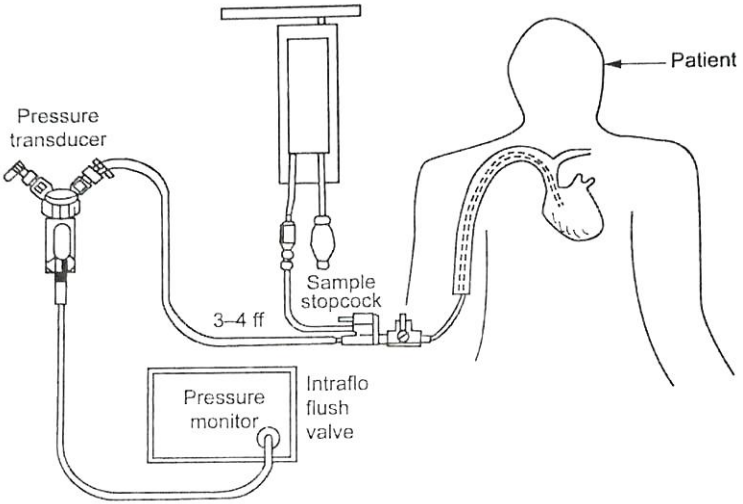


Fig 2.29 Direct blood pressure measurement [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Probe used in Direct Blood Pressure Measurement:

Catheter tip probe sensor mounted at the tip of the probe. Pressure exerted on the tip is converted to the corresponding electrical signal. In fluid filled catheter type. Pressure exerted on the fluid filled column is transmitted to external transducer. This transducer converts pressure in to electrical signal.

Direct Method of Blood Pressure Measurement:

Here fluid filled cattheter is used. Before inserting catheter into blood vessel, fluid filled system should be completely flushed out. Usually sterile saline is used for this purpose. Because blood clotting is avoided.

Working:

Blood taken from vessel using Cather tip probe. Pressure exerted is transmitted to the pressure transducer. The output of transducer is given to pressure monitor.

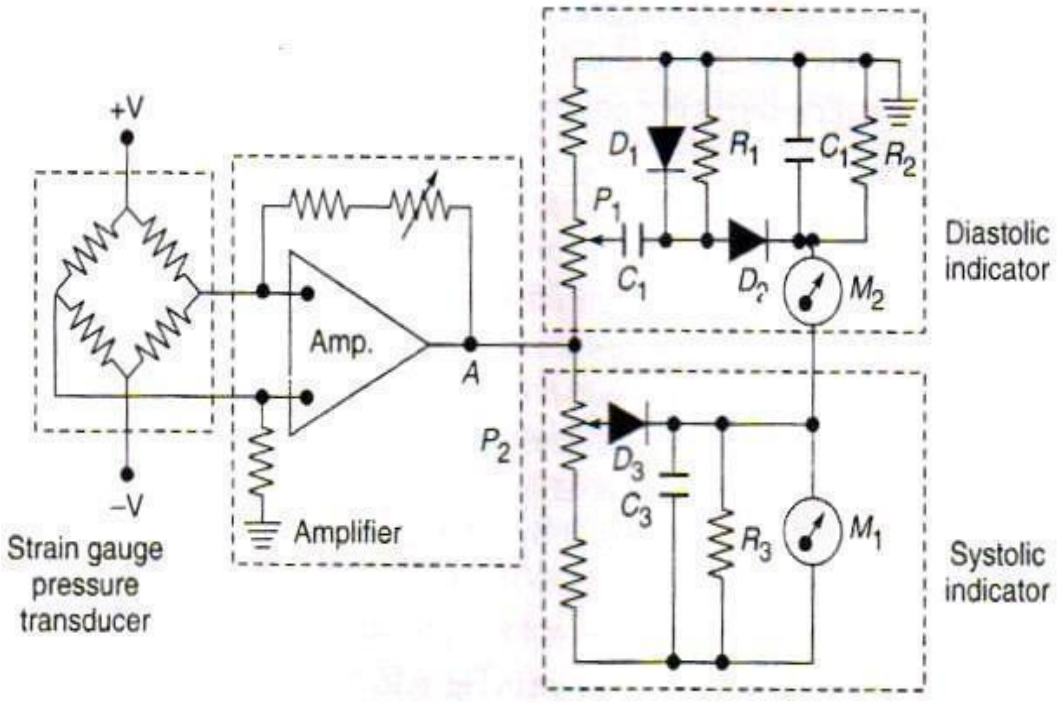


Fig 2.30 Circuit diagram for measurement of systolic and diastolic blood pressure [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Which is used to stable display. Clamping circuit is available C_1 & D_1 used to develop voltage is equal to peak to peak value of the pressure pulse.

M_2 reading = peak systolic value - peak to peak pressure value.

UNIT III

ASSIST DEVICES AND BIO-TELEMETRY

Cardiac pacemaker, DC Defibrillator, Telemetry principles, Frequency selection, Bio-Telemetry, Radio-pill and Telestimulation

INTRODUCTION:

Physiological assist device are very helpful to the patients of different categories. Pacemakers are extending the life of cardiac patients having total bundle block. Implanted artificial heart valves are maintaining the circulation of blood in a normal manner.

PACEMAKER:

Pacemaker is an electrical pulse generator for starting and/or maintaining the normal heart beat. The output of Pacemaker is applied either externally to the chest or internally to the heart muscle. In case of cardiac standstill the use of pacemaker is temporary just long enough to start a normal heart rate.

Energy Requirements to Excite Heart Muscle:

The heart muscle can be stimulated with an electric shock. The minimum energy required to excite heart muscle is 10µJ. For better stimulation and safety purposes 100µJ pulse energy is applied on heart muscle. During ventricular fibrillation heart muscle contracts so rapidly and irregularly. The pulse to space ratio 1:10000

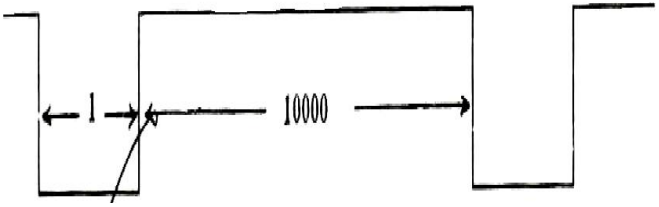


Fig 3.1: Pacemaker pulses [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The negatively going pulses to avoid ionization of muscles. Pulse repetition rate is usually 70 pulses/min but many pacemaker s

are adjustable in the range of 50-150pulses/min. The circulation of each pulse is between 1to2ms.

Methods of Stimulation:

There are two types of stimulation

(i) Internal stimulation

(ii) External stimulation

(i) Internal stimulation: It is employed for long term pacing because of permanent damage. Electrodes in the form of fine wires of Teflon coated stainless steel. The current range is 2-5mA.Bipolar and Unipolar electrode are used.

(ii) External stimulation: It is employed to restart the normal rate of heart in case of cardiac stand still. The paddle shaped electrode are applied on the surface of chest current in the range of 20-150mA

Based on the placement of pacemaker there are two types

(i) External pacemaker

(ii)Implanted (Internal pacemaker)

Different Modes of Operation:

Pacing modes can be either competitive or noncompetitive. Asynchronous pacing is called competitive because the fixed rate impulses may occur along with natural pacing impulses and competition with them in controlling the heart beat. Non competitive pacemakers are programmed either in demand or synchronized mode

Ventricular Asynchronous pacemaker (Fixed rate pacemaker):

It can be used in atrium or ventricle. It has the simplest mechanism and the longest battery life. This pacemaker is suitable for patients with either a stable, total AV block, a slow atrial rate. It is basically a simple astable multivibrator which produces at a fixed rate of heart .

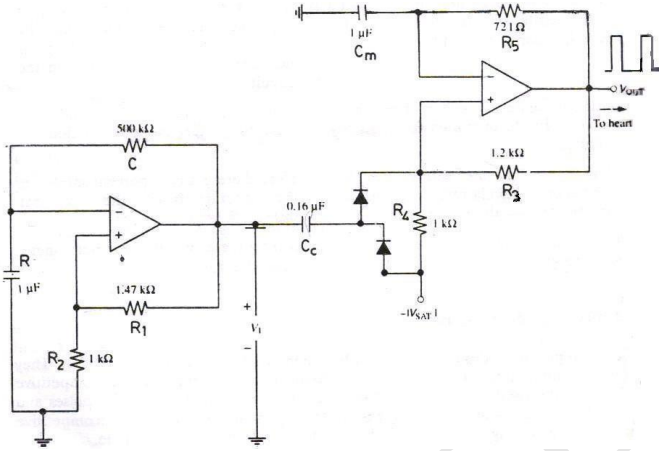


Fig 3.2: Ventricular Asynchronous pacemaker

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

There may be competition between the natural heart beats and pacemaker beats. If the pacemaker impulse reaches the heart during a certain period, ventricular fibrillation may occur. Nowadays the fixed pacemaker is fabricated on a large scale integrated circuit are used. The circuit consists of a square wave generator and a positive edge triggered monostable multivibrator. The output of this combination provides a positively and negatively going square waves with equal duration for positive and negative pulses. The period of square wave generator is given by

$$T = -2RC \ln(1-\alpha/1+\alpha)$$

Where $\alpha = R_2/(R_1+R_2)$

α – feedback voltage fraction

T can be changed by changing α or time constant RC. The square wave generator is nothing but astable multivibrator which switches the output voltage between $|V_{sat}|$ and $-|V_{sat}|$. The output of square wave generator in coupled to the positive edge triggered monostable multivibrator circuit. A positive edge trigger input will pass through capacitor Cc and diode and will raise the voltage at non-inverting terminal of second amplifier. The capacitor Cc is chosen so as to make five time constants equal to pulse duration TD.

Disadvantages:

1. Using fixed rate pacemaker the heart rate cannot be increased
2. Simulation with a fixed impulse frequency results in the ventricles and atria beating at different rates. This varies the stroke volume of heart and causes some loss in cardiac output.
3. Possibility of ventricular fibrillation will be more.

Ventricular synchronous pacemaker (standby pacemaker):

This is used for patients with only short periods of AV block or bundle block. This type does not complete with the normal heart activity. A single transverse electrode placed in the right ventricle both senses R wave and delivers the stimulation.

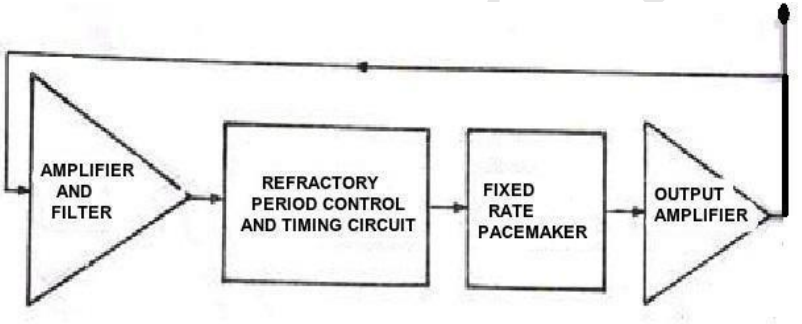


Fig 3.3: Ventricular Synchronous Pacemaker [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Working:

Using the sensing electrode heart rate is detected and is given to the timing circuit in pacemaker. If the detected heart rate is below a minimum level the fixed rate pacemaker is turned on. The pacemaker may detect noise and interpret as its ventricular excitation. This can be eliminated by refractory period or gate circuit. In heart blocks P waves with respect to ventricular excitation. P and R waves have different frequency bands. The high pass filter completely eliminates P-waves and the R-waves. Input amplifier increases peak-to-peak amplitude of R-wave.

Ventricular Inhibited Pacemaker (Demand Pacemaker)

It is also known as R-wave inhibited pacemaker. If the normal heart rate falls below minimum the pacemaker will turn on and provide the heart a stimulus. Hence it is called as

Demand pacemaker.

There is a piezoelectric sensor stielded inside the pacemaker. When the pacemaker can automatically increase or decrease its rate. Thus it can match with greater physical effort.

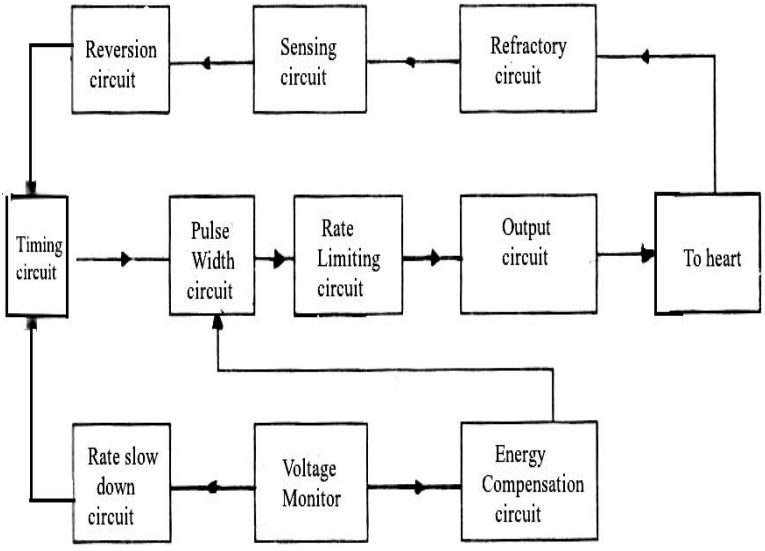


Fig 3.4: Ventricular Inhibited Pacemaker [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The sensing electrode picks up R-wave. The refractory circuit provides a period of time for the sensed R-wave. The sensing circuit detects the R-wave resets the oscillator. The reversion circuit allows the amplifier to detect R wave in the low level SNR. IN the absence of R wave oscillator in timing circuit delivers pulses at its preset rate. The timing circuit determines the pulse rate of pulse generator. The output of timing circuit is fed in to the pulse width circuit which is an RC network.

Atrial synchronous pacemaker:

It is used for young patient with a mostly stable block.

Atrial pacing is a temporary pacing and has many uses in physiologic investigation. It is used in stress testing and coronary artery diseases. It can act as a temporary pacemaker for atrial fibrillation. The atrial activity is picked up by a sensing electrode placed in the dorsal wall of atrium.

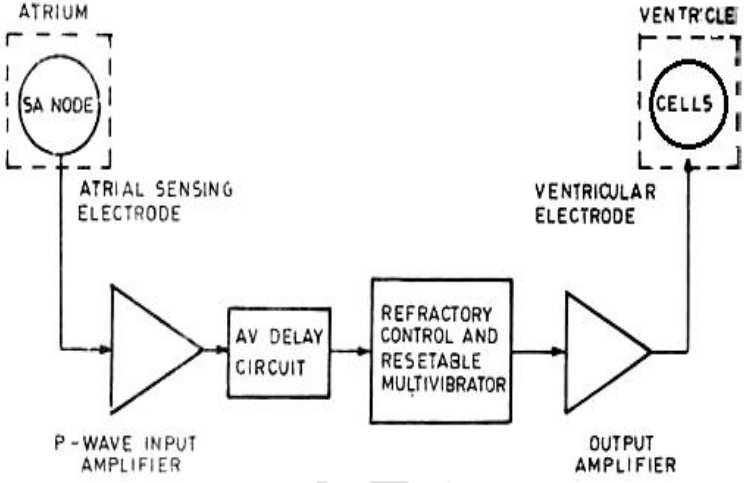


Fig3.5: Atrial synchronous pacemaker

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Atrial sequential Ventricular inhibited pacemaker:

It has the capability of stimulating both atria and ventricles. If atrial function falls this pacemaker will stimulate the atriam and then sense the subsequent ventricular beat.

DEFIBRILLATOR:

A Defibrillator is an electronic device that creates a sustained myocardial depolarization of a patient‘s heart in order to stop ventricular fibrillation or atrial fibrillation. Ventricular fibrillation is a serious cardiac emergency resulting from asynchronous contraction of heart muscles. This results from electric shock or abnormalities of body chemistry.

Types of defibrillators:There are two types of defibrillators based on electrodes placement

(i) Internal defibrillator

(ii) External defibrillator

Internal Defibrillator:

It is used when the chest is opened. It uses large spoon shaped electrodes with insulated handle. Since the electrodes are direct contact with heart the contact impedance is about 50Ω.

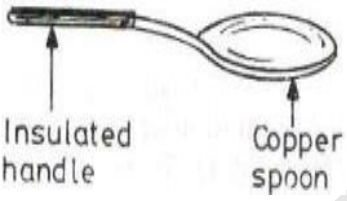


Fig3.6: Spoon Shaped Electrode [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

External Defibrillator:

External defibrillator is used on the chest using paddle shaped electrodes. The bottom of the electrode consists of a copper disc and is attached with highly insulated handle.

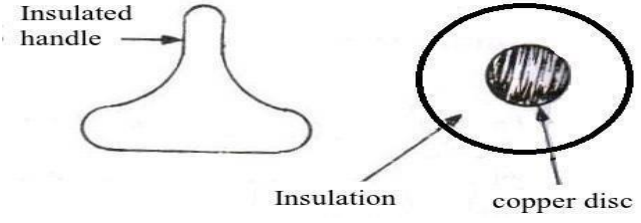


Fig3.7: Paddle Shaped Electrode [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Depending upon the nature of voltage applied the defibrillators can be divided in to six groups.

1. A.C defibrillator
2. D.C defibrillator
3. Synchronised D.C defibrillator
4. Square pulse defibrillator
5. Double squre pulse defibrillator
6. Biphasic D.C defibrillator

A.C Defibrillator:

It is the earliest and simplest type of defibrillator. It has appropriate voltages for both internal and external defibrillation. It consists of a step-up transformer with various tappings on secondary side.

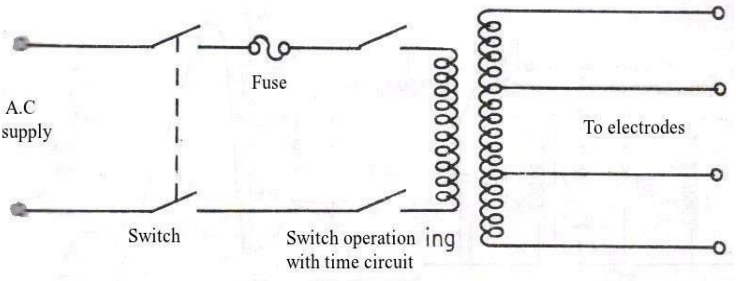


Fig3.8: A.C Defibrillator [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

An electronic timer circuit is connected to the primary of the transformer. The timer connects the output of the electrodes for a preset time. The timing device may be simple capacitor and resistor network which is triggered by a push button switch.

D.C Defibrillator:

D.C defibrillator would not produce undesirable side effects and at the same time it produces normal heart beat effectively. Ventricular fibrillation is terminated by passing a high energy shock through discharging a capacitor to exposed heart or chest of patient .

In this position the capacitor charges to a voltage set by the positioning of auto transformer. During the delivery of shock to patient a push button switch mounted on handle of electrodes operated. The high voltage switch changes to position B‘and the capacitor are discharged across the heart through electrodes. An inductor L‘ is placed in one of the electrode leads so that the discharge from the capacitor is slowed down by the induced counter voltage.

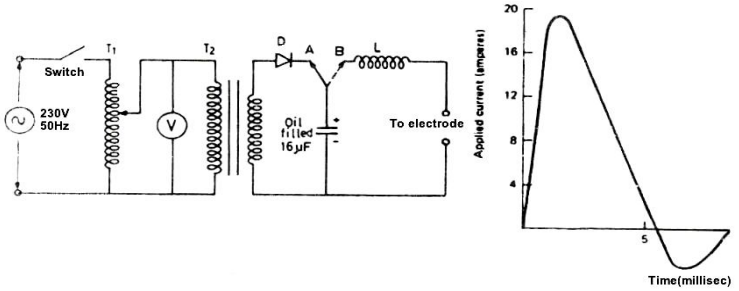


Fig3.9(a): D.C Defibrillator(ordinary type) and its output [Source: Leslie Cromwell - Biomedical instrumentation and measurement] **Dual Peak D.C Defibrillator:**

The passage of high current may damage the myocardium and the chest wall.

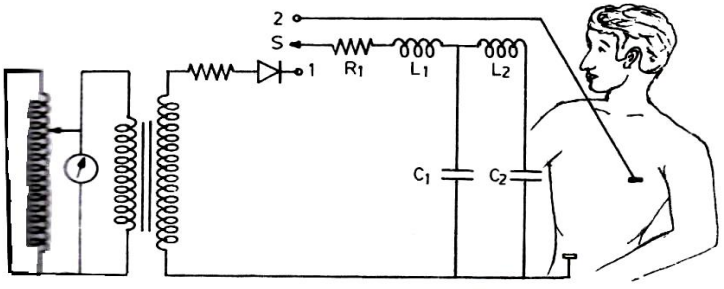
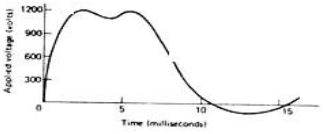


Fig3.9(b): Dual peak d.c defibrillator [Source: Leslie



Cromwell - Biomedical instrumentation and measurement]

Fig3.9(c): output of Dual peak d.c defibrillator [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Truncated defibrillator:

In this type the capacitor discharge is adjusted so that the effective defibrillation is obtained at the desirable low voltage level. The voltage level of the wave is almost constant but its duration is extended to obtain the required energy.

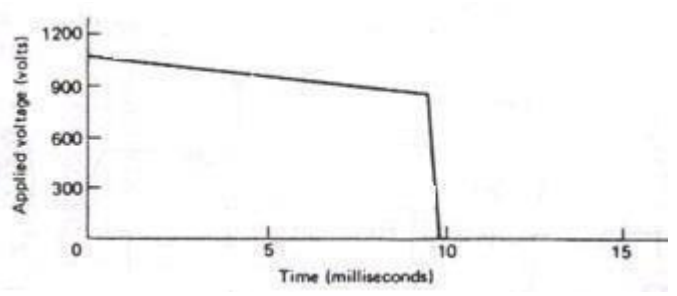


Fig3.10: Truncated defibrillator discharge waveform [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Synchronised D.C defibrillator:

Defibrillator is a risky procedure since if it is applied incorrectly it could induce fibrillation in a normal heart. It is essential to use a defibrillator with synchronizer circuit.

Fig. shows the modern d.c defibrillator circuit consisting of defibrillator electrocardioscope and pacemaker.

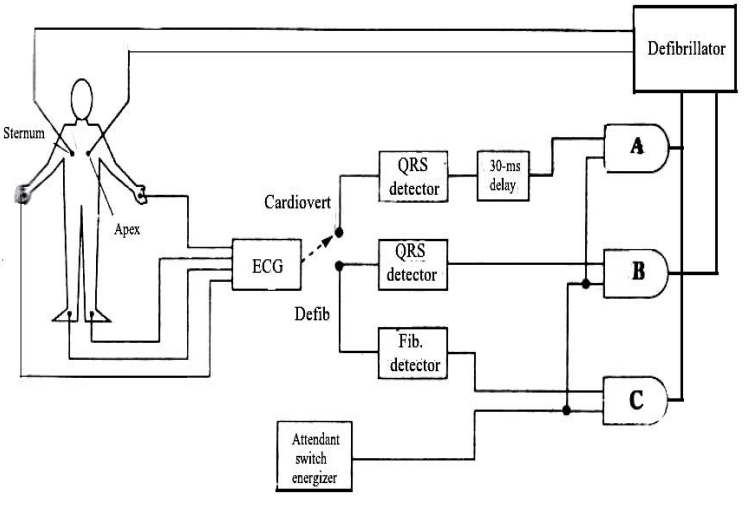


Fig3.11: Modern D.C Defibrillator Circuit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Working:

1 The electrocardiogram is obtained by means of an ECG

unit connected to the patient who is going to receive defibrillation pulse.

2. The switch is placed in the defibrillator mode if ventricular fibrillation is suspected.
3. The QRS detector in that mode consists of a threshold circuit that would pass the signal as output if R wave is almost in electrocardiogram. Otherwise it would not give any output if wave is present.
4. Meanwhile the medical attendant energizes the switch to deliver the defibrillation pulse.
5. AND gate _B' delivers signal to the defibrillator only when the R wave is absent, provided the signal from medical attendant is also present at one of the two inputs of AND gate _B'.
6. If any one of the input is missing then it would not give any output. By this way defibrillator is inhibited and would not deliver the defibrillation pulse.
7. The fibrillation detector searches the ECG signal for frequency components above 150Hz. If they are present fibrillation is probable and detector gives an output signal. A defibrillator pulse is delivered only if the fibrillation detector produces an output at the same time that the attendant energizes the switch. This is provided by the AND gate _C'.
8. When AND gate _B 'and _C' are simultaneously triggering the defibrillator the defibrillation pulse is delivered.

Square Wave Defibrillator:

Here the capacitor is discharged through the subject by turning on a series silicon controlled rectifier (SCR). When sufficient energy has been delivered to the subject a shunt SCR short circuits the capacitor and terminates the pulse. The output can be contrilled by varying the voltage on capacitor or duration of discharge. Defibrillation is obtained at less peak current and so there is no side effect.

Analysis:

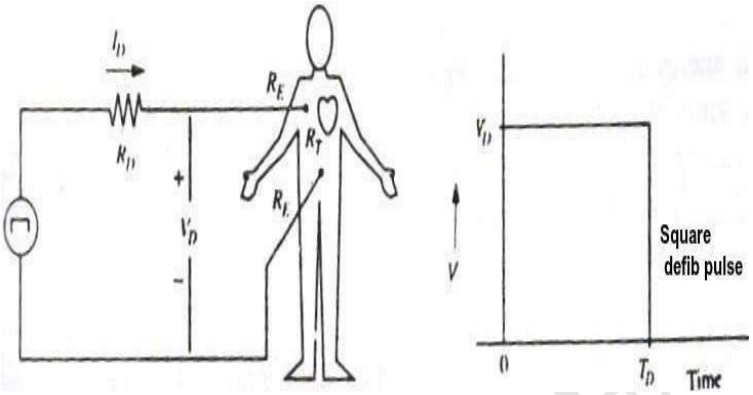


Fig3.12: Equivalent circuit of square pulse defibrillator and its output waveform [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

In fig

R_D-Internal resistance of defibrillator

R_E-electrode skin resistance R_T-

Thorax resistance

The energy in the pulse

$$EP = VDIDTD$$

Where $V_D I_D$-Instantaneous voltage and current available from defibrillator pulse

T_D-Duration of pulse

Total circuit resistance

$$R=R_D+2R_E+R_T$$

$$EC = E_T + 2\,E_{EL} + E_{DL}$$

Thus E_T is dismissed from available due to effects of R_D and R_E

Double Square Pulse Defibrillator:

It is used normally after the open heart surgery. Conventional A.C and D.C defibrillators are producing myocardial injury during the delivery of shock.

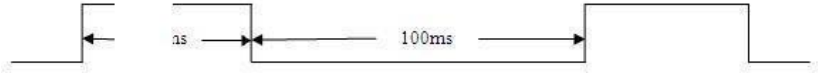


Fig3.13: Double Square Pulse Defibrillator Waveform[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

If the chest is opened only lower energy electrics shock

should be given. Instead of 800-1500V in D.C defibrillators here 8-60V double pulse is applied with a mean energy of 2.4 watt-sec. When the first pulse is delivered some of fibrillating cells will be excitable and will be depolarized.

- Using double square pulse defibrillator efficient and quick recovery of heart to beat in normal manner without side effect like burning of myocardium or inducement of atrial or ventricular fibrillation.
- The double square pulse with required pulse space ratio can be produced with the use of digital circuits.

Biphasic D.C defibrillator:

It is similar to double square pulse defibrillator such that it delivers D.C pulses alternatively in opposite direction. This type of waveform is found to be more efficient for defibrillation of ventricular muscles.

BIO TELEMETRY

Introduction:

Bio telemetry is electrical technique for conveying biological information from a living organism to a location where this information can be observed or recorded.

Elements of Bio-telemetry:

The transducer converts the biological signal into electrical signal. The signal conditioner amplifies and modifies the signal for effective transmission.

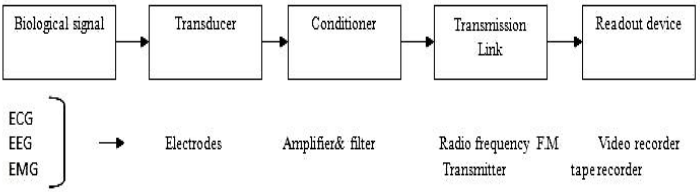


Fig3.13: Block diagram of Bio-Telemetry System [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Design of a Bio-Telemetry System:

1. The telemetry system should be selected to transmit the

bioelectric signals with maximum fidelity and simplicity.

2. There would not be any constraint for living system and any interference with the living system.
3. The size and weight of the telemetry system should be small.
4. It should have more stability and reliability.
5. The power consumption should be very small.
6. For wire transmission shielding of cable is a must to reduce noise level.

Radio telemetry system:

Most biotelemetry systems are involved with radio transmission and reception of biosignals. There are single channel and multichannel

Single channel telemetry system:

A miniature battery operated radio transmitter is connected to the electrodes of the patients. This transmitter broadcasts the biopotential to a remotely located receiver.

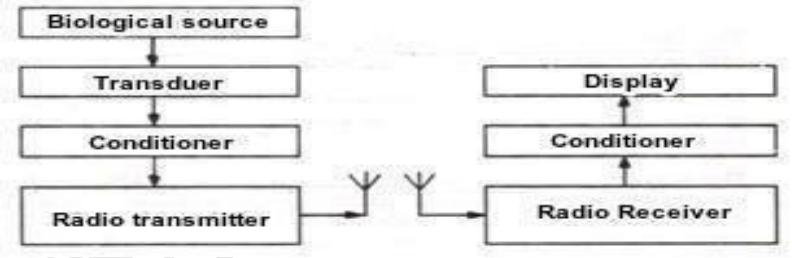


Fig3.14: Block Diagram of a Typical Single Channel Telemetry System
[Source:eslie Cromwell - Biomedical instrumentation and measurement]

The only risk of electric shock to the patient is due to the battery powered transmitter. Since it is kept low there is negligible risk to the patient. The radio frequency used in this system varies from a few 100khz to about 300mhz. Beyond this frequency range Attenuation becomes excessive.

Transmission of Bioelectrical Variables:

In a single channel telemetry system the measurements are made under any of the two categories.

1. Active Measurements: Here the bioelectric variables like ECG, EMG, and EEG are directly measured without any excitation voltage.
2. Active Measurements: Here the bioelectric variables like blood pressure, temperature, blood flow etc are measured indirectly using transducer and excitation voltage.

Multi Channel Telemetry System:

Most bio medical experiments need simultaneous recordings of several signals.

There are two types

1. Frequency division multiplex
2. Time division multiplex

(a) Frequency Division Multiplex System:

Each signal is frequency modulated on a subcarrier frequency. Then these modulated subcarrier frequencies are combined to modulate the main R.F carrier.

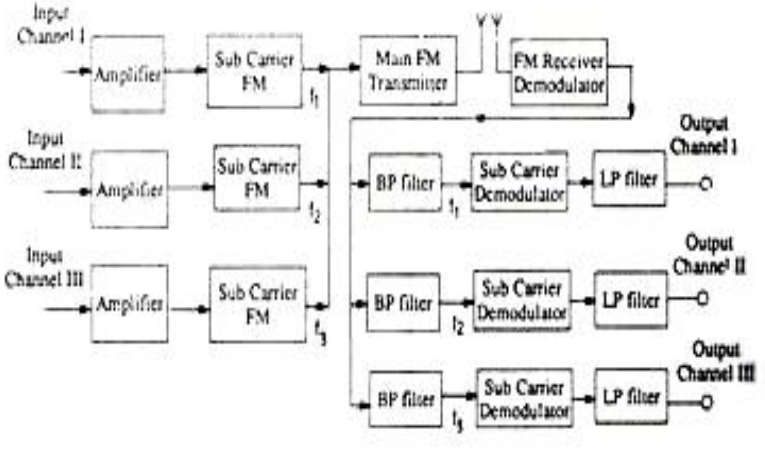


Fig3.15: Frequency Division Multiplex System [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

(b) Time Division Multiplex System:

Since most biomedical signals have low frequency

bandwidth requirements we can use time division multiplex system by the time sharing scheme.

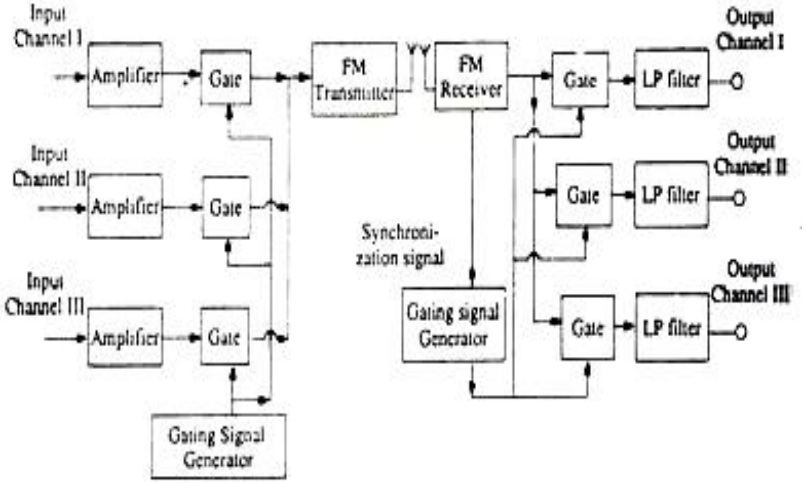


Fig3.16 : Time division multiplex system
[Source: Leslie Cromwell - iomedical instrumentation and measurement]

The transmission channel is connected to each signal channel input for a short time to sample and transmit that signal. Then the transmitter is switched to next signal channel in a definite sequence. When all the channels have been scanned once a cycle is completed and the next cycle will start.

Conditions:

The scanning frequency fn should be at least greater than twice the maximum signal frequency fs.

(ie) fn>2fsmax

If Tn=1/fn=scanning period and tn is the sampling time of each channel than the maximum no. of channels n=Tn/Tn. Practically the no. of channels is smaller than _n' to avoid interference between channels.

Telemetry Circuits:

a) Tunnel diode FM transmitter

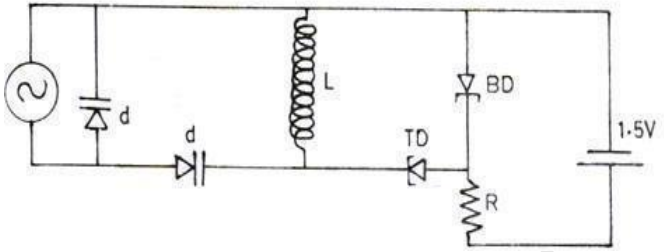


Fig3.17: Single Channel FM Transmitter [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Tunnel diodes are active devices (TD, BD) and this circuit has higher fidelity and sensitivity. Total weight is about 1.44gm with battery. Size is so small (0.8x0.22 cm^2).

Advantages:

- All the signals can be transmitted to a receiver in a normal hospital environment. No shielded room is needed.
- Interference is greatly reduced

b) Hartley type F.M transmitter:

For the transmission of ECG, EEG and EMG

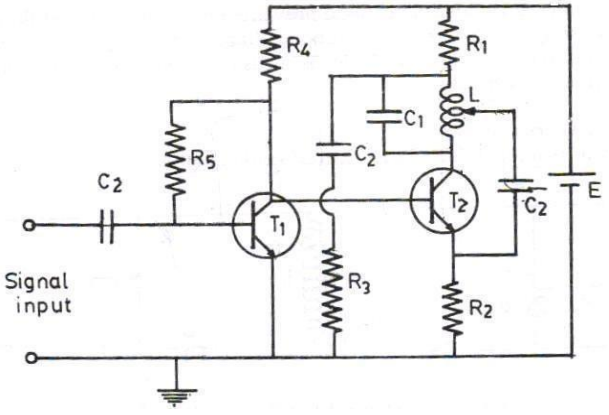


Fig3.18: Hartley type F.M transmitter [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

In this circuit C1 and L form the tank circuit components of Hartley

oscillator. C_2-coupling capacitor
T1-Driver amplifier transistor T2-
oscillator transistor

The capacitance between the emitter and base of a transistor is voltage sensitive is used to frequency modulate the carrier.

c) Pulsed Hartley Oscillator:

To measure temperature a thermistor is placed in the place of R1. To measure pressure the pressure changes should be given to more the core M‘.

The transducers and conditioner are integrated in to components of the oscillator-transmitter. Continuous wave operation can be obtained by reducing then value of R1.

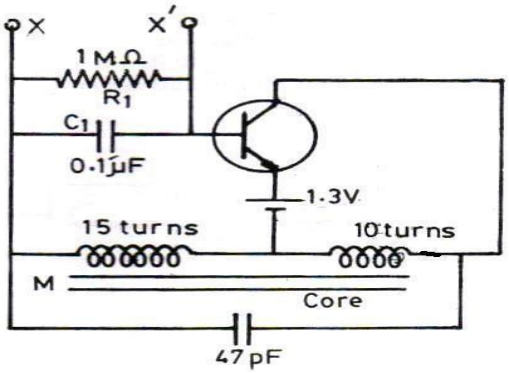


Fig3.19: Physiological Parameters Telemetering Transmitter
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Advantages:

- The circuit is so simple
- Low power consumption from 5μW to 10μW

Limitations:

- In pulse mode operation large error can be produced by power supply voltage variations.
- Interference can be generated over wide frequency band because of self blocking pulsed carrier mode operation

d) Radio telemetry with a sub-carrier:

When the relative position of transmitter changes the carrier frequency and amplitude will change. This is due to the loading change of the carrier frequency resonant circuit.

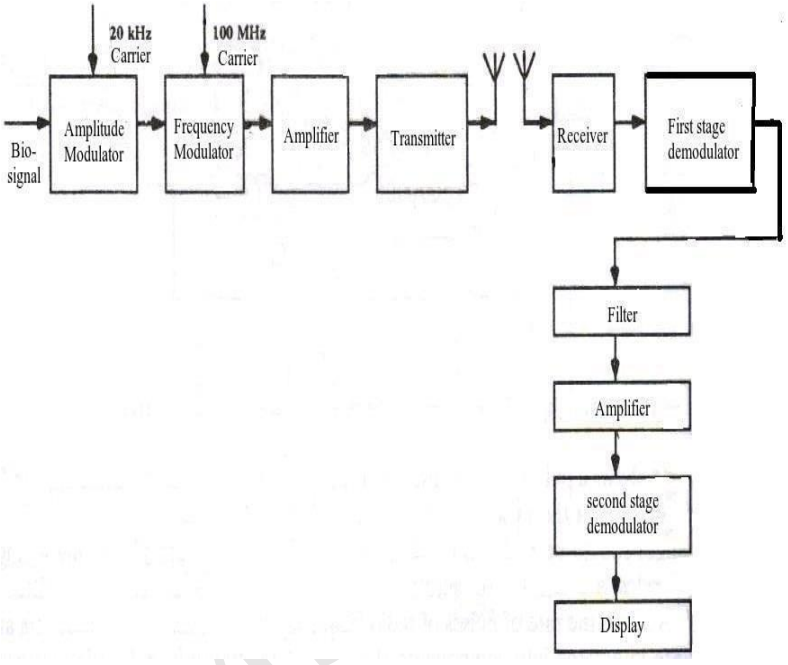


Fig3.20: Biotelemetry System with Subcarrier [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

If the signal has frequency different from loading effect they can be separated by filters. Otherwise the real signal will be distorted by the loading effect. To avoid this loading effect subcarrier system is needed. The signal is modulated on a subcarrier to convert the signal frequency to the neighborhood of subcarrier frequency.

Problems in Implant Telemetry:

For long term telemetry implant telemetry is more useful one. The whole electronic circuit is fully packed as a capsule and then implanted deep in the body to be closer to the signal source and to avoid mechanical difficulties of surface mounted units.

The size and weight limitations are much more serious and

the reliability requirement is more critical.

Power supply: Two special types of power supplies are used

(i) Environmental power supply

(ii) Microwatt power supply

Uses of bio-telemetry:

1. Biotelemetry helps us to record the biosignals over long periods and while the patient is engaged in his normal activities.

2. The medical attendants can easily diagnosis the nature of disease by seeing the telemetered signals without attending the patient‘s room.

RADIO-PILL:

Radio-pill is used in biotelemetry. It is the transmission of biological signal.

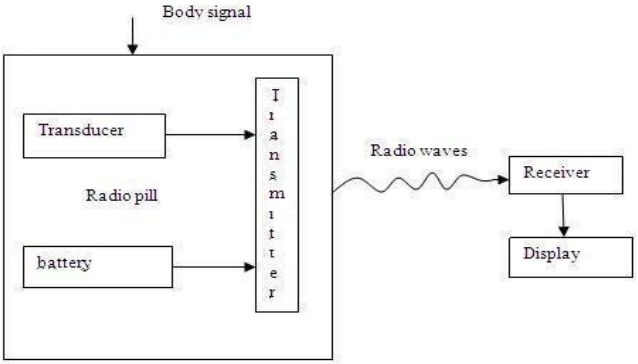


Fig3.21: Block Diagram of Radio Pill [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The radio pill is capable of measuring various parameters. With the help of radio pill type devices, it is possible for use to measure or sense temperature, pH, enzyme activity, and oxygen tension values. These measurements can be made in associated with transducers.

TELEMETRY PRINCIPLES:

Design considerations for a telemetry system

1. Simplicity of the telemetry system
2. Transmission should be with maximum fidelity
3. Telemetry components should be less weight and size

Telemetry system:

Telemetry is defined as the process by which the information regarding the quantity being measured transmitted to a remote location for application like data processing ,recording or displaying

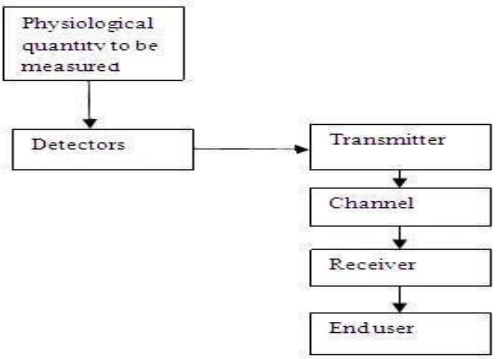


Fig 3.22: Telemetry System [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

In other words telemetry means measuring at a distance. Therefore it becomes essential to transmit data through some form of communication channels.

Methods of Classification of Telemetry System:

a) On the basis of the characteristics of electric signal such as voltage current position ,frequency and pulse
b) Based on form of data transmitted –analog and digital

The physiological quantity to be measured by a suitable detector and given to the transmitter. The electrical telemetry system is broadly classified as DC systems and AC systems.

DC telemetry system:

The signal is transmitted through a telemetry or communication channel which uses direct transmission via cables in order to convey the desired information . This is known as land line

telemetry.

AC telemetry system:

It is used both for land line and radio frequency air borne telemetry techniques.

Amplitude modulation:

In this type of modulation the amplitude of the carrier is varied in accordance with the signal to be transmitted.

Frequency modulation:

In this type of modulation the instantaneous frequency of the carrier is varied in accordance with the amplitude of the modulating signal.

Phase modulation:

Here phase angle is varied in accordance to be transmitted signal.

FREQUENCY SELECTION:

The radio frequencies normally used for medical telemetry purposes are of the order of 37, 102, 153, 159, 220and 450 MHz.

The transmitter is typically of 50mW at 50Ω., which can give a transition range of about 1.5km .

However in medical telemetry system factors such as receiver and antenna design may make the power and frequency characteristics less significant.

TELE STIMULATION:

Tele stimulations are described for chronic indirect muscle stimulation in caged rabbits and mice. Both systems use a 5MHz carrier frequency transmission and consist of a transmitter and a receiver. The system for rabbit uses pulse width modulation for transmitting stimulation and amplitude.

Duration of the stimulus impulse is generated in the receiver.

UNIT-IV

RADIOLOGICAL EQUIPMENTS

Ionosing radiation, Diagnostic x-ray equipments, use of Radio Isotope in diagnosis, Radiation Therapy.

INTRODUCTION

X rays are discovered by Rontgen and hence referred to as Rontgen rays. This type of radiation could penetrate opaque objects and provide an image of their inner structures.

IONIZING RADIATION

The radiation originating in the x ray tube or radioactive materials ionizes the gases through which it travels. Hence it is termed as ionizing radiation. Non ionizing types of radiation are radio waves, light and infrared radiation.

X RAY TUBE (Generation of Ionizing radiation)

X rays are produced by **bremsstrahlung radiation**. When the fast moving electron enters in to the orbit of the anode material atom, its velocity is continuously decreased due to scattering by the orbiting electrons.

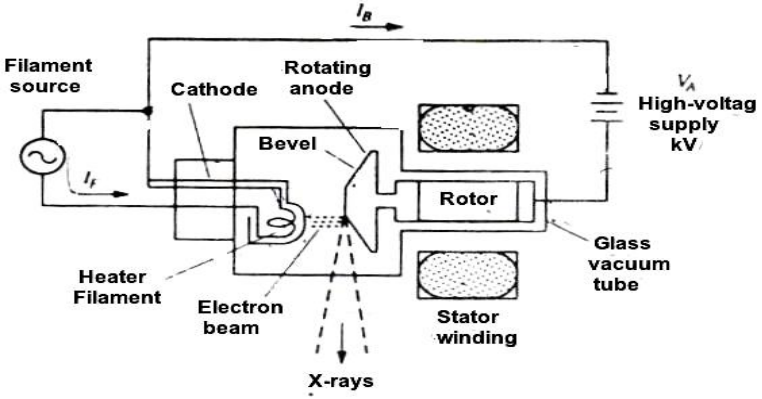


Fig4.1: X Ray Tube [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Approximately 1% of the electron is converted in to x ray and the remaining energy is appeared in the form of thermal energy which may raise the anode temperature. There are proper cooling arrangements. The x ray generation efficiency is very low and is given by

$$\acute{\eta} = \frac{x\text{-}ray\ beam\ energy}{Electron\ beam\ energy} = \frac{1}{I_B V_A t} 4 \times 10 I_B\ ZV\ A^t$$

Where z-Atomic number of anode material

The minimum wavelength of the emitted x rays is given by. $\lambda_{min} = \frac{h_c}{eV_A}$

The intensity of x-rays can be controlled by varying the filament current. Therefore the quality and quantity of x-rays can be easily controlled.

X- RAY MACHIN (Diagnostic x-ray equipment):

The basic components of diagnostic X ray machine are power supply arrangement ,X ray tube aluminum filters ,collimator ,Bucky diaphragm and lead shield. The various components in the machine are used to improve the quality of the image, increase the contrast between different tissues ,improve size resolution and minimize the dose of X rays used on the patient ..

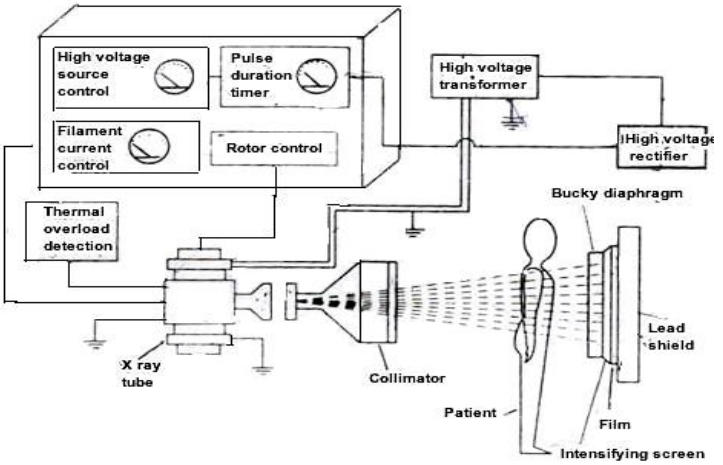


Fig 4.2: Diagnostic X Ray Machine [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The contrast between two tissues 1 and 2 is given by

$C12=10 log \frac{i_1}{} dB$

Let -Emergent x-ray intensity from tissue

I_2-Incident x-ray intensity

But $I=I_0 e^{-\mu\rho s}$ by Lambert's law

Where ρ-density of tissue

s-thickness of tissue

$$c_1 = 10 \log \left(\frac{I_0 e^{\mu_1 \rho_1 s_1}}{I_0 e^{-\mu_2 \rho_2 s_2}} \right) \quad \text{Db}$$

$$c_{12} = 4.3429(\mu_2 \rho_2 s_2 - \mu_1 \rho_1 s_1)$$

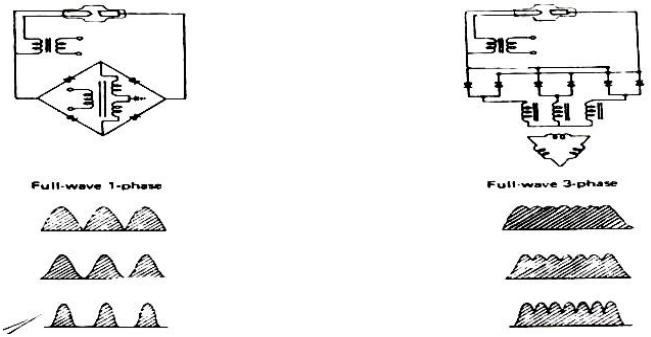
If any one of the tissue absorbs more x-rays then its contrast will be more. **Sharpness or clarity** of the edges of the image is often reduced due to distortion in the x rays beam as it passes from the x ray tube to the patient.

High voltage source

A high voltage source is an autotransformer which is used to get high voltages from 20 to 200 kV in the X ray machine. There is a timer which controls the exposure time so that the patient does not receive an excessive dose.

High voltage rectifier

X-Ray tube requires a high D.C voltage; due to practical difficulties a high D.C voltage with small A.C ripples is used. The full wave rectifier which gives almost constant beam current with a limited ac ripple. But it is not suited because it cannot handle power in an efficient manner.



4.3: Power Supply Single and Three Phase Supply [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

The main voltage is stepped up by a high voltage transformer which is normally an auto transformer. The KV control gives the necessary input to the x ray tube to produce the required wavelength of x rays.

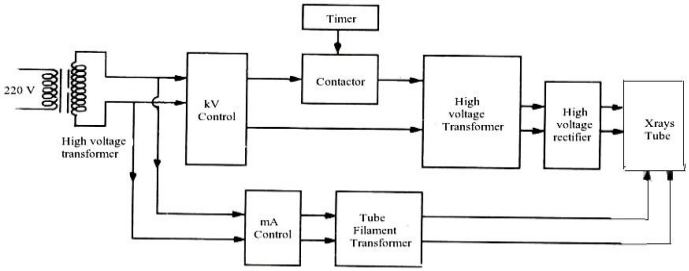


Fig 4.4: Power Supply Arrangement [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

There is a contactor linked with the timer is used to deliver the x ray output in the required time interval. After that it is given to another high voltage transformer followed by the high voltage rectifier.

X Ray Tube

X ray tube is the important element in the x ray machine. Rotating anode rotates at speeds from 3600 to 10000 rpm by rotating magnetic fields.

Aluminium Filters

The emitted x rays contain a broad range of frequencies. The x rays at unwanted frequencies only increase the patient dose and decrease the image contrast.

Collimator:

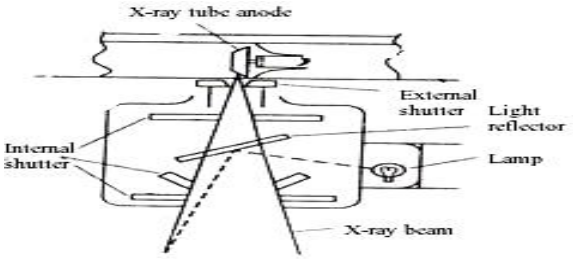


Fig 4.5: Collimator [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Between the patient and aluminum filters the collimator is placed. It is an aperture diaphragm which restricts the beam falling on the patient.

Bucky Grid:

The Bucky grid is introduced between the patient and the film cassette to improve the sharpness of image. A grid consists of thin lead vanes separated by spacers of a low attenuation material.

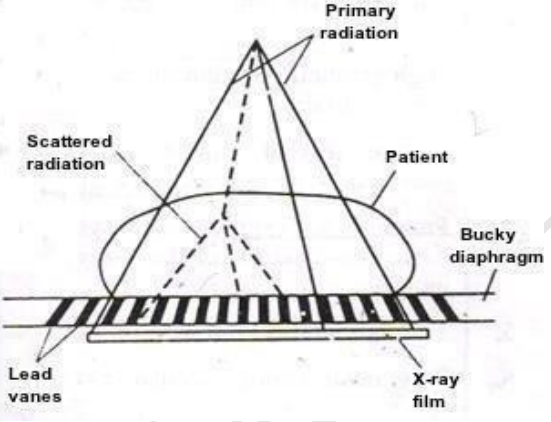


Fig 4.6: Bucky grid [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

VISUALIZATION OF X RAYS

X rays normally cannot be detected by human senses. For visualization 3 different techniques are in common use.

Fluoroscopy

Certain metal salts glowed in the dark when struck by the radiation. The brightness of this fluorescence is a function of the radiation intensity and cardboard pieces coated with such metal salts used to visualize x ray images.

The fluoroscopic image obtained is faint and x ray intensity to obtain a bright image can be harmful to both the patient and observer. If the radiation intensity is reduced to a safer level, then the fluoroscopic image becomes so faint and must be observed in a completely darkened room.

X ray film

Although X-rays have a much shorter wavelength than visible light they react with photographic emulsion. The film that has been exposed to X-rays shows an image of X-ray intensity. The sensitivity can be increased by the use of intensifying screens.

Image intensifiers

The faint image of a fluoroscopic screen can be made brighter with the help of an electronic image intensifier. The intensifier tube contains a fluorescent screen, the surfaces is coated with suitable material to act as a photocathode.

The output image is smaller than the primary fluorescent image. It is possible to observe the image in a normally illuminated room.

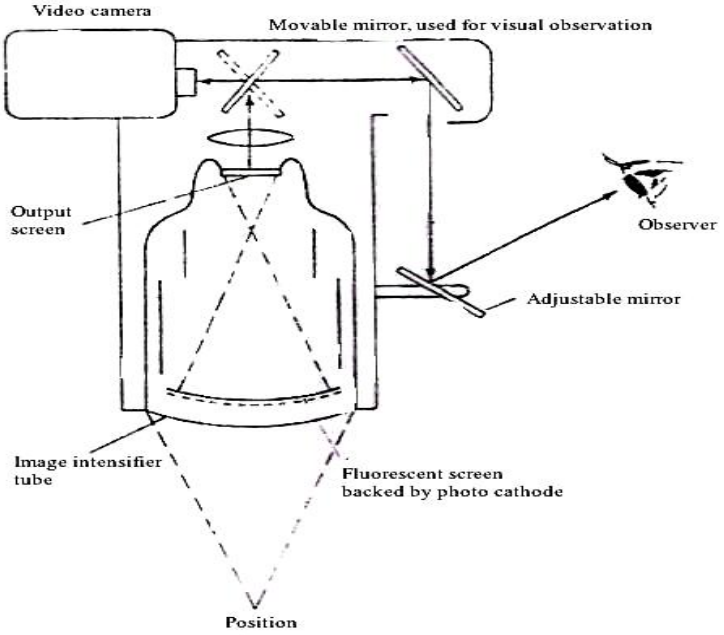


Fig4.7: Image Intensifiers
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

SPECIAL TECHNIQUES FOR DIAGNOSTIC X-RAYS

Special techniques must be used to obtain usable images from certain body structures.

Grids

The x-rays entering the body of patient or actually scattered and no longer travel in a straight line. If the section examined is very thick and if the x-rayed area is large, scattered x-rays can cause a blurring of x-ray image. This effect can be reduced by the use of a grid or a bucky diaphragm.

Foreign bodies and bone absorb the x-rays much more readily than soft tissue. Soft tissue structure of body show very little difference in x-ray absorption.

Angiography

In angiographic procedures, the outlines of blood vessels are made visible on x-ray image by injecting a bolus of contrast medium directly into the blood stream.

Cardiac Catheterization

It is a technique used to diagnose valve deficiencies, septal defects, and other conditions of heart characterized by hemodynamic changes. For this, a special catheter is inserted through artery, vein directly through chest wall into the heart.

Three Dimensional Visualization

A basic limitation of x-ray images is the fact that they are two-dimensional presentations of three dimensional structures. One organ located in front of another organ frequently obscures details in the image of other organ.

In Tomography-ray photo shows the structure of only a thin slice or section of body. Several photos representing slices taken at different levels permits 3D visualization.

USE OF RADIO ISOTOPE IN DIAGNOSIS

Instrumentation For The Medical Use Of Rodioisotopes

The radiation exposure during x-ray examination occurs during only a very short time interval. In diagnostic methods

involving radioisotopes into the body, the exposure time is much larger and hence the radiation intensity must be kept much smaller to get a safe radiation dose.

The concentration of radioactive material in an unknown sample can be determined by comparing the count with a known standard. Greater accuracy is obtained if the number of disintegrations counted is high.

The amplitude of output pulse is proportional to the energy of radiation. This property is used to reduce the background (counts due to natural activity)by means of a pulse height analyzer.

Two types of scintillation detectors are used for the determination of concentration of gamma-emitting radioisotopes.

i. Well counter
ii. Collimated detector

i) Well counter

In the well counter, the scintillation crystal has a hole in to which a test tube with the sample is inserted. All the radiation from the sample passes the crystal and is counted. Lead shield reduces the background count.

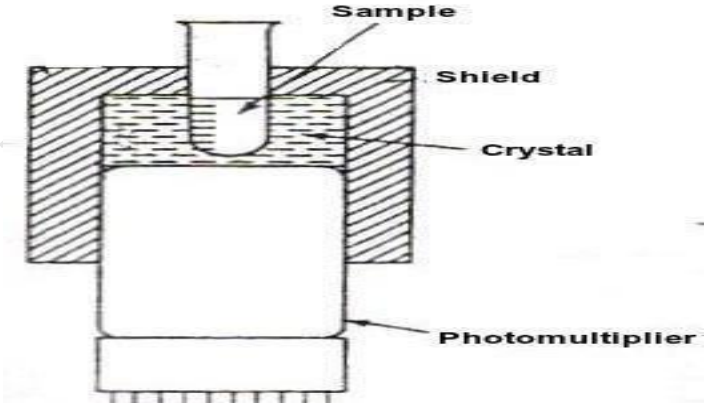


Fig4.8: **Well Counter** [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

ii) Collimated Detector

The lead shield around the scintillation crystal has holes arranged in such a way that radiation from a source at one particular point can reach the crystal. Only a small part of radiation coming from source in front of detector passes the crystal. This detector is much sensitive than the well counter.

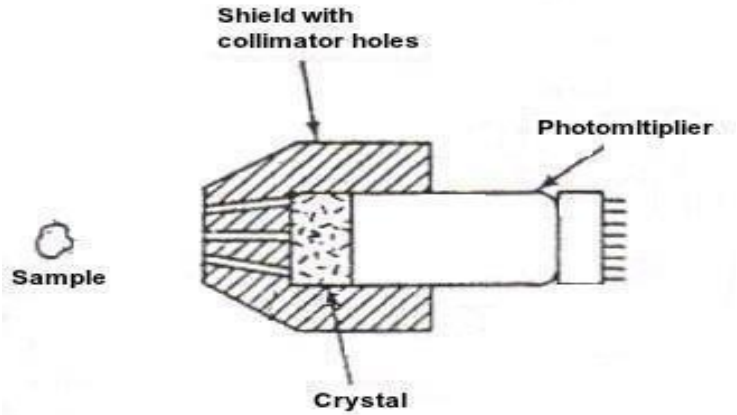


Fig 4.9: Collimated Detector [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Instrumentation System for Radioisotope Measurements

The pulses from the photomultiplier tube are amplified and shortened before they pass through the pulse height analyzer. A timer and gate allow the pulses that occur in a set time interval.

Hydrogen and carbon are the 2 elements that constitute the largest percentage of all organic substances. With these radioisotopes, many natural and synthetic substances can be radioactive and their pathways in the organism can be traced. The detectors for beta radiation are

i) Planchet counter
ii) Liquid scintillation counter

ii) Collimated Detector

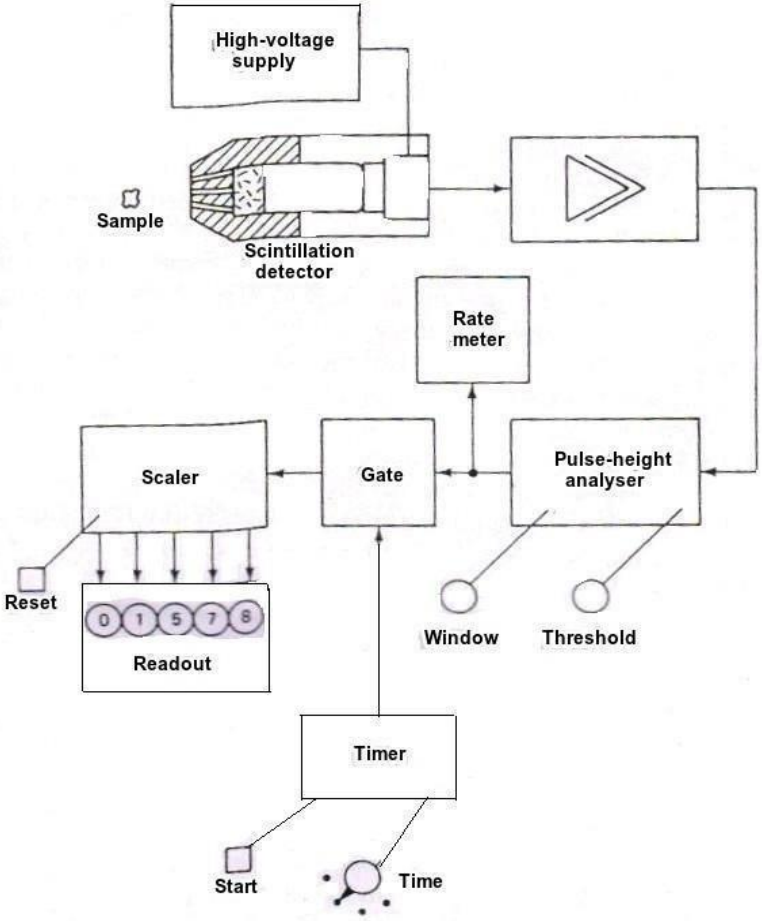


Fig 4.10: Instrumentation System for Radioisotope Measurements Detectors for Beta Radiation [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

i) Planchet Counters

In this, the planchet becomes part of a Geiger Muller counter. The thin layer in which the sample is spread and its close contact with electrodes results in high counting efficiency by a flow of gas that removes ionization products. The sensitivity of planchet counter is marginal.

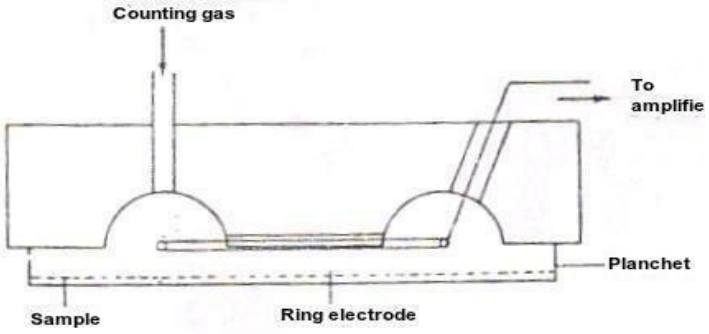


Fig 4.11: Planchet [Source: Leslie Cromwell - Biomedical instrumentation and measurement]**Counter ii) Liquid scintillation**

The sample is placed in a small counting vial where it is mixed with a solvent containing chemical when struck by beta rays. The vial is placed in a detector which is positioned between 2 photomultiplier tubes.

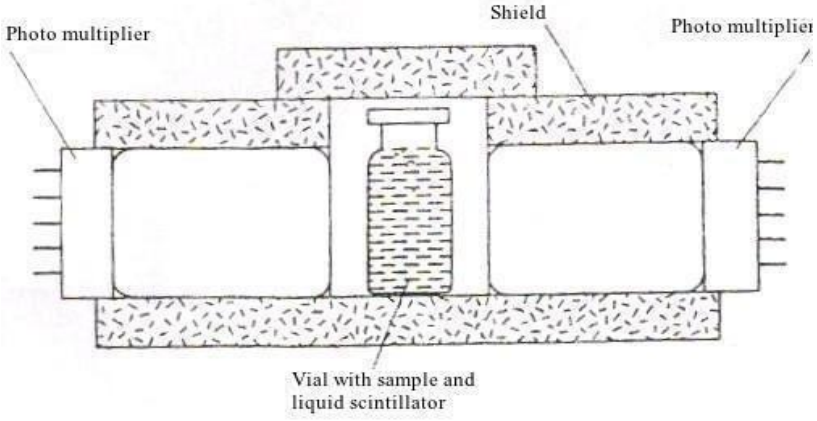
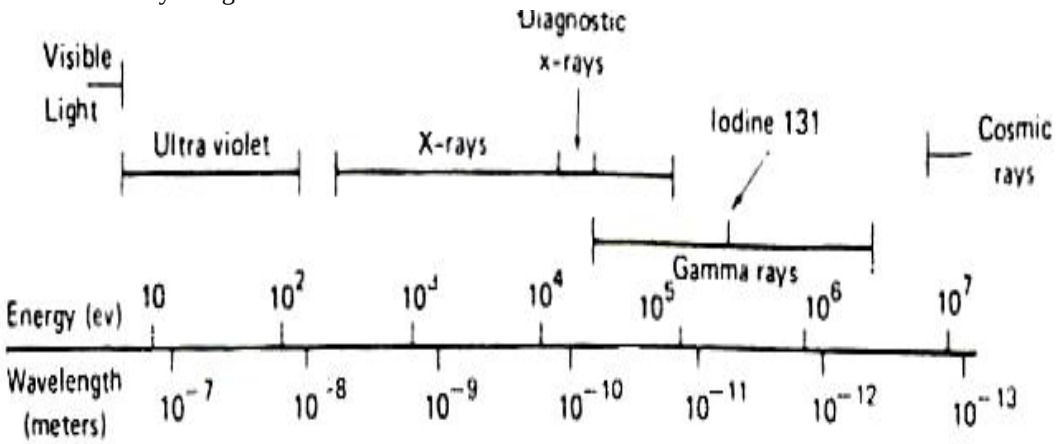


Fig 4.12: Liquid Scintillation [Source: Leslie Cromwell - Biomedical instrumentation and measurement] **RADIATION THERAPY**

The ionizing effect of radiation is used for the treatment of cancer. The use of radiation for the treatment of diseases has become an important subfield of medicine called radiation therapy. There is 3 different types of radiation. Alpha rays are positively

charged particles that travel at a moderate velocity of 5 to 7 percent of velocity of light. Beta rays are negatively charged particles and their velocity can vary over a wide range and almost reach the velocity of light.



E=h f

Where E-energy of radiation (e v) h-planks constant f- frequency

The ionizing effects of X rays are utilized in the treatment of certain diseases especially of certain tumors. In dermatology, very soft x rays are used for the treatment of skin. Soft x rays do not have enough penetration power to enter more deeply

UNIT V

RECENT TRENDS IN MEDICAL INSTRUMENTATION

Thermograph, Endoscopy unit Laser in Medicine, Diathermy unit, Electrical safety in Medical Equipment.

THERMOGRAPH:

Thermography is the process of recording true thermal images of surface of objects under study. In medicine, it displays image representing the thermal radiation of skin areas. Thermogram contains both qualitative and quantitative information relevant to the image and to temperature.

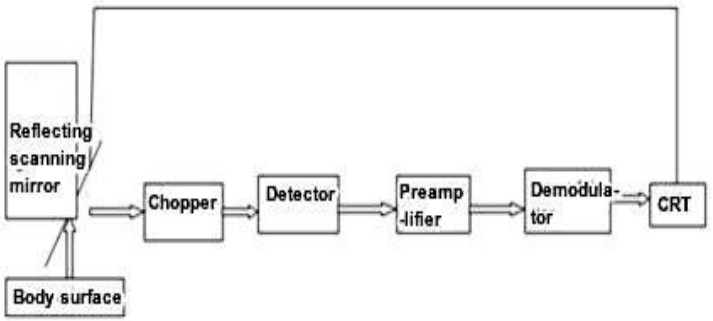


Fig5.1: Simplified Block Diagram of a Thermo Graphic Equipment [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Every thermo graphic equipment is provided with a special Infrared camera that scans the object and Display unit for displaying thermal pictures on screen. The camera contains an optical system in the form of an oscillating flat plane mirror which scans at a very high speed and focuses the collected infrared radiation onto the chopper. The chopper disc interrupts the infrared beam so that A.C signals are produced, amplified and demodulated further. The demodulated signals are given to the cathode ray tube in synchronization with scanning mechanism.

1. Infrared Thermography

2. Liquid crystal Thermography
3. Microwave Thermography

Infrared Thermography:

Human skin emits infrared radiation as an exponential function of its absolute temperature and emissive properties of skin temperature. The radiant energy is emitted in a broad band of wavelengths with maximum emission dependent upon surface temperature.

Photovoltaic and Photo- conductive infrared radiation detectors are commonly used. The operation of a thermography apparatus is as follows. A chopper is inserted infront of a Infrared radiation detector. Infrared radiation from body and from block body enters the detector surface through optical focusing system alternately by chopper to compare the both.

A good thermography equipment must have

- Short frame time
- High resolution
- A small size and light weight optical head
- A wide spectrum band detector
- An easy handling instrument in wards or operation rooms
- Containing interfaces for image processing
- Absolute temperature can be measurable

Solid state electronic circuits can achieve the above said things. There are two types of infrared cameras for medical purpose. a] High speed b] High resolution.

Infra eye, Thermoscope, Thermoviewer, Thermocamera and Infra vision are of the thermographic equipments.

Liquid Crystal Thermography:

Liquid crystals are a class of compounds which exhibit colour-temperature sensitivity in cholesteric phase. Scattering effects with the material give rise to iridescent colours, dominant wavelength being influenced by very small changes in temperature. The high temperature sensitivity makes cholesteric liquid crystals useful for thermal mapping.

i. Red for relatively low temperature.
ii. Violet for high temperature.

In Infrared thermograms violet colour is used to identify low

temperature regions and the bright colour or red for high temperature regions

Microwave Thermography:

Microwave emission intensity from skin surface is very small when compared with infrared radiation intensity. Modern microwave radiometer can defect temperature change of 0.1k. Measurement of temperature by this corresponds to radiations from the skin surface to a depth of several cm.

The error lies in the order of 1-2k. The problem has been solved by adding artificial microwave noise from the antenna, thus providing a radiation balance between the receiver and body surface. Hence a temperature sensitivity of 0.1k could be obtained. To design a thermographs, we must the choice of

- Detector and its response
- Parameters of optical system
- Scanning mechanism
- Time constant of total system
- Method of data presentation

Medical Application of Thermography i]Health cases

The distribution of a health person's skin temperature is symmetrical. This is true with regard to head, face & limbs.

ii] Tumors

In case of benign tumors, difference in temperature with the surrounding tissues is 1^0 C.

iii] Inflammation

The area of an acute inflammation shows a high temperature because of active metabolism and increase in local blood flow.

iv] Diseases of Peripheral Vessels

When the arteries are occluded, blood flow of peripheral vessels either decreases or disappears resulting a low temperature in that part.

v] Burns and Perniones:

In the treatment of burns and perniones, the first thing to do

is deciding on their degree of serenity.

vi] Skin Grafts and Organ Transplantation

The condition of skin grafts after transplantation can be detected by means of local blood flow.

vii] Collagen Diseases

Collagen diseases are usually attended with peripheral vascular discarders.

viii] Orthopedic Diseases

Fractures, arthritis, bruises and sprains can be easily diagnosed because the local skin temperature rises in these cases.

ix] Brain and Nervous diseases

Temperature distribution can be quantitatively diagnosed by means of thermogram.

x] Hormone diseases

Thyroid glands normally register high temperature due to their active metabolism. Patients affected with hyper thyrodism have high temperature.

xi] Examination of placenta attachment

Detection of location of placenta is possible by means of thermogram because increase in local blood flow leads to a high temperature.

Notes:Theremography- Heat camera in Medicine‘ is useful as a screening procedure and can be used to diagnose breast cancer.

ENDOSCOPES

Optical fibers play a vital role in medical field. Endoscopes or fiberoscopes are designed with low quality, large diameter and short silica fibers. Broncho fiberoscopes, gastrointestinal fiberoscopes and laproscopes are the important endoscopes. Endoscopes are used in hospital for examination, treatment of diseases and surgery.

There are two types

1. Flexible
2. Rigid

In each endoscope, there are two fiber bundles.

A typical glass fiber consists of a central _core‘ glass having

high refractive index surrounded by a cladding made of glass of slightly lower refractive index. The numerical aperture (light efficiency) of the fiber is equal to (n 2 2 1/2 collection -n 2 where n_1 & n_2 are refractive index of core and cladding respectively.

Endoscopic Laser Coagulator

It uses argon ion laser as high energy optical source and endoscope as the delivery unit. Argon ion lasers are very useful for the coagulation of blood vessels since its green light is highly absorbed by red blood vessels and hemoglobin.

To control gastric haemorrhage photocoagulation technique is adopted. In fiber optic endoscope, output from argon ion laser is delivered to required spot to arrest the gastric bleeding.

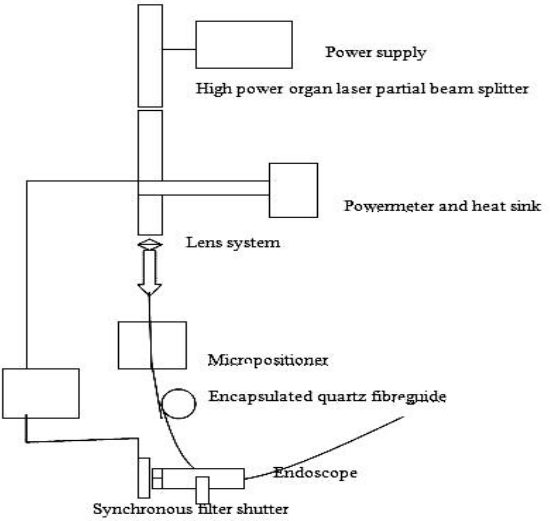


Fig 5.2: Endoscopic Laser Coagulation [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

LASER IN MEDICINE

LASER- Light Amplification by Stimulated Emission of Radiation Basic principle of laser action. Laser beam consists of high intense radiation in unique direction without spreading its energy in other direction. It has high mono chromaticity and high directionality.

Population of atoms in higher energy level is smaller than the lower energy level in an atomic system. During population inversion, the number of atoms in the higher level is more than the number of atoms in the ground level. This can be done by pumping source. Assume that there is population inversion such that the atom in the higher metastable energy level is more.

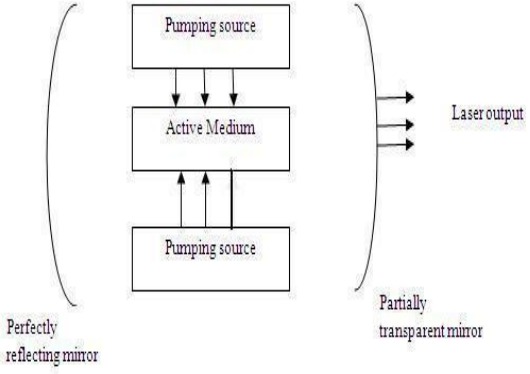


Fig5.3: Laser Principle [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

There are two type of emission

1. Spontaneous emission
2. Stimulated emission

In the case of spontaneous emission, the emission takes place without any inducement. (i.e) Transition from high energy state to any lower energy state takes place voluntarily with the emission of polychromatic radiation. A photo emitted by spontaneous emission has an energy equal to energy difference between laser transmission levels.

Hence laser output can be obtained. The biomedical applications of laser are based on the fact that lasers could produce high photon flux on a localized spot.

The properties of the laser are

- Monochromaticity
- Spatial & Temporal coherence
- Directionality

- Brightness

When light photons fall on the tissues, four bask optical processes may occur

i. Direct reflection at the boundaries of the layer due to change in the refractive index
ii. Scattering by molecules, particle, fibers, cell organelle and cells within the layer
iii. Absorption
iv. Direct transmission through the layer

All the above process depend on

a. Wave of laser
b. Energy density
c. Pulse duration
d. Irradiation time
e. Absorption characteristics of target molecule

The laser photon of wavelength of 600 – 1300 nm can penetrate deep into tissues and that fact is used for phototherapy and selective surgery.

Laser Instrumentation

Laser irradiation of patients with skin tumors is performed in a specially designed operating unit which consists of three

It is intended for remote control unit. The operation can be absorbed by means of a television arrangement.. Lasers are equipped with water cooling system. The energy of radiation is indicated by energy meter and the irradiation time is controlled properly by a timer. The rooms are equipped with warning signal circuits and a blocking system that presents the laser system from working unless the doors of that room are closed.

Advantages of Laser surgery

a. Highly sterile
b. Highly localized & precise
c. Noncontact surgery
d. Dry field, almost bloodless surgery
e. Clear field of view and easy access in confined areas

f. Prompt heating with minimal post operative swelting and scarring

Medical Application of Laser

a) Photothermal Application

Laser heating of tissues is used for two surgical functions. Cutting and photo coagulation. Cutting was used in ophthalmology. It is used to treat variety of eye problems, including retinal bleeding, excessive growth of blood vessels in the eye caused by diabetes and also for spot welding. Spot-welding - Reattaching retinas from back surface of eye, choroid.

b) Photochemical Application

Laser can be used to diagnose and treat diseases non-surgically. Low power lasers can induce more chemical, enzymatic and metabolic changes in human body.

DIATHERMY

Introduction

Operation theatre equipment are very useful both diagnostically and therapeutically.They are mainly useful for monitoring and treatment purpose. During operation, the patient‘s condition is followed carefully by measuring variable like blood flow velocity, cardiac output, blood pressure, P$_H$ value.

Surgical Diathermy

Diathermy is the treatment process by which cutting, coagulation of tissues are obtained. When high frequency current of 1-3 MHz is applied, heating of tissues takes place. The evolving steam bubbles in the tissues continuously rupture the tissues and by that way cutting action is obtained.

The various electro surgery techniques using diathermy unit are

1. Fulguration

When the electrode is held near the tissue without touching it and due to the passage of electric are, destruction of superficial tissues take place. It is related to the localized surface level destruction of tissues. Needle or Ball electrodes are used.

2. Desiccation

The needle point electrodes are stuck into tissue, while passing electric current a local increase in heat creates drying of

tissues.

3. Electrotomy

When the electrode is kept above the skin, an electrical are is sent. The developed heat produces a wedge shaped cutting of tissue on surface. Continuous R.F current is used for cutting.

4. Coagulation

When the electrode is kept above the skin, high frequency current is sent through the tissues in the form of bursts and heating it locally so that it coagulates from inside.

5. Blending

When the electrode is kept above the skin, the separated tissues can be combined together by an electric arc. This is called blending.

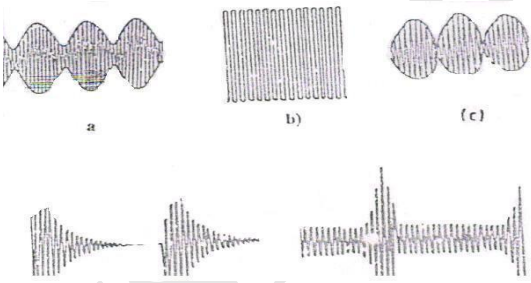


Fig.5.4: Different Types of Waveforms used in Electrosurgical Diathermy Unit

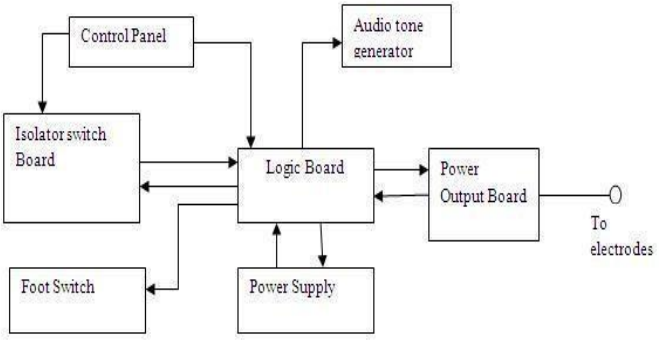


Fig5.5: Block Diagram of Electrosurgical Diathermy Unit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Logic board is the main part of the unit which produces the necessary waveforms for cutting, coagulation and hemostasis mode of operation. An astable multivibrator generates 500 KHz square pulses. The outputs divided into a number of frequencies using binary counters.

Special Features

(i) To secure safety for the patient or operator, the output unit is isolated and insulated from the low frequency primary and secondary voltages.

(ii) The bipolar electrodes are used such that the active electrode is mounted in an insulated handle and in different electrode is placed at the back of patient in the form of plate.

(iii) The output of the unit may be earth referenced or isolated. The isolated output dose not produces any fibrillation and any serious burns.

Short – Wave Diathermy

The heating of tissues is carried out at a high frequency of 27.12 MHz and a wavelength of 11 m. By using currents with very high frequencies, the motor nerves are not stimulated and there is no contraction of muscles. Thus there is no discomfort to the patient.

The output of R.F oscillator is applied to the pair of patient electrodes. The R.F energy heats the tissues and promotes the heating of injured tissues and inflammations.

When R.F current applied to the pads, the dielectric loss of the capacitor produces heat in the intervening tissues. This technique is called condenser or capacitor method. In inductive method, a flexible cable is coiled around the arm.

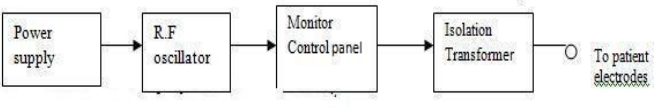


Fig5.6: Block Diagram of Short Wave Diathermy Unit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Instead of continuous R.F wares, R.F pulses of 65 μs with on interval between pulses of 1600 μs are also used. This is called Dia-pulse shortwave diathermy.

Microwave Diathermy

The frequency used is 2450MHz and wavelength of 12.25 cm. heating of tissues is produced due to adsorption of microwave energy. Better therapeutic results are obtained by using microwave diathermy than short wave diathermy. There is no pad shaped electrode. Microwaves are transmitted into the body directly. Magnetrons are used to produce microwaves.

Ultrasonic diathermy

Ultrasonic therapy is used where short wave treatment is failed and where localization of heat effect is desired. It is very helpful to cure the diseases of peripheral nervous system.

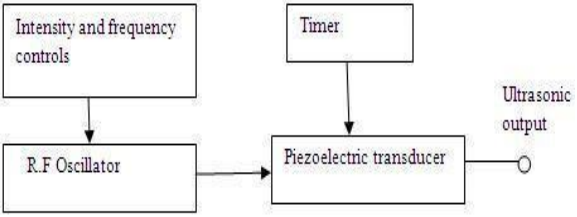


Fig5.7: Block Diagram of an Ultrasonic Diathermy Unit [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

R.F oscillator produces a high frequency alternating current which excites the piezo electric transducer. The ultrasonic waves can be applied in contained or pulsed mode. In

ELECTRICAL SAFETY IN MEDICAL EQU PMENTS

The physiological effects or shock range from discomfort to injury to death, if the heart or respiratory systems are affected. An electrical shock is an unwanted physiological response to current.

Microshock and Macroshock

Macroshock

A physiological response to a current applied to the surface of the body that produces unwanted stimulation like muscle contractions or tissue injury is called macroshock. All hospital patients and medical attendants are exposed to macroshock from

defective electric devices and biomedical equipment.

Microshock

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

Electrical Accidents in Hospitals.

One of the main hazards connected with the use of medical equipment is electrical shock. A macroshock may cause secondary injury to a limb of technician repairing equipment, such as acts on hand as the person pulls away from equipment.

Table 5.4: skin Resistance at 50 Hz

Condition	Skin resistance per Square Centimeter of Electrode
Dry Skin	93.0k Ω
Electrode gel on skin	10.8k Ω
Penetrated skin	200.0Ω

All electrical and electronic devices in the hospitals are sources of potentially harmful current. The electrical power has consists of three wires a hot wires H‘, a neutral wire N‘and a ground wire G‘.

Microshock hazards

Many devices have a metal chassis and cabinet that can be touched by the medical attendants and patients. If they are not ground then an insulation failure or short circuit result and leads to macroshock or microshock.

a) Leakage currents

Most of the accidents occur due to improper grounding and leakage currents, the leakage currents are an extraneous current flowing along a path. This dangerous accident arises because of open ground of the pacemaker by using a two wire extension cord. The leakage current flow is due to

- Undergrounded equipment
- Broken ground wire
- Unequal ground potential

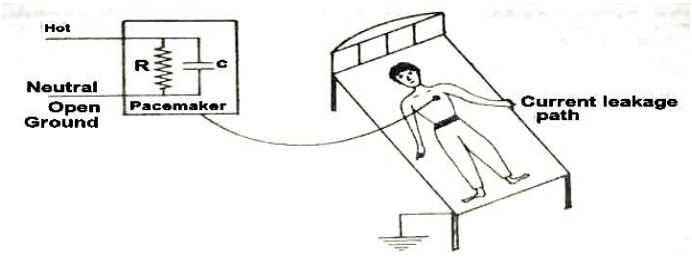


Fig5.8: Microshock due to leakage current [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Even if the three wire (H, N, G) power cord is used with the broken ground wire connection, then the above accident could be occurred. For example the doctor it holding a pacemaker wire by his one hand touching the electrical bed frame by his other hand as shown in fig.

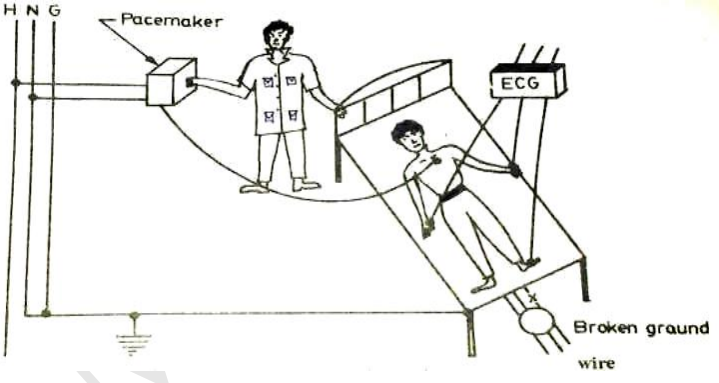


Fig5.8: Microshock for the Patient from the Broken Ground Wire [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Broken ground connection on the electric bed allows a voltage to exist on the frame due to capacitive coupling between bed frame and power line. The pacemaker wire is going into the heart of patient.

b) Static Electricity

Static electricity may be dangerous to people and sensitive equipment having integrated circuit. Sparks from static electricity could ignite flammable gases causing an explosion. Shocks from static electricity could cause cardiac arrest if applied to a pacing catheter. Floor carpeting is very common source of static electricity

charge buildup.

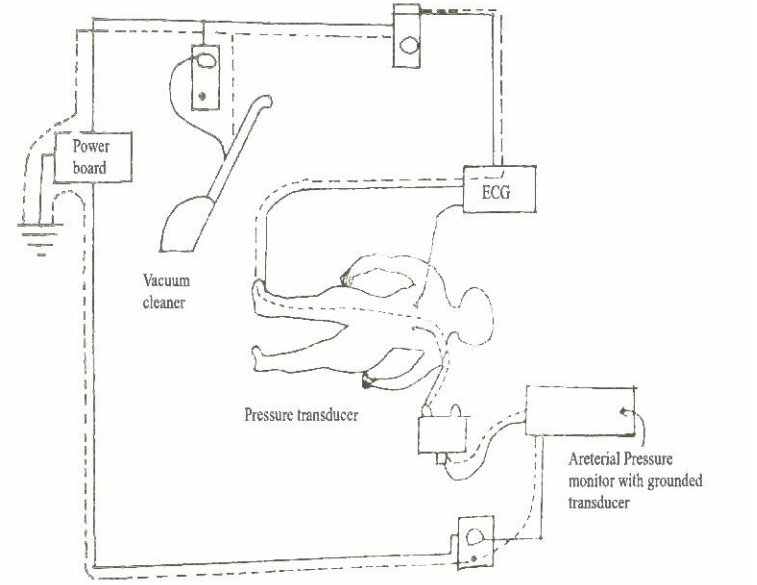


Fig5.8: Microshock from static electricity

[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

c) Interruption of Power

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

Macroshock hazards

Macroshock occurs more often with two-wire system than with three-wire system. If the patient touches H and N wires simultaneously with two limbs, then the currents are flowing directly through vital organs of circulation and respiration. N wires are internally grounded, hence touching H and G wires can produce macroshock.

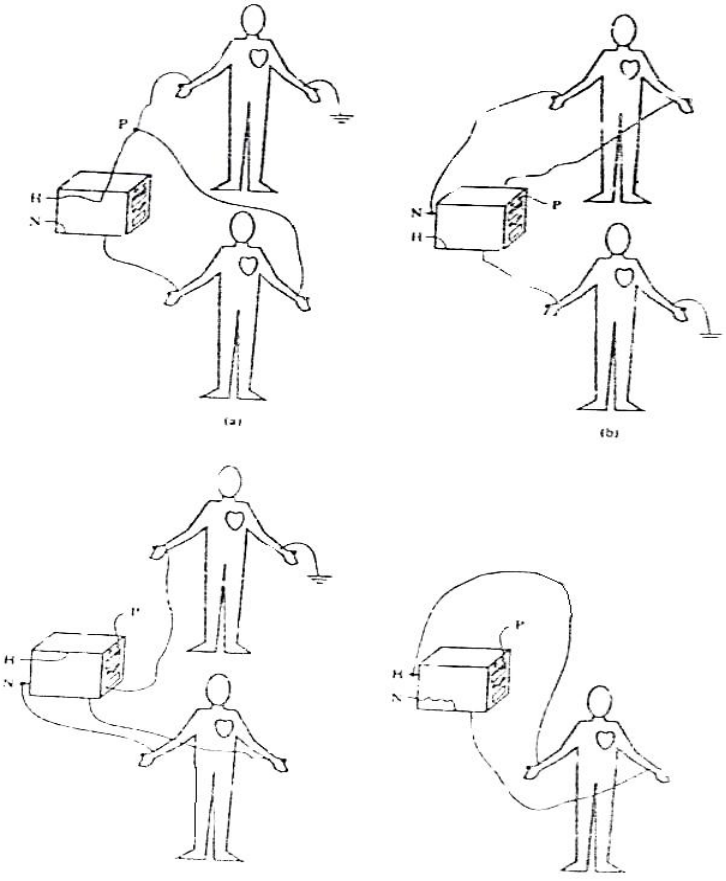


Fig5.9: Microshock Situations in the Case of Two Wire Units
[Source: Leslie Cromwell - Biomedical instrumentation and measurement]

Fig illustrates additional hazardous situations that result from faults which occur in the equipment. In part (a), H lead shorts to patient lead P. Thus a macroshock result if the patient touches ground or chassis.

DEVICE TO PROTECT AGAINST ELECTRICAL HAZARDS

Several devices are available to protect patient and health care workers from hazardous electrical currents.

Ground Fault Interrupter

A ground fault interrupter (GFI) protects against a shock that occurs if a person touches the hot lead with one hand and ground with the other.

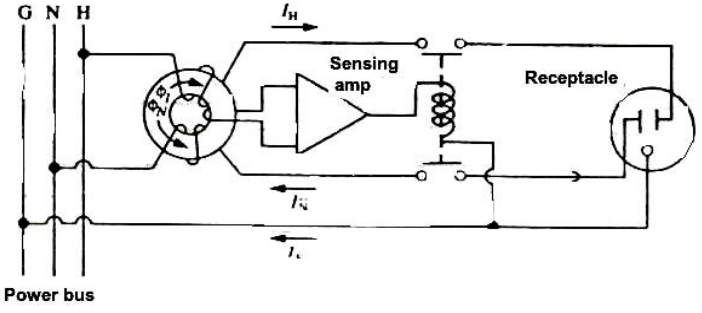


Fig5.10: Ground Fault Interrupts [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

When the system is normal $I_N = I_H$

The magnet flux φ in the coil cancels.

Sensing coil does not have a voltage induced in it When the hot lead faults or is touched by a person, the

fault current. If is shunted to ground. $I_N = I_H - I_F$

I is not equal to I

The corresponding fluxes in the coil are unequal and a net flux exists in the coil which induces a voltage into sensing amplifier.

Isolation Transformer

Isolation transformer provides a second means of protecting against an H lead to G-lead macro shock. It prevents sparks when H lead touches ground, particularly protection in an explosive or flammable environment. Fig (a) shows that a fault such as a short circuit from either secondary lead of transformer to ground will carry no current.

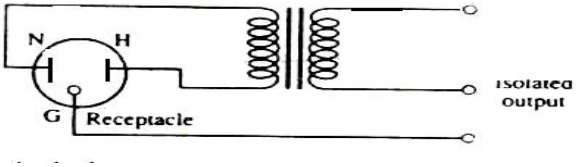


Fig 5.11: An Isolation Transformer

[Source:Leslie Cromwell - Biomedical instrumentation and measurement]

Line Isolation Monitor:

A line isolation monitor (LIM) puts relatively large impedance from either secondary lead through an ammeter to ground of isolation transformer. If there is a conductive path through the equipment as shown in fig (b) the meter in the LIM will read a current.

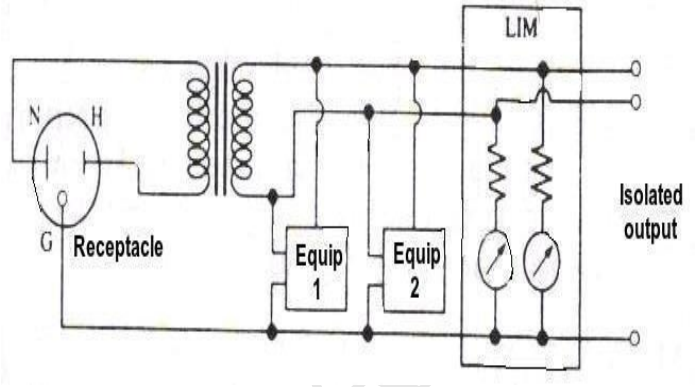


Fig 5.12: An Isolation Transformer Connected to a Line Isolation Monitor and Other Equipment [Source: Leslie Cromwell - Biomedical instrumentation and measurement]

QUESTION BANK

SUBJECT : EC 8073 – MEDICAL ELECTRONICS

SEM / YEAR: V / III year B.E.

UNIT I - ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING			
Sources of bio medical signals, Bio-potentials, Biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics.			
PART A			
Q. No	**Questions**	**BT Level**	**Competence**
1.	List the types of bioelectric potentials.	BTL 1	Remembering
2.	Summarize electrode and the types of electrodes used in the bipolar measurement.	BTL 2	Understanding
3.	Define Lead. Name the type of leads used for ECG.	BTL 1	Remembering
4.	Differentiate micropipette and metal microelectrode.	BTL 2	Understanding
5.	How would you describe the term Conduction velocity?	BTL 1	Remembering
6.	List out the disadvantages of surface electrodes.	BTL 4	Analyzing
7.	Name the electrodes used for recording EMG and ECG?	BTL 1	Remembering
8.	Construct the typical ECG waveform and mention the cause for first & second heart Sounds.	BTL 3	Applying
9.	Examine the term phonocardiogram.	BTL 4	Analyzing
10.	Assess the important bands of frequencies in EEG & their importance.	BTL 5	Evaluating
11.	Distinguish the signal characteristics of ECG and PCG.	BTL 4	Analyzing
12.	Show the EMG signal characteristics.	BTL 2	Understanding
13.	Define relative refractory period.	BTL 6	Creating
14.	Describe the latency related to EMG.	BTL 2	Understanding
15.	Compose biological amplifier.	BTL 6	Creating
16.	Name the 10-20 lead system used in ECG recording.	BTL 1	Remembering
17.	State the importance of PCG signals.	BTL 1	Remembering
18.	Justify the use of Einthoven triangle.	BTL 5	Evaluating
19.	Choose the various EEG signals with amplitude and frequencies.	BTL 3	Applying
20.	Identify the importance of biological amplifier.	BTL 3	Applying
PART – B			
1.	(i) What should be the characteristics of bio potential amplifier? (8) (ii) Show with necessary diagram the origin of bio potential. (5)	BTL 1	Remembering
2.	(i) Analyze in detail about the 10-20 lead system of recording EEG. (8) (ii) List the typical ECG waveform and mark the important features and their associated function of the heart. (5)	BTL 4	Analyzing

3.	(i) Give an account on surface electrode and state its application. (5) (ii) Explain different lead system used in an ECG recorder. (8)	BTL 2	Understanding
4.	Identify and describe the different types of bio potential electrodes used in measurement of bio signals. (13)	BTL 1	Remembering
5.	(i) Compare the signal characteristics of ECG and EMG. (7) (ii) Measure the heartbeat using ECG recording system in detail. (6)	BTL 5	Evaluateing
6.	(i) How a metal microelectrode is formed? Draw its electrical equivalent circuit and explain. (7) (ii) Show the circuit diagram of Darlington pair isolation amplifier and explain. (6)	BTL 1	Remembering
7.	Construct the characteristics of EMG and EOG signals with typical waveform. (13)	BTL 3	Applying
8.	(i) Explain the medical use of Chopper amplifier? Draw the diagram of mechanical Chopper amplifier and explain its working? (7) (ii)Illustrate the ECG curves for normal adult, myocardial infraction, coronary insufficiency and ventricular fibrillation. (6)	BTL 2	Understanding
9.	Develop the EEG waveform in detail and its signal frequency bands. (13)	BTL 6	Creating
10.	(i) Pointout the different requirements for biomedical amplifiers? (4) (ii) Examine the characteristics of a medical preamplifier with neat diagram and deduce an expression for its net gain. (9)	BTL 4	Analyzing
11.	(i) Examine the action potential waveform and discuss about polarization and repolarization. (8) (ii) Show the bipolar limb lead system of an ECG. (5)	BTL 1	Remember
12.	(i) Draw the equivalent circuit of biopotential electrode interface and explain about half cell potential. (5) (ii) List out the advantage and disadvantage of biopotential measurement. (8)	BTL 2	Understanding
13.	Infer the physiology of heart and lungs and derive an approximate engineering system equivalent to the same. (13)	BTL 4	Analyzing
14.	Illustrate an ultrasonic transducer is applied in clinical diagnostic circuit. (13)	BTL 3	Applying
	PART – C		
1.	Design a suitable amplifier that can be used in the front end of an ECG machine. Justify your by specifying the features of the selected amplifier. (15)	BTL 5	Evaluating
2.	(i) Summarize the instrumentation amplifier with circuit diagram. (8) (ii) Evaluate the origin of brain waves. (7)	BTL 5	Evaluating
3.	(i) Generalize the international standard 12 lead system used to record ECG. (10) (ii) Formulate the list and discuss the important characteristics of bio-amplifier. (5)	BTL 6	Creating
4.	(i) Invent the different types of surface electrodes and discuss its applications. (10) (ii) Elaborate the steps for the typical recording setup of EMG with diagram. (5)	BTL 6	Creating

UNIT II - BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT

pH, PO2, PCO2, Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.

PART A

Q.No	Questions	BT Level	Competence
1.	State the principle behind Rheographic method of blood pressure measuring technique.	BTL 1	Remembering
2.	Justify the meaning of pH value of blood.	BTL 5	Evaluating
3.	Infer the measurement method of PO_2 and PCO_2.	BTL 2	Understanding
4.	Define stroke volume of heart.	BTL 1	Remembering
5.	Identify the use of auto analyzer in medical field and types of test performed using it.	BTL 3	Applying
6.	Elaborate the principle used in pulse rate measurement.	BTL 6	Creating
7.	What is colorimeter? State its use.	BTL 1	Remembering
8.	Summarize the merits & demerits of electromagnetic blood flow meter.	BTL 2	Understanding
9.	Examine auto fiber optic temperature sensor.	BTL 4	Analyzing
10.	Name any 4 physical principles based on which blood flow meters are constructed.	BTL 2	Understanding
11.	What are the typical values of blood pressure and pulse rate of an adult.	BTL1	Remembering
12.	Develop the stroke volume in millimeters if the cardiac output is 5.2 litres/minute and heart rate is 76 beats/minute.	BTL 3	Applying
13.	Demonstrate the methods of measurement of cardiac output.	BTL 2	Understanding
14.	List out the components of blood.	BTL 4	Analyzing
15.	Assess the use of Flame photometer.	BTL 5	Evaluating
16.	Describe the cardiac output. What are the methods used to measure cardiac output?	BTL 1	Remembering
17.	Compile the demerits of indirect method of blood pressure measurement.	BTL 6	Creating
18.	Organize the importance of Plethysmographs.	BTL 3	Applying
19.	How is the respiration rate measured?	BTL 1	Remembering
20.	Analyze the term “Korotkoff sounds” and total lung capacity.	BTL 4	Analyzing

PART – B

1.	Examine the principle of following: (i) Filter Photometer (7) (ii)PO_2 measurement (6)	BTL 4	Analyzing
2.	Explain the following techniques with necessary diagram: (i) pCO_2 measurement principle (7) (ii) Dye dilution (6)	BTL 2	Understanding

3.	Discuss about the measurement of pH and pO_2 of the blood with the help of neat diagram. (13)	BTL 6	Creating
4.	How would you describe about spirometer and blood cell counter with neat block diagram. (13)	BTL 1	Remembering
5.	Interpret the working principle of electromagnetic blood flow meter. What are its advantages and disadvantages? (13)	BTL 2	Understanding
6.	Explain the different techniques used in the measurement of pulse rate. (13)	BTL 2	Understanding
7.	Describe in detail the principle of calorimeter with neat diagram. (13)	BTL 1	Remembering
8.	Explain the working principle of conductive method blood cell counter with its construction details. (13)	BTL 5	Evaluating
9.	(i) Analyse the measurement of pH of blood using PH meter. (7) (ii) Classify the temperature measurement methods. (6)	BTL 4	Analyzing
10.	Inspect the parameter with suitable figures and explain how pH, pCO_2 and pO_2 are measured? (13)	BTL 4	Analyzing
11.	(i) Identify the method for cardiac output measurements. (9) (ii) Construct the need for blood pH measurement. (4)	BTL 3	Applyv
12.	How would you use the ultrasonic waves in measuring, (i) Blood Flow (7) (ii) Blood pressure (6)	BTL 3	Applying
13.	(i) Which device is used to measure the Lung capacity and volume with neat diagram and explain its operations? (7) (ii) Show the measurement of heart sound with suitable diagram. (6)	BTL 1	Remembering
14.	(i) What is the principle of sphygmomanometer and explain the operation? (7) (ii) How is the pulse rate measured? (6)	BTL 1	Remembering
	PART – C		
1.	Assess the principle of coulter counter and with block diagram explain multi parameter coulter counter. (15)	BTL 5	Evaluating
2.	Summarize the different types of ultrasonic blood flow meter? Explain each in detail. (15)	BTL 5	Evaluating
3.	Invent the term “Cardiac output”. How is Cardiac output measured by dye dilution technique? Explain. (15)	BTL 6	Creating
4.	Develop auscultatory blood pressure measurement and write its advantages and disadvantages. (15)	BTL 6	Creating

UNIT III ASSIST DEVICES			
Cardiac pacemakers, DC Defibrillator, Dialyser, Ventilators, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems.			
PART A			
Q.No	Questions	BTL Level	Competence
1.	Interpret the need for using a cardiac pacemaker.	BTL 2	Understanding
2.	What are the two parts of pacemaker?	BTL 1	Remembering
3.	Classify the types of Pacemaker.	BTL 2	Understanding
4.	List the types of batteries used for implantable pacemaker.	BTL 1	Remembering
5.	Why do we require a synchronization function in defibrillator?	BTL 1	Remembering
6.	Differentiate internal and external defibrillator.	BTL 4	Analyzing
7.	Draw the schematic diagram of a d.c defibrillator.	BTL 3	Applying
8.	Define LVAD.	BTL 1	Remembering
9.	State dialysate and mention its composition.	BTL 1	Remembering
10.	Infer the function of membrane in the dialysis process.	BTL 2	Understanding
11.	Inspect the mechanism of respiration and need for use of artificial ventilation.	BTL 4	Analyzing
12.	Write the function of a ventilator.	BTL 1	Remembering
13.	Calculate the energy stored in 16 μ F capacitor of a DC defibrillator that is charged to a potential of 5000Vdc.	BTL 5	Evaluating
14.	Identify the types of imaging sequences.	BTL 3	Applying
15.	Deduct the basic components of an NMR imaging system.	BTL 6	Creating
16.	Evaluate the biological effects of MRI imaging modality.	BTL 5	Evaluating
17.	List the advantages of Nuclear Magnetic Resonance and ultrasonic imaging system.	BTL 4	Analyzing
18.	Express characteristic impedance in ultrasound.	BTL 3	Applying
19.	Summarize the advantages of an ultrasound imaging system.	BTL 2	Understanding
20.	Explain the role of frequency, focusing and active element diameter with reference to ultrasound transducers.	BTL 6	Creating
PART B			
1.	(i) How pacemakers are classified based on the modes of operation? (6) (ii) Show the block diagram of stand by and demand pacemakers and explain its working principle. (7)	BTL 1	Remembering
2.	Illustrate the following types of pacemakers with diagram. (i) Demand pacemaker. (6) (ii) Atrial Synchronous pacemaker. (7)	BTL 2	Understanding

3.	Explain the heart lung machine with neat block diagram and discuss about the different types of oxygenators. (13)	BTL 3	Applying
4.	(i) Propose the difference between haemodialysis and peritoneal dialysis. (6) (ii) Elaborate about a haemodialysis machine with the help of block diagram. (7)	BTL 6	Creating
5.	(i) Demonstrate the principle and operations of DC defibrillators. (8) (ii) Identify the advantages and disadvantages of DC defibrillator. (5)	BTL 3	Applying
6.	Write a brief note on: (i) Implantable defibrillator. (6) (ii) LVAD. (7)	BTL 1	Remembering
7.	Elaborate the principle of Nuclear Magnetic Imaging system with the help of appropriate illustrations. (13)	BTL 6	Creating
8.	Draw a block diagram of microprocessor controlled ventilator and analyze the importance of each block. (13)	BTL 4	Analyzing
9.	(i) Interpret the image reconstruction techniques used in NMR imaging. (8) (ii)What is the commonly used method in modern scanners. (5)	BTL 4	Analyzing
10.	(i) Estimate the various imaging modes of ultrasound imaging system. (8) (ii)Distinguish between 'A' and 'B' mode of ultrasound imaging system. (5)	BTL 5	Evaluating
11.	Write the function of a ventilator. How many types of ventilators are there? Explain with the help of diagrams. (13)	BTL 1	Remembering
12.	(i) Outline the significance of relaxation process in MRI imaging and compare T_1 and T_2 relaxation times. (7) (ii) Discuss about FID. (6)	BTL 2	Understanding
13.	Describe with the help of a diagram the various building blocks of a basic pulse- echo apparatus. (13)	BTL 2	Understanding
14.	Discuss the working principle of linear array scanner with the help of a block diagram. (13)	BTL 4	Analyzing
	PART C		
1.	(i) Deduct the various types of implantable pacemakers and explain their functions with necessary diagrams. (10) (ii)Demonstrate the two types of electrode system used in implantable pacemaker. (5)	BTL 5	Evaluating
2.	Evaluate the principle of dialysis in the artificial kidney. What are the different types of dialyzers? Explain their construction and principle of operation. (15)	BTL 5	Evaluating
3.	Elaborate a real time ultrasound imaging system. What are the special requirements of real time imaging systems? (15)	BTL 6	Creating

4.	Discuss the following in detail (i) Intravascular imaging. (7) (ii) Tissue harmonic imaging. (8)	BTL 6	Creating

UNIT IV PHYSICAL MEDICINE AND BIOTELEMETRY

Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry.

PART A

Q.No	Questions	BTL Level	Competence
1.	Write the principle of high frequency heat therapy.	BTL 1	Remenbering
2.	State the term Diathermy.	BTL 1	Remenbering
3.	Draw a circuit diagram of a short wave diathermy unit.	BTL 4	Analyzing
4.	Why do require automatic tuning in a short wave diathermy machine?	BTL 6	Creating
5.	Analyze the features of Ultrasonic type diathermy.	BTL 4	Analyzing
6.	Define desiccation and haemostasis.	BTL 1	Remembering
7.	Show a block diagram of an ultrasonic therapy unit.	BTL 2	Understanding
8.	List the applications of diathermy.	BTL 1	Remembering
9.	Identify two main circuits in a short wave diathermy machine.	BTL 2	Understanding
10.	Interpret the various ways of regulating the intensity of current supplied to the patient from a short wave diathermy machine.	BTL 3	Applying
11.	Classify shortwave and microwave diathermy.	BTL 4	Analyzing
12.	What are the two designs of applicators in microwave diathermy?	BTL 1	Remembering
13.	Compare the heat distribution in the body tissues with short wave and microwave Diathermy.	BTL 5	Evaluating
14.	Evaluate the common modulation methods used in biotelemetry system.	BTL 5	Evaluating
15.	Discuss the applications of Bio-Telemetry.	BTL 6	Creating
16.	Organize the choices of radio carrier frequency for medical telemetry purposes.	BTL 3	Applying
17.	Construct a block diagram of ECG telemetry transmitter.	BTL 3	Applying
18.	Outline various components of the radio telemetry system.	BTL 2	Understanding
19.	Summarize the different elements in Bio-Telemetry.	BTL 2	Understanding
20.	How do we control the dosage in ultrasonic therapy units?	BTL 1	Remembering

PART B

1.	Define diathermy. Draw the circuit diagram of a short-wave diathermy unit and discuss its impact on therapy purpose in detail. Also briefly describe how it can be applied to human subjects? (13)	BTL 1	Remembering

2.	(i) Interpret the application techniques in short- wave diathermy machines. (8) (ii) Why the pulsed therapy is preferred? (5)	BTL 2	Understanding
3.	(i) Explain the principle of heating using microwaves. (5) (ii) Elaborate the working of microwave diathermy machine with the help of a simplified circuit diagram. (8)	BTL 6	Creating
4.	(i) With a block diagram, evaluate the working function of ultrasonic therapy. (8) (ii) what are the advantages of using ultrasonic for therapeutic purposes? (5)	BTL 5	Evaluating
5.	Illustrate the following with respect to ultrasonic therapy unit (i) Dosage control. (6) (ii) Application technique. (7)	BTL 2	Understanding
6.	(i) Summarize the modulation and coding techniques used in bio-telemetry system. (5) (ii) Demonstrate the working of pulse width modulator system with a help of circuit diagram. (8)	BTL 2	Understanding
7.	Describe the working principle of single channel ECG telemetry system with a block diagram. (13)	BTL 1	Remembering
8.	(i) Analyze which type of modulation system is used in a multichannel bio-telemetry system? (5) (ii) Explain the multiplexing methods commonly used in multichannel bio-telemetry systems. (8)	BTL 4	Analyzing
9.	How to transmit bio-signals over telephone lines? Explain a single channel telephone telemetry system with the help of a diagram. (13)	BTL 1	Remembering
10.	Write a brief note on: (i) Telemetry of ECG and Respiration. (6) (ii) Multi Patient Telemetry. (7)	BTL 1	Remembering
11.	Draw a block diagram of a generalized FM telemetry transmitter and receiver and discuss the working in detail. (13)	BTL 3	Applying
12.	Experiment an implantable blood flowmeter based on ultrasonic Doppler shift principle. (13)	BTL 3	Applying
13.	Examine the various components of the radio telemetry system with a block diagram of the internal radio telemetry capsule. (13)	BTL 4	Analyzing
14.	Inspect biotelemetry application on WIMAX networks with necessary diagrams. (13)	BTL 4	Analyzing
	PART C		
1.	Evaluate the various types of High frequency heat therapy for healing injured tissues. (15)	BTL 5	Evaluating
2.	Explain the different methods of applying electrodes in shortwave diathermy treatment. (15)	BTL 5	Evaluating
3.	Develop an implantable telemetry system for flow, pressure and ECG measurements. (15)	BTL 6	Creating

4.	Elaborate the working of three channel telephone transmitter and receiver with the help of a block diagram. (15)	BTL 6	Creating

UNIT V RECENT TRENDS IN MEDICAL INSTRUMENTATION			
Thermograph, endoscopy unit, Laser in medicine, cryogenic application, Introduction to telemedicine. **Telemedicine, Insulin Pumps, Radio pill, Endomicroscopy, Brain machine interface, Lab on a chip.**			
PART A			
Q. No	**Questions**	**BT Level**	**Competence**
1.	Define BMI.	BTL 1	Remembering
2.	Analyze the principle of BMI method and list its applications.	BTL 4	Analyzing
3.	Give the advantages of Insulin pumps.	BTL 2	Understanding
4.	List out the feature of lab on chip.	BTL 1	Remembering
5.	Develop some few applications BMI based system.	BTL 3	Applying
6.	Label the parts of an endomicroscopy.	BTL 1	Remember
7.	Summarize the necessary Parameters of cell signaling in the CNS.	BTL 2	Understanding
8.	Identification the framework of BMIs.	BTL 3	Applying
9.	Mention the advantages of performance of lab on chip module.	BTL 4	Analyzing
10.	Show any one of the implantable infusion system.	BTL 1	Remembering
11.	Illustrate the uses of component used in an implantable insulin pump.	BTL 2	Understanding
12.	Can you recall the principle of telemedicine?	BTL 1	Remembering
13.	Write the working principle of radio pill.	BTL 1	Remembering
14.	Illustrations of condition number and nonstationary properties of the input autocorrelation matrix.	BTL 3	Applying
15.	Discuss the applications passive pumping device of LOC.	BTL 6	Creating
16.	Compare the merits and demerits of various feature of BMI.	BTL 5	Evaluating
17.	Outline the simplified block diagram of insulin pump equipment.	BTL 2	Understanding
18.	Point out the applications of Endomicroscopy method.	BTL 4	Analyzing
19.	Conclude the applications of telemedicine in health care.	BTL 6	Creating
20.	Justify the term Telemedicine for remote diagnosis and treatment in hospital.	BTL 5	Evaluating
PART – B			
1.	Explain the telemedicine based communication method with a suitable block diagram. (13)	BTL 5	Evaluating
2.	Describe the working principle of implantable type infusion system. (13)	BTL 1	Remembeing
3.	Summarize the need for each of the essential components in an endmicroscope & its applications. (13)	BTL 2	Understanding
4.	Discuss on the design procedure involve in the BMI with neat diagram. (13)	BTL 6	Creating
5.	Categorize the detailed description of about infusion pumps system. (13)	BTL 4	Analyzing

6.	(i) Demonstrate about radio pills explain with necessary diagram. (9) (ii) Give some applications radio pills in recent trend medicine field.(4)	BTL 2	Understanding
7	(i) Illustrate the different operations performed using endomicroscopy. (5) (ii) Develop and explain the block diagram of LOC. (8)	BTL 3	Applying
8.	Show the various component used in an implantable insulin pump. (13)	BTL 1	Remembering
9.	(i) Define the nonlinear mixture of competitive linear models in BMI. (7) (ii) Can you recall about Reaching task neuronal sensitivities sorted from minimum to maximum for a movement in Sensitivity-Based Pruning. (6)	BTL 1	Remembering
10.	(i) List out the LOC applications. (8) (ii) Inspect the salient features of Insulin pumps. (5)	BTL 4	Analyzing
11.	Write brief notes on the working principle of: (i) Programmable volumetric infusion pump. (7) (ii)Drop rate counter type infusion system (6)	BTL 1	Remembering
12.	Construct and discuss the working of an endomiroscopic unit. (13)	BTL 3	Applying
13.	A LOC how to diagnosis HIV. Find out design procedure for HIV test using LOC. (13)	BTL 4	Analyzing
14.	i) Write notes on BMI. (5) ii) Explain how telemedicine helps the patients and medical practitioners. (8)	BTL 2	Understanding

PART – C

1.	(i) Explain the various type of insulin pups system in recent trend medicine. (10) (ii) Conclude the specific advantages of insulin pumps. (5)	BTL 5	Evaluating
2.	(i) Summarize the benefits and limitations of telemedicine. (7) (ii) Assess the importance of LOC in recent trend medicine. (8)	BTL 5	Evaluating
3.	Elaborate the principle of operation and application of Radio pill. (15)	BTL 6	Creating
4.	Compile the basic application of BMI to implement different motor function interconnection between brains to hand and leg. (15)	BTL 6	Creating

UNIT-1 ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING

PART A

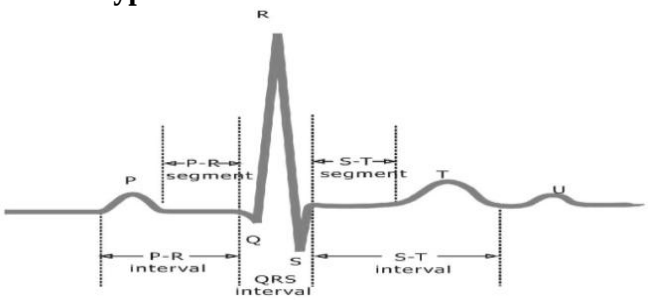
1. State all or none law in respect of cell biopotential.

Regardless of the method of excitation of cells or the 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 none law'.**

2. Define the term Conduction Velocity.

The rate at which an action potential moves down a fiber of a nerve cell or is propagated from cell to cell is called the **propagation rate (or) conduction velocity.** The conduction velocity is defined as $V = [(l_1 - l_2) / (t_1 - t_2)]$ .The conduction velocity in peripheral nerves is normally 50m/s.

3. Draw a typical ECG waveform.



4. State how a phonocardiogram and an electrocardiogram signals differ in their clinical information.

In electrocardiography, only the voltage generated by the electrical activity of the heart is recorded. Any form of arrhythmia (disturbance in the heart rhythm) can be easily diagnosed using electrocardiogram.

The graphic record of the heart sounds is called phonogram. Because the sound is from the heart, it is called as phonocardiogram. The basic aim of phonocardiograph is to pick up the different heart sounds, filter out the heart sounds and to display them.

5. Define resting and action potential.

The membrane potential caused by the different concentration of ions is called as **resting potential** of the cell. The positive potential of the cell membrane during excitation is called as **action potential** and it is about 20mV.

6. Define Latency as related to EMG.

Latency is defined as the elapsed time between the stimulating impulse and the muscle's action potential.

7. List the names and frequency bands of EEG signals

The names and frequency bands of EEG signals are

Alpha waves - 8-13 Hz
Beta waves - 13-30Hz
Theta waves - 4-8 Hz
Delta waves - 05-4 Hz

8. What is the importance of PCG Signal ?

The importance of PCG signals are

1. Different types of heart sounds are measured.
2. Due to vibration setup in the blood inside the heart by sudden closure of valves
3. Additional sounds are hard between normal heart sounds.

9. Mention the importance of biological amplifier.

Generally, Bio signal are having low amplitude and low frequency .so, amplifier are needed to boost the amplitude level of the bio signals. These amplifiers are known as bio- amplifiers.

10. Mention the various lead systems used in ECG recording.

The various lead system used in ECG recording are

(i) Bipolar limb lead/standard lead
(ii)Augmented unipolar limb lead
(iii) Chest lead/precordial lead
(iv)Frank Lead system/corrected orthogonal lead system.

11. What is half cell Potential?

The voltage developed at an electrode-electrolyte interface is designated as the half cell potential or electrode potential. A Characteristics potential difference established by the electrode and its surrounding electrolyte which depends on the metal, concentration of ions in solution and temperature.

12. Give the EMG Signal Characteristics.

The EMG signal ranges from 0.1mV to 0.5mV.The frequency components of the EMG signal vary from 20HZ to 10 KHz and they are restricted to the frequency range of 20HZ to 200HZ for Clinical purpose using a low pass filter.

13. What is EOG?

EOG –Electro oculography – It is the recording of the biopotential generated by the movement of eyes.

14. Compare the signal characteristics of ECG and PCG.

PCG related to mechanical events of heart while ECG related to electrical activity of heart. PCG has three different waves but ECG has only one wave from to analysis the function of heart.

15. What is PCG?

The graphic record of the heart sounds is called as phonogram. Because the sound is from the heart, it is called phonocardiogram. The instrument used to measure the heart sounds is called as phonocardiograph.

16. What are the different types of electrodes used in bipolar measurement?

The different types of electrodes used in bipolar measurement are

a) Metal plate electrodes, b) Suction cup electrode, c) Adhesive tape electrode,
d) Multipoint electrode, e) Floating electrode.

17. Give the ECG Signal Characteristics.

The ECG signal characteristics is given below

Amplitude	P wave	0.25 mV
	R wave	1.60 mV
	Q wave	25% of R wave
	T Wave	0.1 to 0.5 mV
Duration	P-R interval	0.12 to 0.20 sec
	Q-T interval	0.35 to 0.44 sec
	S-T interval	0.05 to 0.15 sec
	P wave interval	0.11 sec
	QRS interval	0.09 sec

18. What is bio electric potential?

The ionic voltages produced as a result of the electrochemical activity of certain special type of cells are known as bio-electric potential.

19. The contraction of skeletal muscle is termed as what? Give its specification.

The contraction of skeleton muscle is termed as Twitch and Tetanic contractions.Twitch contraction is a short burst of stimulation causes the muscle to contract, but the duration is so short that the muscle begins relaxing even before reaching peak force. If the stimulation is long enough, the muscle reaches peak force and plateaus at this level, resulting in a Tetanic contraction.

20. Enlist the electrodes used for recording EEG.

Scalp electrodes: F_{p1}, F_{p2}, F_z, F_3, F_4, F_7, F_8, C_z, C_3, C_4, P_z, P_3, P_4, O_z, O_1, O_2, T_3, T_4, T_5, T_6

Nasopharyngeal electrodes: P_{g1} and P_{g2},

Ear electrodes: A_1 and A_2

21. Define CMRR. Give its importance in physiological signal amplifiers.

$$CMRR = \frac{amplificationofthedifferentialvoltage}{amplificationofthecommon\,\mathrm{mod}\,evoltage}$$

The common mode rejection ratio (CMRR) should be more than 80dB so as to eliminate the 50Hz interference from the mains.

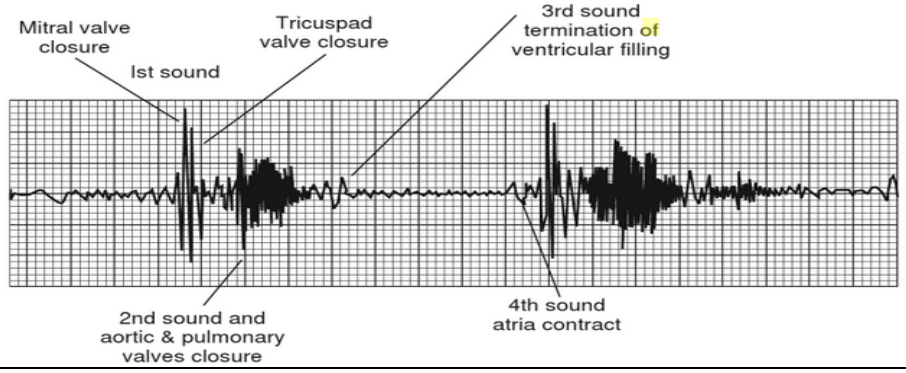
22. List the characteristics needed for Bio Amplifier.

a) The voltage gain of the amplifier should be >100dB.
b) It should have low frequency response.
c) Gain and frequency response should be uniform throughout the Bandwidth.
d) There is no drift in the amplifier.
e) The output impedance should be very small.
f) The common mode rejection ratio (CMMR) should be >80dB.

23. What are the requirement of a biological amplifier?

1. The voltage gain of the amplifier should be more than 100dB so as to amplify the biosignal properly to drive the recorder.
2. The gain and the frequency response should be uniform throughout the required bandwidth.
3. There is no drift in the amplifier.
4. The output impedance of the amplifier should be very small.

24. Draw the wave form of a typical PCG signal and label its components.



25. Name the electrode used for recording ECG and EMG

Surface Electrode and Needle Electrodes are used for recording ECG and EMG.

26. What are the different types of bio potential electrodes?

There are three types of electrodes

1. Micro Electrodes – (Metal micro electrode and Micropipet)
2. Depth and Needle Electrode
3. Surface Electrode – (Metal Plate Electrode, Suction cup electrode , Adhesive tape electrode, Multipoint electrode ,Floating Electrode)

27. Mention the normal amplitude and frequency of EMG signal ?

The normal amplitude of EMG signal is about range from 0.1 to 0.5 mV

The normal frequency of EMG signal is about 60 Hz

28. What is the range of resting potential?

The resting potential range from 70 to 90 mill volt.

29. What are artifacts?

The term artifacts refer to any component of a signal that is extraneous to the variable represented by a signal.

30. Differentiate between heart sound and murmurs.

Heart sound have a transient character and it is of short duration, whereas heart murmurs have a noisy characteristics and last for a longer time. Heart sounds are due to the closing and opening of the valves, murmurs are due to the turbulent flow of blood in the heart and larger vessels.

31. List the important characteristics required for bio-amplifier.

a. The voltage gain of the amplifier should be >100dB.
b. It should have low frequency response.
c. Gain and frequency response should be uniform throughout the Bandwidth.
d. There is no drift in the amplifier.
e. The output impedance should be very small.
f. The common mode rejection ratio (CMMR) should be >80dB.

32. Mention the electrodes used to record bio-potential from a single muscle fibre.

Microelectrodes – i) Metal Microelectrodes ii) Micropipet.

33. State all none law

The all-or-none law is the principle that the strength by which a nerve or muscle fiber responds to a stimulus is independent of the strength of the stimulus. If that stimulus exceeds the threshold potential, the nerve or muscle fiber will give a complete response; otherwise, there is no response.

34. What is ment by conduction velocity

In modern EMG systems, nerve conduction time and nerve velocity are measured. For this measurement, initially nerve is stimulated and EMG is measured.This conduction velocitymeasurement is used to indicate the location and type of nerve lesion

35. Define absolute and relative refractory period

Absolute refractory period: During a short period after the generation of an action potential, the cell does not respond to any stimulus at all. This period is known as theabsolute refractory period.

Relative refractory period: It is the time period between the instant when the membrane potential becomes negative again and the instant when the membrane potential returns to RMP. During this period, the cell responds to a stimulus but less strongly than usual.

36. Mention the cause of first and second heart sounds

Record of heart sounds – 1st and 2nd heart sounds are heard well but 3rd and 4th are not. Heart sounds are generally used for diagnosis of valverelated diseases. Such abnormal heart sounds are called murmurs.

1st heart sound: due to closure of AV valves – long, soft & low-pitched sound – sounds like‘lubb’ – 0.14-0.2 sec – 30-40 Hz.

2nd heart sound: due to closure of semilunar valves – short, sharp & high-pitched sound –sounds like ‘dub’ – 0.08-0.1 sec – 50-70 Hz.

37. List the important characteristics required for bioamplifier

The requirements for bio-potential amplifiers can often be more demandingthan for a lot of electronic equipment as might be used in the entertainment ortelecommunications sectors. When measuring electrical signals, such as the ECG,from the surface of the body typical requirements could be:

• Very High Input Impedance:
• Moderate Bandwidth:
• Sufficient Gain-Bandwidth Product:
• High Common-Mode-Rejection:

38. Mention the electrodes used to record bio potential from a single muscle fiber

single-fiber electromyography electrode within a motor unit used to record bio potential from a single muscle fiber

UNIT-1 PART B& C

1. i) Discuss in detail about Action Potential and Resting Potential**.**
   ii) Write short notes on bio potential electrodes.
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:4-8 & 24-27.

2. i) Explain the working principle of a ECG machine with a neat block diagram.ii) What is Phonocardiography?
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:117-142.

3. i) Explain in detail various types of bio potential electrodes**.**
   ii) Write a short note on electromyogram.
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:21-33 & 153-156.

4. i) Draw an action potential waveform and discuss in detail about polarization and repolarization.
   ii) Draw the bipolar limb lead system of an ECG.
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:4-8 & 120-121.

5. i)What is Half cell potential?
   ii) What are the three types of electrodes and mention its use.
   iii) Discuss Microelectrodes in detail.
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 21, 24 -27.

6. i) Bring out the salient features of phonocardiography.
   ii) With suitable diagram, explain the method of measurement of conduction velocity in peripheral nerves.
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 133-142 & 153-156.

7. Explain the working principle of EEG recording machine.
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 144

8. A) (i) explain the international standard 12 lead system used to record ECG(10)
   (ii) list and discuss the important characteristics and frequency bands of EEC signal(6)
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 132,77

9. (i) discuss in detail about the orgin potential and resting potential with necessary equations.(10)
   (ii) describe the typical recording setup of EMG (6)
   Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:89,123

10. a) discuss the genesis of ECG and explain the working of an ECG machine which is block diagram along with its various lead configuration(16)
    Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 184

11. What is know as biopotential electrodes? Draw its equivalent circuit explain various types of biopotential electrodes with suitable example(16)
    Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 192

12. (i) explain the international standard 12 lead system used to record ECG(10) (i) list and discuss the important characteristics of bioamplifier(6)
    Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 132, 98

13. (i) discuss in detail about the 10 – 20 lead system.(10)
    (ii) describe the typical EMG waveform and its characteristics(6)
    Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 126,67

UNIT-2 – BIO CHEMICAL &NONELECTRICAL PARAMETER MEASUREMENT

PART A

1. What are cardiac output and phonocardiogram?

Cardiac output is the amount of blood delivered by the heart to aorta per minute. Phonocardiogram is used to measure heart sounds in graphical manner

2. What is cardiac output .Mention the methods of measurement of cardiac output .

Cardiac output is the amount of blood delivered by the heart to aorta per minute various Methods to measure the cardiac output is

Fick's method
Indication dilution method
By impedance change

3. What are demerits of electromagnetic blood flow meter?

i) The output voltage of the method is only few micro volts.
ii) Change of magnetic field causes the transducer to act like a transformer and induces error Voltage.

4. Name any two methods of respiration rate measurement?

1. Maximum mid expiratory
2. Maximal expiration flow rate
3. Maximal breathing capacity.

5. What is residual volume?

The Residual Volume (RV) is the volume of gas remaining in the lungs at the end of a maximal expiration.

6. Mention the application of flame photometer.

A flame photometer is used to Analyzing urine or blood in order to determine the concentration of potassium (K), sodium (Na), Calcium (Ca) and Lithium (Li).

7. What is meant by Mean Arterial Pressure (MAP)?

Mean Arterial Pressure is a weighted average of systolic and diastolic pressure. Generally, MAP falls about one-third of the way between the diastolic low and the systolic peak. A simple formula for computing MAP is: MAP = 1/3 (systolic - diastolic) + diastolic

8. What are Korotkoff's sounds?

When an artery is partially occluded so that the blood velocity through the constriction is increased sufficiently, identifiable sounds can be heard downstream through a stethoscope. These sounds are called Korotkoff's sounds, are used in the common method of blood pressure measurement.

9. What is a colorimeter? State its uses?

The Colorimeter is used to measure the transmitted and absorbed light as it passes through a sample. The colorimeter uses light absorption to determine blood proteins and iron levels. Colorimeter can be in the filter photometer or spectrophotometer. When an interference filter is used to select a given wavelength it is called filter photometer. When a diffraction grating or prism is used as a monochromatic to get different spectral components or wavelength of interest in the colorimeter, then it is called spectrophotometer.

10. Name the four physical principles based on which blood flow meters are constructed?

1. Electromagnetic induction
2. Ultrasonic principle(Transit time type, Doppler type)
3. Thermal convection
4. Radiographic Principle
5. Indicated dilution Principle.

11. Name the instrument used to measure PO_2 and PCO_2?

Blood Gas Analyzer

12. How is the pulse rate measured?

The pulse rate is measured using one of the following methods

a) Electrical Impedance Method
b) Strain gauge Method
c) Photoelectric Method
d) Microphone Method

13. What is Stroke Volume?

Stroke Volume (SV) is the Volume of blood pumped from one ventricle of the heart with each beat.

14. What is systolic and diastolic pressure?

Contraction of heart muscle is called as systolic. The systolic pressure is 120 mm of Hg. Relaxation of heart muscle is called as diastole. The diastolic pressure is 80 mm of Hg.

15. How is respiration rate measured?

The measurement of respiration rate provides ideas about relative respiratory activity .Various techniques are used for this measurement are

1. Displacement method
2. Thermistor Method
3. Impedance pneumography
4. CO_2 Method
5. Apnora Detector

16. Which transducer is used for measuring temperature? Why?

Thermoelectric type transducer is used for measuring temperature, because to store and carry plasma, antibiotics etc.

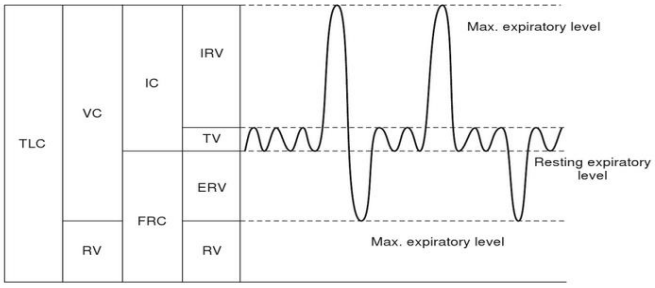
17. What is the principle used in pulse rate measurement?

Piezoelectric type transducer is the principle used in pulse rate measurement.

18. Which flow meters are used to measure pulsatile flow of blood?

Pulsed Doppler Blood flow meter

19. Draw lung volume diagram.



20. How does the pH value determine the acidity and alkalinity in blood fluid?

The pH is a measure of the acid – base balance of a fluid. A neutral solution has a pH of 7.Lower pH numbers indicate acidity , whereas higher pH values define a basic solution .

21. List the various indirect methods for the measurement of blood pressure.

The various indirect methods for the measurement of blood pressure are

1. Percutaneous insertion
2. Catheterization (Vessel cut down)
3. Implant of a transducer in a vessel or in the heart.

22. Write the principle behind electromagnetic blood flow meter.

Continuous measurement of blood velocity can be obtained by placing the electromagnetic flow probe around arteries and veins. This probe operates on **Faraday's law of induced e.m.f**. Blood is a conductor of electricity. When a magnetic field is applied to a blood vessel, the blood flow in the vessel causes an electric field to be induced in a direction mutually perpendicular to the direction of the applied magnetic field and the blood velocity.

23. Nitrogen washout technique is meant for what measurements?

A nitrogen washout can be performed with a single nitrogen breath, or multiple ones. Both tests use similar tools, both can estimate functional residual capacity and the degree of non uniformity of gas distribution in the lungs, but the multiple-breath test more accurately measures absolute lung volumes

24. What is Fick' s Principle? Give its advantages.

The Fick's method is based on the determination of cardiac output by the analysis of the gas keeping of the organism. Thus the cardiac output can be calculated by continuously infusing oxygen in to the blood or removing it from the blood and measuring the amount of the oxygen in the blood before and after its passage.This method is complicated, difficult to repeat, necessitates catheterization, it is practiced at some places.

25. Define cardiac output. Find the cardiac output of a person if his heart rate is 72 BPM and stoke volume is 70ml.

Cardiac output is the amount of blood delivered by the heart to aorta per minute.

$$Cardiacoutput = \frac{stroke volume \times Heart rate}{1000}$$

$$Cardiacoutput = \frac{70 \times 72}{1000} = 5.04 ml / \min ute$$

26. What are the components of Blood?

The components of blood include:
Red blood cells, White blood cells, Platelets, and Plasma.

27. If systolic and diastolic blood pressures are given as 110mmHg and 82 mm Hg . Calculate mean arterial Pressure.(Nov/Dec 2013)

MAP = 1/3(systolic – diastolic) + diastolic
MAP = 1/3(110-82) + 82 = 36.66 mm Hg.

28. Mention the basic principle behind electrochemical pH determination.

The Principle is illustrated as below. Inside the glass bulb is a highly acidic buffer solution. Measurement of the potential across the glass interface is achieved by placing a silver- Silver chloride electrode in the solution inside the glass bulb and a calomel or silver – silver chloride reference electrode in the solution in which the pH is being measured.

29. What is an auto Analyzingr? What are the essential units in it?

Auto Analyzingr is used to measure blood chemistry and display on a graphic recorder.

30. Give the typical values of blood pressure and pulse rate of an adult.

Blood Pressure: 120/80 mmHg
Pulse Rate : 60 to 80 bpm

31. Mention the applications of auto Analyzingr?

1. Clinical analysis – Determine levels of albumin, alkaline phosphates, aspartate transaminase(AST), blood urea nitrogen ,bilirubin ,calcium ,cholesterol ,creatinine , glucose , inorganic phosphorus , proteins and uric acid in blood serum or other bodily samples.
2. Industrial analysis – Mainly for water ,soil extracts and fertilizer.

32. Calculate the stroke volume in millilitres if the cardiac output is 5.2 litres/minute and heart rate is 76 beats/minute?

Cardiac output(ml/min) = Heart rate (beat/min)* Stroke Volume (ml/beat)
Stroke Volume = 5200/76 = 68.42 ml/beat

33. Define cardiac output. Find the cardiac output of a person if his heart rate is 70BPM and stroke volume is 70ml.

Cardiac output is the amount of blood delivered by the heart to aorta per minute.

$$Cardiacoutput = \frac{strokevolume \times Heartrate}{1000}$$

$$Cardiacoutput = \frac{70 \times 70}{1000} = 4.9ml / \min ute$$

34. What are the different types of test performed using auto Analyzingr?

1. Pipetting 2.Diluting 3.Incubatting

35. What is blood pressure state the normal values of blood pressure

The sphygmomanometer consists of (i) an inflatable rubber bladder called the "cuff",
(ii) a rubber squeeze ball pump and valve assembly and (iii) a manometer

36. State the different types of test performed using auto analyser

An automated analyser is a medical laboratory instrument designed to measure different chemicals and other characteristics in a number of biological samples quickly, with minimal human assistance

37. Define cardiac output

Cardiac output is the quantity of blood delivered by the heart to the aorta per minutes. It is amajor determinant of oxygen delivery to the tissues.

38. Stae beer's law

If the path length or concentration increases, the transmittance decreases andabsorbance increases
Absorbtivity related to the nature of the A=aCL absorbing substance and opticalwavelength (known for a standard solutionconcentration).
C: Concentration
L: Cuvette path length

39. Define cardiac output find the cardiac output of person if his heart beat rate is 70 BPM and stroke volume is 70 ml

Cardiac output is the product of two variables, stroke volume and heart beat. Heartbeat is simply a count of the number of times a heart beats per minute. Stroke volume is the amount of blood circulated by the heart with each beat. The formula for this is expressed as CO = SV x HR.
CO=70*70=4900

40. Sate the different types of test performed using auto analyser

An automated analyser is a medical laboratory instrument designed to measure different chemicals and other characteristics in a number of biological samples quickly, with minimal human assistance

PART B & C

1. a) i) Discuss the working principle of a colorimeter with a neat block Diagram.
ii) How will you measure blood pressure using Sphygmomanometer?
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:284-286 & Notes.

2. a) i) Explain the working principle of a electromagnetic type blood flow Meter
ii) Define Cardiac output .Discuss a technique to determine cardiac Output.

Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:233-237 &246-253.

3. a) i) Explain the working principle of a electromagnetic type blood flow Meter**.**
ii) Describe the operation of a blood cell counter.
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 233-237 & 274-277.

4. a) i) Define the terms : residual volume , tidal volume ,vital capacity and Total lung capacity.
ii)Discuss Fick's method for determining cardiac output.
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:254&246-247.

5. a) Describe the measurement of pH in blood.
b) Explain the following : Auto Analyzer
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:265-267 &Notes.

6.	Draw a block diagram of ultrasonic blood flow meter .Explain the method of measuring the velocity of blood flow using (i) Transit time principle (2) Doppler effect **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:237-244.**
7.	Explain the function of a human respiratory system and the possible measurement and inferences made out of them. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:253.**
8.	A) (i) Describe the measurement of PH of blood using pH meter (8) (ii)Explain the meseremeent of respiration rate using impedencetechinique.(8) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 208,211**
9.	(i) state and explain the working principal of electromagnetic blood flow meter. (ii) describe the working of coulter counter. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 200**
10.	a) With suitable diagram describe how ultra sound principles are used in measuring the flow of blood?(16) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 206**
11.	(i)Define blood pressure how it can be measured using sphygmomanometer?(8) (ii)How the lungs volume can be measured ? explain with necessary diagram.(8) **Ans: Text book: Bio medical instrumentation , Notes**
12.	A) (i) Deacribe the measurement of PO2 (8) (ii)Explain the block diagram and working of colorimeter.(8) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 204,215**
13.	(i) Define the term cardiac output how is cardiac output measured by dye diluation technique? Explain (ii) describe the working principal of electromagnetic blood flow meter. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 230,222**

UNIT-3 – ASSIST DEVICES

PART A

1. What is meant by Bradycardia and Tachycardia?

The normal value of heart rate lies in the range of 60 to 100 beats per minute. A slower rate than this is called as**Bradycardia (Slow rate)** and a higher rate, **Tachycardia (fast heart).**

2. When does the need for pacemaker arise? What is its function?

In cardiac diseases, where the ventricular rate is too low, it can be increased to normal rate by using pacemakers. The various arrhythmias (rhythm disturbance) that result in heart block and Adams stokes attacks represent a serious pathological condition. During that time, the patient becomes invalid because of the constant risk of sudden losing consciousness. By fixing the artificial electronic pacemakers, the above defects in the heart can be eliminated.

3. List the typical ranges of pacemaker parameters.

Pulse rate	-	25-155pulses per minute
Pulse width	-	0.1-2.3 ms
Pulse amplitude	-	2.5-10 volts
Battery capacity	-	0.44-3.2amp-hours
Longevity	-	3.5-18 years
End-of-life indicator	-	2-10%drop in pulse rate
Weight	-	33-98 grams
Size	-	22-80cm^3
Encapsulization	-	Silicon rubber, Stainless steel, titanium

4. What are pacemakers?

Pacemaker is an electrical pulse generator for starting and maintaining the normal heart beat.

5. What is meant by demand pacemaker?

If the R wave is missing for a preset period of time, the pace will supply a stimulus. Therefore if the heart rate falls below a pre- determined minimum the pacemaker will turn on and provide the heart a stimulus. For this reason it is called as Demand Pacemaker.

6. What are the batteries used for implantable pacemakers.

The batteries used for implantable pacemakers are

1. Mercury cells
2. Lithium cells
3. Rechargeable cells
4. Nuclear cells
5. Bio Fuel cells
6. Bio Mechanical power generation sources.

7. What is meant by Fibrillation?

The heart is able to perform its important pumping function only through precisely synchronized action of the heart muscle fibers. The rapid spread of action potential over the surface of the atria causes these two chambers of the heart to contract together and pump blood through the two atrio ventricular values in to the ventricles. After a critical time delay the powerful ventricular muscles are synchronously activated to pump blood through the pulmonary and systemic circulatory systems. A condition in which this necessary synchronism is lost is known as Fibrillation.

8. Calculate the energy stored in 16µ F capacitor of a DC defibrillator that is charged to a potential of 5000 V dc.

Energy stored (E) = ½ C V^2

E= ½ *16*10^{-6} * 5000 *5000 = 200 Joules.

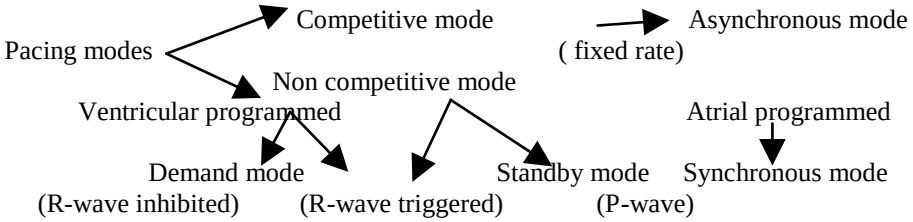
9. Why should a patient susceptible to 'ventricular fibrillation' be watched continuously?

Ventricular fibrillation is far more dangerous, for under this condition the ventricles are unable to pump blood and if the fibrillation is not corrected death will usually occurs with in a few minutes. So patient should be watched continuously.

10. Distinguish between internal pacemakers and external pacemakers.

S.No	External Pacemaker	Internal Pacemaker
1.	The pacemaker is placed outside the body	The pacemaker is miniaturized and is surgically implanted beneath the skin near the chest or abdomen with its output leads are connected directly to the heart muscle.
2.	The electrodes are called endocardiac electrodes and are in contact with the inner surface of the heart chambers	The electrodes are called myocardiac electrodes and are in contact with the outer wall of the heart muscle.
3.	It does not required open chest surgery	It requires an open chest minor surgery to place the circuit
4.	The battery can be easily replaced	The battery can be replaced only by minor surgery
5.	During placement, swelling and pain do not arise due to minimum foreign body reaction.	During placement, swelling and pain arise due to minimum foreign body reaction.
6.	No safety for the pacemaker	Cent percent safety for the pacemaker
7.	Mostly used for temporary heart irregularities	Mostly used for permanent heart damages

12. Classify pacing modes.

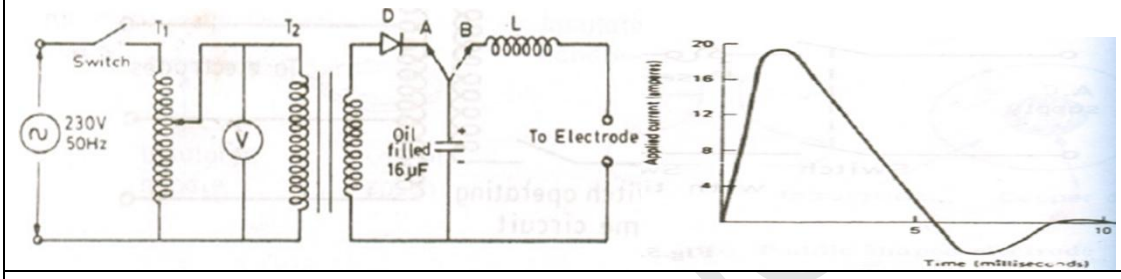


13. What is Defibrillator? State its use.

A Defibrillator is an electronic device that Creatings a sustained myocardial depolarization of a patient's heart in order to stop ventricular fibrillation (or) atrial fibrillation .The instrument for administering the electric shock is called as defibrillator.

1. The method of defibrillation is the application of an electric shock to the area of the heart.
2. Defibrillators are also used to convert other potentially dangerous arrhythmias to one that is easily managed – CARDIO VERSION.
3. Defibrillator discharge may used to convert a tachycardia (fast heart) arrhythmia to a normal rhythm.

14. Draw the circuit of DC Defibrillator and give its output specification.



15. What is heart – Lung Machine?

During open heart surgery for installation of a valve prosthesis or correction of a congenital mal formation, the heart cannot maintain the circulation. It is then necessary to provide extra- corporeal circulation with a special machine called Heart – Lung Machine .

16. What is Systole and Diastole?

Systole is the period of contraction of the ventricular muscles during that time blood is pumped in to the pulmonary artery and the aorta. Diastole is the period of dilation of the heart chambers as they fill with blood.

17. What are the types of oxygenators?

They are four types of oxygenators. They are

1. Bubble oxygenators
2. Film oxygenators
3. Membrane oxygenators
4. Liquid – Liquid oxygenators

18. Define dialysis.

Dialysis is a process by which the waste products in the blood are removed and restoration of normal pH value of the blood is obtained by an artificial kidney machine.

19. Compare Hemodialysis and peritoneal dialysis?

S.No	Hemodialysis	Peritoneal dialysis
1.	In this procedure, blood is purified by an artificial kidney machine called Hemodialysis in which the blood is taken out from the body and waste products diffuse through a semi permeable membrane which is continuously rinsed by a dialyzing solution or dialysate.	The peritoneal cavity in our body is used as a semi permeable membrane and by passing the dialysate into it waste products are removed from the blood by diffusion.
2.	More effective to separate the waste products	Less effective
3.	Technically complex and risk one because the blood is taken out from the body.	Simple and risk free
4.	Dialyzing time is about 3 to 6 hours	Dialyzing time is about 9 to 12 hours

.

20. What are the three physical processes used in dialysis?

The three physical process used in dialysis are i) Diffusion ii) Osmosis iii) Ultra filtration.

21. What are the two types of procedures for doing dialysis?

The two types of procedures for doing dialysis

1. Hemodialysis
2. Peritoneal dialysis

22. Which type of electrode is applied in the case of external stimulation and what is the current range?

The paddle shaped electrodes are applied on the surface of the chest and the current range is 20 -150 mA

23. Which types of electrodes are used in internal stimulation and what is the current range?

The electrodes in the form of fine wires of Teflon coated stainless steel , spoon like electrodes are used .The current range in 2 -15 mA

24. What is external stimulation employed?

The external stimulation is employed to restart the normal rhythm of the heart in case of cardiac stand still.

25. What is internal stimulation employed?

Internal stimulation is employed in cases requiring long term pacing because of permanent damage that prevents normal self triggering of heart.

26. What are the modes of operation of pacemakers?

The modes of operation of pacemakers are

1. Ventricular asynchronous pacemaker(Fixed rate pacemaker)
2. Ventricular synchronous pacemaker
3. Ventricular inhibited pacemaker(Demand pacemaker)
4. Atrial synchronous pacemaker
5. Atrial sequential ventricular inhibited pacemaker

27. What are the types of defibrillator?

The types of defibrillator are

1. A.C Defibrillator
2. D.C Defibrillator
3. Synchronized D.C Defibrillator
4. Square Pulse D.C Defibrillator
5. Double Square Pulse Defibrillator
6. Biphasic D.C Defibrillator

28. Why are asynchronous pacemakers no longer used?

A synchronous pacing is called competitive pacing because the fixed rate impulses may occurs along with natural pacing impulses and would therefore in competition with them in controlling the heart rate.

29. When do you need heart lung machine?

During open heart surgery for installation of a valve prosthesis or correction of a congenital mal formation, the heart cannot maintain the circulation .It is then necessary to provide extra-corporeal circulation with a special machine called heart lung machine.

30. What is the systolic and diastolic pressure of Aorta?

Systolic Pressure/Diastolic pressure: 130/75

31. What is the systolic and diastolic pressure of different areas of heart?

Left Ventricle: 130/5
Right Ventricle: 25/0
Left Atrium: 9/5
Right Atrium: 3/0

32. Differentiate internal and external defibrillator

Momentary application of strong electrical stimulus to bring all the cardiac cells simultaneously into a refractory period thereby arresting their irregular, uncoordinated twitching is known as defibrillation. Types: (i) ac defibrillation & (ii) dc defibrillation.

The ac defibrillation: A brief (0.25 to 1 sec) burst of 60 Hz ac at an intensity of 6 A is applied to the chest of the patient. As an attempt to correct the atrial fibrillation using ac often results in even more serious ventricular fibrillation, ac defibrillation is no longer used.

The dc defibrillation: Several volts of dc is momentarily applied across or through the chest – only fewer repetitions are required to correct ventricular fibrillation so less harm than ac defibrillation – successful in correcting atrial fibrillation.

33. What is dialyasate mentation its composition

themake up of dialysate or the dialysis 'bath', is: sodium chloride, sodim bicarbonate or sodium acetate, calcium chloride, potassium chloride, and magnesium chloride. This is the general composition of dialysate, but other compounds such as glucose may also be included.

34. Distinguish between endocardiac and myocrdiac electrodes.

The endocardial approach (Fig. 2) is to place electrodes at the apex of the right ventricle via any suitable superficial vein above the diaphragm. This may include use of either the external or the internal jugular, the cephalic, or the subclavian vein. It is not advisable to use any veins below the diaphragm for long-term endocardial stimulation. The cephalic and the subclavian are the most desirable veins in as much as they avoid "draping" the electrode catheters over the clavicle. As a practical matter it is wise, when surgically preparing the patient, that the entire side of the chest and neck on the side to be employed be made available for a surgical field.

35. Mention few difference between internal and external defibrillator

EXTERNAL DEFIBRILLATOR:

A unit based on computer technology and designed to Analyzing the heart rhythm itself, and then advise whether a shock is required. It is designed to be used by lay persons, who require little training. It is usually limited in their interventions to delivering high joule shocks for VF and VT rhythms

36. Why are asynchronous pacemaker no longer used?

Heart beat rate cannot be changed. If it is fixed in atrium, atrium beat at a fixed rate. If ventricle beat at a different rate, and then it leads to a severe problem. Ventricular fibrillation may be occurred.

37. When do you need heart lungs machine?

A machine that does the work both of the heart and of the lungs: pumping and oxygenating blood. Blood returning to the heart is diverted through a heart-lung machine before being returned to arterial circulation. Such machines may be used during open-heart surgery. Also known as pump-oxygenator or cardiopulmonary bypass machine.

PART B & C

1. Discuss with suitable block diagram the different modes of operation of Cardiac pacemakers.
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:167-175.

2. a) i) What is defibrillator? ii) Distinguish between Internal and External Defibrillator.
iii) With block diagram describe the operation of synchronized D.C Defibrillator.
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:185-186 &190-193.

3. Explain the operation of Dialyzer with a neat sketch.

Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:212.

4. Explain the operation of Heart – Ling machine with a neat sketch.
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:202.

5. Discuss with suitable block diagram of atria and ventricle Cardiac pacemakers.
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:167-175

6. With block diagram describe the operation of D.C Defibrillator**.**
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:185-186 &190-193.

7. A (i) With a neat diagram explain the block diagram of arterial and ventricular triggered pacemaker.(16)

Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 210

8. Explain in detail the principal and diagram working of hacmodialyser.(16)
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 285

9. a)How pacemakers are classified based on the modes of operation draw the block diagram of stand by and demand pacemakers and explain its working principle.(16)
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 260

10. Enumerate the following oxygenators peritionial dialysis(8+8)
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 243

11. A) (i) With a neat diagram explain the block diagram of DC defibrillator.(8)
(ii) Describe the working of atrial synchronous pacemaker. (8)
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 206, 241

12. Explain in detail the different types of oxygenators and pumps used in heart lung machine.(16)
Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 228

UNIT-4 – PHYSICAL MEDICINE AND BIO TELEMETRY
PART A

1. Write the physiological effects of electricity.

Type of Current	Current range (mA)	Physiological effect
Threshold	1-5	Tingling Sensation
Pain	5-8	Intense or painful sensation
Let-go	8-20	Threshold of involuntary muscle contraction
Paralysis	>20	Respiratory paralysis and pain
Fibrillation	80-1000	Ventricular and heart fibrillation
Defibrillation	1000-10000	Sustained myocardial contraction, temporary respiratory paralysis and possible tissue burns

2. What is the principle of diathermy?

High frequency currents ,apart from their usefulness for therapeutic applications , can also be used in operating rooms for surgical purposes involving cutting and coagulation .The frequency of current used in surgical diathermy units is in the range of 1-3MHz in contrast with much higher frequencies employed in short – wave therapeutic diathermy machines.

3. Mention the situations which account for hazards from electric shock.

Many devices have a metal chassis and cabinet that can be touched by the medical attendants and patient. If they are not grounded, then short circuit leads to micro or macro shock. Other situations which may be hazards is due to

- Leakage currents
- Static electricity
- Interruption of power
- Unequal ground potential
- Broken ground wire, etc.,

4. Can pain be relieved through electrical stimulation? What is the equipment used for it?

Yes pain can be relieved through electrical stimulation.The equipment used for it is **Transcutaneous Electrical Nerve Stimulator (TENS).**

5. Define Let-go current.

Let-go current is the minimum current to produce muscular contraction. Let-go current for men is about 16 mA and for women is about 10.5 mA.

6. Distinguish between Micro shock and Macro shock.

MICRO SHOCK	MACRO SHOCK
A physiological response to a current applied to the surface of the heart that results in unwanted stimulation like muscle contraction or tissue injury is called **Micro 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**.

7. What is diathermy? List its types.

Diathermy is the treatment process by which cutting, coagulation, etc., of tissues are obtained.

The various types are:

1. Surgical diathermy
2. Short wave diathermy
3. Microwave diathermy
4. Ultrasonic diathermy

8. What are the electrical safety methods used in hospitals?

The electrical safety methods used in hospitals

1. Proper grounding of equipment.
2. Double insulation
3. Protection by Low voltage
4. Ground Fault Interrupter
5. Isolation Transformer.

9. How electrical hazards do occurs due to medical equipments?

One of the main hazards connected with the use of medical equipment is electrical shock.

10. What is the use of ultrasonic diathermy?

It is used for curing the diseases of peripheral nervous system, skeletal muscle system and skin ulcers.

11. What is tele- stimulation?

Tele-stimulation is the measurement of biological signals over long distance. Tele- stimulation refers to study of diseases by stimulating into animals without killing them and to monitor them by receiving their bio – signals.

12. List the application of Bio- Telemetry.

The application of Bio- Telemetry

1. Monitoring ECG even under ergonomic conditions
2. Monitoring the health of astronauts in space
3. Patient Monitoring in an ambulance and other locations away from hospital
4. Research on anaesthetized animals.

13. List out any six bioelectric and physiological variables adaptable for biotelemetry Measurements

Bioelectric variables---ECG, EEG, EMG and Physiological variables---blood pressure, gastrointestinal pressure, blood flow, temperature.

14. What is radio pill?

Radio pill is used to monitor stomach pressure or pH. A pill consisting of a sensor and miniature transmitter is swallowed and the data are picked up by a receiver and recorded

15. List out the advantages of a Bio-telemetry system

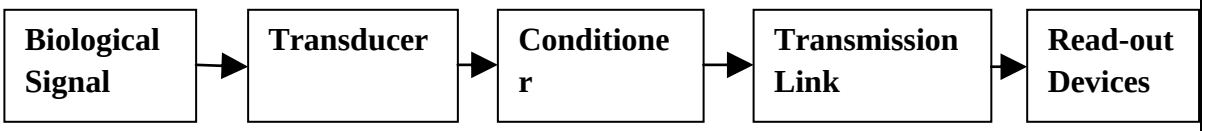
The advantages of a Bio-telemetry system

- Bio-telemetry helps us to record the bio-signals over long periods and while the patient is engaged in his normal activities.
- Computer or the medical attendants can easily diagnosis the nature of disease by seeing the telemetric bio-signals without attending the patient's room.
- Patient is in his room without any mechanical (or) physical disturbance during recording by means of Bio-telemetry
- For future reference (or) to study the treatment effect, the bio-telemetry is the essential one.
- For recording on animals, particularly for research, the bio-telemetry is greatly used.
- For monitoring the person who is in action, the bio-telemetry is an ideal one.

16. Explain the principle of tele-stimulation.

Tele-stimulation is the measurement of biological signals over long distance.

17. Draw the block diagram of a Bio – Telemetry system.



18. What care must be taken while measuring responses to electrical stimulation?

The care must be taken while measuring responses to electrical stimulation

1. Proper Grounding
2. Protection is provided by removing the power from the defective
3. Device by tripping the circuit breaker.

19. What is meant by single channel telemetry?

For a single channel system, a miniature battery operated radio transmitter is connected to the electrodes of the patients. This transmitter broadcasts the bio potential over a limited range to a remotely located receiver, which detects the Radio signals and recovers the signals for further processing.

20. List the two types of multiplexing involved in multi channel wireless telemetry?

The two types of multiplexing involved in multi channel wireless telemetry are

1. Time division Multiplexing
2. Frequency division Multiplexing

21. What are the precaution necessary to avoid micro shock?

1. In the vicinity of the patient, use only apparatus or appliances with three-wire power cords.
2. Provide isolated input circuits on monitoring equipment

22. Specify the frequencies used for biotelemetry?

The frequencies used for biotelemetry are of the order of 37,102,153,159,220 and 450MHz.

23. Give the types and frequencies of operation of diathermy units

The types and frequencies of operation of diathermy units are

1. Fulguration -100Hz
2. Deciccation-100Hz
3. Electrotomy-500Hz
4. Coagulation-250Hz
5. Blending-500Hz

24. Name the instrument needed for a bio-telemetry system.

The instruments needed for a bio-telemetry system are

1. Tunnel Diode FM transmitter
2. Hartley type FM transmitter
3. Radio Telemetry with a sub-carrier
4. Pulsed Hartley oscillator

25. What is use of high frequency current in diathermy?

The use of high frequency current is to avoid the intense muscle activity and the electrocution hazard which occurs if low frequencies are used.

26. Where is ultra sonic diathermy used?

Ultra sonic diathermy is used where short wave treatment is failed and in cases where localization of the heart effect is desired.

27. Name few diseases that can be cured by ultrasonic diathermy?

The few diseases that can be cured by ultrasonic diathermy are

1. Neurits
2. Arthritis
3. Skin ulcers.

28. What are the factors of leakage current flow?

The factors of leakage current flow are

1. Ungrounded equipment
2. Broken ground wire
3. Unequal ground potential

29. What are the two divisions in patient monitoring systems?

The two divisions in patient monitoring systems are

1. Intensive care unit
2. Intermediate coronary care unit

30. What is the purpose of patient monitoring system?

The purpose of patient monitoring system is to follow the patient condition carefully by repeated measurement of many variables.

31. Define desiccation and haemostasis

Desiccation is the state of extreme dryness, or the process of extreme drying. A desiccant is a hygroscopic (attracts and holds water) substance that induces or sustains such a state in its local vicinity in a moderately sealed container

Hemostasis or haemostasis is a process which causes bleeding to stop, meaning to keep blood within a damaged blood vessel (the opposite of hemostasis is hemorrhage). It is the first stage of wound healing. This involves coagulation, blood changing from a liquid to a gel

32. List the applications of biotelemetry

Motorracing Agriculture Water Management Rocketry Flight Test

33. What are the choices of radio carrier frequency for medical telemetry purposes

Use and Outcomes of Telemetry Monitoring on a Medicine Service. Telemetry is a powerful tool for real-time monitoring of a patient's heart rhythm and QRS pattern. Beds with telemetry monitoring are limited and expensive in most institutions; therefore, the use of this resource would ideally be evidence based.

34. Define let go current.

The "Let Go" Threshold is the current level where we lose control of our muscles and the electricity causes muscles to contract until the current is removed

35. List the devices used to safeguard against electrical hazards

Ground Fault Interrupter (GFI)
Line Isolation Monitor (LIM)
Safety Analyzingr
Receptacle Tester

36. Which is radio pill mentaion the application of radio pill

It contains transducer sensitive to pH, temperature and pressure. It is used for telemetering continuous informations about one or various variables from lumen of the gut. Temperaturesensitive pills are designed by the medical research council's bioengineering lab.

PART B & C

1. Explain working principle of a diathermy unit with a neat block diagram.

Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:219

2. a) i) Explain in detail the components of a Bio –telemetry system.
ii) Discuss the various applications of telemetry in patient care.

	Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:311&320.
3.	a) i) Explain the physiological effects of electric current at 50Hz. ii) With reference to electrical safety explain a) Ground fault circuit interrupter b) Protection by low voltage **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 329**
4.	Explain the single channel and multi channel bio telemetry system with neat diagram. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 312**
5.	Write short notes on frequency selection for telemetry applications. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 313**
6. **7.**	Explain working principle of a surgical diathermy unit with a neat block diagram. Briefly explain about the electrical safety Instrumentation. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:322-340.**
8.	A) (i) Explain the working and application techniques of short wave diathermy(10) (ii) Discuss the different operation performed using surgical diathermy treatment.(6) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 284, 291**
9.	B) (i) Describe the physiological effect of electricity on humans(8) (ii) write a short notes on frequency selection for telemetry applications .(8) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 290, 312**
10.	a) Define diathermy draw the circuit diagram of a short wave diathermy unit and discuss its impact on therapy purpose in details also brief describe how its can be applied to human subjects(16) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 273**
11.	(i) Explain the working of ground fault interrupter(8) (ii) With suitable diagram explain how ECG signal can be transmitted using single channel telemetry system.(8) **Ans: Text book: Bio medical instrumentation By Arumugam , notes**
12.	A) (i) Explain the simplified circuit diagram of a microwave diathermy machine(10) (ii) Discuss the different methods of applying electrodes in shortwave diathermy treatment.(6) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 261, 242**
13.	(i) Describe the single channel ECG telemetry system(8) (ii) briefly discuss about micro and macro shocks.(8) **Ans: Text book: Bio medical instrumentation By Arumugam .,notes**

UNIT-5 – RECENT TRENDS IN MEDICAL INSTRUMENTATION
PART A

1. List the parts of endoscope unit.

The parts of endoscope unit are:

1. High power argon laser
2. Partial beam splitter
3. Power meter and heat sink
4. Lens system
5. Micropositioner
6. Encapsulated quartz fibreguide
7. Endoscope
8. Synchronous filter shutter
9. Firing control and timing unit

2. Name the laser commonly used for ophthalmic application. Why?

The Laser commonly used for ophthalmic application is Argon ion Laser and Nd-YAG Laser. Argon ion laser which emits blue green light that is readily absorbed by the blood are preferred for photocoagulation of small blood vessels in the eye.

3. Bring out the clinical applications of endoscopy?

Type	Range of Use	Diagnostic problem
1. Bronchoscope	Trachea larger airways	Foreign bodies infections, aspiration of mucus,
2. Cardioscope	Heart cavities	valvular defects and septal defect
3. Laparoscope	Abdominal cavity	Tumors, family planning operation
4. Cystoscope	Urinary bladder	Tumors ,inflammation,stones.

4. Mammograms are used for what purposes?

A mammogram is a low dose x-ray exam of the breast that is used to detect and evaluate breast changes (or) breast cancer. It is used to aid in the early detection and diagnosis of breast diseases in women.

5. List out the properties of LASER.

The properties of LASER are

1. Laser light is highly coherent
2. Laser is highly powerful
3. It is also directional and monochromatic
4. It is capable of propagation over long distance
5. It is extremely bright
6. Laser beams are not easily absorbed by the water.

6. What is Thermograph? State its applications.

Thermograph is the process of recording true thermal images of the surfaces of objects under study. In medicine, Thermograph displays images representing the thermal radiation of skin areas.

Application:
1. It is important diagnostic aid in Breast cancers
2. Rheumatic diseases or joint diseases.
3. Tumors
4. Collagen and Orthopedic diseases
5. Examination of placenta attachment
6. Harmone, Brain and Nervous diseases.

7. What are the functions of endoscopy unit?

Endoscope is a tubular optical instrument to inspect or view the body cavities which are not visible to the naked eye normally. The endoscope is so designed for easy sterilization. In the endoscope, at the object end there is an assembly of objective lens and prism and at the viewing end, there is an eye lens. Endoscopic pictures can be recorded with color film and video tape recorder.

8. Mention the advantages of performing surgery using LASER.

1. Highly sterile
2. Highly localized and precise
3. Noncontact surgery
4. Dry – field ,almost bloodless surgery

9. Which laser is used for surgery?

LASER is used for surgery are : Argon Iron, CO2 and Nd-YAG laser.

10. Mention the application of LASER in ophthalmology.

1. Photocoagulation of retinal bleeding
2. Retinal Reattachment
3. Iridectmies
4. Glaucoma
5. Senile macular degeneration
6. Lens capsule surgery

11. What type of LASERs are used for patient treatment?

The types of LASERs used for patient treatment are

1. Pulsed Nd-Yag Laser
2. Continuous Wave CO_2 Laser
3. Continuous Wave Argon ion Laser

12. What is Telemedicine?

Telemedicine is the application of telecommunication and computer technology to deliver health care from one location to another.

13. State the application of Telemedicine.

The applications of Telemedicine are

1. Tele-radiology – Radiological images like X-ray , CT or MRI Scan etc
2. Tele-pathology- microscopic images of pathology slides and biopsy reports
3. Tele-cardiology – Transmission of ECG , Echo ,Color Doppler
4. Tele-education – Delivery of medical education programmes to the physicians

14. What are essential parameters for Telemedicine?

The essential parameters for telemedicine relating to a patient are

1. Primary patient data
2. Patient History
3. Clinical Information
4. Investigation
5. Data and Reports

15. Name the technologies used in telemedicine.

The technologies used in telemedicine are :

1. Transmission of Medical Images
2. Transmission of Video Images
3. Transmission of digital Audio
4. Video Conferencing
5. Digital Communication Systems
6. Telemedicine using Mobile Communication
7. Use of Internet resources for telemedicine

16. Name some uses of CO_2 Laser in surgery?

The CO_2 Laser are used for the distruction of tumors by coagulation whereas CO_2 Laser functions as a nonmaterial, light knife for performing tissues incisions and tumor nodule excisions.

17. Mention few advantages of Laser Surgery.

The advantages of Laser Surgery are

1. Highly sterile
2. Highly localized and precise
3. Non Contact Surgery
4. Dry-Field ,almost bloodless surgery
5. Short periods of surgical time.

18. What are the diseases that can be diagnosed by thermograph?

Thermograph is an important diagnostic in many diseases especially in breast cancers in rheumatic diseases or joint diseases.

19. What are the classifications of thermograph?

The classifications of thermograph

1. Infrared thermograph
2. Liquid crystal thermograph
3. Microwave thermograph

20. What are the characteristics of good thermograph equipment?

The characteristics of good thermograph equipment

1. Short frame time
2. High resolution
3. A small size and light weight optical head
4. Absolute temperature can be measureable

21. List out the factors of photo physical event that depends on?

The factors of photo physical event that depends on

1. Wavelength of Laser
2. Energy density
3. Pulse duration
4. Irradiation time
5. Absorption characteristics of target molecule

22. List out the four photo biological Laser processes.

The four photo biological Laser processes are

1. Photo chemical processes
2. Thermal processes
3. Photoablative processes
4. Electromechanical processes

23. Name the type of LASER used in Photo chemical processes.

The LASER used in Photo chemical processes are He-Ne .Nd-YAG.

24. Name the type of LASER used in Photo thermal processes.

The LASER used in Photo Thermal processes are CO_2 andNd-YAG.

25. Name the type of LASER used in Electro mechanical processes.

The LASER used in Electro mechanical processes are Nd-YAG.

26. List the types of pumping sources used in LASER.

Stimulated Emission

27. What is LASER?

LASER is Light Amplification by Stimulated Emission of Radiation.

28. On What factor LASER action depends?

LASER action depends upon the phenomenon of stimulated emission.

29. On what properties LASER is determined?

1. The gain of the medium
2. The pumping Mechanism
3. The resonator design

30. What is cryogenic surgery?

It is based on the development of heat at the operating site during irradiation. Tissues are killed when their temperature is below 20 degree C.When the tissue are at 20 degree C ,there is no formation of ice crystals and increase of salt concentration within the cells. Thus necrosis of the tissue takes place. This method of killing diseased cells is called as cryogenic surgery which is painless and it is taking place without blood shedding.

31. What makes thermograph useful?

- Get a visual picture so that you can compare temperatures over a large area
- It is real time capable of catching moving targets
- Able to find deteriorating components prior to failure
- Measurement in areas inaccessible or hazardous for other methods
- It is a non-destructive test method

32. List the properties of laser beam

Characteristics of Laser Light

A laser generates a beam of very intense light. Laser light has three distinct characteristics that distinguish it from ordinary light: Laser light is:

Collimated

Monochromatic

Coherent

33. Define the physical factors which affect the amount of infrared radiation from human body

All objects, including human bodies, emit electromagnetic radiation. The wavelength of radiation emitted depends on the temperature of the objects. Such radiation is sometimes called thermal radiation. Most of the radiation emitted by human body is in the infrared region, mainly at the wavelength of 12 micron.

34. Mentation few applications of lasers in medicine

Angioplasty cancer diagnosis cancer treatment cosmetic dermatology such as scar revision, skin resurfacing, laser hair removal, tattoo removal dermatology to treat melanoma frenectomy lithotripsy laser mammography medical imaging microscopy ophthalmology (includes Lasik and laser photocoagulation) optical coherence tomography optogenetics prostatectomy plastic surgery, in laser liposuction surgery to ablate and cauterize issue

35. Sate the application of telemedicine

Telemedicine is the use of telecommunication and information technology to provide clinical health care from a distance. It has been used to overcome distance barriers and to improve access to medical services that would often not be consistently available in distant rural communities.

Blood Pressure

Interstitial Fluid Pressure (IFP)

Pressure-Volume Loop Studies

Telemetry Biopotential

Telemetry Pressure and Biopotential

Specialized Telemetry

36. List the types of pumping sources used in LASER

Optical pumping · Pumping cavities · Flashlamp pumping · External laser pumping

PART B & C

1.	a) Discuss working principle of an infrared thermo graphic equipment. Mention applications of thermo graph **(May/June 2007) (Apr/May 2011)(Nov/Dec 2011) (Nov/Dec 2014) (May/June 2013)(May/June 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:367-373.**
2.	a) Discuss in detail the different application of Laser in medicine. **(Nov/Dec 2007)(Apr/May 2012) (April/May 2015)(May/June 2014) (May/June 2013)(May/June 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:347.**
	What is an endoscope? Discuss the working of an endoscopic unit. **(Apr/ May 2008) (Nov/Dec11)(Apr/May 2012(April/May2015)(Nov/Dec 2015)(May/June 2014)(May/June 2013)(May/June 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:219-223 &356-359.**
3.	Briefly explain about the importance of Telemedicine. **Ans: Text book: Bio medical instrumentation By R.S.Khandpur .pg.no:303**
4.	What is cryogenic? List some cryogenics agents with its operating temperature and explain how it is used to perform surgery? **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:359.**
5.	Explain the basic principle of LASER. **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no:347.**
6.	A) (i) What is thermography ? explain the block diagram of infrared imaging system(10) (ii) Describe the different operation involved in endoscopy(6) **(May/June 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 310,295**
7.	(i) what is cryogenic list some cryogenics agents with its operating temperature and explain how it is used to perform surgery(10) **(May/June 2016)** (ii) write short notes on applications of LASER in medicine.(6) **(May/June 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 324,290**
8.	a)Explain the infrared thermographic instrumentation with a suitable block diagram and what are the

	different medical applications(16) **(Nov/Dec 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 320**
9.	(i) Write a notes on cryogenic surgery(8) **(Nov/Dec 2016)** (ii) Write a notes on endoscopy unit(8) **(Nov/Dec 2016)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 336, 314**
10.	A) (i) What is endoscope ? explain the different types of operations performed using endoscopy(10) **(May/June 2017)** (ii) Describe the working principle of thermograph(6) **(May/June 2017)** **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 290, 298**
11.	B) (i) Explain different typers of LASER(10) (May/June 2017) (ii) write short notes on cryogenic applications.(6) **Ans: Text book: Bio medical instrumentation By Arumugam .pg.no: 318,338**

EC8073 MEDICAL ELECTRONICS

ECE - PROFESSIONAL ELECTIVE I

Regulations 2017

UNIT I ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING

TOPIC 1.1 SOURCES OF BIO MEDICAL SIGNALS

1. Which of the following statement is true for an instrumentational amplifier?
a) the input resistance of both the inputs is very high and does not change as the gain is varied
b) the input resistance of both the inputs is very low and does not change as the gain is varied
c) the input resistance of both the inputs is very high and does change as the gain is varied
d) the input resistance of both the inputs is very low and does change as the gain is varied

Answer: a
Explanation: The input resistance of both the inputs is very high and does not change as the gain is varied in and instrumentational amplifier. Voltage gain from differential input (V1–V2) to single ended output, is set by one resistor. V0 does not depend on common-mode voltage, but only on their difference.

2. Which of the following is not the property of the instrumentational amplifier?
a) Extremely high input impedance
b) Low bias and offset currents
c) High slew rate
d) Very low CMRR

Answer: d
Explanation: Instrumentational amplifiers have very high CMRR. The instrumentation amplifier offers the following advantages for its applications in the biomedical field. Some of them are like extremely high input impedance, low bias and offset currents, high slew rate.

3. CMRR is measured in _____
a) v/s
b) dB
c) dB/s
d) dB/ms

Answer: b
Explanation: CMRR is an important specification referred to the differential amplifier and is normally expressed as decibels. The ability of the amplifier to reject common voltages on its two input leads is known as common-mode rejection. It is specified as the ratio of common-mode input to differential input to elicit the same response.

4. The carrier amplifier consists of an oscillator and a capacitance coupled amplifier.
a) True
b) False

Answer: a
Explanation: The carrier amplifier consists of an oscillator and a capacitance coupled amplifier. The oscillator is used to energize the transducer with an alternating carrier voltage. The transducers, which require ac excitation, are those whose impedance is not purely resistive.

5. Electromagnetic coupling cannot be reduced by _____
a) shielding
b) wire twisting
c) multiple grounding
d) common grounding

Answer: c
Explanation: Having multiple grounds in a single circuit increases the electromagnetic coupling effect by producing ground loop which may generate so much noise that it may completely obscure the useful signal. Thus, the electromagnetic coupling is reduced by shielding, wire twisting and proper grounding which provide a balanced signal pair with satisfactory noise rejection characteristics.

6. Which on the following is not a type of isolation amplifier?
a) capactively coupled isolation amplifiers
b) optically isolated isolation amplifiers
c) resistive coupled isolation amplifiers
d) transformer type isolation amplifiers

Answer: c
Explanation: There is nothing such as the resistive coupled isolation amplifiers. All the other three types are in common use, though the transformer isolation amplifier is more popular. Opto-coupled amplifier uses a minimum number of components and is cost effective, followed by the transformer coupled amplifier. The capacitor coupled amplifier is the most expensive.

7. The isolation includes different supply voltage sources and different grounds on each side of the isolation barrier.
a) True
b) False

Answer: a
Explanation: The isolation includes different supply voltage sources and different grounds on each side of the isolation barrier. Three methods are used in the design of isolation amplifiers: (i) transformer isolation (ii) optical isolation (iii) capacitive isolation. Isolation amplifiers are commonly used for providing protection against leakage currents.

8. _____ are commonly used for providing protection against leakage currents.
a) Isolation amplifiers
b) Differential amplifiers
c) Instrumentational amplifiers
d) Inverting amplifiers

Answer: a
Explanation: Isolation amplifiers are commonly used for providing protection against leakage currents. They break the ohmic continuity of electric signals between the input and output of the amplifier. The isolation includes different supply voltage sources and different grounds on each side of the isolation barrier.

TOPIC 1.2 BIO-POTENTIALS

1. Source of Bioelectric potential is _____ in nature.
a) electronic
b) electric
c) ionic
d) mechanical

Answer: c
Explanation: Bioelectric potentials are generated at cellular level and the source of these potentials is ionic in nature. The prominent ions are K^+, Na^+, and Cl^-. Electronic potential is seen in commonly used cells for example the Galvanic cell.

Mechanical potential is found nowhere. Electrical potential is found in electricity.

2. Palsied muscles mean _____
a) paralyzed muscles
b) active muscles
c) voluntary muscles
d) involuntary muscles

Answer: a
Explanation: Palsied is an adjective that means paralyzed. It is used to describe a muscle on which an individual has lost all control (cannot move). Voluntary muscles are the muscles on which the individual has complete control. Involuntary muscles are the ones on which the individual has no control for example heart wall muscles.

3. The principal ion that is not involved with the phenomena of producing cell potentials is _____
a) sodium
b) potassium
c) chlorine
d) hydrogen

Answer: d
Explanation: Sodium (Na^+), Potassium (K^+), and Chlorine (Cl^-) are the principal ions involved with the phenomena of producing cell potentials. Na+ is present outside the cell membrane and creates a positively charged environment outside the cell membrane. Cl^- is present inside the cell membrane and is responsible for the negative environment inside the cell membrane.

4. What is the relatively static membrane potential of quiescent cells called?
a) half-cell potential
b) action potential
c) resting membrane potential
d) cell potential

Answer: c
Explanation: Resting membrane potential or the resting potential is the relative static membrane potential of quiescent cell. That is if the resting membrane potential of a neuron is about -70 mV (mV=millivolt) it means that the inside of the neuron is 70 mV less than the outside of the neuron. An action potential occurs when the potential of the membrane of a given axonal position increases and decreases rapidly. This depolarization causes depolarization of adjacent positions in a similar way.

5. The variation of the electrical potential associated with the passage of a pulse along the membrane of a muscle cell or a nerve cell is called _____
a) muscle potential
b) action potential
c) resting potential
d) half cell potential

Answer: b
Explanation: An action potential occurs when the potential of the membrane of a given axonal position increases and decreases rapidly. This depolarization causes depolarization of adjacent positions in a similar way. Resting membrane potential or the resting potential is the relative static membrane potential of a quiescent cell.

6. Cells depolarize and action potential in generated as soon as a stimulus is applied.
a) True
b) False

Answer: b
Explanation: This statement is False. This is because unless a stimulus above a certain minimum value is applied, the cell will not be depolarized and no action potential will be generated. This value of potential above which the depolarizes and an action potential is generated is known as the stimulus threshold.

7. After a cell is stimulated, a finite period of time is required for the cell to return to its pre-stimulus state. This period is known as

_____
a) restoration period
b) refactory period
c) regain period
d) regenerative period

Answer: b
Explanation: After a cell is stimulated, a finite period of time is required for the cell to return to its pre-stimulus state. This is because the energy associated with the action potential is developed from metabolic process within the cell which takes time for completion. This time period is called refactory period.

8. Electrooculography (EOG/E.O.G.) is a technique for measuring what?
a) abnormal function of the retina
b) heart rate
c) respiration rate
d) cornea-retinal standing potential

Answer: d
Explanation: Electrooculography (EOG / E.O.G) is a technique for measuring the potential of the corneal retinal standing potential that exists between the front and back of the human eye. The resulting signal is called electrooculogram. The main applications are in the diagnosis of ophthalmology and the recording of eye movements.

9. EKG stands for _____
a) Electrocardiography
b) Electroencephalography
c) Electromyography
d) Electrtokinetcography

Answer: a
Explanation: Electrocardiography (ECG or EKG) is the way toward recording the electrical action of the heart over some stretch of time utilizing anodes put on the skin. It could simply be understood as the electrical representation of heart beat. Electroencephalography is the electrical recording of brain.

10. Phonocardiography is listening to _____
a) arm muscle sound
b) lungs sound
c) heart sound
d) respiratory tract sound

Answer: c
Explanation: A phonocardiogram (or PCG) is a record high-constancy recording of sounds and mumble made by the heart with the assistance of the machine called phonocardiography. Consequently, phonocardiography is the chronicle of the considerable number of sounds made by the heart amid a heart cycle. Mostly stethoscope is used phonocardiography.

TOPIC 1.3 BIOPOTENTIAL ELECTRODES

1. The material used in limb surface electrode is _____
a) German silver
b) Copper
c) Gold
d) Platinum

Answer: a
Explanation: The most common type of electrode most routinely used for recording ECG are rectangular or circular surface limb electrodes. The material used in them is German silver, nickel silver or nickel plated steel. They are applied to the surface of the body with electrode jelly.

2. Welsh cup electrodes have _____
a) low contact impedance
b) negligible contact impedance
c) high contact impedance
d) zero contact impedance

Answer: c
Explanation: Welsh cup electrodes or suction electrodes is a metallic cup shaped electrode which is used for recording ECG from various positions from the chest. It has a high contact impedance as only the rim of the electrode is in contact with the skin. It is commonly used to record the unipolar chest leads.

3. In floating electrodes metal electrode does not make direct contact with the skin.
a) True
b) False

Answer: a
Explanation: In floating electrode the metal electrode does not make direct contact with the skin. The electrode consists of a light weighted metalled screen or plate held away from the subject by a flat washer which is connected to the skin. Floating electrodes can be recharged, i.e. the jelly in the electrodes can be replenished if desired.

4. The main design feature of pregelled disposable electrodes which helps to reduce the possibility of artefacts, drift and baseline wandering is _____
a) low absorbency buffer layer with isotonic electrolyte
b) high absorbency buffer layer with isotonic electrolyte
c) high absorbency buffer layer without isotonic electrolyte
d) low absorbency buffer layer without isotonic electrolyte

Answer: b
Explanation: The main design feature of pregelled disposable electrode that helps in reducing the possibility of artefacts, drift and baseline wandering is the provision of high absorbency buffer layers with isotonic electrolyte. This layer absorbs the effects of movement of the electrode in relationship to the skin and attempts to maintain the polarization associated with the half-cell potential constant.

5. Recording electrical activities associated with heart is known as _____
a) EEG
b) EOG
c) EMG
d) ECG

Answer: d
Explanation: The recording of the electrical activities associated with the functioning of the heart is known as electrocardiogram. ECG is a quasi-periodical, rhythmically repeating signals synchronized by the function of the heart, which acts as a generator of bioelectric events. This generated signals can be described by the means of a simple electric dipole.

6. Which of the following is considered to be the primary pacemaker of the heart?
a) sino-atrial node
b) atrio-ventricular node
c) purkinje fibres
d) bundle of his

Answer: a
Explanation: Located in the top right atrium near the entry of the vena cava, are a group of cells known as the sino-atrial node (SA node) that initiates the heart activity. Because this is also considered as the primary pacemaker of the heart. The SA node is 25 to 30 mm in length and 2 to 5 mm in thickness.

7. Atrio ventricular node is located at _____
a) upper part of the heart wall between the two atrial
b) lower part of the heart wall above the two atrial
c) lower part of the heart wall between the two atrial
d) upper part of the heart wall above the two atrial

Answer: c
Explanation: The AV node is located in the lower part of the wall between the two atria. The AV node delays the spread of excitation for about 0.12s, due to the presence of a fibrous barrier of non-excitable cells that effectively prevent its propagation from continuing beyond the limits of stria.

8. Buffer amplifier converts _____
a) low impedance signals to high impedance signals
b) high impedance signals to low impedance signals
c) ac impedance signals to dc impedance signals
d) dc impedance signals to ac impedance signals

Answer: b
Explanation: Noise is typically generated from motion artefacts and power line interference. A common solution used to suppress noise in dry electrode signals is a buffer amplifier. A buffer amplifies is essentially an impedance converter, that converts high impedance signals to low impedance signals.

9. Which of the following is a wireless ECG acquiring system?
a) pregelled disposable electrodes
b) limb electrodes
c) pasteless electrodes
d) smart pad

Answer: d
Explanation: Smart pad is a system that displays patients electrocardiogram signals without adhesive pads, wires or active intervention from a clinician. The system automatically selects three electrodes from an array of Cu/Ni fabric based electrodes patterned on a thin pad on which the patient lies. The selected electrodes are used to provide a differential 3 lead measurement of the patient's ECG, which is then transmitted wirelessly and displayed on a laptop computer.

10. Before placing the electrodes the skin should be _____
a) wet
b) dry
c) hairy
d) oily

Answer: b
Explanation: The skin should be dry. Poor skin prep prompts undesirable curio and not putting the terminals where they ought to be can change the morphology (shape) of the waveforms the specialist will decipher. The purpose of decent skin prep is to expel soil, dead skin cells, oils, skin cream, counterfeit tan, body powder, sweat and so forth. These sources can prompt poor contact with the sensors and ancient rarity.

TOPIC 1.4 BIOLOGICAL AMPLIFIERS

1. Bio potential amplifiers have _____ input terminals.
a) 3
b) 4
c) 5
d) 6

Answer: a
Explanation: Bio potential has three input terminals. Out of the three one is arranges at the reference potential. The other two are live terminals. Bio potential amplifiers are also known as differential amplifiers. The differential amplifier is employed when it is necessary to measure the voltage difference between two points, both of them varying in amplitude at different rates and in different patterns.

2. The ability of the amplifier to reject common voltages on its two input leads is known as _____

a) common mode rejection rate
b) coupled mode rejection rate
c) common mode rejection ratio
d) coupled mode rejection ratio

Answer: c
Explanation: The ability of the amplifier to reject common voltages on its two input leads is known as common-mode rejection. It is specified as the ratio of common-mode input to differential input to elicit the same response. It is abbreviated as CMRR (Common-mode rejection ratio).

3. CMRR is measured in _____
a) V/s
b) dB
c) dB/s
d) dB/ms

Answer: b
Explanation: CMRR is an important specification referred to the differential amplifier and is normally expressed as decibels. The ability of the amplifier to reject common voltages on its two input leads is known as common-mode rejection. It is specified as the ratio of common-mode input to differential input to elicit the same response.

4. CMRR of the preamplifiers should be as high as possible.
a) True
b) False

Answer: a
Explanation: CMRR of the preamplifiers should be as high as possible so that only the wanted signals find a way through the amplifier and all unwanted signals get rejected in the preamplifier stage. The ability of the amplifier to reject these common voltages on its two input leads is known as common-mode rejection and is specified as the ratio of common-mode input to differential input to elicit the same response. CMRR is an important specification referred to the differential amplifier and is normally expressed as decibels.

5. The common mode rejection for most op-amps is typically between _____
a) 10-50dB
b) 20-40dB
c) 60-90dB
d) 100-120dB

Answer: c
Explanation: The common mode rejection for most op-amps is typically between 60 dB and 90 dB. This may not be sufficient to reject common mode noise generally encountered in biomedical measurements. Also, the input impedance is not very high to handle signals from high impedance sources.

6. The output of differential gain is given by _____
a) (difference of the two input voltage)* (feedback resistance/input resistance)
b) (sum of the two input voltage)*(feedback resistance/input resistance)
c) (difference of the two input voltage)*(input resistance/feedback resistance)
d) (sum of the two input voltage)*(input resistance/feedback resistance)

Answer: a
Explanation: The output of differential gain is given by (difference of the two input voltage)*(feedback resistance/input resistance). gain is given by (feedback resistance/input resistance). The input resistances of but the inputs are the same.

7. In order to be able to minimize the effects of changes occurring in the electrode impedances, it is necessary to employ a preamplifier having a high input impedance.
a) True
b) False

Answer: a
Explanation: True. In order to be able to minimize the effects of changes occurring in

the electrode impedances, it is necessary to employ a preamplifier having a high input impedance. It has been found that a low value of input impedance gives rise to considerable distortion of the recordings.

8. The impedance of the input should be _____ in order to obtain high CMRR in the differential amplifier.
a) low
b) High
c) Does not matter
d) Very low

Answer: b
Explanation: This shows that high input impedance is very necessary in order to obtain a high CMRR. Also, the electrode skin resistance should be low and as nearly equal as possible. In order to be able to minimize the effects of changes occurring in the electrode impedances, it is necessary to employ a preamplifier having a high input impedance.

TOPIC 1.5 ECG

1. The frequency range of ECG is _____
a) 0.05-150 HZ
b) 500-1500 Hz
c) 5-500 kHz
d) 0.5-150 MHz

Answer: a
Explanation: The diagnostically useful frequency range is usually accepted as 0.05 to 150 Hz. Although the electric field generated by the heart can be best characterized by vector quantities, it is generally convenient to directly measure only scalar quantities, i.e. a voltage difference of mV order between the given points of the body.

2. Which of the following amplifier circulatory is employed to reduce the hum noise generated by the power supply in the ECG circuit?
a) band pass filters
b) high pass filters
c) notch filters
d) low pass filters

Answer: c
Explanation: A notch filter is employed to suppress the hum noise generated by the power supply in the ECG circuit. CMRR of the order of 100–120 dB with 5 kW unbalance in the leads is a desirable feature of ECG machines. The instability of the baseline, originating from the changes of the contact impedance, demands the application of the automatic baseline stabilizing circuit.

3. The branch of medicine that deals with the provision and use of artificial devices such as splints and braces is _____
a) prosthetics
b) orthotics
c) laproscopic
d) augmentative communication

Answer: c
Explanation: The branch of medicine that deals with the provision and use of artificial devices such as splints and braces are orthotics. A modality-specific appliance that aids the performance of a function or movement by augmenting or assisting the residual capabilities of that function or movement. An orthopaedic brace is an orthosis.

4. The sensitivity of an electrocardiograph is typically set at 10 mm/mV.
a) True
b) False

Answer: a
Explanation: It is true. The sensitivity of an electrocardiograph is typically set at 10 mm/mV. For routine work, the paper recording speed is 25 mm/s. Amplitude measurements are made vertically in millivolts. Time measurements and heart rate

measurements are made horizontally on the electrocardiogram.

5. The volume of blood within the dialyzer is known as _____
a) secondary volume
b) quarterly volume
c) priming volume
d) residual volume

Answer: c
Explanation: The volume of blood within the dialyzer is known as priming volume. It is desirable that this should be minimal. Priming volume of present day dialyzers ranges from 75 to 200 ml, depending on the membrane area geometry and operating conditions.

6. The ideal membrane should possess _____ to water.
a) low permeability to water
b) high permeability to water
c) medium permeability to water
d) high permeability to waste

Answer: b
Explanation: The ideal membrane should possess high permeability to water, organic metabolites and ions, and the capability of retaining plasma proteins. The membrane should be of sufficient wet strength to resist tearing or bursting and non-toxic to blood and all body cells.

7. To achieve optimum performance and to enable the relationship of change in resistance with the volume of the cell to hold good, it is recommended that the ratio of the aperture length to the diameter of the aperture should be _____
a) 75:1
b) 0.75:100
c) 0.75:1
d) 0.5:10

Answer: c
Explanation: To achieve optimum performance and to enable the relationship of change in resistance with volume of the cell to hold good, it is recommended that the ratio of the aperture length to the diameter of the aperture should be 0.75:1, i.e. for an orifice of 100 m diameter the length should be 75 m. The instrument based on the Coulter principle works most satisfactorily when the average diameter of the particles ranges between 2 to 40% of the diameter of the measuring hole.

8. The blood is a poor conductor of electricity.
a) True
b) False

Answer: a
Explanation: It is true. Blood is a poor conductor of electricity. This principle is used in Coulter counters to count the number of RBCs in the blood.

9. In floating electrodes metal electrode does not make direct contact with the skin.
a) True
b) False

Answer: a
Explanation: In a floating electrode, the metal electrode does not make direct contact with the skin. The electrode consists of a light weighted metalled screen or plate held away from the subject by a flat washer which is connected to the skin. Floating electrodes can be recharged, i.e. the jelly in the electrodes can be replenished if desired.

TOPIC 1.6 EEG

1. Electrodes to measure EEG are placed on _____
a) forehead
b) scalp
c) cheek
d) ears

Answer: b
Explanation: Electrode to measure EEG are

placed on the scalp. The position of each electrode is specified using the International 10/20 system. Each electrode site is labeled with a letter and a number.

2. According to the international 10/20 system to measure EEG, even number denotes which side of the brain?
a) left
b) top
c) bottom
d) right

Answer: d
Explanation: The position of each electrode is specified using the International 10/20 system. Each electrode site is labeled with a letter and a number. Even number denotes the right side of the head.

3. Letter F in the EEG electrode placement system denotes?
a) front
b) face
c) frontal lobe
d) fast

Answer: c
Explanation: F denotes frontal lobe of the head. The position of each electrode is specified using the International 10/20 system. Each electrode site is labeled with a letter and a number.

4. Normal EEG frequency range is _____
a) 50-500Hz
b) 0.5-50HZ
c) 0.05-5Hz
d) 1-200Hz

Answer: b
Explanation: The frequency varies greatly with different behavioral states. The normal EEG frequency content ranges from 0.5 to 50Hz. The nature of the wave varies over the different parts of the scalp.

5. The letter T in the EEG electrode placement system denotes?
a) temporal lope
b) temper lobe
c) trace
d) timpanic

Answer: a
Explanation: T denotes temporal lobe of the head. The position of each electrode is specified using the International 10/20 system. Each electrode site is labeled with a letter and a number.

6. According to the international 10/20 system to measure EEG, odd number denotes which side of the brain?
a) left
b) right
c) top
d) front

Answer: a
Explanation: The position of each electrode is specified using the International 10/20 system. Each electrode site is labeled with a letter and a number. Odd number denotes the left side of the head.

7. The delta wave in EEG ranges from _____
a) 0.5-4Hz
b) 4-8Hz
c) 8-13Hz
d) 13-22Hz

Answer: a
Explanation: The delta wave in EEG ranges from 0.5-4Hz. The theta wave in EEG ranges from 4-8Hz. The alpha wave in EEG ranges from 8-13Hz and beta from 13-22Hz.

8. Disturbance in the EEG pattern resulting from the external stimuli is called _____
a) provoked response
b) ckoored response
c) evoked response
d) impulse response

Answer: c
Explanation: Disturbance in the EEG pattern resulting from the external stimuli is called evoked response. The stimuli could be a flash light or a click of sound. The stimuli can be repeated and the EEG waveform can be observed to find the activities occurring because of the stimuli.

9. The peak to peak amplitude of the waves that can be picked from the scalp is

_____
a) 100mV
b) 100V
c) 100uV
d) 10mV

Answer: c
Explanation: The EEG signal can be picked up with electrodes either from the scalp or directly from the cerebral cortex. The peak to peak amplitude of the waves that can be picked up from the scalp is normally 100uV. The frequency varies greatly with different behavioral states.

10. Which rhythm is the principal component of the EEG that indicates the alertness of the brain?
a) theta rhythm
b) gamma rhythm
c) beta rhythm
d) alpha rhythm

Answer: d
Explanation: The alpha rhythm is the principal component of the EEG and is an indicator of the state of alertness of the brain. It serves as an indicator of the depth of anesthesia in the operating room. The frequency of the EEG seems to be affected by the mental activity of a person.

TOPIC 1.7 EMG

1. Convert the point (3,4,5) from Cartesian to spherical coordinates

a) (7.07,45º,53º)
b) (0.707,45º,53º)
c) (7.07,54º,63º)
d) (0.707,54º,63º)

Answer: a
Explanation: $r = \sqrt{(x^2+y^2+z^2)} = \sqrt{50} = 7.07$
$\Theta = \cos^{-1}(z/r) = \cos^{-1}(5/5\sqrt{2}) = 45º$
$\Phi = \tan^{-1}(y/x) = \tan^{-1}(4/3) = 53º.$

2. Example of spherical system in the following is
a) Charge in space
b) Charge in box
c) Charge in dielectric
d) Uncharged system

Answer: a
Explanation: From a point charge +Q, the electric field spreads in all 360 degrees. The calculation of electric field in this case will be spherical system. Thus it is charge in the space.

3. Spherical systems are employed in waveguides. State True/False
a) True
b) False

Answer: b
Explanation: There is no waveguide designed spherically to avoid absorption, rather than propagation.

4. Choose which of following condition is not required for a waveguide to exist.
a) The dimensions should be in accordance with desired frequency
b) Cut-off frequency should be minimum 6GHz
c) The shape should be spherical
d) No specific condition is required for waveguide design

Answer: c
Explanation: A waveguide need not be spherical, it has to be rectangular or circular, as it violates the propagation of the wave.

5. Find the spherical coordinates of A(2,3,-1)
a) (3.74, 105.5º, 56.13º)
b) (3.74, 105.5º, 56.31º)
c) (3.74, 106.5º, 56.13º)
d) (3.74, 106.5º, 56.31º)

Answer: b
Explanation: $r = \sqrt{(x^2+y^2+z^2)} = \sqrt{14} = 3.74$
$\Theta = \cos^{-1}(z/r) = \cos^{-1}(-1/3.74) = 105.5^º$
$\Phi = \tan^{-1}(y/x) = \tan^{-1}(3/2) = 56.31^º$.

6. Find the Cartesian coordinates of B(4,25º,120º)
a) (0.845, 1.462, 3.625)
b) (-0.845, 1.462, 3.625)
c) (-8.45, 2.462, 6.325)
d) (8.45, 2.462, 6.325)

Answer: b
Explanation: $x = r \sin\theta \cos\varphi = 4 \sin 25^º \cos 120^º = -0.845$
$y = r \sin\theta \sin\varphi = 4 \sin 25^º \sin 120^º = 1.462$
$z = r \cos\theta = 4 \cos 25^º = 3.625$.

7. The area of sphere can be computed from the sphere volume. State True/False.
a) True
b) False

Answer: a
Explanation: On double integrating the differential volume, the area can be computed for a sphere.

8. Given B= (10/r)i+(rcos θ) j+k in spherical coordinates. Find Cartesian points at (-3,4,0)
a) -2i + j
b) 2i + k
c) i + 2j
d) –i – 2k

Answer: a
Explanation: $r = \sqrt{(x^2+y^2+z^2)} = \sqrt{25} = 5$
$\Theta = \cos^{-1}(z/r) = 1$
$\Phi = \tan^{-1}(y/x) = \tan^{-1}(-4/3)$
Thus, B = -2i + j.

9. The scalar factor of spherical coordinates is
a) 1, r, r sin θ
b) 1, r, r
c) r, r, 1
d) r, 1, r

Answer: a
Explanation: The radius varies from unity to infinity, the plane angle from zero to 360 º and the z plane from (-∞, ∞) .

10. Transform the vector (4,-2,-4) at (1,2,3) into spherical coordinates.
a) 3.197i – 2.393j + 4.472k
b) -3.197i + 2.393j – 4.472k
c) 3.197i + 2.393j + 4.472k
d) -3.197i – 2.393j – 4.472k

Answer: b
Explanation: $r = \sqrt{(x^2+y^2+z^2)} = 3.74$
$\Theta = \cos^{-1}(z/r) = \cos^{-1}(3/3.74) = 36.7^º$
$\Phi = \tan^{-1}(y/x) = \tan^{-1}(2/1) = 63.4^º$
$A = (4 \sin\theta \cos\varphi – 2 \sin\theta \sin\varphi – 4\cos\theta)i + (4 \cos\theta \cos\varphi – 2 \cos\theta \sin\varphi + 4 \sin\theta)j + (-4 \sin\varphi – 2 \cos\varphi)k$
On substituting r, θ, φ, A = -3.197i + 2.393j – 4.472k.

TOPIC 1.8 PCG

1. An arrhythmia monitor is basically a _____
a) Sophisticated monitoring system
b) Sophisticated alarm system
c) Patient monitoring system
d) ECG interpretation system

Answer: b
Explanation: An arrhythmia monitor is basically a sophisticated alarm system. It is not an ECG interpretation system. It constantly scans ECG rhythm patterns and issues alarms to events that may be premonitory or life threatening.

2. In arrhythmia monitoring system, it gives alarm light signals whenever the prematured

or widened ectopic beats exist up to the rate of _____
a) 6/min to 10/min
b) 6/min to 12/min
c) 6/min or 10/min
d) 6/min or 12/min

Answer: d
Explanation: In arrhythmia monitoring instrument, it gives alarm light signals whenever the prematured or widened ectopic beat exist up to the rate of 6/min or 12/min.It is one of the operating sequences of the arrhythmia monitoring instrument.

3. In automated arrhythmia monitoring system, which task is performed after the Ventricular fibrillation detection?
a) Rhythm definition
b) Beat labeling
c) Atrial fibrillation detection
d) Noise detection

Answer: a
Explanation: In automated arrhythmia monitoring system, Rhythm definition is performed after the Ventricular fibrillation detection. Rhythm definition is also performed after the beat labeling and atrial fibrillation detection in automated arrhythmia monitoring and analysis system.

4. In signal conditioning, ECG signal is amplified, filtered with 0.05-100 Hz for monitoring purposes and 1-40 Hz for diagnostic purposes.
a) True
b) False

Answer: b
Explanation: ECG signal is amplified and filtered with 0.05-100 Hz for diagnostic purposes and 1-40 Hz for monitoring purposes in signal conditioning.

5. Which analog-to-digital converter is used in the digitization of ECG signal in signal conditioning?
a) 16 bit
b) 12 bit
c) 32 bit
d) 64 bit

Answer: b
Explanation: In signal conditioning, ECG signal is amplified, filtered and digitized using an 8 or 12 bit analog-to-digital converter with a typical sampling rate of 250 Hz.

6. By using a _____ rather than a _____ the amplitude of low frequency noise as well as the low frequency components of the ECG will be reduced without affecting the QRS.
a) High-pass filter, Band-pass filter
b) Low-pass filter, Band-pass filter
c) Band-pass filter, Low-pass filter
d) Band-pass filter, High-pass filter

Answer: c
Explanation: The maximum of the QRS energy spectrum is in the vicinity of 10 Hz, the filter is designed to have a bandwidth of about 15 Hz with a centre frequency of 10-12 Hz. By using a bandpass filter rather than a low-pass filter, the amplitude of low frequency noise as well as the low frequency components of the ECG will be reduced without affecting the QRS.

7. The steep, large amplitude variation of the QRS complex is the obvious characteristics to use and this is the function of the R wave detector.
a) True
b) False

Answer: a
Explanation: Arrhythmia monitors require reliable R wave detectors as a prerequisite for subsequent analysis. The steep, large amplitude variation of the QRS complex is the obvious characteristics to use and this is the function of the R wave detector.

8. In the process of the ECG waveform, the detection filter removes _____ and _____

a) Baseline wander, motion noise
b) Muscle artifact, motion noise
c) Low frequency noise, motion noise
d) Baseline wander, muscle artifact

Answer: c
Explanation: The ECG waveform is processed by two digital filters: a detection filter and a classification filter. The detection filter removes low frequency noise (baseline wander) and muscle artifact. P waves and T waves are diminished.

9. How many steps are there in QRS detection?
a) Three steps
b) Two steps
c) Four steps
d) One step

Answer: b
Explanation: QRS detection is now almost universally performed digitally in a two-step process. The ECG is first preprocessed to enhance the QRS complex while suppressing noise, artifact and non-QRS portions of the ECG. The output of the preprocessor stage is subjected to a decision rule that confirms the detection of QRS if the processor output exceeds a threshold.

10. _____ is based on analyzing the shape of the QRS complexes and separating beats into groups or clusters.
a) Timing classification
b) Morphology characterization
c) Beat labeling
d) Noise detection

Answer: b
Explanation: Morphology characterization is based on analyzing the shape of the QRS complexes and separating beats into groups or clusters of similar morphology. Most algorithms for real time arrhythmia analysis maintain no more than 10-20 clusters at a time, order to limit the amount of computation needed to assign a QRS complex to a cluster.

11. When will be R-R interval declared premature?
a) If it is greater than 85% of the predicted interval
b) If it is less than 85% of the predicted interval
c) If it is greater than 75% of the predicted interval
d) If it is less than 75% of the predicted interval

Answer: b
Explanation: In timing classification, the observed R-R interval is compared to an estimate of the expected R-R interval. An R-R interval will be declared premature if it is less than 85% of the predicted interval. Similarly, an R-R interval is long if it is greater than 110% of the predicted value.

12. Which is the final stage in arrhythmia analysis?
a) Beat labeling
b) Alarms
c) Rhythm labeling
d) Summary statistics

Answer: c
Explanation: Rhythm labeling is the final stage in arrhythmia analysis. It is based on defined sequences of QRS complexes. The analysis systems are heavily oriented towards detecting ventricular arrhythmias, particularly single PVCs.

13. Ventricular Fibrillation is detected by _____

a) Shape of the QRS complexes
b) Difference of the R-R interval
c) Timing sequence of QRS complexes
d) Frequency domain analysis

Answer: d
Explanation: Ventricular fibrillation is usually detected by frequency domain analysis. The system is characterized as a narrow-band, low frequency signal with energy concentrated in a band around 5-6 Hz. It can be distinguished from noise by appropriately designing band-pass filters.

14. Which techniques are used in a new algorithm proposed by Jen and Hwang to obtain the long term ECG signal feature and extract the meaningful information hiding in the QRS complex?
a) Cepstrum time warping and Dynamic coefficient
b) Cepstrum coefficient and Dynamic time warping
c) QRS detection and Dynamic coefficient
d) QRS detection and Cepstrum time warping

Answer: b
Explanation: Jen and Hwang proposed a new algorithm using cepstrum coefficient and the dynamic time warping techniques to obtain the long term ECG signal feature and extract the meaningful information hiding in the QRS complex. This algorithm may also be used for arrhythmia detection by simply checking the difference of R-R wave intervals through signal feature extraction comparison for a certain period of time.

15. What is the sampling rate of the analog-to-digital converter in digitizing of ECG signal in signal conditioning?
a) 250 Hz
b) 215 Hz
c) 40-100 Hz
d) 200-215 Hz

Answer: a
Explanation: In signal conditioning, ECG signal is amplified, filtered (0.05-100 Hz for diagnostic purposes, 1-40 Hz for monitoring purposes) and digitized using an 8 or 12-bit analog-to-digital converter with a typical sampling rate of 250 Hz.

TOPIC 1.9 TYPICAL WAVEFORMS AND SIGNAL CHARACTERISTICS

1. The variation of a quantity such as voltage or current shown on a graph is known as

_____
a) Waveform
b) Peak value
c) Instantaneous value
d) Period

Answer: a
Explanation: The variation of a quantity, which is voltage or current in this case, shown on a graph with the x-axis as time is known as a waveform.

2. What is the duration of one cycle known as

_____
a) Waveform
b) Peak value
c) Instantaneous value
d) Period

Answer: d
Explanation: The duration of one cycle is known as a period. A function which repeats the same waveform at equal intervals of time is known as a periodic function.

3. The repetition of a variable quantity, recurring at equal intervals, is known as

_____
a) Waveform
b) Instantaneous value
c) Cycle
d) Period

Answer: c
Explanation: Each repetition of a variable quantity, recurring at equal intervals, is termed as a cycle.

4. The value of a given waveform at any instant time is termed as _____
a) Waveform

b) Instantaneous value
c) Cycle
d) Period

Answer: b
Explanation: Instantaneous value is the value of the waveform at that instant. Hence the value of a given waveform at any instant time is termed as instantaneous value.

5. The maximum instantaneous value measured from zero value is known as?
a) Peak value
b) Peak to peak value
c) Cycle
d) Period

Answer: a
Explanation: The maximum instantaneous value measured from the zero value is termed as the peak value.

6. The maximum variation between the maximum positive and the maximum negative value is known as?
a) Peak value
b) Peak to peak value
c) Cycle
d) Period

Answer: b
Explanation: The maximum variation between the maximum positive instantaneous value and the maximum negative instantaneous value is the peak-to-peak value.

7. What is the correct relation between the peak value and peak to peak value for a sinusoidal waveform?
a) Vp=4Vp-p
b) Vp=Vp-p
c) Vp-p=2Vp
d) Vp=2Vp-p

Answer: c
Explanation: The maximum variation between the maximum positive instantaneous value and the maximum negative instantaneous value is the peak-to-peak value. For a sinusoidal waveform, it is twice the peak value. Hence Vp-p=2Vp.

8. If the peak to peak voltage is 10V, calculate the peak voltage.
a) 10V
b) 2V
c) 4V
d) 5V

Answer: d
Explanation: Vp-p=2Vp
Substituting the values from the question, we get Vp=5V.

9. If the peak voltage is 9V, calculate the peak to peak voltage.
a) 9V
b) 20V
c) 18V
d) 12V

Answer: c
Explanation: Vp-p=2Vp
Substituting the values from the question, we get Vp-p= 18V.

UNIT II BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT

TOPIC 2.1 PH

1. Which of the following is the formula for pH calculation?
a) log10[H+]
b) -log10[H+]
c) log2[H+]
d) -log2[H+]

Answer: b
Explanation: pH is defined as the negative logarithm of hydrogen ion concentration. Hence, its formula is -log10[H+].

2. Pure water is known to be which of the following?
a) Weak electrolyte
b) Strong electrolyte
c) Neither weak nor strong
d) Not an electrolyte

Answer: a
Explanation: Pure water is a weak electrolyte. It dissociates to form hydrogen ions and hydroxyl ions.

3. Which of the following is the value of hydrogen ion concentration of pure water?
a) 1×10^{7} moles/litre
b) 1×10^{5} moles/litre
c) 1×10^{6} moles/litre
d) 1×10^{8} moles/litre

Answer: a
Explanation: The hydrogen ion concentration of pure water is 1×10^{7} moles/litre. It can be represented as $[H+]=1\times10^{7}$ moles/litre.

4. Which of the following is the value of hydroxyl ion concentration of pure water?
a) 1×10^{7} moles/litre
b) 1×10^{5} moles/litre
c) 1×10^{6} moles/litre
d) 1×10^{8} moles/litre

Answer: a
Explanation: The hydroxyl ion concentration of pure water is 1×10^{7} moles/litre. It can be represented as $[OH-]=1\times10^{7}$ moles/litre.

5. Which of the following is the relation between hydrogen and hydroxyl ion concentration of pure water?
a) Value of hydrogen ion concentration is greater
b) Value of hydroxyl ion concentration is greater
c) They are both always the same
d) The concentrations keep changing

Answer: c
Explanation: In water, the value of hydrogen and hydroxyl ion concentrations are the same. It can be represented as [H+]=[OH-].

6. The Nernst equation is given by which of the following statements?
a) $E=E_o + 2.303\ RT/F \log CH$
b) $E=E_o - 2.303\ RT/F \log CH$
c) $E=E_o + 2.303\ RT\times F \log CH$
d) $E=E_o - 2.303\ RT\times F \log CH$

Answer: a
Explanation: The Nernst equation is represented as, $E=E_o + 2.303\ RT/F \log CH$. it is used for measuring the potential of electrodes.

7. Which of the following is the relation between the concentration of hydrogen and hydroxyl ions in an acidic solution?
a) Value of hydrogen ion concentration is greater
b) Value of hydroxyl ion concentration is greater
c) They are both always the same
d) The concentrations keep changing

Answer: a
Explanation: In acidic solution, the value of hydrogen ion concentration is greater than that of hydroxyl ion concentration. It can be represented as [H+]>[OH-].

8. Which of the following is the relation between the concentration of hydrogen and hydroxyl ions in a basic solution?
a) Value of hydrogen ion concentration is greater
b) Value of hydroxyl ion concentration is greater

c) They are both always the same
d) The concentrations keep changing

Answer: b
Explanation: In basic solution, the value of hydroxyl ion concentration is greater than that of hydrogen ion concentration. It can be represented as [H+]<[OH-].

9. The measurement of hydrogen ion concentration can be made by measuring the potential developed in an electrochemical cell.
a) True
b) False

Answer: a
Explanation: The measurement of hydrogen ion concentration can be made by measuring the potential developed in an electrochemical cell.

10. Slope factor is independent of temperature.
a) True
b) False

Answer: b
Explanation: Slope factor is dependent on temperature. Slope factor is given by – 2.303 RT/F.

TOPIC 2.2 PO2

1. Which gas saturation is of great importance in clinical practice?
a) oxygen
b) carbon dioxide
c) hydrogen
d) nitrogen

Answer: a
Explanation: In clinical practice, the percentage of oxygen saturation in the blood is of great importance. This saturation being a bio-constant is an indication of the performance of the most important cardio-respiratory functions. It is maintained at a fairly constant value to within a few percents in a healthy organism.

2. Liquid part of blood is _____
a) Platelets
b) Red Blood Cells
c) White Blood Cells
d) Plasma

Answer: d
Explanation: The plasma (liquid part of the blood) is a very poor carrier of oxygen. At the pressures available, only 0.3 ml of oxygen can dissolve in 100 ml of plasma, which is quite insufficient for the needs of the body.

3. What does red blood cells contain for combining with a large volume of oxygen?
a) Proteins
b) Haemoglobin
c) Lipids
d) Platelets

Answer: b
Explanation: The red blood cells contain haemoglobin which can combine with a large volume of oxygen so quickly that in the lungs it may become 97% saturated forming a compound called oxyhaemoglobin.

4. How much quantity of oxygen bound with haemoglobin in the normal arterial blood?
a) 20.3ml %
b) 21.5ml %
c) 19.4ml %
d) 20.1ml %

Answer: c
Explanation: The total quantity of oxygen bound with haemoglobin in the normal arterial blood is approximately 19.4 ml percent at a pO2 of 95 mmHg. On passing through the tissue capillaries this amount is reduced to 14.4 ml percent at a pO2 of 40 mmHg.

5. When blood is withdrawn from the subject under anaerobic conditions and measurement for oxygen saturation is made at a later time in the laboratory, the procedure is referred to as _____ oximetry.
a) in vitro
b) in vivo
c) transmission
d) reflection

Answer: a
Explanation: When blood is withdrawn from the subject under anaerobic conditions and measurement for oxygen saturation is made at a later time in the laboratory, the procedure is referred to as in vitro oximetry.

6. For discrete blood samples, a spectrophotometric measurement of oxygen saturation can be made by which method?
a) in vitro
b) in vivo
c) transmission
d) cannot be determined

Answer: c
Explanation: For discrete blood samples, a spectrophotometric measurement of oxygen saturation can be made by either a transmission method or a reflection method.

7. Which principle is used by ear oximeter usually?
a) in vivo
b) transmission
c) reflection
d) in vitro

Answer: b
Explanation: Ear oximeters usually make use of the transmission principle to measure arterial oxygen saturation. In this case, the pinna of the ear acts as a cuvette. Blood in the ear must be made similar to arterial blood in composition.

8. Blood in _____ must be made similar to arterial Blood in composition.
a) heart
b) brain
c) ear
d) eyes

Answer: c
Explanation: Blood in the ear must be made similar to arterial blood in composition. This is done by increasing the flow through the ear without appreciably increasing the metabolism. Maximum vasodilatation is achieved by keeping the ear warm.

9. By keeping the ear warm, maximum vasodilatation is achieved.
a) True
b) False

Answer: a
Explanation: Yes, maximum vasodilatation is achieved by keeping the ear warm. It takes about 5 or 10 min for the ear to become fully dilated after the ear unit has been put up in place and the lamp turned on.

10. What is time taken for the ear to become fully dilated after ear unit has been placed?
a) 5-10 min
b) 10-15 min
c) 15-20 min
d) 20-25 min

Answer: a
Explanation: Maximum vasodilatation is achieved by keeping the ear warm. It takes about 5 or 10 min for the ear to become fully dilated after the ear unit has been put up in place and the lamp turned on.

11. Merrick and Hayes (1976) describe details of a _____ oximeter which enables the measurement of oxygen saturation of blood.
a) Pulse
b) Ear
c) Skin Reflactance
d) Intravascular

Answer: b
Explanation: Merrick and Hayes (1976) describe details of an ear oximeter which enables the measurement of oxygen saturation of the blood. This measurement is independent of a wide range of encountered variables and is made without involving patients in any calibration or standardization procedure.

12. This technique involves measuring the optical transmittance of the ear at how many wavelengths?
a) 12
b) 6
c) 8
d) 10

Answer: c
Explanation: In brief, the technique involves measuring the optical transmittance of the ear at 8 wavelengths in the 650 to 1050 nm range. A 2.5 m long flexible fibre ear probe connects the patient to the instrument.

13. Ear probe which connects the patient to instrument is _____ m long.
a) 1.5
b) 2.0
c) 2.5
d) 3.0

Answer: c
Explanation: A 2.5 m long flexible fibre ear probe connects the patient to the instrument. The ear probe can be either held in position for discrete measurements or can be conveniently mounted to a headband for continuous display.

14. Ear oximeter instrument is based on Beer-Lambert law.
a) True
b) False

Answer: a
Explanation: The instrument is based on the Beer-Lambert law. However, it is assumed that the optical absorbers act independently and additively and that the effects of light scattering by the ear tissue can be minimized by a proper source and detector geometry.

TOPIC 2.3 PCO2

1. pH meters can be considered as voltage sources with which of the following internal resistances?
a) Very low resistance
b) Moderate resistance
c) Very high resistance
d) No resistance

Answer: c
Explanation: pH meters can be considered as voltage sources with very high internal resistance. In order to eliminate errors, no current should flow from the source.

2. The electrodes used in pH measurement have which of the following internal resistances?
a) Very low resistance
b) Moderate resistance
c) Very high resistance
d) No resistance

Answer: c
Explanation: The electrodes used in pH measurement have very high internal resistance. It is of the order of 1000M ohm.

3. Which of the following is not a failure in pH meters?
a) Defective electrodes
b) Defective input circuitry
c) Defective electronic circuitry
d) Defective calibration

Answer: d
Explanation: Defective calibration is not a failure in pH meters. Failure occurs due to defective electrodes, defective input circuitry and defective electronic circuitry.

4. Which of the following is the simplest of pH meters?
a) Null-detector type pH meter
b) Direct reading type pH meter
c) Digital pH meter
d) Modern pH meter

Answer: a
Explanation: Null-detector type pH meter is the simplest of all pH meters. It is also known as the potentiometer type.

5. In which of the following ways can zero drift be reduced in pH meters?
a) Using filter
b) Giving zero adjustment arrangement
c) Keeping the input impedance high
d) Using balanced and differential amplifiers

Answer: d
Explanation: Zero drift be reduced in pH meters using balanced and differential amplifiers. Their response to external signals are additive and to internal noise are subtractive.

6. Which of the following can be used to provide automatic temperature compensation?
a) Proper insulation
b) Calibration for different temperatures
c) Thermistor
d) Thermometer

Answer: c
Explanation: To provide automatic temperature compensation, thermistors must be used. As the temperature of the solution changes, the circuit constants are altered accordingly.

7. Which of the following is not the characteristic of null-detector type pH meter?
a) It can be battery operated
b) It has less accuracy
c) It is easy to maintain
d) Its electronic circuits are simple

Answer: b
Explanation: Null-detector type pH meter has greater accuracy than 0.01 pH. pH value is read from the calibrated precision voltage source dial.

8. Which of the following is not the characteristic of direct reading type pH meters?
a) Simple operation
b) Quick to use
c) Continuous indication output
d) It requires balancing process

Answer: d
Explanation: Direct reading type pH meters do not require balancing process. Its operation is simple and readings can be read directly.

9. Which of the following is not the characteristic of chopper amplifier pH meter?
a) Direct voltage from the electrodes is chopped at the main frequency
b) Using choppers for high-input resistance gives rise to spikes of waveforms at the output
c) It leads to stability in DC output of phase-sensitive rectifier
d) Magnitude of surge increases in the glass electrode output

Answer: c
Explanation: The use of chopper amplifier in pH meter leads to zero instability. It leads to various other problems for high-input resistance.

10. In which of the following ways can the disadvantages of chopper amplifier type pH meter be overcome?
a) Using zero corrected DC amplifier
b) Using modern design
c) Using digital design
d) Using vibrating condenser

Answer: d
Explanation: The disadvantages of chopper

amplifier type pH meter can be overcome using a vibrating condenser. It is used in the place of the mechanical chopper.

11. The zero stability of vibrating condenser amplifier type pH meter is much better than a direct coupled amplifier.
a) True
b) False

Answer: a
Explanation: The zero stability of vibrating condenser amplifier type pH meter is much better than a direct coupled amplifier. The capacity can be changed by vibrating one of its plates.

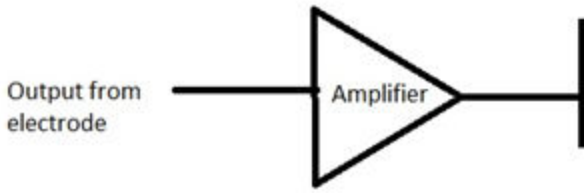
12. In vibrating condenser amplifier type pH meter, to maintain good performance which of the following has to be done?
a) Frequency of the vibrator should be stable
b) Frequency of the vibrator should be constant
c) Amplitude of the vibrator should be constant
d) Both frequency and amplitude of the vibrator should be constant and stable

Answer: d
Explanation: In vibrating condenser amplifier type pH meter, to maintain good performance, both frequency and amplitude of the vibrator should be constant and stable.

13. If an instrument fails to balance at zero, it is most likely that the electrodes are defective.
a) True
b) False

Answer: b
Explanation: If an instrument fails to balance at zero, it is most likely that the electronic circuitry is defective. Errors may also occur due to leakage of capacitance.

14. Given below is the block diagram of digital pH meter. Identify the unmarked component.



a) Filter
b) Buffer
c) A/D converter
d) D/A converter

Answer: c
Explanation: The unmarked component is A/D converter. Microprocessor operates only on digital data. Electrodes give analog signals. Hence, A/D converter must be present.

TOPIC 2.4 COLORIMETER

1. What is the use of a bomb calorimeter?
a) To calculate the calorific value of a volatile liquid
b) To calculate the calorific value of a gas
c) To calculate the calorific value of a non-volatile liquid
d) To calculate the calorific value of sparingly soluble salt

Answer: c
Explanation: It can also be used for calculating the calorific value of solids. If the compound in a volatile liquid or gas, the flame calorimeter offers itself as an instrument due to which further processes cannot take place.

2. Why does bomb calorimeter require high pressure oxygen?
a) To increase the rate of reaction
b) To ensure that the given sample in the

crucible burns completely
c) To increase the ignition temperature
d) To increase the kinetic energy

Answer: b
Explanation: A pressure of 30 bar should be used to carry out this whole process. The oxygen assists in the burning of coal sample.

3. Which material is used in the making of the cylindrical bomb?
a) Carbon steels
b) Alloy steels
c) Ferritic stainless steels
d) Austenitic stainless steels

Answer: d
Explanation: These steels are used to prevent the bomb from corrosion. These steels are also capable of withstanding a pressure of at least 50 atm.

4. What is the role of the small ring attached to the electrode in a bomb?
a) It acts as a support to the crucible
b) It is used to connect the electrode and the crucible
c) It is used as an intermediate for magnesium wire
d) It helps to collect the fuel at a point in the crucible

Answer: a
Explanation: Since the electrode connected is of tubular form, the ring attached to it makes good support between them. This electrode also acts as an oxygen inlet.

5. Why does the copper calorimeter surrounded by an air jacket and water jacket respectively in a bomb?
a) To resist the calorimeter with moisture particles
b) To carry out the process of combustion
c) To prevent the loss of heat due to radiation
d) To provide stability to the crucible inside the bomb

Answer: c
Explanation: When there is a change in temperature inside the bomb, there is a loss of heat due to radiation which is then absorbed by the air jacket and water jacket present in it.

6. Why only Beckmann or fixed zero thermometer are used to note down the temperature reading?
a) Since they can read temperature difference upto 1/100th of a degree
b) Since they have a high mercury level
c) Since they give a precise value of the temperature
d) Since they give accurate readings when dissolved in water

Answer: a
Explanation: When the current is supplied from a 6 volt battery, then there is a rise in temperature, due to which some temperature change occurs which is very small, so to calculate a perfect value for this temperature change Beckmann thermometer is used.

7. What is the use of gas releasing pin in the bomb?
a) To remove the oxygen gas from the bomb
b) To release the pressure from the bomb
c) To release the water vapour
d) To remove the carbon containing gases (such as CH_4, CO_2 etc)

Answer: b
Explanation: The pressure required in the bomb should be constant, so as to measure the change in enthalpy of the solution. Sometimes when the value of pressure is increased above to the suitability of the bomb, then to keep the pressure constant gas releasing pin is used.

8. Which material is used for making the wires, which are connected to the crucible containing fuel sample?
a) Arsenic
b) Phosphorous

c) Sulphur
d) Magnesium

Answer: d
Explanation: Since these wires are connected to the electrode from the crucible, they should be good conductors. Platinum is also used for this process.

9. What is the basic formulae for calculating gross calorific value in bomb calorimeter?
a) $\theta = [(W+w)(t_2+t_1)]/m$
b) $\theta = [(W-w)(t_2-t_1)]/m$
c) $\theta = [(W+w)(t_2-t_1)]/m$
d) $\theta = [(W+w)(t_2+t_1)]/m$

Answer: c
Explanation: Its unit is cal/gm. Here t_2-t_1 is the temperature difference and W+w is the total weight.
$\theta = [(W+w)(t_2-t_1)]/m$
where θ is gross calorific value, W is the weight of the water sample taken in calorimeter, w is the weight of water equivalent, t_1 is the initial temperature, t_2 is the final temperature and m is the weight of the fuel sample taken respectively.

TOPIC 2.5 BLOOD FLOW METER

1. Which of the following physiological parameter is most difficult to measure accurately?
a) Blood pressure
b) Blood Flow
c) Blood Volume
d) Skin color

Answer: b
Explanation: Blood flow is one of the most important physiological parameters and also one of the most difficult to measure accurately. This is because instruments for measuring the flow through blood vessels within the body have to meet certain stringent specifications; e.g. sensitivity and stability requirements depend upon the magnitude of flow, location and the diameter of the individual vessels.

2. Which of the following instrument is most commonly used for measurement of blood flow?
a) NMR Blood Flowmeter
b) Ultrasonic Blood Flowmeter
c) Electromagnetic Blood Flowmeter
d) Laser Doppler Blood Flowmeter

Answer: c
Explanation: The most commonly used instrument for the measurement of blood flow is of the electromagnetic type. With this type of instrument, blood flow can be measured in intact blood vessels without cannulation and under conditions which would otherwise be impossible. However, this method requires that the blood vessel be exposed so that the flow head or the measuring probe can be put across it.

3. Magnitude of voltage picked up is denoted as e = CHVd, where H is _____
a) velocity of blood flow
b) strength of magnetic field
c) diameter of blood vessel
d) constant of proportionality

Answer: b
Explanation: The magnitude of the voltage picked up is directly proportional to the strength of the magnetic field, the diameter of the blood vessel and the velocity of blood flow, i.e. e = CHVd, where e = induced voltage, H = strength of the magnetic field, V = velocity of blood flow,d = diameter of the blood vessel and C = constant of proportionality.

4. Magnitude of voltage picked up is denoted as e = CHVd, where C is _____
a) velocity of blood flow
b) strength of magnetic field

c) diameter of blood vessel
d) constant of proportionality

Answer: c
Explanation: The magnitude of the voltage picked up is directly proportional to the strength of the magnetic field, the diameter of the blood vessel and the velocity of blood flow, i.e. e = CHVd, where e = induced voltage, H = strength of the magnetic field, V = velocity of blood flow, d = diameter of the blood vessel and C = constant of proportionality.

5. The induced emf is picked by point electrodes made from _____ in electromagnetic blood flowmeter.
a) copper
b) graphite
c) platinium
d) copper tungsten

Answer: c
Explanation: In actual practice, the electromagnetic flowmeter transducer (Wyatt, 1984) is a tube of non-magnetic material to ensure that the magnetic flux does not bypass the flowing liquid and go into the walls of the tube. The tube is made of a conducting material and generally has an insulating lining to prevent short circuiting of the induced emf. The induced emf is picked up by point electrodes made from stainless steel or platinum.

6. What is the external diameter of flow heads?
a) 0.5 mm
b) 1 mm
c) 1.5 mm
d) 2 mm

Answer: b
Explanation: The flow head contains a slot through which the intact blood vessel can be inserted to make a snug fit. Several probes of different sizes must therefore accompany the flowmeter to match the full range of sizes of the blood vessels which have various diameters. It is naturally more difficult to construct flow heads suitable for use with very small blood vessels. However, flow heads having as small as 1 mm external diameter have been reported in the literature.

7. The operating principle underlying all electromagnetic type flowmeters is based upon Kirchoff's law.
a) True
b) False

Answer: b
Explanation: False, The operating principle underlying all electromagnetic type flowmeters is based upon Faraday's law of electromagnetic induction which states that when a conductor is moved at right angles through a magnetic field in a direction at right angles both to the magnetic field and its length, an emf is induced in the conductor. In the flowmeter, an electromagnetic assembly provides the magnetic field placed at right angles to the blood vessel in which the flow is to be measured.

8. The average flow velocity appears to be _____ cm/s in arteries.
a) 5 to 10
b) 10 to 12
c) 12 to 18
d) 20 to 25

Answer: d
Explanation: The flow-induced voltage of an electromagnetic flowmeter is, within certain limitations, proportional to the velocity of the flow. This velocity is the average across the flow stream with an axis symmetric velocity profile. The average flow velocity appears to be 20 to 25 cm/s in arteries and 10 to 12 cm/s in veins.

9. What is the average flow velocity in veins?
a) 5 to 10 cm/s
b) 10 to 12 cm/s

c) 12 to 18 cm/s
d) 20 to 25 cm/s

Answer: b
Explanation: The flow-induced voltage of an electromagnetic flowmeter is, within certain limitations, proportional to the velocity of the flow. This velocity is the average across the flow stream with an axis symmetric velocity profile. The average flow velocity appears to be 20 to 25 cm/s in arteries and 10 to 12 cm/s in veins.

10. What is velocity for the cardiovascular system taken for designing the probe?
a) 5 cm/s
b) 10 cm/s
c) 15 cm/s
d) 20 cm/s

Answer: c
Explanation: For designing the probe, velocity for the cardiovascular system is taken as 15 cm/s. For non-cannulated probes, a uniform magnetic field over the measuring area is so selected that it has a convenient shape and the smallest size (Cunningham et al. 1983).

11. Iron cored electromagnets are used in probes having a diameter between _____
a) 0.1 to 1 mm
b) 1 to 8.2 mm
c) 8.2 to 10 mm
d) 10 to 15 mm

Answer: b
Explanation: Iron cored electromagnets are used in probes having a diameter between 1 to 8.2 mm, and air cored electromagnets are used in diameters above 8.2 mm. Cannulated probes for extracorporeal use can have greater field strengths and magnet size as the constraint of small size is no longer present.

12. To protect probe from chemical attack, it must be encapsulated in silicon rubber.
a) True
b) False

Answer: a
Explanation: True, To protect the probe from chemical attack, it must be encapsulated in a biologically inert material having a high electrical and chemical resistance, e.g. silicone rubber. The probes can generally be sterilized by chemical means. Probe calibration is carried out in 0.9% saline during manufacture and each probe is given a calibration factor that is engraved on the connector.

13. The cable from the transducer to an instrument is sleeved with medical grade silicon rubber.
a) True
b) False

Answer: a
Explanation: True, the cable from the transducer to the instrument should comprise of a teflon insulated wire completely shielded with a tinned copper braid. The entire cable is sleeved with medical grade silicone rubber tubing and impregnated with silicone rubber to minimize leakage and electrical noise.

14. Air cored electromagnets are used in probes having a diameter _____
a) between 0.5 to 1 mm
b) between 1 to 2 mm
c) below 8.2 mm
d) above 8.2 mm

Answer: d
Explanation: Iron cored electromagnets are used in probes having a diameter between 1 to 8.2 mm, and air cored electromagnets are used in diameters above 8.2 mm. Cannulated probes for extracorporeal use can have greater field strengths and magnet size as the constraint of small size is no longer present.

TOPIC 2.6 CARDIAC OUTPUT

1. Which of the following statement is correct?
a) 130/90 mm Hg is considered high and require treatment
b) 100/55 mm Hg is considered an ideal blood pressure
c) 105/50 mm Hg makes one active
d) 190/110 mm Hg may harm vital organs

Answer: d
Explanation: The high blood pressure may harm vital organs of the body. It is the condition in which the force of blood against the artery valve is very high.

2. Blood pressure is the pressure exerted by blood against _____
a) kidneys
b) artery walls
c) brain
d) stomach

Answer: b
Explanation: Blood pressure exerted by circulating blood on the walls of blood vessels.

3. Blood pressure is measured in terms of _____
a) mm Hg
b) mm
c) cm Hg
d) Hg

Answer: a
Explanation: Blood pressure values are generally measured in terms of millimeters of mercury. It is measured using an instrument called as sphygmomanometer.

4. A person can suffer from both low blood pressure and high blood pressure.
a) True
b) False

Answer: a
Explanation: Low blood pressure is when the systolic and diastolic blood pressure is below for the age of the person. High BP is when blood pressure is high than 120/80 mm Hg.

5. A normal heart rate in an adult at rest is _____
a) 110
b) 125
c) 60
d) 75

Answer: d
Explanation: A normal resting heart rate for an adult ranges from 70-85 beats a minute. Generally, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness.

6. Unhealthy growth of tissue due to higher pressures on the walls of the artery is termed as _____
a) atheroma
b) aroma
c) adenoma
d) aroma and adenoma

Answer: a
Explanation: Atheroma is the growth of tissues due to higher pressure on walls of artery. High pressures increases heart work load.

7. Any mechanism that increases heart rate is said to have a positive _____ effect.
a) cholinergic
b) inotropic
c) chronotrophic
d) feedback

Answer: c
Explanation: Chronotrophic are those that change the heart rate. It changes the heart rate by affecting the electrical conduction system of the heart.

8. The colloid osmotic pressure of blood plasma is due to high concentration of _____
a) albumin

b) hemoglobin
c) sodium
d) glucose

Answer: a
Explanation: Albumin is a family of globular protein. The most important function is maintaining intra vascular colloid osmotic pressure.

9. The sinoatrial node depolarizes more frequently under the influence of _____
a) medulla oblongata
b) vagus nerve
c) norepinephrine
d) acetylcholine

Answer: c
Explanation: Norepinephrine is similar to adrenaline. It is used to treat life threatening low BP that can occur with certain medical conditions.

10. _____ is the enzyme that converts Angiotensinogen to Angiotensin I.
a) Rennin
b) ACE
c) ANP
d) ADH

Answer: a
Explanation: Angiotensin is a peptide hormone that causes an increase in blood pressure. Angiotensin I is produced by the action of rennin, which is formed in the liver.

TOPIC 2.7 RESPIRATORY

1. Name the process of gaseous exchange in the body.
a) Lymphatic system
b) Respiration
c) Cardiovascular system
d) Respiratory system

Answer: b
Explanation: Respiration is the process of gaseous exchange in the body while cardiovascular regulates the blood flow throughout the body.

2. Nose, larynx, pharynx, lungs, trachea, and bronchi are the parts of the respiratory system.
a) True
b) False

Answer: a
Explanation: Respiratory system consists of all the organs which take part in the respiration. It includes bronchi, trachea, lungs, nose, larynx, and pharynx.

3. Which of the following is NOT the function of the respiratory system?
a) Regulate blood pH
b) Helps in gaseous exchange
c) Protection against blood loss
d) Contains receptors for the sense of smell

Answer: c
Explanation: Respiratory system helps in regulation of blood, pH, and also contain receptors of smell, produces vocal sound and filter inspired air while cardiovascular system protects against blood loss by the formation of blood clots.

4. Which of this statement is TRUE for pulmonary respiration?
a) Exchange of gases between alveoli of lungs and the blood
b) Exchange of gases between blood and tissue cells
c) Breathing between the atmosphere and the alveoli of the lungs
d) Production of ATP

Answer: a
Explanation: Pulmonary respiration is the exchange of gases between the alveoli of the lungs and the blood in the capillaries. Exchange of gases between blood and tissue cell occurs in internal respiration.

5. Which of the following controls the normal breathing process?
a) Amino acids
b) Cholesterol
c) Ventral respiratory group
d) Dorsal respiratory group

Answer: d
Explanation: Ventral respiratory group contains both inspiratory and expiratory neurons and controlled forced breathing while dorsal respiratory group contains only inspiratory neurons control normal breathing.

6. Oxygen and hemoglobin bind in a reversible manner to form_____
a) Carboxyhemoglobin
b) Oxyhemoglobin
c) Methoglobin
d) BPG

Answer: b
Explanation: Oxyhemoglobin is formed by the combination of oxygen and hemoglobin. Oxygen binds to the hemoglobin in a reversible manner. 98% of oxygen is trapped inside RBC.

7. How many oxygen molecules bound to hemoglobin to give 50% saturation?
a) 6
b) 4
c) 2
d) 7

Answer: c
Explanation: Hemoglobin can bind with maximum 4 oxygen molecules, so for obtaining 50% saturation only 2 molecules of oxygen should be bound to hemoglobin.

8. What is the name of the gland which secrete melatonin?
a) Pituitary gland
b) Pineal gland
c) Thyroid gland
d) Hypothalamus

Answer: b
Explanation: Pineal gland is the smallest endocrine gland attached to the roof of the brain and secrete melatonin. Melatonin is responsible for settling of the biological clock.

TOPIC 2.8 BLOOD PRESSURE

1. Which of the following statement is correct?
a) 130/90 mm Hg is considered high and require treatment
b) 100/55 mm Hg is considered an ideal blood pressure
c) 105/50 mm Hg makes one active
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d) acetylcholine

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Explanation: Norepinephrine is similar to adrenaline. It is used to treat life threatening low BP that can occur with certain medical conditions.

10. _____ is the enzyme that converts Angiotensinogen to Angiotensin I.
a) Rennin
b) ACE
c) ANP
d) ADH

Answer: a
Explanation: Angiotensin is a peptide hormone that causes an increase in blood pressure. Angiotensin I is produced by the action of rennin, which is formed in the liver.

TOPIC 2.9 TEMPERATURE AND PULSE MEASUREMENT

1. Which of the following instrument is used for recording the electrical activity of the brain?
a) ECG
b) EMG
c) PCG
d) EEG

Answer: d
Explanation: Electroencephalograph is an instrument for recording the electrical activity of the brain, by suitably placing surface electrodes on the scalp. EEG, describing the general function of the brain activity, is the superimposed wave of neuron potentials operating in a non-synchronized manner in the physical sense.

2. EEG electrodes are larger in size than ECG electrodes.
a) True
b) False

Answer: b
Explanation: Several types of electrodes may be used to record EEG. These include: Peel and Stick electrodes, Silver plated cup electrodes and Needle electrodes. EEG electrodes are smaller in size than ECG electrodes.

3. _____ is the superimposed wave of neuron potentials operating in a non-synchrronized manner in a physical sense.
a) VCG
b) ECG
c) EEG
d) PCG

Answer: c
Explanation: Electroencephalograph is an instrument for recording the electrical activity of the brain, by suitably placing surface electrodes on the scalp. EEG, describing the general function of the brain activity, is the superimposed wave of neuron potentials operating in a non-synchronized manner in the physical sense.

4. Which of the following is material is used to improve electrical contact?
a) Silver Tungsten
b) Electrode jelly
c) Silver Graphite
d) Copper Tungsten

Answer: b
Explanation: Electrode jelly or paste is used to improve the electrical contact. If the electrodes are intended to be used under the skin of the scalp, needle electrodes are used. They offer the advantage of reducing movement artefacts.

5. Whose electrodes give high skin impedance as compared to ECG?
a) VCG
b) PCG
c) EMG
d) EEG

Answer: d
Explanation: EEG electrodes give high skin contact impedance as compared to ECG electrodes. Good electrode impedance should be generally below 5 kilohms. The impedance between a pair of electrodes must also be balanced or the difference between them should be less than 2 kilohms.

6. What are generally designed to have a very high value of input impedance to take care of high electrode impedance?
a) Montages
b) Electrodes
c) Preamplifiers
d) Filters

Answer: c
Explanation: Good electrode impedance should be generally below 5 kilohms. Impedance between a pair of electrodes must

also be balanced or the difference between them should be less than 2 kilohms. EEG preamplifiers are generally designed to have a very high value of input impedance to take care of high electrode impedance.

7. Voltage difference between an active electrode on the scalp with respect to reference electrode at ear lobe or any other part of body is known as _____ recording.
a) Monopolar
b) Bipolar
c) Unipolar
d) Nonpolar

Answer: a
Explanation: EEG may be recorded by picking up the voltage difference between an active electrode on the scalp with respect to a reference electrode on the ear lobe or any other part of the body. This type of recording is called 'monopolar' recording.

8. How is bipolar recording done?
a) Omni channel EEG
b) Multi channel EEG
c) Uni Channel EEG
d) Non Channel EEG

Answer: b
Explanation: 'bipolar' recording is more popular wherein the voltage difference between two scalp electrodes is recorded. Such recordings are done with multi-channel electroencephalographs.

9. EEG signals picked up by surface electrodes are usually small as compared to ECG.
a) True
b) False

Answer: a
Explanation: Yes, EEG signals picked up by the surface electrodes are usually small as compared with the ECG signals. They may be several hundred microvolts, but 50 microvolts peak-to-peak is the most typical.

10. A pattern of electrodes on the head and the channels they are connected to are _____
a) Amplifiers
b) Oscilloscope
c) Montage
d) Wires

Answer: c
Explanation: A pattern of electrodes on the head and the channels they are connected to is called a montage. Montages are always symmetrical. The reference electrode is generally placed on a nonactive site such as the forehead or earlobe.

11. Where is the reference electrode placed?
a) nasal
b) cervical
c) forehead
d) facial

Answer: c
Explanation: A pattern of electrodes on the head and the channels they are connected to is called a montage. Montages are always symmetrical. The reference electrode is generally placed on a nonactive site such as the forehead or earlobe.

12. What is the typical value of the calibration signal?
a) 10 uV/cm
b) 30 uV/cm
c) 50 uV/cm
d) 70 uV/cm

Answer: c
Explanation: A calibrating signal is used for controlling and documenting the sensitivity of the amplifier channels. This supplies a voltage step of adequate amplitude to the input of the channels. A typical value of the calibration signal is 50 uV/cm.

13. Preamplifiers used in electroencephalograph have high gain and low noise characteristics.
a) True
b) False

Answer: a
Explanation: Yes, preamplifier used in electroencephalographs must have high gain and low noise characteristics because the EEG potentials are small in amplitude. In addition, the amplifier must have very high common-mode rejection to minimize stray interference signals from power lines and other electrical equipment.

14. EEG machines have notch filter sharply tuned at _____ Hz as to eliminate mains frequency interference.
a) 10
b) 30
c) 50
d) 70

Answer: c
Explanation: EEG machines have a notch filter sharply tuned at 50 Hz so as to eliminate mains frequency interference. These however have the undesirable property of 'ringing' i.e. they produce a damped oscillatory response to a square wave calibration waveform or a muscle potential. The use of notch filters should preferably be restricted to exceptional circumstances when all other methods of eliminating interference have been found to be ineffective.

15. What is the typical frequency range of standard EEG machines?
a) 0.025 to 0.05 Hz
b) 0.05 to 0.1 Hz
c) 0.1 to 70 Hz
d) 70 to 140 Hz

Answer: c
Explanation: The typical frequency range of standard EEG machines is from 0.1 Hz to 70 Hz, though newer machines allow the detection and filtering of frequencies up to several hundred Hertz. This may be of importance in some intracranial recordings.

TOPIC 2.10 BLOOD CELL COUNTERS.

1. The blood corpuscles are of _____ kinds.
a) 5
b) 4
c) 2
d) 3

Answer: d
Explanation: The blood corpuscles are of 3 types. They are colored corpuscles- erythrocytes, Colorless corpuscles – Leucocytes and blood platelets.

2. Blood is stained with _____ stain.
a) Methylene blue
b) Safranin
c) Leishman stain
d) Carbol fuchsine

Answer: c
Explanation: Leishman stain is used in microscopy for staining blood smears. It is generally used to differentiate and identify leucocytes malaria parasites and trypanosomas.

3. Process of formation of blood corpuscles is called _____
a) Haemolysis
b) Haemozoin
c) Haemopoesis
d) Haemoter

Answer: c
Explanation: The Process of formation of blood corpuscles is called Haemopoesis. It occurs in the bone marrow.

4. Graveyard of RBC is _____
a) Spleen

b) Liver
c) Kidney
d) Thymus

Answer: a
Explanation: Old red blood cells are recycled in the spleen. Platelets and white blood cells are stored there. Spleen also helps fight certain kinds of bacteria that cause pneumonia and meningitis.

5. Which leucocytes release heparin and histamine in blood?
a) Neutrophil
b) Basophil
c) Eosinophil
d) Monocytes

Answer: b
Explanation: Basophil contains heparin which is an anticoagulant. It is a type of white blood cell.

6. Which blood cells secrets antibody?
a) Eosinophils
b) Monocytes
c) Lymphocytes
d) Neutrophils

Answer: c
Explanation: A Lymphocyte is a type of white blood cell that is a part of the immune system. There are 2 main types of Lymphocyte: B cells and T cells. The B cells produce antibodies that are used to attack invading bacteria, viruses and toxins.

7. Vitamin essential for blood clotting is _____
a) Vitamin K
b) Vitamin A
c) Vitamin B
d) Vitamin C

Answer: a
Explanation: Vitamin K is used by the body to help blood clot. Warfarin is used to slow blood clotting. By helping the blood clot vitamin k might decrease the effectiveness of warfarin.

8. Hemoglobin is a _____
a) Reproductive pigment
b) Respiratory pigment
c) Carbohydrate
d) Fat

Answer: b
Explanation: Hemoglobin is a protein in RBC that carries oxygen throughout the body. Lower Hemoglobin counts indicate anemia.

9. Absence of which clotting factor leads to Hemophilia-A?
a) Factor VII
b) Factor VIII
c) Factor IX
d) Factor X

Answer: b
Explanation: Hemophilia-A is also called factor VIII deficiency or classic hemophilia. It is a genetic disorder caused by missing or defective factor VIII a clotting protein.

10. What prevents the clotting of blood inside blood vessels?
a) Heparin
b) Serotonin
c) Fibrinogen
d) Fibrin

Answer: a
Explanation: Heparin is an anticoagulant that prevents the formation of blood clots. It is used to treat blood clots in veins arteries or lung.

11. Red cell count is carried out by _____
a) Electrogram
b) Sphygmomanometer
c) Haemoglobinometer
d) Haemocytometer

Answer: d
Explanation: Haemocytometer is a device designed and used for counting blood cells. It was invented by Louis Charles Malassez.

12. Blood is five times more viscous than distilled water.
a) True
b) False

Answer: a
Explanation: When hematocrit raised to 60% or 70% the blood viscosity can become as great as 5 to 6 times that of water and it flows through blood vessels is greatly retarded because of increased resistance to flow.

UNIT III ASSIST DEVICES

TOPIC 3.1 CARDIAC PACEMAKERS

1. Any disturbance in the heart's normal rhythmic contraction is called?
a) Heart stroke
b) Cardiac arrest
c) Arrhythmias
d) Premature contraction

Answer: c
Explanation: Any disturbance in the heart's normal rhythmic contraction is called an arrhythmias or cardiac dysrhythmia. In this arrhythmias heart can't beat in a regular rhythm. In arrhythmia heart-rate will be higher than normal rate or will be less than the normal rate.

2. Which diagnostic statement is based on ECG wave shapes that attempt to describe the state of the working muscle masses?
a) Rhythm statements
b) Morphological statements
c) Morphological-Rhythm statements
d) Rhythm-Morphological statements

Answer: b
Explanation: Morphological statement-primarily based on ECG wave shapes that attempt to describe the state of the working muscle masses. The other type of diagnostic statement is Rhythm statement. These both diagnostic statements are observed from the ECG records.

3. Rhythm statements concerned with the site and rate of the cardiac pacemaker and the propagation of impulses through the conduction system.
a) True
b) False

Answer: a
Explanation: Rhythm statements concerned with the site and rate of the cardiac pacemaker and the propagation of impulses through the conduction system is true because the other type of the diagnostic statements is Morphological statements and it is primarily based on ECG wave shapes that attempt to describe the state of the working muscle masses.

4. Which wave from ECG waveforms becomes widened when the self-triggering impulse does not arrive through the AV node?
a) P wave
b) QRS wave
c) ST wave
d) T wave

Answer: b
Explanation: Sometimes irritation occurs in the ventricles, the self-triggering impulse does not arrive through the node and thus travels a different and slower path in spreading over the ventricles. The QRS wave then becomes widened and is classified as a ventricular ectopic beat.

5. When the self-triggering impulse does not arrive at the AV node and travels a different and slower path over the ventricles, the QRS becomes widened and is classified as

_____
a) Ectopic beat
b) Ventricular-ectopic beat
c) Ventricular beat
d) Atrio-ventricular beat

Answer: b
Explanation: Sometimes irritation occurs in the ventricles, the self-triggering impulse does not arrive through the node and thus travels a different and slower path in spreading over the ventricles. The QRS wave then becomes widened, and is classified as a ventricular ectopic beat. This ectopic beat is classified from ventricles so it is called as a ventricular ectopic beat.

6. An ectopic beat, which starts in an abnormal location in the heart and is often premature, therefore also called _____
a) Pre ventricular contraction
b) Premature ventricular beat
c) Pre ventricular beat
d) Premature ventricular contraction

Answer: d
Explanation: An ectopic beat is a beat, which starts in an abnormal location in the heart and is often premature, therefore also called premature ventricular contraction (PVC), i.e. it occurs sooner than the next expected beat.

7. When the heartbeat is slower than the normal rate of the heart(less than 60), this type of arrhythmias called _____
a) Bradycardia
b) Tachycardia
c) Arterial contraction
d) Ventricular contraction

Answer: a
Explanation: There are 2 types of arrhythmias, i) Bradycardia-when the heart-rate is to slow(less than 60), ii)Tachycardia-when the heart-rate is to fast(greater than 100). Here the answer is Bradycardia because heart rate is less than 60.

8. Which of the following are resuscitation techniques?
a) Cepstrum coefficient
b) Prophylactic therapy
c) Transthoracic defibrillation
d) Dynamic time warping

Answer: d
Explanation: The necessity for early detection of the arrhythmias led to the establishment of coronary care units in hospitals for the intensive monitoring and treatment of such patients. The attempt in these units was to effectively carry out resuscitation techniques such as cardiac massage and transthoracic defibrillation.

9. If heart rate is x, then which value of x is known as tachycardia?
a) $x < 60$
b) $x > 60$
c) $60 < x < 100$
d) $x > 100$

Answer: d
Explanation: There are 2 types of arrhythmias,i)Bradycardia-when the heartrate is to slow(less than 60), ii)Tachycardia-when the heartrate is to fast(greater than 100).Here the answer is Bradycardia because,heart rate is less than 60.

10. Photo-diodes work in _____
a) forward biased
b) reverse biased
c) independent of forward and reverse biasing
d) any configuration

Answer: b
Explanation: The photodiode is a P-N junction semiconductor diode. It always operated in the reversed biased condition. The light is always focused through a glass lens on the junction of the photo diode.

11. Parallel flow dialyzer has a low internal resistance. Because of this blood pump is required.
a) True
b) False

Answer: b
Explanation: Parallel flow dialyzer has a low internal resistance which allows adequate blood flow through the dialyzer with the patient's arterial blood pressure, eliminating the need for a blood pump. The dialyzing surface area of a parallel flow dialyzer is about 1 sq m. At a blood flow rate of 200 ml/min and a dialysate flow of 500 ml/min, the urea and creatinine clearance is about 80 and 64 ml/min.

12. CMRR is measured in _____
a) V/s
b) dB
c) dB/s
d) dB/ms

Answer: b
Explanation: CMRR is an important specification referred to the differential amplifier and is normally expressed as decibels. The ability of the amplifier to reject common voltages on its two input leads is known as common-mode rejection. It is specified as the ratio of common-mode input to differential input to elicit the same response.

TOPIC 3.2 DC DEFIBRILLATOR

1. Any disturbance in the heart's normal rhythmic contraction is called?
a) Heart stroke
b) Cardiac arrest
c) Arrhythmias
d) Premature contraction

Answer: c
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TOPIC 3.3 DIALYSER

1. Dialysis commonly refers to _____
a) heamo dialysis
b) chemo dialysis
c) liver dialysis
d) pancreatic dialysis

Answer: a
Explanation: When the term dialysis is mentioned, it usually means the purification of blood and removal of nitrogenous wastes from the body. It refers to the work done by the kidney by drawing out blood and purifying it.

2. The membrane used for dialysis is made of _____
a) cellulose
b) polyvinyl chloride
c) polyethylene
d) chitin

Answer: a
Explanation: Cellulose is an easily available material which does not cause any harm to the blood or body. It is cheap and with certain tampering, it's strength can be increased. It has a good pore size, small enough to stop the blood cells but large enough to pass out the waste products.

3. The latest form of dialysis machine being used has what kind of membrane arrangements
a) Parallel Plate
b) Hollow Fibre
c) Coil Tube
d) Hollow Plate

Answer: b
Explanation: The hollow fibre is dialyzer is a tube like structure with fibers planted in polyurathanes at the opposite ends. This forms hollow pipe like structures for the blood to flow through and allow for the exchange of materials across the membrane.

4. Dialysis can also be used in situations of _____

a) extreme fever
b) acute poisoning
c) low blood pressure
d) blood transfusions

Answer: b
Explanation: When a person is suspected of acute poisoning, the person may be made to undergo dialysis. Poison will be regarded as a toxin by the body and will be removed normally by kidney and liver which may cause damage to these organs. Thus, the blood is extracted out and sent to the dialysis machine so that any harm to the organs and the body can be minimized.

5. The parameters being monitored during dialysis are _____
i. Blood Pressure
ii. Diabetes
iii. Embolus Formation
iv. Pulse
v. Temperature
vi. Flow Rate
v. Albumin level
vi. Createnine
vii. Repiratory Rate
a) i, ii, vi, vii
b) ii, iii, iv, vii
c) i, ii, iv, v, vi, vii
d) vi, v, vi, vii

Answer: c
Explanation: All the parameters mentioned above are monitored for dialysis but some are monitored before and some after the dialysis. The parameters monitored during dialysis are of blood pressure, embolus formation, pulse, temperature, flow rate and respiratory rate as they directly affect the health of the patient and are indicative of abnormalities.

6. The dialysis that can be performed even at home is _____
a) Apheresis
b) Peritoneal Dialysis
c) Hemodialysis
d) Perfusion

Answer: b
Explanation: In this procedure, the diaphragm is used to conduct dialysis. There is cannula which allows the electrolyte to be entered in the body. The electrolytes stay in the body for up to 6 hours during which the person's blood vessels and diaphragm act as filtering membranes and the unwanted products like creatinine and urea get filtered out. Then the stopper on the cannula is opened once more and the electrolyte is allowed to flow out.

7. The principle behind dialysis is _____
a) Adhesion
b) Cohesion
c) Capillary Action
d) Reverse – Osmosis

Answer: d
Explanation: It is the movement of solutes from the area of high concentration to low concentration through a semi permeable membrane. Dialysis is done with the electrolytes flowing through one side and the blood flowing in the opposite direction. The two fluids flow in opposite directions across a semi permeable membrane which causes a pressure to be created and the wastes flow out from the blood to the dialysate.

8. The dialysate consists of _____
i. Sodium
ii. Potassium
iii. Iron
iv. Carbon
v. Magnesium
vi. Manganese
vii. Chlorine
viii. Sulphur
ix. Phosphorus
x. Calcium
a) i, iii, viii,ix
b) vi, vii, ix,
c) i, ii, v, vii, x
d) ii, iii, ix, x

Answer: c
Explanation: Sodium 140.0 mmol / l, potassium 1.0 mmol / l, calcium 1.25 mmol / l, bicarbonate 34.0 mmol / l, magnesium 0.5 mmol / l, chloride 107.5 mmol / l, glucose 5.5 mmol / l. Normally, these ions are present in the blood plasma as well. Since the principle is osmosis under high pressure, also called as ultra-filtration, these salts help create a pressure difference across the membrane. This causes the unwanted materials like creatinine and urea to be filtered out from the blood.

9. How does the doctor diagnose dialysis?
a) GFR via Blood Test
b) Number of WBCs in Blood Test
c) Presence of blood in urine
d) Low urine quantity

Answer: a
Explanation: Glomerular Filtration Rate (GFR) is used to test if the kidneys are functioning normally. In kidneys, the glomerulus is the site for ultrafiltration, i.e. filtration of blood under high pressure. Everything except cellular components moves out in this phase and the required materials are reabsorbed in the following phases. Thus, if the glomerulus is not functioning well, unwanted wastes like creatinine will be high in the blood which will all get reflected in the GFR. Thus, the doctors will be able to suggest if the person needs to go for dialysis or not.

10. When a subclavian vein or a femoral vein is used for dialysis, what kind of incision/insertion is made?
a) Catheter
b) Shunt
c) Graft
d) Fistula

Answer: a
Explanation: When the femoral vein or the subclavian vein is used to extract blood for dialysis, a simple catheter is used. A simple incision at the site of insertion is made and is used to insert the catheter. Usually, it is filled with heparin & capped to maintain patency between dialysis treatments.

TOPIC 3.4 VENTILATORS

1. The term _____ is used to mean the free passage of clean air in a structure.
a) Circulation
b) Ventilation
c) Dissipation
d) Condensation

Answer: b
Explanation: In other words, the removal of all vitiated air from a building and its replacement with fresh air is known as ventilation. It is important from the engineering viewpoint for various reasons.

2. For comfortable working, the _____ content should be limited to about 0.6% by volume.
a) Oxygen
b) Hydrogen
c) Carbon monoxide
d) Carbon dioxide

Answer: d
Explanation: It is observed that breathing is difficult when the amount of carbon dioxide by volume is about 6% and a man loses consciousness when it reaches about 10% or so. The more the amount of carbon dioxide, the more difficult is the breathing.

3. The difference of temperature between the outside air and inside air tends to the deposition of moisture in the room surfaces known as _____
a) Ventilation
b) Diffusion
c) Condensation
d) Dissipation

Answer: c
Explanation: The proper and sufficient ventilation results in the absence of condensation. It can be effectively controlled by the provision of suitable ventilation of the room.

4. Where people are working, there has to be _____ to cause proper ventilation of the premises.
a) Air change
b) Humidity
c) Temperature
d) Moisture

Answer: a
Explanation: The minimum and maximum rates of air change per hour is 1 and 60 respectively. If the rate of change is less than 1/hour, it will not create any appreciable effect of the ventilation system. On the other hand, at the rate of air changes more than 60/hour, it will result in discomfort due to high velocities of air.

5. The rate of amount of water vapour present to the amount it would have contained, had it been saturated, is known as the _____ the temperature being same.
a) Relative humidity
b) Saturated air
c) Dry bulb temperature
d) Wet bulb temperature

Answer: a
Explanation: When a certain volume of air at a certain temperature contents as much water vapour as it can, it is said to be Saturated air. Generally, the air is not saturated at all times. But it contains a certain amount of water vapour in it.

6. For working a temperature of 21 degree Celsius, range of 30% to 70% of _____ is desirable.
a) Saturated air
b) Dry bulb temperature
c) Relative humidity
d) Wet bulb temperature

Answer: c
Explanation: The value of relative humidity is obtained by comparing dry bulb and wet bulb temperature. For higher temperatures, the low humidity and greater air movements are necessary for removing greater portion of heat from the body.

7. The _____ plays an important role in the comfort of persons affected by ventilation system.
a) Carbon monoxide
b) Purity of air
c) Volume of room
d) Health of occupant

Answer: b
Explanation: The air should be free from odours, organic matter, inorganic dust and unhealthy fumes of gases such as carbon monoxide, carbon dioxide and Sulphur Dioxide, etc. All the above impurities depend on the habits of occupants, volume of a room, source of ventilating air, etc.

8. It is quite evident that the incoming air for ventilation should be _____ in summer and _____ in winter before it enters the room.
a) cool, warm
b) warm, cool
c) humid, dry
d) dry, humid

Answer: a
Explanation: The usual difference of temperature between inside and outside is kept as about 8°C to 10°C. With regards to human comfort, the term effective temperature is used. It is an index which combines the effect of air movements, humidity and temperature.

9. _____ is an index which combines the effect of air movement,

humidity and temperature.
a) Saturated air
b) Effective humidity
c) Dry bulb temperature
d) Effective temperature

Answer: d
Explanation: Effective temperature indicates the temperature of air at which sensation of same degree of cold or warmth will be experienced as in quite a fully saturated at the same temperature. Thus, if two rooms have the same effective temperature, no change of temperature will be experienced by a person when he suddenly leaves one room and enters the room.

10. The value of _____ depends on type of activity, geographical conditions, age of occupants, etc.
a) Saturated air
b) Relative humidity
c) Effective temperature
d) Condensation

Answer: c
Explanation: The popular values of effective temperature in winter and summer or 20°C and 22°C respectively. It should however be remembered that the effective temperature indicates same feeling of cool or warmth. But it results in human comfort only when it is correlated with humidity and air movements.

11. In _____ system, the use is made of doors, windows, ventilators and skylights to make the room properly ventilated.
a) Artificial ventilation
b) Air conditioning
c) Natural ventilation
d) Mechanical ventilation

Answer: c
Explanation: Natural ventilation is useful for small buildings and it cannot be adopted for big offices, theatres, auditoriums, etc. The only advantage of the system is that it is economical in the sense that no special equipment is necessary for making the room adequately ventilated and that is affords living under natural conditions.

12. In _____ system, some mechanical arrangement is adopted to provide enough ventilation to the room.
a) Natural ventilation
b) Skylight
c) Artificial ventilation
d) Man made

Answer: c
Explanation: Mechanical or Artificial ventilation has become popular due to recent change in notion regarding ventilation. At present, the ventilation is required not nearly to furnish warm air or cool air. But the ventilation system should provide air of such qualities regarding humidity, temperature, etc.

13. Exhaust system, supply system, air conditioning, etc. comes under _____ type of ventilation system.
a) Natural
b) Mechanical
c) Man made
d) Doors

Answer: b
Explanation: The mechanical system is costly, but it results in a considerable increase in the efficiency of the person under the command of the system. This system is adopted for big offices, banks, industrial plants, theatres, etc.

14. In _____ system, the partial vacuum is created inside of the room by exhausting the vitiated inside air by fans or blowers.
a) Supply
b) Plenum
c) Air conditioning
d) Exhaust

Answer: d
Explanation: In exhaust system, the extraction of air from inside sets of the current of fresh air from outside to inside and thus, it becomes possible to provide fresh air to the room through doors and windows. The fans or blowers are installed at suitable places in the outside wall and they are connected to different rooms through duct system.

15. _____ system is just the reverse of the exhaust system.
a) Air conditioning
b) Exhaust
c) Plenum
d) Supply

Answer: d
Explanation: Supply system consist in supplying fresh air to the room by installing input fans in outside walls. This system is used for ventilating rooms near an unusual quantity of heat or odours is not produced.

TOPIC 3.5 MAGNETIC RESONANCE IMAGING

1. The commonly used MRI's have a magnetic strength of _____
a) 1.5 – 3 Tesla
b) 3 – 6 Tesla
c) 6 – 12 Tesla
d) 12 – 24 Tesla

Answer: a
Explanation: MRI's have three major portions which work together to form an image. The largest portion is taken up by the magnet. This magnet is always on and produces a Magnetic Field of the strength of 1.5 – 3 Tesla. Commercially, 1.5 – 2 T was used but now even with 3T have been introduced. For research purposes, MRI of 7T has also been constructed.

2. The cooling agent for the MRI magnet is _____
a) Helium
b) Neon
c) Argon
d) Xenon

Answer: a
Explanation: Helium is a noble gas which is non reactive in nature. A good coolant has a high thermal capacity, low viscosity, non toxic, chemically inert, all the properties that Helium possesses. Another advantage is that Helium does not have the tendency to absorb any neutrons and so it cannot become radioactive. Being a noble gas, it is non reactive and so non corrosive in nature. Thus, it is used a coolant for the MRI machine, especially the magnet.

3. If an MRI was done for a long bone, the part of the bone that will be imaged is the _____
a) Bone salts
b) Bony Prominence
c) Inflamed Joints
d) Bone Marrow

Answer: d
Explanation: Bone marrow is a soft tissue as compared to the encasing bone structure. Also, it had water whose Hydrogen is used by the MRI to form an image. The other parts of the bone do contain hydrogen but the hydrogen is placed in a crystal structure, making it difficult to move or be magnetized. Thus, it is difficult to image any other parts of the bone with MRI except for the bone marrow.

4. A hypothetical MRI is made having a magnetic field (B0) of 7 Tesla. This uses nitrogen for study. The gyrometric ratio of nitrogen 15 is -4.316. Find the Lamar frequency.
a) -35.889
b) – 30.212
c) 0
d) -189.812

Answer: b
Explanation: Gyrometric ratio is the ratio of the magnetic moment to the angular moment of the element. Lamar frequency, also called as Lamar precision is the frequency by which the element will undergo a change in orientation when placed in a strong external magnetic field. Lamar frequency is given by the formula: f = γn x B0/2Π
Here γn/2Π is the gyrometric ratio. Thus, f = -4.316*7 = -30.212.

5. If the XY grid is selected in MRI then the slice selection is in which plane?
a) X plane
b) Y plane
c) Z plane
d) XY plane

Answer: c
Explanation: An MRI can give a 3D image of an object and we can choose the form which direction and from which angle we would like to view the image. The image is always perpendicular to the grid that has been selected. As it is given that our grid is XY, then slice selection can be done only in Z plane and so, therefore, the image is also in Z plane.

6. The smallest unit in the reconstruction/projection of an MRI image is called as _____
a) pixel
b) voxel
c) binary unit
d) dot

Answer: b
Explanation: Voxel stands for the volumetric pixel. MRI is unique in a way that it can image segments of the organ from different angles with various slice selections. These slice selections help choose which layer of the organ will be imaged and the smallest unit of this image is called a voxel. Since MRI can produce 3D scans, the image is volumetric in nature and thus, volumetric pixel or voxel is used.

7. MRI has a high _____ resolution.
a) spatial
b) temporal
c) frequency
d) magnitude

Answer: a
Explanation: MRI can form a 3D image of the organ which is anatomical in nature. It gives good clarity and resolution for the finer details of the image. In the same way, fMRI has a good temporal resolution. It maps the brain with respect to time, scanning the oxygen used at the regular intervals.

8. In a brain scan of a person suffering/suspected of suffering from schizophrenia, the brain _____
a) has gray matter which more than normal
b) has white matter which more than normal
c) is of a size bigger than normal
d) has shrunk

Answer: b
Explanation: A person suffering from schizophrenia suffers from problems like hallucinations, listening to non existent sounds etc. The persistent problem can be analyzed by looking at the brain scan which shows that the white matter in a particular part of the brain has become more than normal. Since white matter is responsible for sending impulses, a bigger area of white matter will mean faster travelling of impulses and therefore such thoughts. However, since the CT shows the negatives of the original, the white matter will look gray and gray matter will look white. Thus, in a scan, if there is a large gray area and the person suffers from symptoms like hallucinations or anxiety etc, then it's a high possibility that they have schizophrenia.

9. The scans for lissencephaly will show a brain _____

a) with no gyri and sulci
b) with excess gyri and sulci
c) with deformed brain structure
d) with a smaller than normal brain size

Answer: a
Explanation: Lissencephaly is a neuronal defect that is present right from birth. It may or may not be detected in the fetal stage. In this disorder, the brain in smooth without the presence of any gyri and sulci. A child born with lissencephaly often has a normal head structure so it is often difficult to detect the presence of this defect till a later age.

10. Frontotemporal Dementia brain scan shows a _____
a) growing brain
b) shrinking brain
c) brain with lesions
d) brain with a tumour

Answer: b
Explanation: Frontotemporal Dementia (FTD) is the most common kind of dementia found in the population. In this, the neural cells of the brain go for apoptosis (cell death) causing an atrophy (shrinkage) of the brain. This causes the person to have memory disorders.

TOPIC 3.6 | 3.7 ULTRASONIC IMAGING SYSTEMS.

1. What property of sound waves acts like the principle of ultrasound?
a) Reflection and Refraction
b) Reflection only
c) Refraction only
d) Propagation

Answer: a
Explanation: The ultrasound works on the principle of reflection and refraction. While it is necessary that sound waves need a medium to travel, so we can say propagation is important but it is only because the sound wave gets refracted when the medium changes and are reflected back that the image is formed. Thus, the principle for ultrasound is reflection and refraction.

2. Ultrasound is also useful for _____
i. detecting fault in metal sheets ii. imaging marine depths iii. looking for metals beneath the earth's surface iv. detecting distances v. detecting earthquakes
a) ii, iii, v
b) i, iv, v
c) i, ii, iv
d) ii, iii

Answer: c
Explanation: Ultrasound is used for detecting the fault in metal sheets, imaging marine depths and detecting distances. If the metal sheets have faults like cracks or deformity, the reflected sound waves will not be uniform. SONAR and RADAR are used to detect distances and work on the principle of ultrasound.

3. Which of the following medical imaging modality other than ultrasound does not use any form of radiation?
a) PET Scan
b) SPECT Scan
c) CT Scan
d) MRI

Answer: d
Explanation: MRI uses the electromagnetism of the atoms present in the body to get the images while all the other imaging modalities use some sort of radioactivity in order to take the images. Ultrasound relies on the sound waves while MRI relies on the electromagnetic waves. Thus, they are both non radioactive imaging modalities.

4. For which of these areas can the ultrasound be taken for an infant but not for an adult?
a) Cranium
b) Chest

c) Arms
d) Legs

Answer: a
Explanation: Bones are natural impedance providers to ultrasound and so if any organ is covered or surrounded by bones, it is not possible or very difficult to take their ultrasound. For an infant, their bones are soft and do not provide so much of a resistance to the passage of the ultrasound waves. Thus, it is possible to take an ultrasound of the brain at an infant stage but not at an adult stage.

5. A piezoelectric crystal is used to produce the ultrasound waves. What kind of ultrasound is produced?
a) Pressure wave ultrasound
b) Electrical wave ultrasound
c) Sound wave ultrasound
d) Simple ultrasound

Answer: a
Explanation: A piezoelectric crystal is a special transducer which converts mechanical energy into electrical energy and vice-versa. Thus, when the electrical impulses are given to the transducer, it is converted into mechanical energy. The transducer starts vibrating causing a pressure difference and the ultrasound waves are produced.

6. How is a medium characterized?
a) By its thickness
b) By its acoustic impedance
c) By its water content
d) By its density

Answer: b
Explanation: Acoustic impedance is the resistance that a sound wave faces when it propagates from one medium to another in the body. Thickness, density and water content (for a living body) are all factors that are taken into account when measuring the acoustic impedance. Thus the medium is characterized by its acoustic impedance. The impedance offered by the bones is extremely high.

7. The wave velocity of ultrasound in soft tissues is 1540m/s and the impedance offered by it is 1.63 X 106 kg/m^2s. What is the density of the soft tissue?
a) 0.1058441 kg/m^3
b) 10.58441 kg/m^3
c) 1058.441kg/m^3
d) 105844.1 kg/m^3

Answer: c
Explanation: The impedance is given by $z = \rho c$ where z = impedance, ρ = density and c = velocity of the ultrasound. Since the wave velocity and the impedance offered are given, $\rho = z/c$. This results in 1058.441 kg/m^3 of density for the soft tissue.

8. Which of the following relations are true?
a) γ increases, penetration of sound increases, resolution decreases
b) γ increases, penetration of sound decreases, resolution decreases
c) γ increases, penetration of sound decreases, resolution increases
d) γ decreases, penetration of sound increases, resolution increases

Answer: a
Explanation: When the frequency (γ) of the sound waves increases, it gains more energy to overcome the impedance barrier and so is able to penetrate deeper. However, the penetration may not be uniform in all places and reflection may be uneven thus it affects the resolution of the image.

9. When an abdominal ultrasound is done, why is it advised to have a full bladder?
a) To have a good acoustic window
b) To increase the water content
c) To lower impedance
d) To allow for better propagation of waves

Answer: a
Explanation: Acoustic window is a small opening through which the sound waves can pass and can help image the structures beyond. When the bladder is full, it is properly stretched and the folds of the bladder do not provide any impedance. The water helps in the better propagation of the sound and visualization of the structures beyond the bladder.

10. What does the red dot on the probe help within the produced image?
a) To check if the correct probe was used
b) To check the probe orientation
c) To check the depth of the probe that was used
d) To check the plane of the image.

Answer: b
Explanation: When the probe is being used, it can move in various ways but the image being formed is a horizontal image. Thus, the red dot at the head of the probe appears to the left of the image and helps in working out the orientation of the organ or the foetus.

UNIT IV PHYSICAL MEDICINE AND BIOTELEMETRY 9

TOPIC 4.1 DIATHERMIES-SHORTWAVE

1. For what all purposes is diathermy principal used?
a) Surgical and Therapeutic
b) Therapeutic and Diagnostic
c) Diagnostic and surgical
d) Diagnostic and rehabilitative

Answer: a
Explanation: Diathermy is a process by which the body is treated by the electromagnetic waves or waves of high frequency. These waves beyond certain frequencies have heating effects and can help in easing the pain in the body. This type of diathermy is used for therapeutic purposes. When the heat is increased and concentrated at a point, it can cause cutting action by boiling and burning the cells. This type of diathermy is used for surgical purposes.

2. What surgical functions are performed by the diathermy machine?
a) cutting, coagulation, fulguration
b) cutting, fulguration
c) cutting, coagulation
d) coagulation, fulguration

Answer: a
Explanation: Cutting happens when the heat is given is so high that the cell burns and is separated. This causes the incision to be formed, hence cutting. Coagulation happens when the cytoplasm is heated so much that it boils and joins together. Fulguration is a process in which the heat is applied and a spread out action takes place. It covers a larger area.

3. The types of therapeutic diathermy machines that exist are _____
a) Short wave, micro wave and ultrasound
b) Short wave, ultrasound and cold compress
c) Cold compress, microwave and electrical impulse
d) Electrical impulse, microwave and ultrasound

Answer: a
Explanation: Shortwave diathermy uses the infrared heat waves to treat the patient while microwaves go inside the body and produce heat for treatment. Ultrasound also produces sound waves which travel in the body, produce heat and cause healing.

4. Which of the diathermy machine is good for deep tissue healing?

a) short wave
b) ultrasound
c) cold compress
d) electrical impulse

Answer: a
Explanation: The short wave diathermy produces heat by sending in infrared waves. These waves are produced by the plates or coils that are placed around the area to be treated. These heat waves can travel deeper into the body than the waves produced by microwave diathermy or ultrasound diathermy.

5. What is the frequency range of the sound used for ultrasound diathermy?
a) 0.1 – 0.7 MHz
b) 0.7 – 3.3 MHz
c) 3.3 – 5 MHz
d) 5 – 15 MHz

Answer: b
Explanation: The ultrasound treatment can penetrate up to 2 – 5 cm deep within the skin to relieve pain. The frequency of 0.7 – 3.3 MHz is used. If the frequency is increased, it can cause excess heat causing heat burns in the body and doing damage rather than therapy.

6. What precaution is used in diathermy?
a) the patient is made to lie on a soft pillow
b) pads are used for grounding and completing the circuit
c) the patient is made to drink a large number of fluids
d) wooden blocks are used for grounding

Answer: b
Explanation: Diathermy machines produce electromagnetic waves and the current used to produce these waves is huge. In case of any accidents, the person on whom diathermy is being performed and the one who is performing it, both can get severely injured. Thus, electrode gel and pads are both used for diathermy, surgical and therapeutic.

7. In heat wave diathermy, the maximum power given out is 500 W and the maximum voltage possible is 4000V. Thus, what is the highest resistance that heat wave diathermy machine can deal with?
a) 3.2 K ohm
b) 32 K ohm
c) 320 K ohm
d) 3200 K ohm

Answer: b
Explanation: The simple formula for power, voltage and resistance is used. $P = V2/R$
$R = V2/P$
$R = 40002/500$
$R = 32$ K ohm.

8. Which of the following is used to measure the biological damage caused by radiation?
a) Curie
b) Rem
c) Rad
d) Roentgens

Answer: b
Explanation: Rem is also a forming unit of radiation. It is used to measure the amount of exposure to radiation the person has had and determine if it is within safe limits or beyond it. If the safety limits have been crossed, the person must stay away from the radiology area for a specific period of time of quit working there altogether.

9. Beyond what dose is the cerebral system shows signs of failure?
a) 25 – 200 rad
b) 200 – 600 rad
c) 600 – 1000 rad
d) > 1000 rad

Answer: d
Explanation: Various studies show that more mature a cell, higher is its resistance to radiations. Nerve cells and muscle cells show high resistance to radioactivity. Nerve cells once generated, they stay for a long period of

time. Thus, they are highly mature cells and so provide high resistance to the radioactivity.

10. What is the relation between 1 Rad, 1 Rem and 1 R?
a) 1 Rad ≈ 1.5 Rem ≈ 1000 R
b) 1 Rad ≈ 10 Rem ≈ 1.8 R
c) 1 Rad ≈ 1 Rem ≈ 1 R
d) 1 Rad ≈ 10 Rem ≈ 100 R

Answer: c
Explanation: All three units have almost the same values and they all are units and doses of radiations. Rad stands for radiation absorbed dose and it measures the radiation absorbed by the tissues of the body. Rem is radiation equivalent and it measures the biological damage caused by different types of radiation.R is for Roentgens and is used as a unit for X – Rays.

11. The two known units of radioactivity and the relation between the two are _____
a) Curie and Becquerel 1 Ci = 3.7 x 1010 Bq
b) Curie and Becquerel 1 Bq = 3.7 x 1010 Ci
c) Curie and Roentgens 1 Ci = 1000 R
d) Roentgen and Becquerel 1 R = 1000 Bq

Answer: a
Explanation: Curie and Becquerel signify the amount of disintegration of the radioactive substance in a unit time. Curie was an older unit and had a very high value which was not feasible for elements with lower activity. Thus, Becquerel unit was created which is one disintegration per second.

12. In a hypothetical radioactive material, the total number of active photons are 20000 and the decay constant is found out to be 4.916 X 10^{-17} per second. How much of the material will be left in a 100 years? (1 year = 365 days. Leap year is not assumed in the calculations)
a) 1589.99999
b) 19,999.9999
c) 19.999999
d) 123.99999

Answer: b
Explanation: $N = N0\ e^{-\lambda t}$ where N = particles left after decay, N0 is the original number of particles, t is the time duration and λ is the decay constant. Thus, putting the values in the formula, we get :
$N = 20000 * e^{(- (4.916* 10^{-17}) *} 365*100*24*60*60) = 19999.99999$.

13. If the half life is found to be 100 msec, what is the decay constant?
a) 693 per second
b) 24948 per hour
c) 0.1155 per minute
d) 59875.2 per day

Answer: b
Explanation: Half life is and decay constant are related by $t^{1/2} = \ln 2/\lambda$
$t^{1/2} = 0.693/\lambda$
Since the half life is given in seconds, appropriate conversions are used for hours, minutes and day. By this, we get:
$\lambda = 0.693*3600/t^{1/2} = 249480$ per hour.

14. With what energy must the radiation be given to image a bone of thickness 5 cm which has covering of skin of thickness of 2 cm on the both sides and the emerging intensity of the X – Ray is 200MeV. (impedance for bone = b for skin = s)
a) $2000e^{9}$
b) $200e^{(4s + 5b)}$
c) 20/e
d) 2e

Answer: b
Explanation: The formula goes like : $I = I0e^{(-\mu t)}$ where I is the final radiation, I0 is the initial radiation, μ is the impedance and t is the thickness. Since we know the emerging radiation, by using back processing formula, we get $200e^{(4s+5b)}$.

TOPIC 4.2 ULTRASONIC AND MICROWAVE TYPE AND THEIR APPLICATIONS

1. Basically sound waves are

_____
a) Voltage signals
b) Pressure waves
c) Current
d) Radiation

Answer: b
Explanation: Sound waves are pressure waves in character.

2. Which of the following is not a character of a sensor of a sound wave?
a) Causes no health hazard
b) They are suitable in a harsh environment
c) They are only suitable in cold environment
d) They can be used in corrosive environment

Answer: c
Explanation: Sound sensors can be used in any environment.

3. Sound waves are similar to light waves in all aspects.
a) True
b) False

Answer: b
Explanation: While considering reflection and refraction, sound waves and light waves are similar.

4. SONAR stands for _____
a) Sound navigation and ranging
b) Sound number approximation and ranging
c) Sound nullifying ranging
d) None of the mentioned

Answer: a
Explanation: Sonar is the short form of sound navigation and ranging.

5. Which of the following type sound generators are not possible?
a) Piezo electric
b) Magnetostrictive
c) Both piezo electric and magnetostrictive
d) None of the mentioned

Answer: d
Explanation: Both piezo electric and magnetostrictive devices are successful sources of sound waves.

6. Mosaic regarding sonar is _____
a) Surface of sonar
b) Frequency of sound wave
c) Pattern of vibrating elements
d) Depth of sea to which it is applicable

Answer: c
Explanation: Specific pattern of the vibrating element is known as mosaic.

7. All elements of sonar are driven electrically.
a) True
b) False

Answer: a
Explanation: All elements of sonar are driven electrically using an external power supply.

8. Piezo electric materials are well cut for

_____
a) Good dimension
b) Good coupling coefficient
c) Compact shape of device
d) Increasing frequency

Answer: b
Explanation: Piezo electric materials are so cut as to have maximum coupling coefficient between mechanical strain and electrical polarization direction.

9. Which of the following can be used in sonar?
a) ADP

b) Rescelle salt
c) ADP and Roscelle salt
d) ADP and Roscelle salt in sealed condition

Answer: d
Explanation: ADP and Roscelle salt are used as sealed with oil since they are soluble in water.

10. Magnetostriction transmitter uses _____
a) Electrostrictive phenomena
b) Horizontal vibration of nickel tube
c) Longitudinal vibration of nickel tube
d) All of the mentioned

Answer: c
Explanation: Magnetostriction transmitter uses longitudinal vibration of nickel tube used.

TOPIC 4.3 SURGICAL DIATHERMY

1. For what all purposes is diathermy principal used?
a) Surgical and Therapeutic
b) Therapeutic and Diagnostic
c) Diagnostic and surgical
d) Diagnostic and rehabilitative

Answer: a
Explanation: Diathermy is a process by which the body is treated by the electromagnetic waves or waves of high frequency. These waves beyond certain frequencies have heating effects and can help in easing the pain in the body. This type of diathermy is used for therapeutic purposes. When the heat is increased and concentrated at a point, it can cause cutting action by boiling and burning the cells. This type of diathermy is used for surgical purposes.

2. What surgical functions are performed by the diathermy machine?
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14. With what energy must the radiation be given to image a bone of thickness 5 cm which has covering of skin of thickness of 2 cm on the both sides and the emerging intensity of the X – Ray is 200MeV. (impedance for bone = b for skin = s)
a) $2000e^{9}$
b) $200e^{(4s + 5b)}$
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d) 2e

Answer: b
Explanation: The formula goes like : $I = I0e^{(-\mu t)}$ where I is the final radiation, I0 is the initial radiation, μ is the impedance and t is the thickness. Since we know the emerging radiation, by using back processing formula, we get $200e^{(4s+5b)}$.

TOPIC 4.4 BIOTELEMETRY

1. Leucocytes are in the shape of _____
a) sphere
b) cube
c) hollow
d) cuboid

Answer: a
Explanation: Leucocytes are in the shape of a sphere. Leucocytes have a nucleus. They live for seven to fourteen days and there is a rapid turn over, with constant destruction and replacement. There are normally 5000–

10,000 white cells per cubic mm of blood but their number varies during the day.

2. What should be the frequency response of the amplifiers that are used for the amplification purpose of the input signal in medical devices?
a) high frequency response
b) low frequency response
c) frequency response has no role to play in it
d) average frequency response

Answer: b
Explanation: The response should be down to less than one hertz which is a very frequent requirement. The bioelectric signals in medical science contain components of extremely low frequency. Thus the amplifiers must also have a low frequency response.

3. Leucocytes are not responsible for the formation of the defence mechanism of the body that fights against infection.
a) True
b) False

Answer: b
Explanation: It is False. Leucocytes form the defence mechanism of the body against infection. The number and proportion of these types of leucocytes may vary widely in response to various disease conditions. They are of two main types: the neutrophils and the lymphocytes. Neutrophils ingest bacteria and lymphocytes are concerned with immunological response.

4. To achieve the _____ required for medical applications, the amplifier must have large values of coupling capacitance.
a) random frequency response
b) high frequency response
c) average frequency response
d) low frequency response

Answer: d
Explanation: In all RC-coupled amplifiers, low frequency response is limited by the reluctance of the coupling capacitors. The response should be down to less than one hertz which is a very frequent requirement. To achieve the low frequency response required for medical applications, the amplifier must have large values of coupling capacitance.

5. Neutrophils are bigger than the red cells.
a) True
b) False

Answer: a
Explanation: It is True. Neutrophils are nearly twice as big as the red cells.Lymphocytes are of the same size as the red cells but contain a large density staining nucleus and no granules. Neutrophils contain both a nucleus divided into several lobes and granules in their protoplasm.

6. High pass filter amplifies frequency _____
a) above certain value
b) below certain value
c) above and below certain value
d) at certain value

Answer: a
Explanation: High pass filter amplifies signal above a certain frequency. Band pass filter amplifies frequencies with in a certain band. Band stop filter amplifies all the frequencies except those in a certain band. Low pass filter amplifies signals below a certain frequency.

7. Mean Platelet Volume is the ratio of the _____ and is expressed in femolitres.
a) integrated platelet volume to the platelet count
b) integrated platelet volume to the WBC count
c) integrated RBC volume to the platelet count
d) integrated platelet volume to the RBC count

Answer: a
Explanation: Mean Platelet Volume (MPV) is the ratio of the integrated platelet volume to the platelet count and is expressed in femolitres. Platelet Distribution Width is related to the size range covered by those platelets lying between the sixteenth and eighty fourth percentile. Red Cell Distribution Width is a numerical expression of the width of the size distribution of red cells.

8. Unit of Mean Platelet Volume is expressed in?
a) millilitres
b) femolitres
c) picolitres
d) decilitres

Answer: c
Explanation: Unit of Mean Platelet Volume is expressed in femolitres. 1f/l = 10–15 . 1 litre of blood contains 0.45 litres of red cells. Mean Platelet Volume (MPV) is the ratio of the integrated platelet volume to the platelet count and is expressed in femolitres.

9. Low pass filter amplifies signals below a certain frequency.
a) True
b) False

Answer: a
Explanation: It is true. Low pass filter amplifies signals below a certain frequency. Band stop filter amplifies all the frequencies except those in a certain band. High pass filter amplifies signal above a certain frequency. Band pass filter amplifies frequencies within a certain band.

10. _____ is the percentage of the total specimen volume occupied by the platelets.
a) Mean Platelet Volume
b) Plateletcrit
c) Red Cell Distribution Width
d) Platelet Distribution Width

Answer: b
Explanation: Plateletcrit is the percentage of the total specimen volume occupied by the platelets. Red Cell Distribution Width is a numerical expression of the width of the size distribution of red cells. Mean Platelet Volume is the ratio of the integrated platelet volume to the platelet count and is expressed in femolitres.

11. Modern instrument use _____ for intravascular oximetry?
a) photodiode
b) red and infrared LED's
c) optical fibre
d) phototransistor

Answer: c
Explanation: For intravascular oximetry, modern instruments make use of optical fibres to guide the light signal inside the vessel and the reflected light from the red blood cells back to the light detector.

12. Optical fiber sensors are immune to electromagnetic disturbances.
a) True
b) False

Answer: a
Explanation: It is True. Optical fiber sensors are electrically passive and consequently immune to electromagnetic disturbances. They can be miniaturized and are most suitable for telemetry applications. They are geometrically flexible and corrosion resistant.

13. Currently available oximeters utilize _____ wavelengths.
a) Equal to 2
b) Cannot be determined
c) Less than 2
d) More than 2

Answer: d
Explanation: Currently available fiber-optic oximeters utilize more than two wavelengths to adjust for haematocrit variation. For

estimating SO_2, usually the reflectance at two wavelengths, one in the red and the other in the near infrared regions, are used.

14. Mix venous saturation is measured by _____

a) Ear Oximeter
b) Intravascular Oximeter
c) Skin Reflectance Oximeter
d) Pulse Oximeter

Answer: b
Explanation: Mixed venous saturation varies in reflecting the changes of oxygen saturation, cardiac output, haematocrit or haemoglobin content and oxygen consumption. Intravasacular oximeters are normally used to measure mixed venous saturation, from which the status of the circulatory system can be deduced.

15. Which of the following is correct expression for RDW index?
a) [(20^{th} – 80^{th}) Percentile Volume / (20^{th} – 80^{th}) Percentile Volume] X 100 X K
b) [(20^{th} – 80^{th}) Percentile Volume / (20^{th} + 80^{th}) Percentile Volume] X 100 X K
c) [(20^{th} + 80^{th}) Percentile Volume / (20^{th} – 80^{th}) Percentile Volume] X 100 X K
d) [(20^{th} + 80^{th}) Percentile Volume / (20^{th} + 80^{th}) Percentile Volume] X 100 X K

Answer: b
Explanation: The total erythrocyte count is scanned by a continuously variable thresholding circuit. The RDW index is expressed by the following equation [(20^{th} – 80^{th}) Percentile Volume / (20^{th} + 80^{th}) Percentile Volume] X 100 X K. It is a numerical expression of the width of the size distribution of red cells. It is derived by analog computation. The upper threshold is moved progressively lower from a level equivalent to 360 femolitres until 20 per cent of all erythrocytes present have a size above a certain value.

UNIT V RECENT TRENDS IN MEDICAL INSTRUMENTATION 9

TOPIC 5.1 TELEMEDICINE

1. _____ will reject any common mode signal that appears simultaneously at both amplifier input terminal.
a) ac coupled amplifiers
b) dc amplifiers
c) carrier amplifiers
d) differential amplifiers

Answer: d
Explanation: Most of the amplifiers used for measuring bioelectric signals are of the differential type. A differential amplifier is one which will reject any common mode signal that appears simultaneously at both amplifier input terminals and amplifies only the voltage difference that appears across its input terminals. AC amplifiers have a limited frequency response and are, therefore, used only for special medical applications such as electrocardiograph machine.

2. The amplifier from the following that has a limited frequency response is _____
a) dc amplifiers
b) differential amplifier
c) ac coupled amplifiers
d) carrier amplifiers

Answer: a
Explanation: AC amplifiers have a limited frequency response and are, therefore, used only for special medical applications such as electrocardiograph machine. For electrocardiograms, an ac amplifier with sensitivity, giving 0.5 mV/cm, and frequency response up to 1 kHz and an input impedance of 2 to 5 MW is used. For such applications

as retinography, EEG and EMG, more sensitive ac amplifiers are required, giving a chart sensitivity of say 50 mV/cm with a high input impedance of over 10 MW.

3. Which of the following amplifiers are used with transducers which require an external source of excitation?
a) ac coupled amplifiers
b) dc amplifiers
c) carrier amplifiers
d) differential amplifier

Answer: c
Explanation: Carrier amplifiers are used with transducers which require an external source of excitation. They essentially contain a carrier oscillator, a bridge balance and calibration circuit, a high gain ac amplifier, a phase-sensitive detector and a dc output amplifier. They are characterized by high gain, negligible drift, extremely low noise and the ability to operate with resistive, inductive or capacitive type transducers.

4. Which feedback system is employed in DC amplifiers?
a) Can be any positive or negative doesn't matter
b) Negative
c) Depends on the application
d) Positive

Answer: b
Explanation: DC amplifiers are generally of the negative feedback type. They are not practical for very low level applications because of dc drift and poor common-mode rejection capabilities. They are used for medium gain applications down to about 1 mV signal levels for full scale.

5. Digital filters are not sensitive to temperature as compared with analog filters.
a) True
b) False

Answer: a
Explanation: It is True. Digital filters are insensitive to temperature as compared with analog filters. They are also insensitive to ageing, voltage drift and external interference as compared to analog filters. Their response is completely reproducible and predictable, and software simulations can exactly reflect product performance.

6. The number of amplifiers incorporated in the module of a Chopper stabilized dc amplifiers are _____
a) 1
b) 2
c) 3
d) 4

Answer: c
Explanation: Chopper stabilized dc amplifiers are used for low level but preferably wideband applications such as oscilloscopes, tape recorders and light beam oscilloscope recorders. This includes an ac amplifier for signals above about 20 Hz, a dc chopper input amplifier for signals from about 20 Hz down to dc plus wideband feedback stabilized dc amplifier. These are complex amplifiers having three amplifiers incorporated in the module.

7. _____ is employed with resistive transducers which require an external source of excitation.
a) differential amplifier
b) dc bridge amplifier
c) carrier amplifier
d) ac coupled amplifier

Answer: b
Explanation: Essentially, the amplifier comprises a stable dc excitation source, a bridge balance and calibration unit, a high gain differential dc amplifier and a dc output amplifier. DC bridge amplifiers are employed with resistive transducers which require an external source of excitation. They can be used as conventional dc high gain amplifiers

and offer operating simplicity and high-frequency response.

8. Which of the following IC is a variable negative voltage regulator?
a) 7912
b) 7905
c) LM337
d) LM317

Answer: c
Explanation: LM337 is a variable negative voltage regulator IC. It is capable of drawing current up to 1.5A and voltage range from (-1.25V) – (-30V) ideally. LM317 is a variable positive voltage regulator IC. 7905 and 7912 are fixed voltage regulator IC that give output voltage as -5V and -12V respectively.

9. Chopper input dc amplifiers are preferred for high level inputs to instrumentation systems because of their high sensitivity, negligible drift and excellent common mode rejection capability.
a) True
b) False

Answer: b
Explanation: It is False. Chopper input dc amplifiers are preferred for low level inputs to instrumentation systems because of their high sensitivity, negligible drift and excellent common mode rejection capability. Their high frequency response is limited to about one half of the input chopper frequency.

10. The amplifier configuration must contain _____ to achieve the low frequency response for medical applications?
a) higher resistance
b) lower resistance
c) lower capacitance
d) higher capacitance

Answer: d
Explanation: To achieve the low frequency response required for medical applications, the amplifier must have large values of coupling capacitance. The response should be down to less than one hertz which is a very frequent requirement. In all RC-coupled amplifiers, low frequency response is limited by the reluctance of the coupling capacitors.

TOPIC 5.2 INSULIN PUMPS

1. Diabetes insipidus is due to insufficient release of _____
a) Insulin
b) ADH
c) Thyroxine
d) Glucagon

Answer: b
Explanation: Diabetes insipidus is a disorder of salt and water metabolism marked by intense thirst and heavy urination. Diabetes insipidus is due to insufficient release of ADH.

2. Which of the following gastrointestinal hormone stimulates insulin secretion?
a) GIP
b) CCK
c) Gastrin
d) Secretin

Answer: a
Explanation: GIP is gastroinhibitory peptide. It is also known as glucose dependent insulinotroic peptide. It is a weak inhibitor of gastric acid secretion; its main role is to stimulate insulin secretion.

3. Which of the following element is needed for insulin to exert its maximal effect in glucose uptake?
a) Vanadium
b) Molybdenum
c) Selenium
d) Chromium

Answer: d
Explanation: Chromium is an essential

mineral that appears to have a beneficial role in the regulation of insulin action and its effects on carbohydrate, protein and lipid metabolism. Chromium is an important factor for enhancing insulin activity.

4. Insulin promotes _____
a) Glucosuria
b) Glycogenesis
c) Glycogenolysis
d) Gluconeogenesis

Answer: b
Explanation: Glycogenesis is a process of glycogen synthesis from sugar. Insulin promotes Glycogenesis.

5. Humulin is being commercially produced from a transgenic species of _____
a) Rhizobium
b) Saccharomyces
c) Escherichia
d) Mycobacterim

Answer: c
Explanation: Humulin is being commercially produced from a transgenic species of Escherichia. Humulin is a man-made form of hormone that is produced from the body. It was first done by Eli Lily company.

6. Insulin receptors are _____
a) Extrinsic protein
b) Intrinsic protein
c) G protein
d) Trimeric protein

Answer: a
Explanation: Insulin receptors are extrinsic protein. Insulin binds to r4ecetors on the cell surface. This activates the cell's glucose transporter molecules to form a doorway in the cell membrane so that glucose can enter the cell.

7. What do endocrine cells of the pancreas secrete?
a) Omega growth hormone
b) Beta somatostatin
c) Delta insulin
d) Alpha glucagon

Answer: d
Explanation: Alpha glucagon is secreted by endocrine cells of the pancreas. They make up to 20% of human islet cells synthesizing and secreting glucagon.

8. Where does synthesis of insulin begin?
a) rRER
b) sRER
c) Nucleolus
d) Mitochondria

Answer: c
Explanation: Nucleolus is a part of eukaryote cell where ribosomes are made. It is the largest structure in the nucleus. Synthesis of insulin begins in Nucleolus.

9. How many intermolecular and interamolecular disulfide bond is present in insulin?
a) 1 Intermolecular, 2 intramolecular
b) 2 Intermolecular, 2 intramolecular
c) 2 Intermolecular, 1 intramolecular
d) 1 Intermolecular, 3 intramolecular

Answer: c
Explanation: There are 2 Intermolecular and 1 intramolecular disulfide bond is present in insulin.

10. Which of the following order is correct?
a) Insulin > Proinsulin > Preproinsulin
b) Preproinsulin > Insulin > Proinsulin
c) Proinsulin > Preproinsulin > Insulin
d) Preproinsulin > Proinsulin > Insulin

Answer: d
Explanation: Insulin is made up of two peptide chains referred to as A chain and B chain. A and B chains are linked together by disulfide bonds and an additional disulfide bond is formed within A chain.

11. What is the beta subunit of the insulin receptor?
a) Protein kinase
b) Tyrosine kinase
c) Tryptophan kinase
d) Taurine kinase

Answer: b
Explanation: Tyrosine kinase is an enzyme that can transfer a phosphate group from ATP to a protein in the cell. It functions as an on or off switch in many cellular functions.

12. What do delta cells secrete?
a) Cortisol
b) Glucose
c) Pancreatic enzyme
d) Somatostatin

Answer: d
Explanation: Somatostatin is also known as growth hormone. It is a peptide hormone. Somatostatin is secreted by delta cells.

13. What is the function of GLUT 4?
a) Glucose transport
b) Glycogen transport
c) Insulin transport
d) Glucagon transport

Answer: a
Explanation: GLUT 4 is the insulin regulated glucose transporter found primarily in adipose tissues and striated muscle.

14. Hyperglycemia is a condition of high blood glucose.
a) True
b) False

Answer: a
Explanation: Hyperglycemia is an abnormally high blood glucose level. It is a sign of diabetes. The main symptoms are increased thirst and frequent need to urinate.

TOPIC 5.3 RADIO PILL

1. Radio telemetry is useful when source and receiver is at _____
a) Long distance separation
b) Short distance separation
c) Varying separation distance
d) All of the mentioned

Answer: d
Explanation: Radio telemetry can be used where the distance between source and receiver may vary.

2. PLCC stands for _____
a) Power Load Carrier Current
b) Power Line Carrier Current
c) Peak Line Carrier Current
d) None of the mentioned

Answer: b
Explanation: PLCC is the short of power line carrier current.

3. Multiplexing is not possible in radio telemetry.
a) True
b) False

Answer: b
Explanation: Multiplexing of data in radio telemetry is possible.

4. Carrier frequency in radio telemetry will be _____
a) Very low value
b) Very high value
c) Any value greater than 100 Hz
d) Frequency appropriate to conductor size

Answer: d
Explanation: For multiplexing in radio telemetry, carrier frequency should be appropriate to conductor size.

5. For space telemetry, carrier frequency should be _____
a) Very high value
b) Very low value

c) Frequency appropriate to distance
d) Any value greater than 100 Hz

Answer: a
Explanation: Very high value of carrier frequency helps in reducing antenna size.

6. Frequency range of space telemetry should be _____
a) Less than 216 MHz
b) Between 216 – 235 MHz
c) Between 235 – 412 MHz
d) Above 412 MHz

Answer: b
Explanation: Carrier frequency range of space telemetry system should be between 216 MHz and 235 MHz.

7. Which of the following represent stability relaxation for RF carrier?
a) 0 %
b) +/- 1 %
c) +/- 0.1 %
d) None of the mentioned

Answer: c
Explanation: RF carrier must remain stable within +/- 0.1 %.

8. For FM/FM modulation, what is the bandwidth allowed?
a) 0.2 MHz
b) 0.5 MHz
c) 0.9 MHz
d) 1 MHz

Answer: b
Explanation: For FM/FM modulation, bandwidth allowed is 0.5 MHz.

9. Output power of transmitter will be _____
a) Very low
b) Very high
c) Varying
d) None of the mentioned

Answer: a
Explanation: Output power of the transmitter is kept very low.

10. Output power of transmitter will be _____
a) 2 to 10 w
b) 2 to 50 w
c) 2 to 100 w
d) Above 100 w

Answer: c
Explanation: Output power of the transmitter is always kept very low and it lies in the range of 2 to 100 w.

TOPIC 5.4 ENDOMICROSCOPY

1. The endoscope that examines the respiratory tract is called as _____
a) Bronchoscopy
b) Laparoscopy
c) Colonoscopy
d) Arthroscopy

Answer: a
Explanation: Broncoscope is inserted in the body via the nasal passage and it used to image the respiratory tract. It has a very thin tube so that the patient feels minimal discomfort as the scope goes down the track. A laryngoscope can be used to examine the larynx. It is inserted through the mouth and the direction of the scope is changed at the epiglottis. This allows the scope to look at the larynx and not enter the GI tract.

2. Endoscope used to examine the upper GI tract is _____
a) Laparoscopy
b) Bronchoscopy
c) Esophagogastroduodenoscopy
d) Laryngoscopy

Answer: c
Explanation: As the name suggests, this particular endoscope has a really long range

and can be used to view esophagus, stomach and the duodenum. The region till here is mostly considered as the upper GI tract.

3. Capsule endoscope has a _____ for taking images.
a) CCD camera
b) LED camera
c) X-Ray camera
d) US camera

Answer: a
Explanation: The CCD (Charge coupled device) camera is small and is easily fitted in the capsule. It does not require too much energy and the range of the camera is wide enough. It may also be called as CMOS (Complementary Metal Oxide Semiconductor) imager.

4. Extraction of a small piece of the diseased organ is called _____
a) biopsy
b) surgery
c) chemotherapy
d) replacement

Answer: a
Explanation: The smallest unit of any system is its cell. Every organ is made of tissues and tissues are a collection of similar cells. Thus, what a tissue system does is a result of the network of the similar cells. So, when a tissue is diseased or injured, a part of the tissue is extracted to study the nature of the trauma or disease. This extracted part is called a biopsy.

5. The cleaning of the endoscope is done with _____
i) 2% Glutarldehyde (CIDEX)
ii) Sodium Hypochlorite
iii) Hydrochloric acid
iv) Iodophor (Betadine-providone)
v) 1% Saline Solution
vi) 70% ethyl or isopropyl alcohol
vii) Ethylene oxide (ETO)
viii) Formaldehyde vapour
ix) Phenol Solution
x) Vinegar
a) i,iv, vi, vii, viii
b) i, vii, viii, ix, x
c) ii, iii, ix, x
d) iii, iv, v, ix

Answer: a
Explanation: The body of an endoscope is flexible because it is made of polymers. The cleaning agents used need to be harsh enough for the microbes that may get attached to the endoscope as it is examining the patient but they should not corrode or harm the body of the endoscope.

6. None of the endoscopic procedures require any cuts.
a) True
b) False

Answer: b
Explanation: Some procedures like laparoscopy and arthroscopy require a small cut to allows the devices to go in. Laparoscopy is done for the diaphragm and the organs in that region. It can help look at kidneys and the reproductive organs in women.

7. Which of the following operations can be done with an endoscope?
i. Bypass surgery
ii. Cardiac Catherization
iii. Kidney Stone Removal
iv. Knee Replacement
v. Biopsy
vi. Tracheotomy
vii. Appendix Removal
a) i, ii, iii, iv, vii
b) ii, iii, v, vii
c) iii, vii
d) v, vi, vii

Answer: b
Explanation: All of the above mentioned processes are minimally invasive procedures and can be quickly resolved with the help of endoscopes. Come to require a small cut to

allow insertion of the scope along with the micro instruments while others may be performed without any incisions. These use the nasal opening, oral opening, the anal opening and the vaginal opening for visualization and surgery.

8. Which if the following diagnostic procedures require an endoscope?
a) Transesophagal Echocardiography
b) X Ray of the Chest
c) Counting the Number of Platelets
d) Detecting Leukemia

Answer: a
Explanation: This is a type of Ultrasound of the heart where the endoscope is sending through the oral cavity and placed close to the heart via the oesophagus. This helps in taking an unhindered ultrasound of the heart.

9. Which endoscope can be used to look at the knees before and after a surgery?
a) Colonoscopy
b) Arthroscopy
c) Bronchoscopy
d) Laryngoscopy

Answer: b
Explanation: Arthroscopy is a process where the bones are visualized and worked upon with the help of an endoscope. The soft parts of the knee like the cartilage or the synovial capsule cannot be properly visualized with an X-Ray so an arthroscope is used to look at them. The healing of the bones after a surgery can be monitored by the arthrocope. Small operations regarding the bones can be performed with the help of the arthroscope.

TOPIC 5.5 BRAIN MACHINE INTERFACE

1. What is the primary interactive method of communication used by humans?
a) reading
b) writing
c) speaking
d) all of the mentioned

Answer: c
Explanation: None.

2. Elementary linguistic units that are smaller than words are?
a) allophones
b) phonemes
c) syllables
d) all of the mentioned

Answer: d
Explanation: None.

3. In LISP, the atom that stands for “true” is _____
a) t
b) ml
c) y
d) time

Answer: a
Explanation: None.

4. A mouse device may be _____
a) electro-chemical
b) mechanical
c) optical
d) both mechanical and optical

Answer: d
Explanation: None.

5. An expert system differs from a database program in that only an expert system _____
a) contains declarative knowledge
b) contains procedural knowledge
c) features the retrieval of stored information
d) expects users to draw their own conclusions

Answer: b
Explanation: None.

6. Arthur Samuel is linked inextricably with a program that played _____

a) checkers
b) chess
c) cricket
d) football

Answer: a
Explanation: None.

7. Natural language understanding is used in _____
a) natural language interfaces
b) natural language front ends
c) text understanding systems
d) all of the mentioned

Answer: d
Explanation: None.

8. Which of the following are examples of software development tools?
a) debuggers
b) editors
c) assemblers, compilers and interpreters
d) all of the mentioned

Answer: d
Explanation: None.

9. Which is the first AI programming language?
a) BASIC
b) FORTRAN
c) IPL(Inductive logic programming)
d) LISP

Answer: d
Explanation: None.

10. The Personal Consultant is based on?
a) EMYCIN
b) OPS5+
c) XCON
d) All of the mentioned

Answer: d
Explanation: None.

TOPIC 5.6 LAB ON A CHIP.

1. How many gates per chip are used in first generation Integrated Circuits?
a) 3-30
b) 30-300
c) 300-3000
d) More than 3000

Answer: a
Explanation: The first generation ICs belongs to small scale integration, which consists of 3-30 gates per chip (approximately).

2. Find the chip area for a Medium Scale Integration IC?
a) 8 mm^3
b) 4 mm^2
c) 64 mm^3
d) 16 mm^2

Answer: d
Explanation: The approximate length and breadth of Medium Scale Integration would be 4 mm. Therefore, its area is given as = length × breadth = 4mm × 4mm = $16mm^2$.

3. The number of transistors used in Very Large Scale Integration is
a) 10^7 transistors/chip
b) $10^6 – 10^7$ transistors/chip
c) $20^3 – 10^5$ transistors/chip
d) $10^2 – 20^3$ transistors/chip

Answer: c
Explanation: Very Large Scale Integration (VLSI) ICs are fabricated using more than 3000 gates/chip, which is equivalent to 20,000 – 1,00,00,00 transistors/chip.

4. What type of integration is chosen to fabricate Integrated Circuits like Counters, multiplexers and Adders?
a) Small Scale Integration (SSI)
b) Medium Scale Integration (MSI)
c) Large Scale Integration (LSI)
d) Very Large Scale Integration (VLSI)

Answer: b
Explanation: Fabrication of ICs like counter, multiplexers and Adders requires 30-300 gates per chip. Therefore, Medium Scale Integration is best suitable.

5. Determine the chip area for Large Scale Integration ICs.
a) 1,00,000 mil^2
b) 10,000 mil^2
c) 1,60,000 mil^2
d) 16,000 mil^2

Answer: c
Explanation: The chip area for a Large Scale Integration IC is 1 cm^2.
=> Area of LSI = 10mm × 10mm = 1cm × 1 cm = 1cm^2.
=> 1,60,000mil^2 (1cm=400mil).

6. Ultra Large Scale Integration are used in fabrication of
a) 8-bit microprocessors, RAM, ROM
b) 16 and 32- bit microprocessors
c) Special processors and Smart sensors
d) All of the mentioned

Answer: c
Explanation: Ultra Large Scale Integration have nearly $10^6 – 10^7$ transistors/chip. Hence, it is possible to fabricate smart sensors and special processor.

7. The concept of Integrated circuits was introduced at the beginning of 1960 by
a) Texas instrument and Fairchild Semiconductor
b) Bell telephone laboratories and Fair child Semiconductor
c) Fairchild Semiconductor
d) Texas instrument and Bell telephone Laboratories

Answer: a
Explanation: The concept of Integrated circuits was introduced by Texas instrument and Fairchild Semiconductor, whereas Bell telephone laboratories developed the concept of transistors.

8. Which process is used to produce small circuits of micron range on silicon wafer?
a) Photo etching
b) Coordinatograph
c) Photolithography
d) Ion implantation

Answer: c
Explanation: It is possible to fabricate as many as 10,000 transistors on a 1cmX1cm chip, using photolithography process.

9. Mention the technique used in photolithography process
a) X-ray lithographic technique
b) Ultraviolet lithographic technique
c) Electron beam lithographic technique
d) All of the mentioned

Answer: d
Explanation: All these techniques are used to produce device dimension as small as 2μm or even down to sub micron range (<1μm).