OMD551-BASIC OF BIOMEDICAL INSTRUMENTATION

SEMESTER V

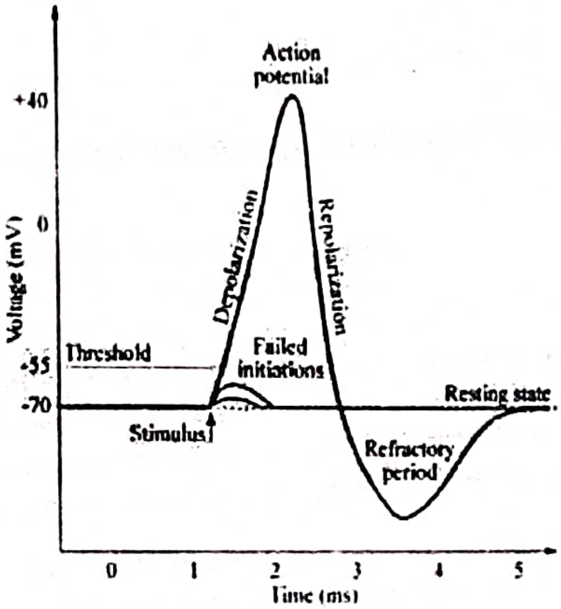
REGULATION 2017

Unit - I

1. **Define Resting Potential and Action potential**

Resting potential is defined as the electrical potential of an excitable cell relative to its surroundings when not stimulated or involved in passage of an impulse. It ranges from 60mVto -100mV

Action potential is defined as the change in electrical potential associated with the passage of an impulse along the membrane of a cell.



2. **Define depolarization and repolarisation.**

Depolarization is when a cell membrane's charge becomes positive to generate an action potential. This is usually caused by positive sodium and calcium ions going into the cell.Repolarization is when a cell membrane's charge returns to negative after depolarization. This is caused by positive potassium ions moving out of the cell.

3. **What is electrode? List out the types and explain**

It is a component used to pickup the biopotential signals. Bascially there are 2 types of electrode polarizable and non polarizable electrode.

→ Surface Electrode

→ Needle Electrode

→ Micro Electrode.

- Pressure : 1013 millibars (or 760 torr)
- Absolute humidity : 17 gm/m^3
- Reference atmospheric conditions according to the British Standard Specifications:
  - Temperature : 20^{0}C

...requiring no energy to make the transition.

4. **What are the classfication of non polarizable electrode?**

There are 2 types of non polarizable electrode 1) internal electrode 2) external electrode
Internal electrode- the electrode are inserted depth to body
External electrode – the electrodes are placed to the surface of the skin.

5. **List out some example of internal and external electrode and their uses.**

- **External electrode**
- Silver silver cholride electrode- EEG
- Calomel electrode - electrochemical applications
- Metal plate electrode (Surface) -ECG &EMG
- Suction electrode - ECG limb electrode
- Floating electrode - EMG
- Flexible electrode - ECG &Respiration by impedence technique
- **Internal electrode**
- Micro electrode or Needle electrode

6. **Define half cell potential.**

The half-cell potential is the potential developed at the electrode of a half cell due to the process of oxidation or reduction. This potential is used to indicate corrosion activity, and measures the tendency of one reaction, like oxidation, to proceed at its one half-cell electrode and similarly measures the corresponding tendency for reduction to proceed at the other half-cell electrode.

Each half-cell potential is associated with an electrode-solution potential difference. The potential magnitude depends on the nature of the specific electrode reaction and on the concentrations of the dissolved solution. The sign of this potential difference depends on the direction (oxidation or reduction) in which the electrode reaction proceeds.

A half-cell potential measurement is a non-destructive method to assess the corrosion risk of steels in concrete. This method is cheaper and can be easily used. In reinforcing concrete, an electrode forms one half of the cell and the reinforcing steels in the concrete form the other half cell. The behavior of steel in concrete can be characterized by measuring its half-cell potential. The chances of corrosion occurring on the steel in concrete and half-cell potential are directly proportional; the higher the potential, the higher the risk of corrosion occurrence.

7. How will you reduce the polarization effects of electrodes?

A depolarizer or depolariser, in electrochemistry, according to an IUPAC definition, is a synonym of electroactive substance, i.e., a substance which changes its oxidation state, or

partakes in a formation or breaking of chemical bonds, in a charge-transfer step of an electrochemical reaction.
In the battery industry, the term "depolarizer" has been used to denote a substance used in a primary cell to prevent buildup of hydrogen gas bubbles. A battery depolarizer takes up electrons during discharge of the cell; therefore, it is always an oxidizing agent. The term "depolarizer" can be considered as outdated

or misleading, since it is based on the concept of "polarization" which is hardly realistic in many cases .

8. State the uses of electrode paste.

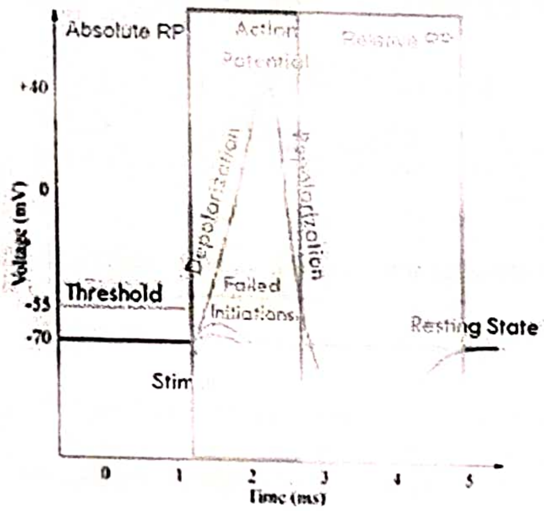
The Electrode Gel is best used when storing pads between sessions. The amount of moisture in the pad is related to the pad's adhesion. As the pads start to lose their moisture content, the adhesion is reduced. A small dab of gel spread over the pad's sticky side before it is placed on the film for storage will increase the moisture content and adhesion of the pad.

9. Distinguish between metallic and non-metallic microelectrode.

Electrode terminal through which electric current passes between metallic and nonmetallicparts of an electric circuit. In most familiar circuits current is carried by metallic conductors, but insome circuits the current passes for some distance through a nonmetallic conductor. For example,in electrolysis current passes through a liquid electrolyte; in a fluorescent lamp current passesthrough a gas. An electrode is usually in the form of a wire, rod, or plate. It may be made of a metal,e.g., copper, lead, platinum, silver, or zinc, or of a nonmetal, commonly carbon.
The electrode through which current passes from the metallic to the nonmetallic conductor is called the anode,and that through which current passes from the nonmetallic to the metallic conductor, the cathode.(Electron flow is in a direction opposite that of conventionally defined current.) In most familiarelectric devices, current flows from the terminal at higher electric potential (the positive electrode) tothe terminal at lower electric potential (the negative electrode); therefore, the anode is usually thepositive electrode and the cathode the negative electrode.

10. Define absolute and relative refractory period.

Absolute: Is the period of time during which a second action potential ABSOLUTELY cannot be initiated, no matter how large the applied stimulus is. Relative: Is the interval immediately following the Absolute Refractory Period during which initiation of a second action potential is INHIBITED, but not impossible. As voltage-gated potassium channels open to terminate the action potential by repolarizing the membrane, the potassium conductance of the membrane increases and the K+ ions move out of the cell and bring the membrane potential closer to the equilibrium potential for potassium and this can lead to membrane hyperpolarization.



11. What are the salient features of needle electrodes?

Small needle electrodes are sometimes used for carrying out special EEG studies when they are inserted subcutaneously. Electrodes for electromyographic work are usually of the needle type.Needle electrodes are used in clinical electromyography, neurography and other electrophysiological investigations of the muscle tissues underneath the skin and in the deeper tissues. The material of the needle electrode is generally stainless steel. In spite of the fact that stainless steel is unfavourable electrode material from the point of view of noise, it is preferred in EMG work due to its mechanical solidity and low price. Needle electrodes are designed to be fully autoclavable and in any case they should be thoroughly sterilized before use.

12. What is bio electric potential?

Certain systems of the body generate their own monitoring signals conveying useful information about the functions they represent. Such signals are bio electric potentials and are related to nerve
conduction, brain activity, heart beat etc.

13. State all or nothing law.

Regardless 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 the all or nothing law.

14. What is meant by sodium pump?

It is an active process, by which the sodium ions are quickly transported to the outside of the cell and the cell again becomes polarized& assumes its resting potential. The operation of this pump is linked with the influx of potassium into the cell, as if a cyclic process involving an exchange of sodium for potassium existed.

15. List the different types of Surface electrodes.

Metal Plate electrodes

Suction cup electrodes
Adhesive tape electrodes
Multi point electrodesFloating electrodes

16. **List the different types of Micro electrodes.**

Metal microelectrodes
Supported metal micro electrodes and Micropipette electrodes

17. **List the different types of internal electrodes.**

Wire loop electrode
Silver sphere cortical electrode and Multi element depth electrode

18. Give any 4 factors to be consider when design a medical equipment?

Accuracy,frequency,linearity ,s/n ratio, stability

19. Define sensitivity

The electrical output per unit change in the physical parameter high sensitivity is generally desirable for transducer

20. What is electrode potential?

The voltage developed by an electro-electrolyte interface is called electrode potential.

UNIT 2

1. **Define ECG**

Electrocardiography deals with the study of the electrical activity of heart muscles. The potentials originated in the individual fibres of heart muscle are added to produce ECG waveform.

2. **What are the different artefacts encountered while recording ECG?**

- Interference from the power line
- Shifting of the base line
- Muscle tremor.

3. **Define EEG**

Electroencephalography deals with the recording and study the electrical activity of brain .By means of electrode attached to the skull of a patient the brain waves can be picked up and recorded.

4. **What are the important bands of frequencies in EEG and state their importance.**

Waves	**Frequency (Hz)**	**Observation**
Delta(δ)	0.5 – 4	These wave occur in deep sleep in premature babies and in very serious organic brain disease

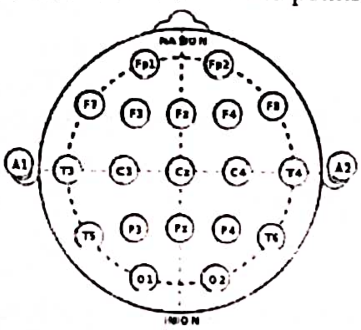
Theta (θ)	4 – 8	These wave occurs during emotional stress in some adults particularly during disappointment and frustration
Alpha(α)	8 – 13	They found in the normal persons when they are awake in a quiet, resting state. During sleep they disappear.
Beta(β)	13- 22	It is observed when the person is alert active, busy, or anxious thinking, active concentration

5. **What are the different artefacts encountered while recording EEG?**

- **Artifacts due to electrode problems may result from**
- Poor contact
- Improper positioning
- **Artifacts due to physiological positioning**
- The heart ECG
- Tongue and facial movement
- Eye movement
- **Artifacts due to electrical interference**
- 60V AC common mode interface

6. **What is montage system?**

The most commonly used electrode system for recording EEG signal is termed as 10-20 electrode system or montage electrode system.The electrodes are placed symmetrically on the both sides of the skull, at a distance of 10% and 20% appropriately form the distance between the extreme and points of the skull namely nasion, inion,right and left ear lobes.



7. **What is evoked potential?**

The external stimuli are detected by the sense organs which cause changes in the electrical activity of the brain. Due to this, potential is developed in the brain as the response to external stimului like light, sound etc. It is called as evoked potential.

8. **Define EMG**

Electromyography is the study of electrical activity of muscle fibres with the help of this the nerve conduction velocity is obtained.

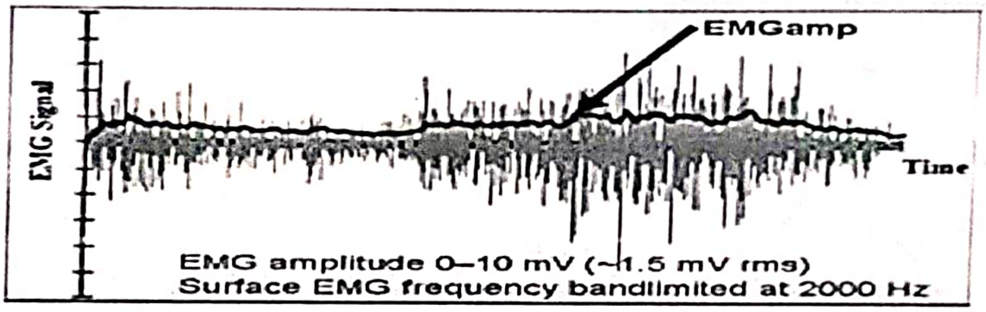
9. **Define latency as related to EMG.**

Latency is defined as the elapsed time between the stimulating impulse and the muscle action potential. In other words it is the time delay between stimulus and response

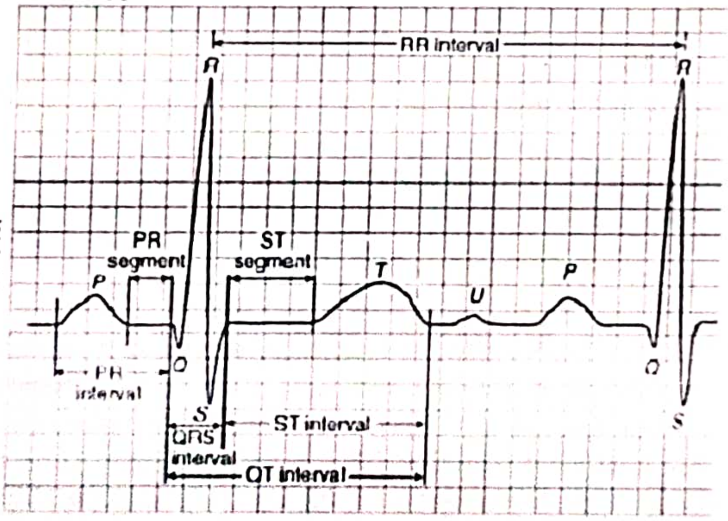
10. **Define – Conduction Velocity**

Conduction velocity is defined as the rate at which an action potential moves down a fiber or is propagated from cell to cell. It is also called as Nerve conduction rate.

11. **Draw the typical EMG waveform.**



12. **Draw the typical ECG waveform.**



Wave **Amplitude (mV)** **Duration (sec)**

P	0.25	0.12 – 0.22 (P – R interval)
R	1.06	0.07 – 0.1
T	0.1 – 0.5	0.05 – 0.15 (S – T segment)
QRS Complex	-	0.09

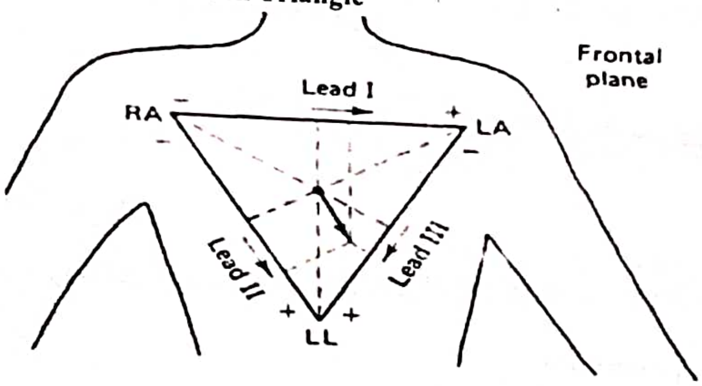
13. What are the different types of ECG lead configuration?

- Bipolar limb leads
- Augmented unipolar limb leads
- Chest leads
- Frank lead system

14. Write the physiological nature of ECG waveform

- P wave - Atrial polarization or contraction
- R wave - repolarization of the artia and the depolarization of ventricles
- T wave - ventricular repolarization
- S-T interval - ventricular contraction
- U wave - slow repolarization of the ventricles

15. Draw the Einthoven Triangle



16. Define latency in EMG

The interval between the stimulation of a compound muscle and the observed response.Normal nerve conductionvelocity is above 40 m/sec in the lower extremities and above 50 m/sec in the upperextremities, but age, muscle disease, temperature, and other factors can influence the velo city.

17. What are unipolar and bipolar modes of EMG?

In a unipolar measurement the output signals are formed by several input electrodes that are amplified against one so called reference. This can be an electrode, or a calculated internal reference potential. This is not a two channel recording, but a multichannel measurement. This type of recording is often used when measuring EEG or multichannel ECG. A new field of unipolar measurements is the high density surface EMG, where for instance 128 channels are measured using so called grid electrodes.

Two types of unipolar measurement principles are known:

- Common reference
- Average reference

The common reference amplifier just has one electrode, which is used as one part of every bipolar input and several other electrodes that form the other parts of the bipolar inputs.In the average reference amplifier there is no electrode that acts as the reference for the measurement system. Instead, the multichannel bipolar derivatives are made by using one electrode as one part of the input of each bipolar amplifier, and the mean of all the connected electrodes as the other input of each bipolar amplifier.The average reference principle has several advantages over the common reference principle. It should be stressed, however, that the way in which the signals are recorded and the way they are analyzed are two different things.

18. Define NCV

NCV is defined as nerve conduction velocity,the time taken to pass the through a neuron.

NCV=difference between the electrodes/time

19. What are the electrode used for the measurement of EMG?

Needle electrode

Surface electrode

20. What are abnormalities of ECG?

- 1 ORDER STROKE
- 2ORDER STROKE
- ARRTHYMIA

UNIT 3

1. Write the effect of power line interference in bio signal recording?

Modern biomedical amplifiers have a very high common mode rejection ratio. Nevertheless, recordings are often contaminated by residual power-line interference. Traditional analogue and digital filters are known to suppress ECG components near to the power-line frequency. Different types of digital notch filters are widely used despite their inherent contradiction: tolerable signal distortion needs a narrow frequency band, which leads to ineffective filtering in cases of larger frequency deviation of the interference. Adaptive filtering introduces unacceptable transient response time. especially after steep and large QRS complexes. Other available techniques such as Fourier transform do not work in real time. The subtraction procedure is found to cope better with this problem.

2. **What is the need for band pass filters in biological pre-amplifiers?**

A band-pass filter (also bandpass filter, BPF) is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range.based on power spectra estimation of the QRS complex.that a band pass filter with the center frequency 17HZ.and a Q of five ,yield the best signal to noise ratio.

- By using a bandpass filter rather than a lowpass filter, the amplitude of low frequency noise as well as the low frequency components of the ECG will be reduced without affecting the *QRS.*
- Since the frequency spectrum of the foetal ECG differs somewhat from the maternal ECG, some initial signal separation is achieved by using the appropriate bandpassfiltering in each channel. The bandpass filter, therefore, enhancesthe signal/noise ratio—the noise in this context being, for example, foetal movements at lowfrequencies and maternal placental blood flow at high frequencies.
- Pacemaker sensing amplifiers employ bandpass filters to discriminate between R-wave and T-wave. A consequence of this is that R-waves of smaller slew rate are also attenuated and therefore, it is likely that an R-wave with an amplitude exceeding the R-wave sensitivity of the sensing amplifier may not be sensed. This is of critical importance in cases of low amplitude R-waves (under 5 mV) where even moderate attenuation could lead to sensing problems.

3. **Write any two conditions of biological preamplifiers.**
   - The single-ended output, often differential input.
   - High common mode rejection ratio(CMRR).
   - Extremely high-input impedance.
   - Variable gain adequate to do the job intended.
   - Frequency response suitable for the application. In the case of a universal bioelectric amplifier, the response should be variable through switch selection.Zero suppression. This feature allows shift about the zero baseline by nullimg offsets inherent in the signal.

4. **What is powerline interference?**

Filtering such PLI signal is a challenging problem given that the frequency of the time-varying powerline signal lies within the frequency range of the ECG and EEG signals [1,2]. Another well-known method for cancelling the 50/60-Hz interference is using a notch 50/60-Hz filter.the inference may be due to the stray effect of alternating current on the patient or patient table.

5. **Differentiate single ended and differential ended mode of a biological amplifier.**

One of the most common questions asked is the difference between single-ended and differential inputs, and what applications they should be considered in. First, a simple definition:

- DIFFERENTIAL INPUTS - A signal input circuit where SIGNAL LO and SIGNAL HI are electrically floating with respect to ANALOG GROUND. For example, a differential input A/D card will have one HI (+) and one LOW (-) pin for each input. There will also be a LLGND (LOW LEVEL GROUND) pin which may be used if a ground connection is required. This allows the measurement of the voltage difference between two signals tied to the same ground and provides superior common-mode noise rejection. Where differential inputs should be used? Whenever electromagnetic interference (EMI) or radio frequency interference (RFI) is present, a voltage can be induced on BOTH signal wires. A differential input amplifier will reject the COMMON MODE VOLTAGE, provided that the common mode voltage plus the input signal does not exceed the device's CMR specification. The effect on a single-ended input is usually a voltage fluctuation between signal high and signal ground.
- SINGLE-ENDED INPUTS - A single-ended input has no common mode range because there is only ONE low wire, which is shared by all inputs. For example, if you have an A/D board with 16 single-ended inputs, there will be 16 HIGH (+) lines and one LOW (-) line (sometimes called LLGND). Some cards may have several LOW lines to provide extra places to make your ground connection, however, these lines are tied together and are basically the same thing.

6. **When to use single-ended or differential inputs?**
Differential inputs provide a more stable reading when EMI or RFI is present, and therefore, it is recommended to use them whenever noise is generally a problem. This is especially true when measuring THERMOCOUPLE, STRAIN GAGE and BRIDGE TYPE PRESSURE SENSOR inputs, since they produce very small signals that are very susceptible to noise.Single-ended inputs are lower in cost, and provide twice the number of inputs for the same size wiring connector, since they require only one analog HIGH (+) input per channel and one LLGND (-) shared by all inputs. Differential inputs require signal HIGH and LOW inputs for each channel and one common shared LLGND. Single-ended inputs save connector space, cost, and are easier to install.

7. **Why do we require isolation amplifiers in a biomedical instrument?**
Isolation amplifiers are commonly used for providing protection against leakage currents. Theybreak the ohmic continuity of electric signals between the input and output of the amplifier. Theisolation 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.

8. Mention the different types of filters used in biosignal measurement.

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. This filter helps avoid an erroneous detection of tall *T* wavesas beats. Even though the shape of the *QRS*is distorted, the output from the detection filter is usedonly for beat detection.The classification filter removes signal irregularities, and preserves the important features oftheQRS. So, the resulting ECG output can be used for feature measurements and beat classification.The biosignals, say for example ECG, originate from the body potentials whereas the noise is mainly from the man-made electrical sources. 50-60Hz Power-line frequencies are the worst enemies in bio-potential amplification/processing so you need to filter out these first. Usually a notch filter is applied to remove these power-line components and a low pass filter is used to restrict other high frequency signals entering into your system. This is needed particular to avoid the aliasing effect (filter act as anti-aliasing) in sampled systems with digital processing of the signals.

9. What are the characteristics of a DC amplifier?

It may need balanced differential inputs giving a high Common Mode Rejection Ratio (CMRR).It should have extremely good thermal and long term stability.

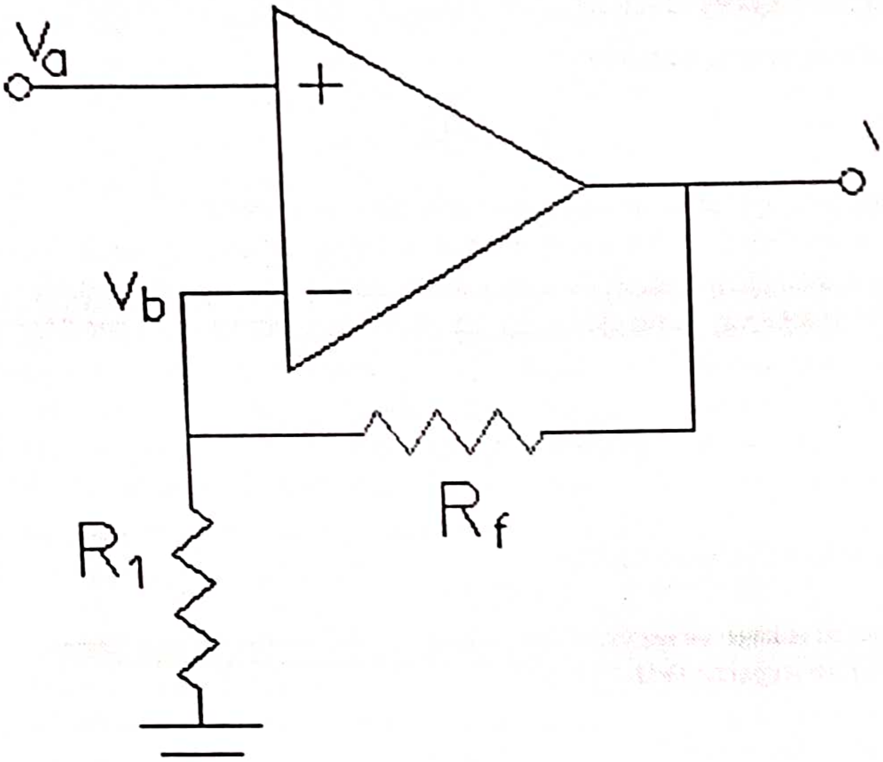
10. What are the types of chopper amplifier?

- Mechanical chopper amplifier
- Non mechanical chopper amplifier

11. Mention the characteristics of instrumentation amplifier

High gain
High CMRR
Low output impedance

12. Draw the circuit diagram of a non-inverting amplifier ?[AUC May 2008]



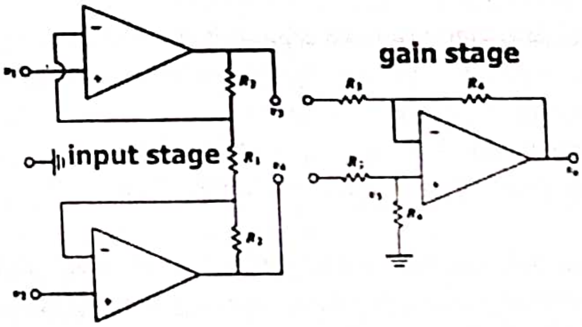
13. Mention the applications of an instrumentation amplifier.[AUC May 2009]

- Data acquisition system.
- Temperature indicator
- Temperature controller.
- Light intensity meter

14. Why active guard drive is necessary for an instrumentation amplifier?[AUC MAY 2012]

- The common ground is shared by variety of circuits.
- Due to ground loop interference , additional voltage drop develops and lead to error in low voltage measurement.
- Due to distributed cable capacitances degradation of CMRR occurs.
- The active guard drive eliminates all these problems.

15. Draw the instrumentation amplifier diagram



16. What is frequency distortion?

- if filter specification does not match the frequency content of biopotential
- then the result is hig qy h and low frequency distortion

17. what is mean by preamplifier?

UNIT 4

1. Explain the principle of electromagnetic blood flow measurement.

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 (Fig. 11.1) in which the flow is to be measured. The blood stream, which is a conductor, cuts the magnetic field and voltage is induced in the blood stream. This induced voltage is picked up by two electrodes incorporated in the magnetic assembly. 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

C = constant of proportionality

2. **What is thermal dilution in cardiac output measurement?**

Measurement of Cardiac Output-The blood temperature is **measured** by a thermistor at the catheter tip, which lies within the pulmonary artery, and a computer is used to acquire the **thermodilution** profile; that is, the computer quantifies the change in blood temperature as it flows over the thermistor surface.

3. **What is cardiac output and stroke volume?**

Cardiac output, expressed in liters/minute, is the amount of blood the heart pumps in 1 minute. Cardiac output is logically equal to the product of the stroke volume and the number of beats per minute (heart rate).

stroke volume (SV) is the volume of blood pumped from the left ventricle per beat. Stroke volume is calculated using measurements of ventricle volumes from an echocardiogram and subtracting the volume of the blood in the ventricle at the end of a beat (called end-systolic volume) from the volume of blood just prior to the beat (called end-diastolic volume). The term *stroke volume* can apply to each of the two ventricles of the heart, although it usually refers to the left ventricle. The stroke volumes for each ventricle are generally equal, both being approximately 70 mL in a healthy 70-kg man.

4. What is korotkoft sound?

When cuff in inflated to a pressure that only partially occludes the brachial artery turbulence isgenerated in thee blood as it spurts through the tiny arterial opening during each systole. Thesounds generated by this turbulence are called korotkoft sounds.

5. What are the methods used to measure blood pressure is directly?

Catheterization method involving the sensing of blood pressure through a liquid column. In thismethod the transducers is external to the body and blood pressure is transmitted through a salinesolution column in a catheter to this transducers. This method also involves the placement oftransducers through a catheter at the actual site of measurement in the blood stream. Percutaneousmethods in which the blood pressure is sensed in the vessel just under the skin by the use of aneedle or catheter. Implantation technique in which the transducer is more permanently placed inthe blood vessel.

6. What is meant by Doppler Effect?

The frequency of the reflected ultrasonic energy is increased or decreased by a moving interface.The amount of frequency shift can be expressed as, $f=2V/\lambda$, f=shift in frequency of the reflected wave, V=velocity of the interface, λ=wavelength of the transmitted ultrasound. The frequency increases when interface moves towards the transducer & decreases when it moves away.

7. Give the methods for measuring blood flow.

1.Indirect method – sphygmomanometer.

2.Direct method

3.Percutaneous insertion

4.Catheterization (vessel cut down)

5.Implantation of a transducer in a vessel or in the heart.

8. What is cardiac output and its normal rate?

Blood flow is highest in the pulmonary artery and the aorta, where the blood vessels leave the heart. The flow at these points is called cardiac output, is between 3.5 and 5liters/min in a normal adult at rest.

9. What are the causes of Cerebrovascular accident (CVA)?

When the blood flow in a certain vessel is completely obstructed, the tissue in the area supplied by this vessel may die. Such an obstruction in a blood flow of the brain is one of the causes of CVA or stroke.

10. What are the methods involved in direct blood pressure measurement?

- Auscultator method
- Palpatory method

11. Give the principle of transduction of heart sounds.

The sounds and murmurs which originate from the heart can be picked up from the chest using stethoscope or by transduction of heart sounds in to electrical signal.

12. What is meant by mean arterial pressure?

The cuff pressure at the point of maximum oscillations usually corresponds to the mean arterial pressure. The point above the mean pressure at which the oscillations begin to rapidly increase in amplitude correlates with the diastolic pressure (Fig. 6.31). These correlations have been derived and proven empirically but are not yet well explained by any physiologic theory. The actual determination of blood pressure by an oscillometric device is performed by a proprietary algorithm developed by the manufacturer of the device. The oscillometric method is based on oscillometric pulses (pressure pulses) generated in the cuff during inflation or deflation. Blood pressure values are usually determined by the application of mathematical criteria to the locus or envelope formed by plotting a certain characteristic, called the oscillometric pulse index, of the oscillometric pulses against the baseline cuff pressure (Fig. 6.32). The baseline-to-peak amplitude, peak-to-peak amplitude, or a quantity based on the partial or full time-integral of the oscillometric pulse can be used as the oscillometric pulse index. The baseline cuff pressure at which the envelope peaks (maximum height) is generally regarded as the MAP (mean arterial pressure). Height-based and slope-based criteria have been used to determine systolic and diastolic pressures.

13. **Define systole and diastole.**

Diastolic pressure occurs near the beginning of the cardiac cycle. It is the minimum pressure in the arteries when the pumping chambers of the heart — ventricles — fill with blood. Near the end of the cardiac cycle,**systolic pressure**, or peak pressure, occurs when the ventricles contract.As the heart beats, it pumps blood through a system of blood vessels, which carry blood to every part of the body. Blood pressure is the force that blood exerts on the walls of blood vessels. All or any of the events related to the flow or blood pressure that occurs from the beginning of one heartbeat to the beginning of the next is called a cardiac cycle. Problems in the cardiac cycle can cause low or high blood pressure.

14. Comparison chart for systole and diastole pressure.

Diastolic versus Systolic comparison chart		
	Diastolic	**Systolic**
Definition	It is the pressure that is exerted on the walls of the various arteries around the body in between heart beats when the heart is relaxed.	It measures the amount of pressure that blood exerts on arteries and vessels while the heart is beating.
Normal range	60 – 80 mmHg (adults); 65 mmHg (infants); 65 mmHg (6 to 9 years)	90 – 120 mmHg (adults); 95 mmHg (infants); 100 mmHg (6 to 9 years)
Importance with age	Diastolic readings are particularly important in monitoring blood pressure in younger individuals.	As a person's age increases, so does the importance of their systolic blood pressure measurement.
Blood Pressure	Diastolic represents the minimum pressure in the arteries.	Systolic represents the maximum pressure exerted on the arteries.

Ventricles of the heart	Fill with blood	Left ventricles contract
Blood Vessels	Relaxed	Contracted
Blood Pressure reading	The lower number is diastolic pressure.	The higher number is systolic pressure.
Etymology	"Diastolic" comes from the Greek diastole meaning "a drawing apart."	"Systolic" comes from the Greek systole meaning "a drawing together or a contraction."

15. **How respiration rate is measured using thermistor method?**

Since air is warmed during its passage through the lungs and the respiratory tract, there is a detectable difference of temperature between inspired and expired air. This difference of temperature can be best sensed by using a thermistor placed in front of the nostrils by means of a suitable holding device. In case the difference in temperature of the outside air and that of the expired air is small, the thermistor can even be initially heated to an appropriate temperature and the variation of its resistance in synchronism with the respiration rate, as a result of the cooling effect of the air stream, can be detected. This can be achieved with thermistor dissipations of about 5 to 25 mW. subject.

16. **What are the direct methods of blood pressure measurement?**

The direct method of pressure measurement is used when the highest degree of absolute accuracy,dynamic response and continuous monitoring is required. The method is also used to measure thepressure in deep regions inaccessible by indirect means. For direct measurement, a catheter or aneedle type probe is inserted through a vein or artery to the area of interest. Two types of probescan be used. Measurement of blood pressure by the direct method, though an invasive technique, gives notonly the systolic, diastolic and mean pressures, but also a visualization of the pulse contour andsuch information as stroke volume, duration of systole, ejection time and other variables. Once anarterial catheter is in place, it is also convenient for drawing blood samples to determine thecardiac output (by dye dilution curve method), blood gases and other chemistries.

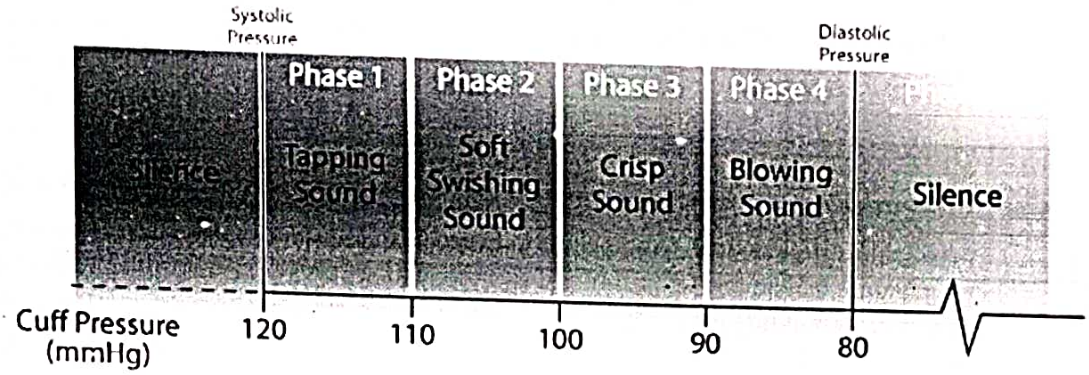
17. **Define and mention the significance of korotkoff sounds.**

Korotkoff sounds (or K-Sounds) are the "tapping" sounds heard with a stethoscope as the cuff is gradually deflated. Traditionally, these sounds have been classified into five different phases (K-1, K-2, K-3, K-4, K-5) and are shown in the figure below.

- K-1 (Phase 1): The appearance of the clear "tapping" sounds as the cuff is gradually deflated. The first clear "tapping" sound is defined as the systolic pressure.
- K-2 (Phase 2): The sounds in K-2 become softer and longer and are characterized by

a swishing sound since the blood flow in the artery increases.

- K-3 (Phase 3): The sounds become crisper and louder in K-3 which is similar to the sounds heard in K-1.
- K-4 (Phase 4): As the blood flow starts to become less turbulent in the artery, the sounds in K-4 are muffled and softer. Some professionals record diastolic during Phase 4 and Phase 5
- K-5 (Phase 5): In K-5, the sounds disappear completely since the blood flow through the artery has returned to normal. The last audible sound is defined as the diastolic pressure.



Korotkoff sounds are blood flow sounds that healthcare providers observe while taking blood pressure with a sphygmomanometer over the brachial artery in the antecubital fossa. These sounds appear and disappear as the blood pressure cuff is inflated and deflated.

18. **How can the pulse be detected using piezoelectric crystals?**

The method consists in putting a cuff around the upper part of the patient's arm and place microphone over the brachial artery. The compressed air required for inflating the cuff is provided by a pumping system incorporated in the apparatus. Usually the inflating is done to a preset pressure level, well beyond the systolic value at the rate of approximately 30 mmHg/s. The pressure in the cuff is then decreased at a relatively slow pace at the rate of 3–5 mmHg/s. The cuff is to be applied in such a way that the veins are not occluded. While air is allowed to leak from the cuff, the Korotkoff sounds are picked up by a special piezoelectric microphone. The corresponding electrical signals are fed to a preamplifier. The amplified signals are then passed on to a bandpass filter having a bandwidth of 25 to 125 Hz. With this passband, a good signal-to-noise ratio is achieved when recording Korotkoff sounds from the brachial artery beneath the lower edge of the cuff. The system is so designed that the appearance of the first Korotkoff sound switches in the systolic manometer and locks the reading on the indicating meter. In a similar way, the diastolic value is fixed by the last Korotkoff sound. The cuff is completely deflated, automatically, after an interval of 2–5 s after the determination of the diastolic value.

19. **Define respiration rate.**

The respiration rate is the number of breaths a person takes per minute. The rate is usually measured when a person is at rest and simply involves counting the number of breaths for one minute by counting how many times the chest rises. Respiration rates may increase with fever, illness, and with other medical conditions. When checking respiration, it is important to also note whether a person has any difficulty breathing. Normal respiration rates for an adult person at rest range from 12 to 16 breaths per minute.

20. What are the methods to measure the respiration rate?

Displacement method, thermistor method, impedance pneumography and CO_2 method.

21. Write short notes on auscultatory method of pressure measurement?

The auscultatory method (also known as the Riva Rocci Korotkoff or manual method for blood pressure measurement) is the LISTENING of Korotkoff sounds in the brachial artery. The gold standard for clinical blood pressure measurement has always been to take a blood pressure using the auscultatory method where a trained healthcare provider uses a sphygmomanometer and listens for the Korotkoff sounds using a stethoscope. However, there are many variables that affect the accuracy of this method and numerous studies have shown that physicians and healthcare providers rarely follow the established guidelines for taking proper manual blood pressure measurements.

22. Write short notes on oscillometric method of pressure measurement?

The oscillometric technique operates on the principle that as an occluding cuff deflates from a level above the systolic pressure, the artery walls begin to vibrate or oscillate as the blood flows turbulently through the partially occluded artery and these vibrations will be sensed in the transducer system monitoring cuff pressure. As the pressure in the cuff further decrease, the oscillations increase to a maximum amplitude and then decrease until the cuff fully deflates and blood flow returns to normal.The cuff pressure at the point of maximum oscillations usually corresponds to the mean arterialpressure. The point above the mean pressure at which the oscillations begin to rapidly increase inamplitude correlates with the diastolic pressure. These correlations have been derivedand proven empirically but are not yet well explained by any physiologic theory. The actualdetermination of blood pressure by an oscillometric device is performed by a proprietary algorithmdeveloped by the manufacturer of the device.

UNIT 5

1. What are photometers?

A photometer, generally, is an instrument that measures light intensity or the optical properties of solutions or surfaces. Most photometers detect the light with photoresistors, photodiodes or photomultipliers. To analyze the light, the photometer may measure the light after it has passed through a filter or through a monochromator for determination at defined wavelengths or for analysis of the spectral distribution of the light.

2. **What are the prinicipal components of auto analyser?**

- auto-sampler,proportioning pump,manifold,photocolorimeter,recorder (chart recorder).
- The sampler consists of a sample tray and a metal probe. The sample tray holds the cups that the sample is poured into. The tray on this model can hold up to 40 cups.
- The loaded sample tray rotates and the metal probe dips into each cup and aspirates a portion (1ml or less) of the contents for a given time interval. Near the probe wash receptacle is a sampler wheel.
- The sampler wheel deiermines the speed of the sampler and the ratio of sample to rinse. The speed and ratio is different for various chemical determinations or assays.

3. **How does the pH value determine the acidity or alkalinity in blood?**

The term pH means potentials of Hydrogen. Acidity and alkalinity are expressed on the pH scale, which ranges from 0 (strongly acidic) to 14 (strongly basic, or alkaline). A pH of 7.0, in the middle of this scale, is neutral. Blood is normally slightly basic, alkaline, with a pH range of 7.35 to 7.45. To function properly, the body maintains the pH of blood close to 7.40. An important property of blood is its degree of acidity and alkalinity, and this is referred to as acid-base balance. The acidity or alkalinity of the blood is indicated on the pH scale. The acidity level increases when the level of acidic compounds in the blood rises or when the level of alkaline compounds in the blood falls. Alkalinity levels increases with the reverse process.

The level of acidic or alkaline compounds in the body rises through increased intake, production, or decreased elimination and falls through decreased intake, production, or increased elimination

4. **What is the principle of colorimeter?**

A colorimeter is a device used in colorimetry. In scientific fields the word generally refers to the device that measures the absorbance of particular wavelengthsof light by a specific solution. This device is commonly used to determine the concentration of a known solute in a given solution by the application of the Beer-Lambert law, which states that the concentration of a solute is proportional to the absorbance.

5. **What is an autoanalyser and what are it's advantages and disadvantages?**

The autoanalyzer sequentially measures blood chemistry and displays this on a graphic readout.

Advantage:

Rapid test results

More samples tested simultaneously.

Disadvantages:

One problem with automatic analysers is certain identification of samples. Patient data can be intermixed with that of other patients if care is not taken.

Patient's life may hinge on accurate measurement obtained by clinical instrumentation.

6. **What are the differences between spectrophotometer and colorimeter?**

S.NO	Spectrophotometer	Colorimeter
1	A spectrophotometer is an instrument designed for physical sample analysis via full spectrum color measurement. By providing wavelength-by-wavelength spectral analysis of a sample's reflectance, absorbance, or transmittance properties, it produces precise data beyond that observable by the human eye.	A colorimeter is designed to perform a type of psychophysical sample analysis by mimicking human eye-brain perception. In other words, it is designed to see color the way we do.
2	Colorimeters are extraordinarily accurate for straightforward color measurement and ideally suited for determination of color difference, fastness, and strength as well as routine comparisons of similar colors. As such, they can be invaluable for color quality control and are primarily used in the production and inspection phases of manufacturing.	Spectrophotometers offer a higher level of flexibility and versatility than colorimeters due in part to the fact that they offer multiple illuminant/observer combinations and can operate in multiple geometric arrangements, including 45°/0° and d/8°. As such, spectrophotometers are capable of measuring metamerism, identifying colorant strength, analyzing a comprehensive range of sample types, and giving users a choice between including or excluding specular reflectance to account for geometric attributes.
3	While colorimeters can produce highly accurate color measurements, they also have several shortcomings; they are not able to identify metamerism or colorant strength, are not ideally suited for color formulation, and cannot be used under variable illuminant/observer conditions.	Although historically spectrophotometers have been significantly larger and more complex instruments that made them unattractive to some, today's technological advances have made it possible to manufacture smaller and more user-friendly spectrophotometers, eliminating many of those concerns. However, not all manufacturers require the capabilities of spectrophotometric instruments and may find that their needs are met by a colorimeter.

7. Mention the clinical significance of PO2 and PCO2 in blood.

pCO2 (partial pressure of carbon dioxide) reflects the the amount of carbon dioxide gas dissolved in the blood. Indirectly, the pCO2 reflects the exchange of this gas through the lungs to the outside air.

PO2 (partial pressure of oxygen) reflects the amount of oxygen gas dissolved in the blood. It primarily measures the effectiveness of the lungs in pulling oxygen into the blood stream from the atmosphere.

8. What is Fick's technique?

Developed by Adolf Eugen Fick (1829–1901), the Fick principle has been applied to the measurement of cardiac output. Its underlying principles may also be applied in a variety of clinical situations.

The essence of the Fick principle is that blood flow to an organ can be calculated using a marker substance if the following information is known:

- Amount of marker substance taken up by the organ per unit time
- Concentration of marker substance in arterial blood supplying the organ
- Concentration of marker substance in venous blood leaving the organ

In Fick's original method, the "organ" was the entire human body and the marker substance was oxygen.

The principle may be applied in different ways. For example, if the blood flow to an organ is known, together with the arterial and venous concentrations of the marker substance, the uptake of marker substance by the organ may then be calculated.

9. What is the principle of blood glucose sensor?

A **glucose** meter is a medical device for determining the approximate concentration of **glucose** in the **blood**. ... A small drop of **blood**, obtained by pricking the skin with a lancet, is placed on a disposable test strip that the meter reads and uses to calculate the **blood glucose** level.

10. What are the methods of blood cells counting?

Manual cell counting : counting chamber

Automatic cell counting : flow resistance, flow cytometry

Indirect cell couting: Spectrophotometry