SUMMER– 14 EXAMINATION

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

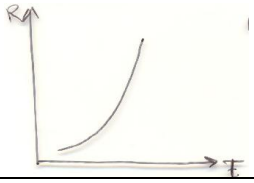
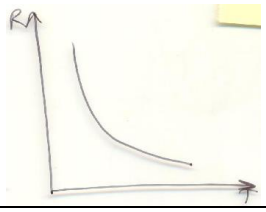
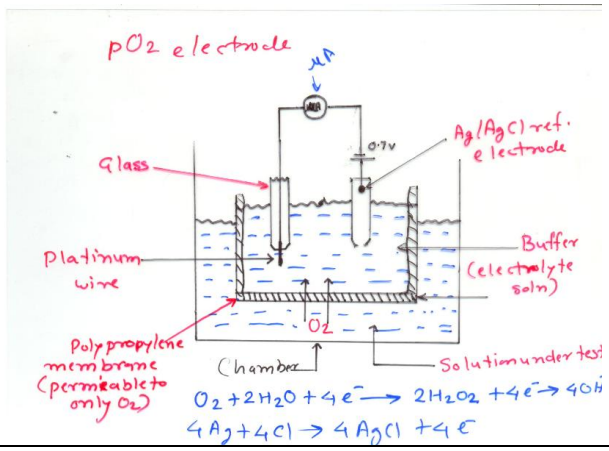
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.

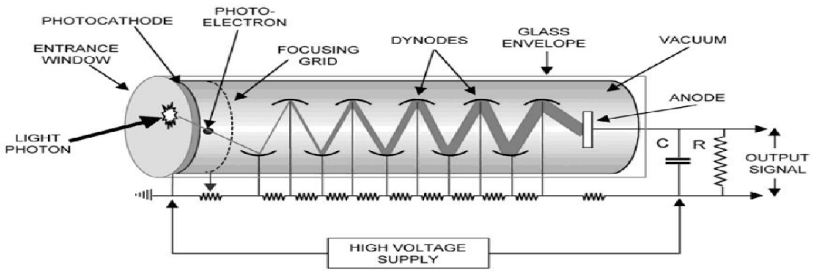
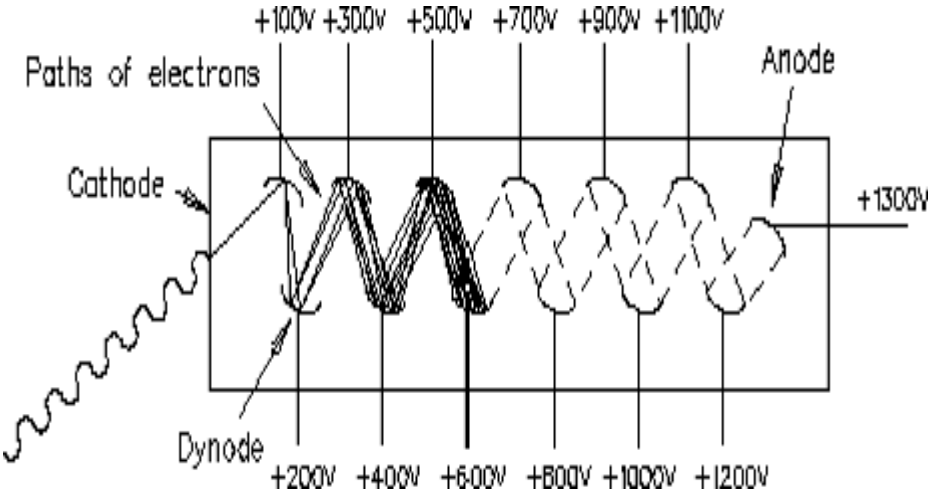
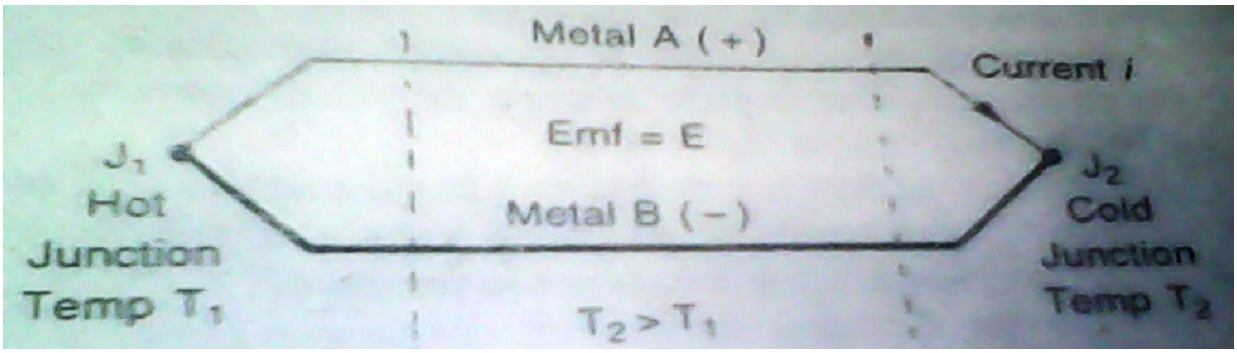
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

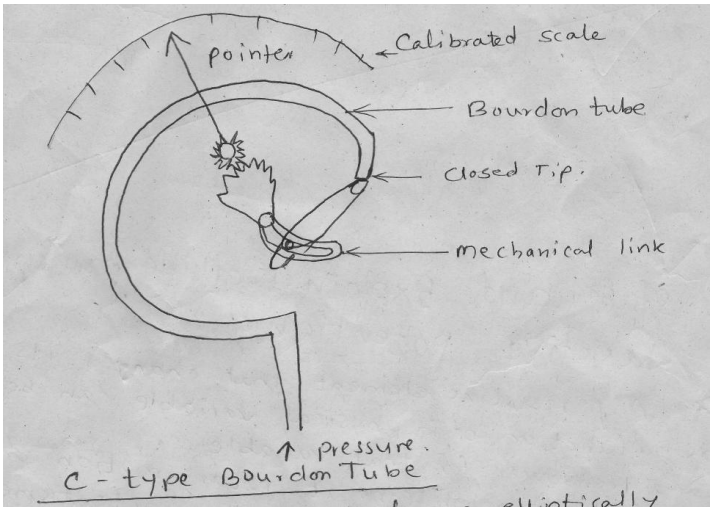
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1)A)	**Attempt any Six of the following.**	**12**
i)	**List any two source of biomedical signal.** **Ans:-** 1) Heart **2)** Brain **3)** Muscles	**02**
ii)	**Write four constraints in design of medical instrumentation** **Ans:-**General constraints in design of medical instrumentation system are as follows: 1)Inaccessibility of the signal source 2)Variability of Physiological parameters 3)Interference among physiological System 4)Transducer interface problem.	**02**
iii)	**State the principle of thermal convention** **Ans:-** When the heat is applied to junction(hot junction) of two dissimilar metals, an emf is generated which can measured at the other junction (cold junction). The two dissimilar metals form an electric circuit, and current flows as a result of the generated emf. This current will continue to flow as long as $T_1 > T_2$. Metal B is describe as –ve with respect to a metal A if current flows into it at the cold junction.	**02**
iv)	**Draw resistance temperature characteristics of PTC and NTC thermistor** **Ans:-** PTC  NTC 	**02**
v)	**Draw labeled diagram of PO2 electrode** **Ans:-** 	**02**

vi)	**Draw a neat diagram of photomultiplier tube** **Ans:-**  **OR**  	**02**
vii)	**State function of electrode gelly.** **Ans:-** Jellies have been used to facilitate a more intimate contact between the subject's skin and the recording electrodes. Thus reducing the skin contact impedance.	**02**
viii)	**Write working principle of thermo-couple.**  The operation of the thermocouple is based on the seebeck effect. When the heat is applied to junction (hot junction) of two dissimilar metals, an emf is generated which can measured at the other junction (cold junction).	**02**

	The two dissimilar metals form an electric circuit, and a current flows as a result of the generated emf. This current will continue to flow as long as $T_1 > T_2$. Metal B is describe as –ve with respect to a metal A if current flows into it at the cold junction. The emf produces is function of the difference in temperature of hot and cold junctions	
Q.1)B)	**Attempt any TWO**	**08**
i)	**List of define four static characteristics of transducer** -Accuracy: It is the algebraic difference between the indicated value and the true or theoretical value of the measurement. Practically it is expressed as percentage of full scale output. It is the degree of closeness with which measured value approaches to the true value. -Precision: It refers to the degree of repeatability of the measurement. It is the degree of agreement within the group of measurement -Resolution: The resolution of a transducer indicates the smallest measurable input increment. -Sensitivity: It describes the transfer ratio of output to input. -Drift: It indicates a change of base line output when input is zero or the sensitivity with time, temperature etc. -Linearity: It is the degree to which variation in the output of an instrument follows the input variation. Basically it reflects that the output is in some way is proportional to input. -Reproducibility: The ability of an instrument to give some output for equal input applied over some period of time is called reproducibility. -Hysteresis: It results when some of the energy is applied for increasing input is not recovered when input decreases. -Span: It indicates total operating range of the transducer. -Noise: It is an unwanted signal to the output due to internal source or too interference. -Threshold: Threshold of the transducer is the smallest change which will result in a measurable change in transducer.	**04** **Any 4**
ii)	**Draw C-type bourdon tube and describe working of it. Also state two type of bourdon tube.** types of B.T. are 1. C – type Bourdon tube. 2. Spiral type of Bourdon tube. 3. Helical type of Bourdon tube.	**04** **01**

Working principal of C type of Bourdon tube.



02

C type of Bourdon tube is made up of an elliptically flattened tube bent in such a way as to produce the 'C' shape.

One end of this tube is closed or sealed & the other end is opened for the pressure to enter.

The free end connected to the pointer with the help of geared sector & pinion. Calibrated scab & pointer is provided to indicate the pressure.

The pressure which is to be measured is applied to the Bourdon tube through open end.

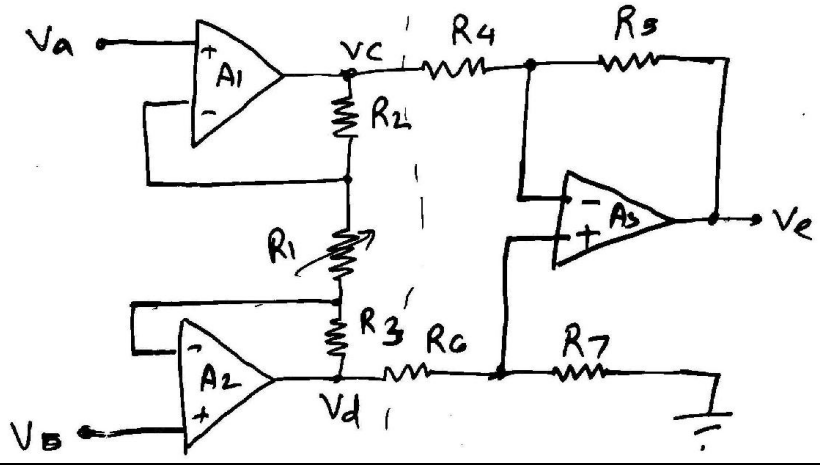
When the pressure enters the tube, the tube tends to straighten out proportional to applied pressure.

01

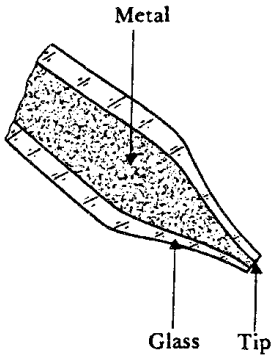
This causes the measurement of the free end & the displacement of this end is given to the pointer through mechanical linkage.

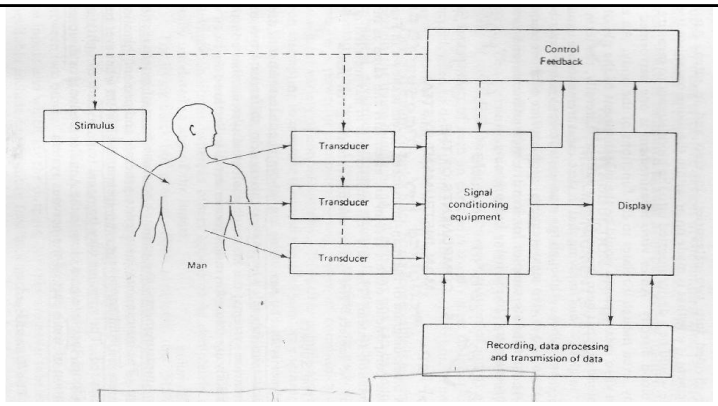
The pointer moves on the calibrated scale in terms of pressure

iii) **Draw diagram of instrumentation amplifier. List any four application of it.** **04**



02

	Applications of Instrumentation Amplifier:- 1) Data acquisition from low output transducers. 2) Medical instrumentation system 3) Current/ votlage monitoring 4) Audio appliences involving weak auio signals or noisy environment. 5) High speed signal conditioning for video data acquisition and imaging 6) High frequency signal amplification in cable RF system.	**02**
Q.2)	**Attempt any FOUR of the following**	**16**
a)	**Describe metal micro electrode with a neat labeled diagram** **Ans:-**  The metal microelectrode is essentially a subminiature version of the needle electrode. In this case, a strong metal such as tungsten is used. One end of this wire is etched electrolytically to give tip diameters on the order of a few micrometers. The structure is insulated up to its tip, and it can be passed through the membrane of a cell to contact the cytosol. The advantage of these electrodes is that they are both small and robust and can be used for neurophysiologic studies. Their principal disadvantage is the difficulty encountered in their fabrication and their high source impedance.	**04** **02** **02**
b)	**List any four advantages of optical fiber sensors.** **Ans:-** Advantages – i)They are immune from crosstalk ii)Optical fiber sensors are non-electrical and hence free from electrical interference iii)There is high degree of mechanical flexibility iv)The cost is low enough to make the sensors disposable for many applications.	**04**
c)	**Draw man instrumentation system and describe its working**	**04**



02

System components are given below:-

i) The subject – The subject is human being on whom the measurements are made.

ii) Stimulus – The instrument used to generate and present this stimulus to the subject is a vital part of man – instrument system when responses are measured.

Stimulus may be visual (e. g. flash of light), auditory (e.g. a tone), tactile (e.g. a blow to the Achilles tendon) or direct electrical stimulation of some part of nervous system. **02**

iii) The Transducer – A device capable of converting one form of energy or signal to another. Here each transducer is used to produce an electrical signal that is analog of the phenomenon. Transducer may measure temperature, pressure, flow or any other variables found in body.

iii) Signal condition equipment – The part of instrumentation system that amplifies modifies or in any other way changes the electric output of transducer is called signal conditioning Equipment. It also combines or relates the output of two or more transducers output signal is greatly modified with respect to the input.

iv) Display Equipment –

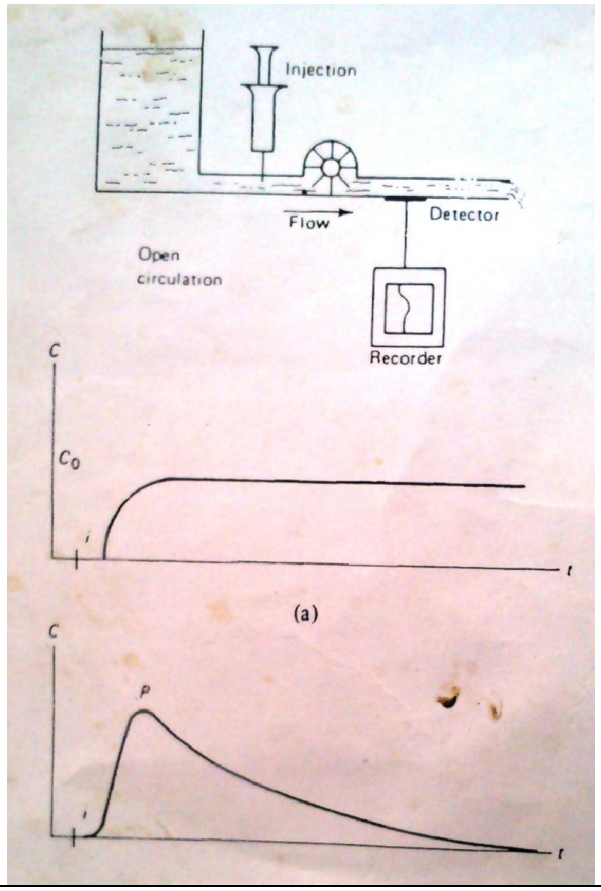
Electric output of signal conditioning equipment must be converted into a form that can be perceived by one of mans senses and can convey information. Obtained by measurement in meaningful way. Input to display device is modified electric signal and its output is some is form of visual, audible or possible tactile information here display equipment may include graphic pen recorder.

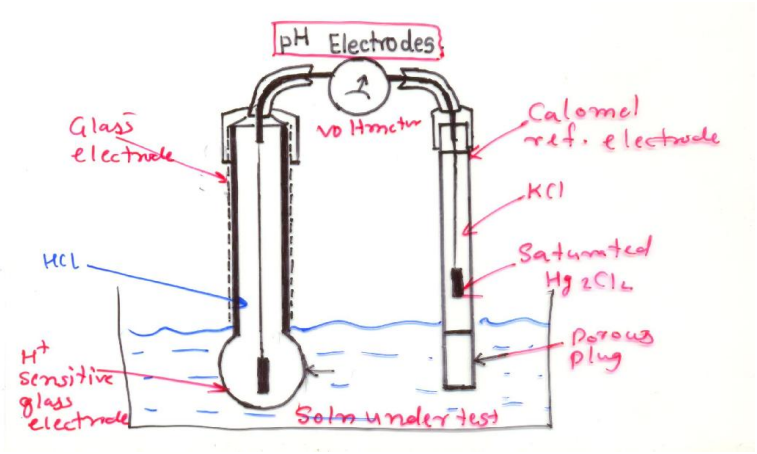
v) Recording Data – Processing & Transmission equipment -

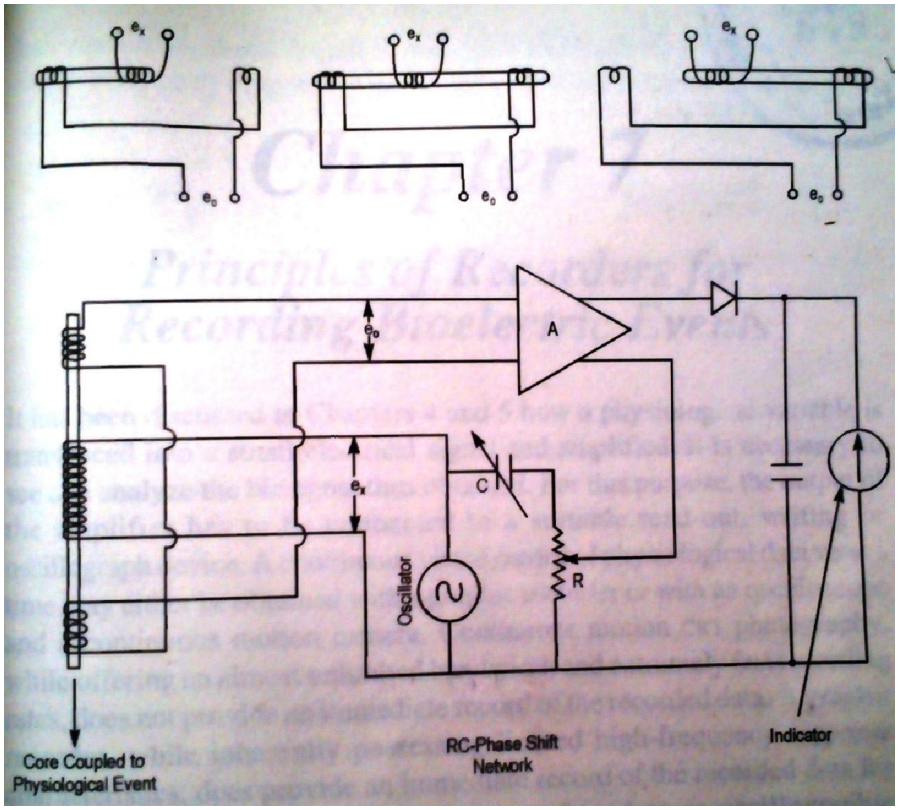
It is often necessary to record the measured information for possible latter use or to transmit it from one location to another on-line digital computer mau be part of this system where automatic storage or processing data is required.

vi) Control devices –

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

d)	**Describe indicator dilution method of flow measurement.** **Ans:-** The indicator or dye dilution methods are the only method of blood flow measurement that really measures the blood flow and not the blood velocity. In principle, any substance can be used as an indicator if it mixes readily with the blood and its concentration in the blood can be easily determined after mixing. The principle of the dilution method is shown in figure. The indicator is injected in to the blood flow continuously, beginning at time t, at a constant infusion rate I (grams/minute). The detector measures the concentration downstream from the injection point. At a certain time after the injection, the indicator begins to appear, the concentration increases, and finally it reaches a constant value, C0 (milligrams per litre). From the measured concentration and the known injection rate. I, the flow can be calculated as, $$F\ (\text{litres / minute}) = \frac{I\ (\text{milligrams / minute})}{Co\ (\text{milligrams / litre})}$$  	**04**
e)	**A 20 mm length of wire used as a strain guage exhibits a resistance of 150 Ω, when a force is applied in tension, the resistance changes by 2 Ω and length changes by 0.07 mm. find guage factor GF.** **Ans:-** $GF = \frac{\triangle R/R}{\triangle L/L}$ $= \frac{2/150}{0.07/20}$ $= 3.8$ Therefore gauge factor GF is 3.8.	**04**

f)	**Draw and state the working of pH electrode.**	**04**
		**02**
	The pH electrode consists of a reference terminal and an active terminal. The reference terminal uses a metal. In this case Ag/AgCl in KCl solution. The salt bridge consisting of fiber wick saturated with KCL is inert to the solution under test. However, it maintains the KCl at a potential of the solution and keep the reference terminal potential essentially the same regardless of the solution under test. The active terminal is similar in concentration to reference electrode but its tip is made up of glass membrane which is sensitive to H^+ ions and thus to pH of the solution. The pH sensitive glass consists of a hydrated gelatinous glass layer. Its membrane potential is proportional to the pH of solution in which it is dipped. Thus the potential difference between two electrodes is a measure of pH.	**02**
	The potential (V) of the glass electrode can be expressed by Nernst equation $V = V_o - (2.3036RT/F)\ \Delta pH$ Where, V_o is the standard potential R is gas constant T is temperature in Kelvin F is Faraday's constant ΔpH is pH value deviated from 7	
Q.3)	**Attempt any FOUR of the following**	**16**
a)	**List types of transducer used for the following physical measurement.** **i) Force or (Pressure)** **ii) Displacement** **iii) Flow** **iv) Temperature** **Ans:-** 1) Bourdon tube, Bellow tube, Diaphragm, strain gauge. 2) LVDT	**04**

	3) Electromagnetic flow meter, Ultrasonic 4) Thermistor, Thermocouple, RTD.	
b)	**Draw phase sensitive amplifier. State its importance.** **Ans:-** The use of phase sensitive detector permits setting the LVDT core to its center position and determining directional changes regardless of which side of the center the core is displaced. In this detector the oscillator voltage and voltage derived from the LVDT are added before rectification. With the core in its central position, the oscillator voltage, corrected for phase shift by the adjustment of C, is fed to the indicator to bring it to mid scale by adjusting R. as the core is displaced from central position, the voltage e0 after amplification, adds to or subtract from the oscillator voltage. Depending On the magnitude and phase of e0 which in turn depends on the magnitude and direction of the displacement.  	**04** **02** **02**
c)	**What are motion artifacts? How it can be reduced?** - When a polarizable electrode is in contact with an electrolyte double layer of charge forms at the interface. If the electrode is moved with respect to the electrolyte this movement mechanically disturbs the distribution of charge of the interface and results in momentary charge of the half-cell potential until equilibrium can be reestablished. If a pair of electrodes is in an electrolyte and one move while the other remains stationary, a potential difference appears between the two electrodes during this movement. This potential is known as motion artifacts.	**04**

This motion artifact can be a serious cause of interference in the measurement of biopotentials.

Motion artifacts must be as less as possible.

Methods to reduce motion artifacts:-

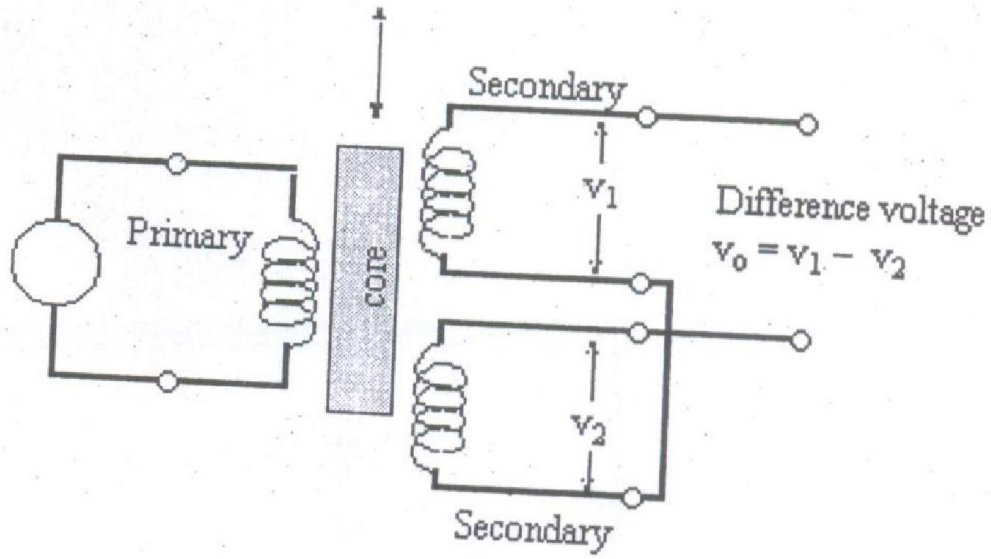
1) By instructing patient to relax.
2) By using digital signal processing
3) By using noise filters
4) By using non-polarizable electrodes
5) By using algorithms.

d) **Compare RTD and thermistor (any four points)** **04**

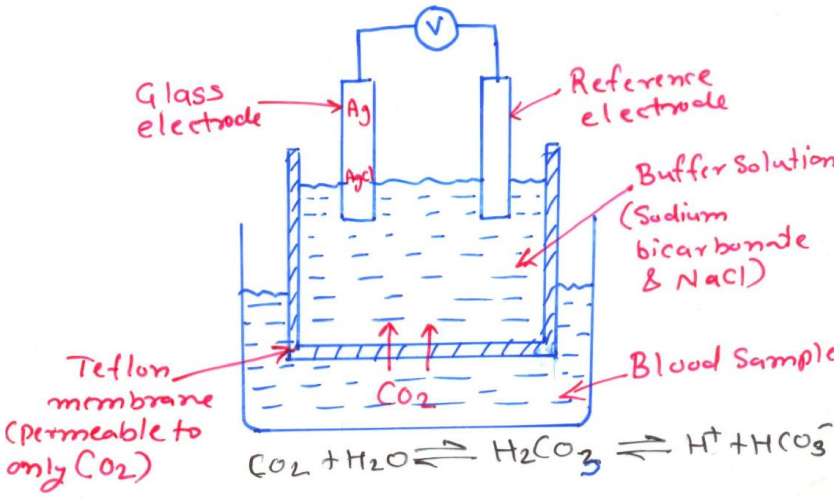
Ans:-

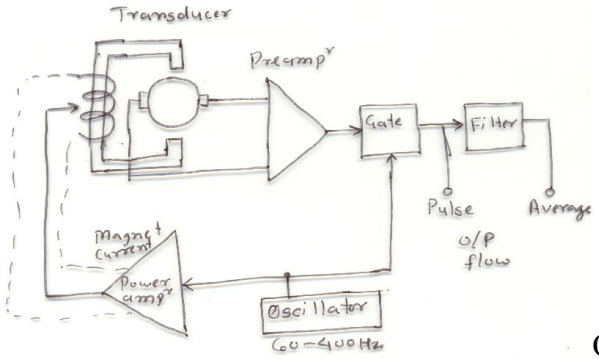
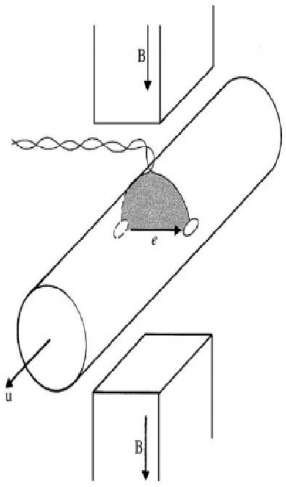
Sr. No.	Parameter	RTD	Thermistor
1)	Principle	the resistance of certain wire varies with temperature	The resistance of certain metal oxides varies with variation in temperature
2)	Material	Platinum, tungsten, copper, nickel etc.	Manganese, cobalt, iron oxides
3)	Accuracy	Less accurate	More accurate
4)	Temp. range	-270 ^{0}C to 2800 ^{0}C	-150 ^{0}C to 300 ^{0}C
5)	Cost	High cost	Low cost

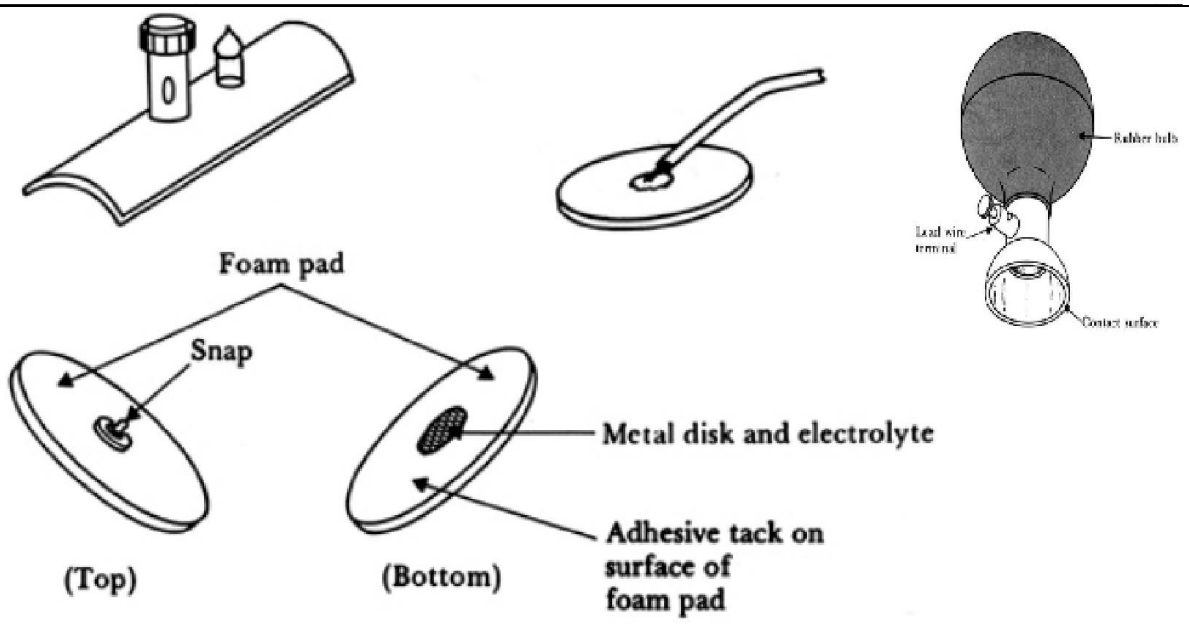
e) **Describe how displacement can be measured using LVDT with suitable diagram** **04**



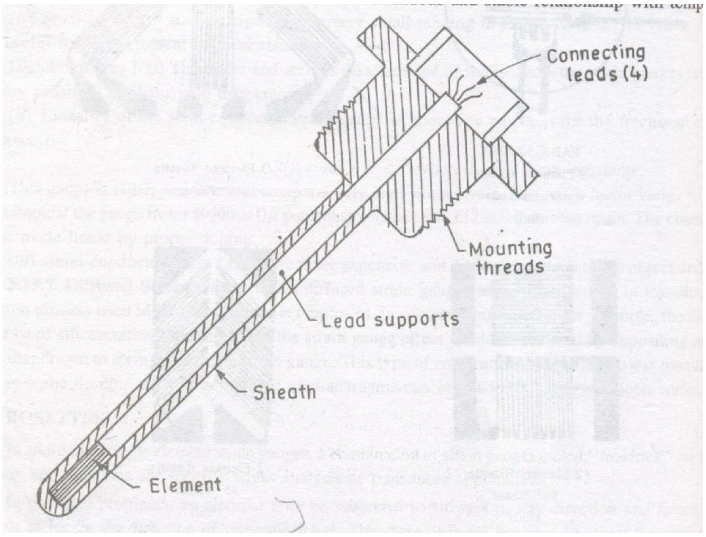
02

	LVDT can be used for the measurement of displacement. In this the moving part can be attached to the core of the transformer. When the displacement occurs the core moves upward and downward. As shown in above diagram the potential that will be developed in the secondary windings will be dependent of the position of the core between primary and secondary coil. As a result when core moves some potential is developed in the secondary which will be proportional to the displacement. The exact displacement can be calculated by suitably calibrating the LVDT for unit length and developing potential.	**02**
f)	**Write down working of electrode used to measure partial carbon di oxide pressure in the blood with suitable diagram.**  - Applications of PCO_2 electrode TCM monitoring Pulse Oximetry. PCO_2 electrode The pH electrode is used as a component of a PCO_2 electrode to measure the partial pressure of CO_2 by the arrangement as shown in the figure. Sample chamber with one side made of silicon rubber membrane or Teflon membrane is in contact with another chamber containing sodium bicarbonate solution into which is dipped a pH electrode. Blood or other fluid for which PCO_2 is to be measured enters a sample chamber. It comes in contact with Teflon or Silicon rubber membrane this membrane separates the fluid from sodium solution but it is permeable to CO_2 into the solution. CO_2 combines with H_2O so as to produce free hydrogen ion	**04** **02** **02**

Q 4.)	**Attempt any FOUR of the following**	**16**
a)	**Draw electromagnetic blood flow meter and describe its working** Electromagnetic blood flow meter**:** $e = \int_0^{L_1} \mathbf{u} \times \mathbf{B} \cdot d\mathbf{L}$ where **B** = magnetic flux density, T **L** = length between electrodes, m **u** = instaneous velocity of blood, m/s  OR  The electromagnetic flow meter measures instantaneous pulsatile flow of blood. It operates with any conductive liquid, such as saline or blood. The meter is placed such that the part of body through which the blood is to be determine like limb is subjected to the electric field. The flow meter depends on the movement of blood, which has a conductance similar to that of saline. Faraday's law of induction gives the formula for the induced emf. When blood flows in the vessel with velocity **u** and passes through the magnetic field **B**, the induced emf **e** is measured at the electrodes.	**04** **02** **02**
b)	**Describe the surface electrodes used for measurement of bio-potential with help of diagrams.** **Ans:-** This category includes electrodes that can be placed on the body surface for recording bioelectric signals. The integrity of the skin is not compromised when these electrodes are applied, and they can be used for short-term diagnostic recording such as taking a clinical electrocardiogram or long-term chronic recording such as occurs in cardiac monitoring. These electrodes consist of a metallic conductor in contact with the skin with a thin layer of an electrolyte gel between the metal and the skin to establish this contact. Metals commonly used for this type of electrode include German silver (a nickel-silver alloy), silver, gold, and platinum. Sometimes these electrodes are made of a foil of the metal so as to be flexible, and sometimes they are produced in the form of a suction electrode to make it easier to attach the electrode to the skin to make a measurement and then move it to another point to repeat the measurement. These types of electrodes are used primarily for diagnostic recordings of bio-potentials such as the electrocardiogram or the electroencephalogram.	**04**



c) **Draw and describe construction RTD. Also draw and describe characteristics of RTD** **04**



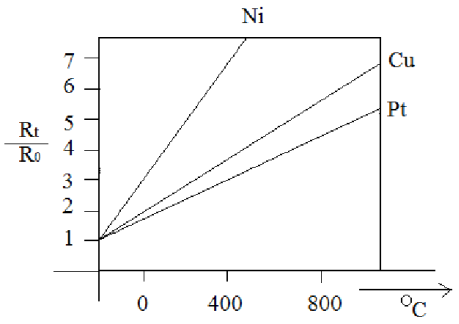
Construction of RTD:-

The RTD is a wire resistor enclosed ina protective sheath of glass, quartz, porcelain or stainless steel, depending upon the range of temperature and the pressure of air inside the sheath.-
Material used for construction RTD:

-Platinum

-Nickel
-Copper
- Tungsten

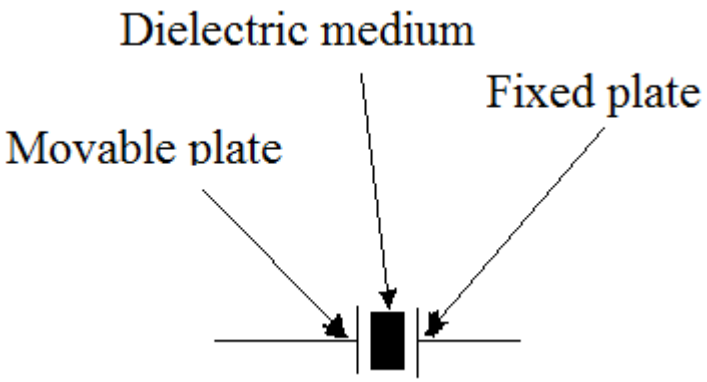
Characteristics of RTD:-



The characteristics of the RTD are as shown above. As the temperature increases the factor Rt/R0 value for different materials shows different pattern of changing. This factor generally increases with the temperature.

d) **Draw and describe working of capacitive transducer.** **04**

Ans:-



02

Construction and working: It consists of a fixed plate and a movable plate which is free to move as the pressure applied changes. According to the change in pressure the movable plate also changes its position, due to which the distance d is changed. With an increase in pressure, the distance d becomes less, due to which the capacitance C is increased (as C α 1/d). With a decrease in pressure, the distance d increases and thus capacitance C is decreased. This change in capacitance can be calibrated to measure the change in pressure.

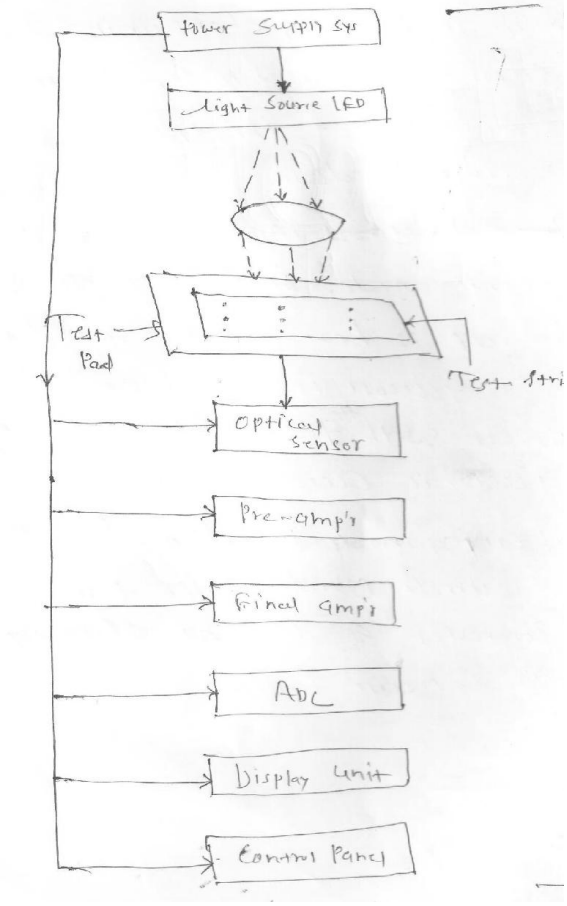
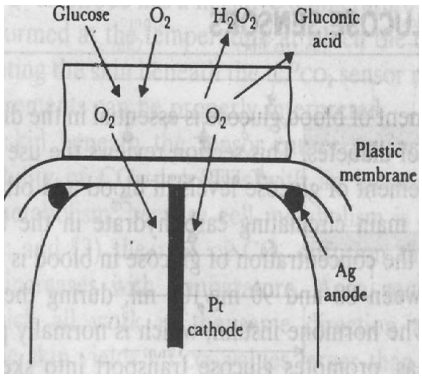
In place of a movable plate a diaphragm may be used, which expands and contacts due to change in pressure. The diaphragm plate acts as a movable plate of a capacitor. A fixed plate is placed near the diaphragm. These plates form a parallel plate capacitor which is connected as one of the arms of the arms of the bridge. Any change in pressure causes a change in distance between the diaphragm and fixed plate, which unbalances the bridge. The voltage output of the bridge corresponds to the pressure applied to the diaphragm plate. **02**

-The principle of operation of capacitive pressure transducer is based upon the familiar capacitance equation of the parallel plate capacitor, i.e.

$$C = (\varepsilon_o \varepsilon_r A/d) \text{ farad}$$

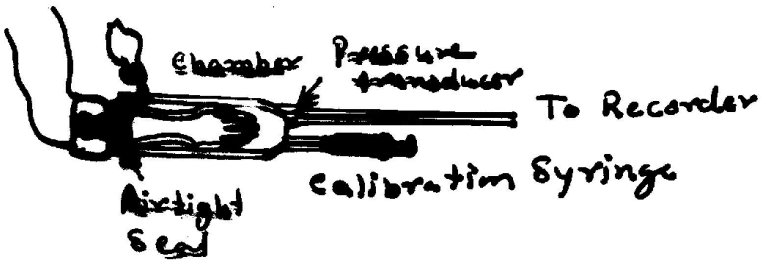
Where, C= the capacitance of a capacitor in farad

A= area of each plate in m^2

	D= distance between the two plates in m ε_o= 8.854*10^{-12} farad/m^2 ε_r = dielectric constant (relative permittivity)	
e)	**Distinguish between passive and active transducer(Any 2 points).** **-Active transducer:** 1 Transducer that converts one form of energy directly into another that is it does not require external power supply. It is self generating transducer. 2 Eg. Photovoltaic cell, thermocouple etc. 3 This transducer develops their own voltage and current. The energy required for production of an output signal is obtained by physical phenomena being measured. **-Passive Transducer:** 1 The transducer which requires energy to be put it in order to translate changes due to measurand. It requires external power supply. 2 Eg: LVDT, Strain gauge.	**04**
f)	**How blood glucose can be measured? Draw its diagram and describe its working**  or 	**04** **02**

	The principle behind glucose meter is base on reaction that are analyses by electro chemical sensor on strip there are layer plastic base plate of other layer containing chemical. There is layer containing two electrode silicon or other similar metal there is also layer of immobilize enzyme glucose oxides and other layer containing micro crystalline potatiom terrycynide specifically the reaction of interested is between glucose and glucose oxides the glucose in blood sample react with the glucose oxides to form gluconic acid which then react with terrycynide	**02**
Q 5)	**Attempt any FOUR of the following.**	**16**
a)	**Write a detailed classification of transducer based on process used, principle and application.** 1 Active and passive transducers Active transducers convert an input physical quantity in to electrical output without any external supply. Ex Themocouple Passive transducers require external power supply. Ex RTD 2 Analog & digital transducers Analog transducers convert an input physical quantity into analog output which is a continuous function of time Ex Thermistors Digital transducers convert an input physical quantity into discrete steps of electrical output which is in the form of pulses. Ex Rotary encoder. 3 Primary & secondary transducers Primary transducers are detectors which sense a physical phenomenon. The displacement given by bourdon tube is applied to the core of LVDT to convert displacement into proportional electrical quantity. Here LVDT is secondary and bourdon tube is primary. 4 Transducers and inverse transducers Transducers are devices which convert nonelectrical quantity into electrical quantity. Ex Thermistor Inverse transducers are those which convert electrical quantity into nonelectrical quantity. Ex Piezoelectric transducers. 5 Based on Application Teperature: RTD, Thermocouple, Thermistor Pressure: Piezoelectric Displacement: LVDT Force: Straingauge, loadcell	**04**

b)	**What is Plethysmography? Describe how it is useful to record blood volume with neat diagram.**	**04**



-Plethysmography

The measurement of blood flow is the measurement of volume changes in any part of the body that results from pulsation of blood occurring with each heart beat. Such measurements are useful in the diagnosis of arterial obstruction as well as for pulse wave velocity measurement. Instruments measuring volume changes or providing outputs that can be related to them are called plethysmographs and the measurement of these volume changes is called as plethysmography.

A true plethysmography is one that actually responds to changes in volume, such an instrument consist of rigid cup or chamber placed over the limb in which volume changes are to be measured.

The cuff is tightly sealed to the member to be measured so that any changes of volume in the limb reflect as pressure changes inside the chamber.

Either fluid or air can be used to fill the chamber. Plethysmography may be designed for constant pressure or constant volume within the chamber. Hence pressure or displacement transducer must be included to respond to pressure changes within the chamber to provide the signal that can be calibrated to represent the volume of the limb.

The type of plethysmography can be used in two ways:

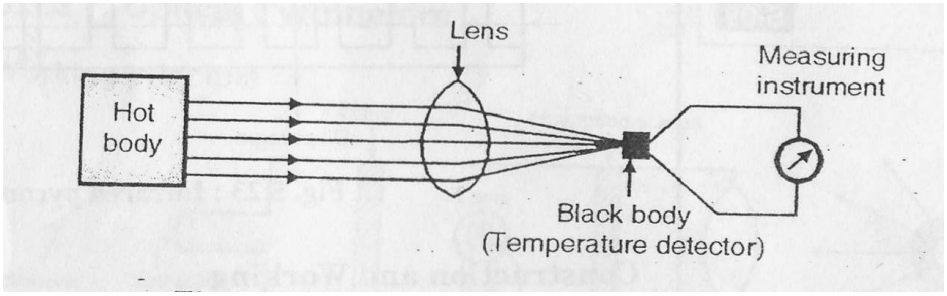
I) If the cuff placed upstream from the deal, it is not inflated; the output signal is simply a sequence of pulsation proportional to the individual volume changes with each heart beat.

The plethysmography can be used to measure the total amount of blood flowing into the limb being measured.

II) By inflating the cuff to a pressure just above venous pressure, arterial blood can flow past the cuff, but venous blood cannot leave.

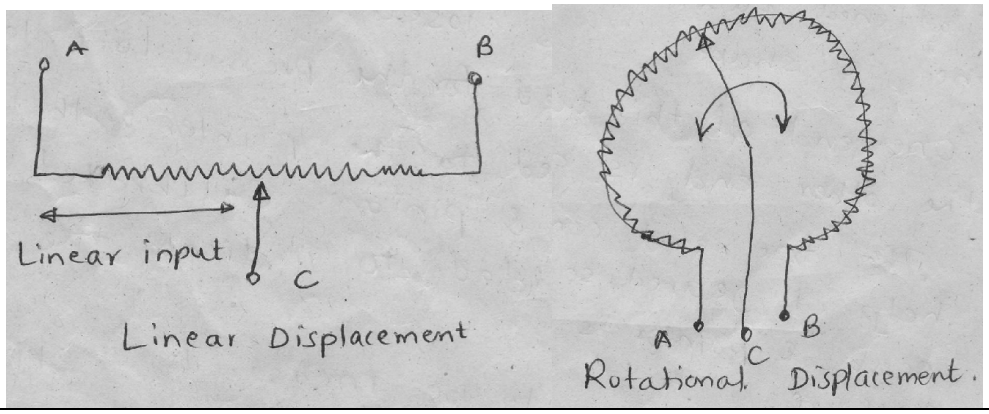
The result is that the limb increases its volume with each heart beat by the volume of the blood entering during that bit.

c)	**Define biometrics and state objective of medical instrumentation system.**	**04**
	Biometrics: The branch of science that includes the measurement of physiological variables and parameters is known as biometrics.	**01**
	Objectives of Medical Instrumentation System Cardio vascular Measurements – Blood Pressure Measurements 1. Arterial : Pressure variations from 30 to 400 mmHg. Pulsating pressure with each heartbeat. Measured at variation points in arterial circulatory system. Measured directly by implemented pressure transducer, transducer connected to catheter in blood stream, or manometer indirectly by sphygmomanometer. 2. Blood Volume measurements – Plethysmograph measurement – a measurement of local blood volume changes in limbs. This is actual change in volume measured as a displacement change in a closed cup or tube. Volume pulsations occur at rate of heart beat can also be measured indirectly with photoelectric device used to measured effectiveness of circulation, and pulse – wave velocity measurements. a) Respiration Measurements b) Temperature Measurements c) Skin Resistance Measurements d) Bioelectric Potentials 1. ECG 2. EEG 3. EMG	**03**
d)	**Define static characteristic and dynamic characteristics. Write any two dynamic characteristics.**	**04**
	Static characteristics: When the instrument is used to a measured a quantity that do not vary with respect to time than it is called as static characteristics. The qualities of measurement of an unvarying process condition are stated in terms of accuracy, repeatability, precision and sensitivity	**01**
	Dynamic Characteristics :When the instrument is used to a measured a quantity that vary with respect to time thaen it is called as dynamic characteristic. Instead of unvarying measurand the instrument is required to measure an input which is likely to change from instant to instant the dynamic response behavior of the instrument becomes important. e.g. Fidelity, speed of response	**01** **02**

e)	**List any eight basic requirement of bio-medical amplifier.** **Ans:-** 1) Low output impedance 2) High input impedance 3) High CMRR 4) High accuracy 5) High sensitivity 6) High operating range 7) High stability 8) Low non-linearity 9) Low hysteresis 10) High resolution 11) High degree of repeatability.	**04**
f)	**Describe radiation thermometry with a neat labeled diagram.**  * When physical contact with the medium to be measured is not possible or impractical due to very high temperature (above 1400 C), pyrometers are used for temperature measurement. * The operation of pyrometer is based on the principal of thermal radiation. Radiation pyrometer measured the radiant heat emitted of reflected by hot object. * Thermal radiation is electromagnetic radiation emitted as a result of temperature. * In industry where the high temperature of vapors or liquids destroys temperature measuring instruments like thermocouples, thermistors and thermometers, in that case pyrometer are used. Working – Pyrometer work on the principle of thermal radiation, which state that, the energy radiated by a hot body is a function of its temperature. The operation of thermal radiation pyrometer is based on blackbody concept. The total thermal radiation is emitted by blackbody.	**04** **02** **02**

Q.6)	**Attempt any FOUR of the following**	**16**
a)	**Describe how potentiometer can be used for the measurement of linear of angular displacement with suitable diagram.** Any resistance element that changes its resistance as a function of a physical variable can be used as a transducer for that variable. Potentiometer convert rotary motion or displacement into a change of resistance. Linear	**04**

potentiometer can be used to convert linear displacement into a resistance change.



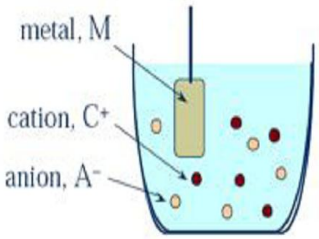
b) **Describe electrolyte electrode interface with neat diagram** **04**

Ans:-

At an electrode electrolyte interface Electrode discharges some metallic ions into electrolytic solution this can results in two different conditions either Increase in free electrons in electrode and increase in positive cations (electric charge) in solution or ions in solution combine with metallic electrodes that decrease in free electrons in electrode and decrease in positive cations in solution. As a result, a charge gradient builds up between the electrode and electrolyte and this in turn creates a potential difference. **02**

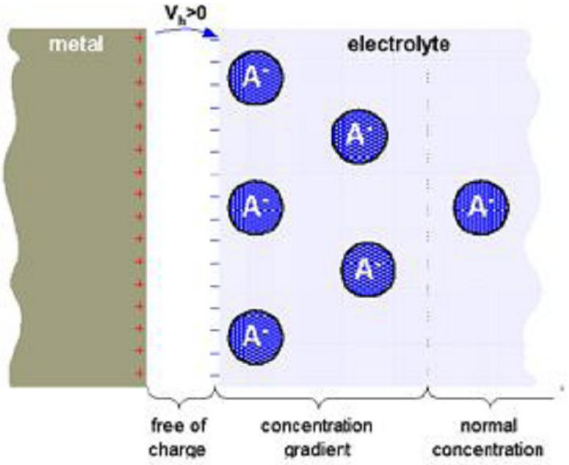
- Current flow from electrode to electrolyte : Oxidation (Loss of e-)
- Current flow from electrolyte to electrode : Reduction (Gain of e-).

For both mechanisms, (Oxidation = Loss of e-, and reduction = Gain of e-), two parallel layers of oppositely charged ions are produced; i.e. the electrode double layer



$M \rightarrow M^{+} + e^{-}$

$C^{+} + e^{-} \rightarrow C$



02

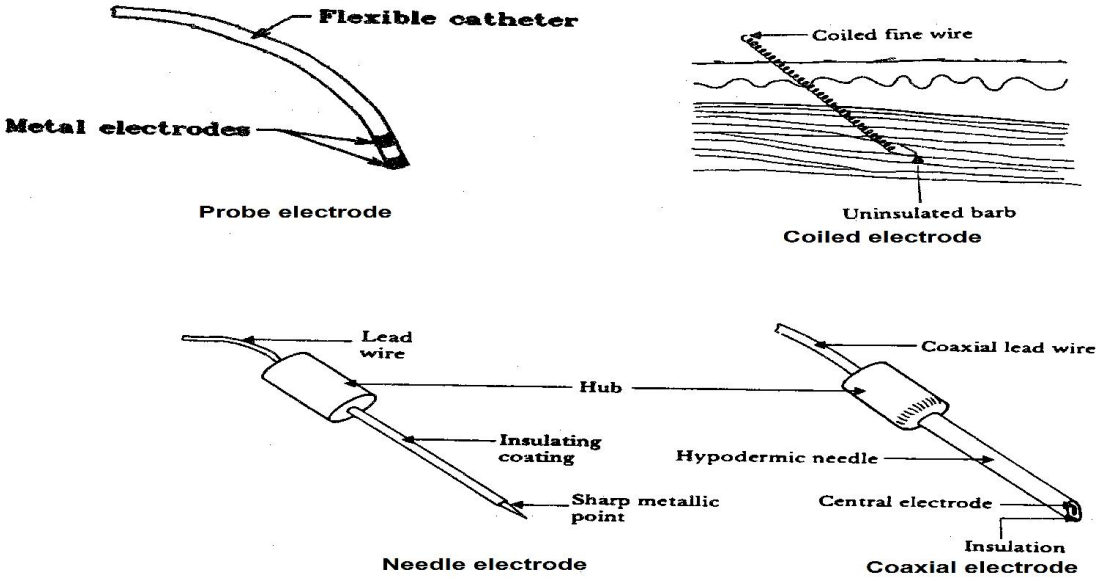
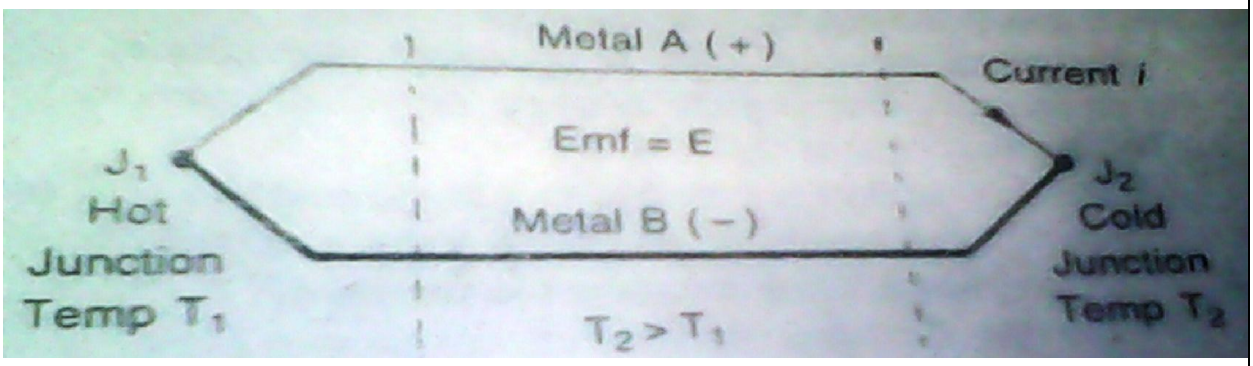
c) **Describe internal electrode with neat labeled diagram.** **04**

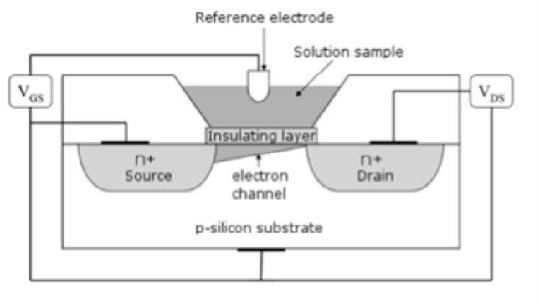
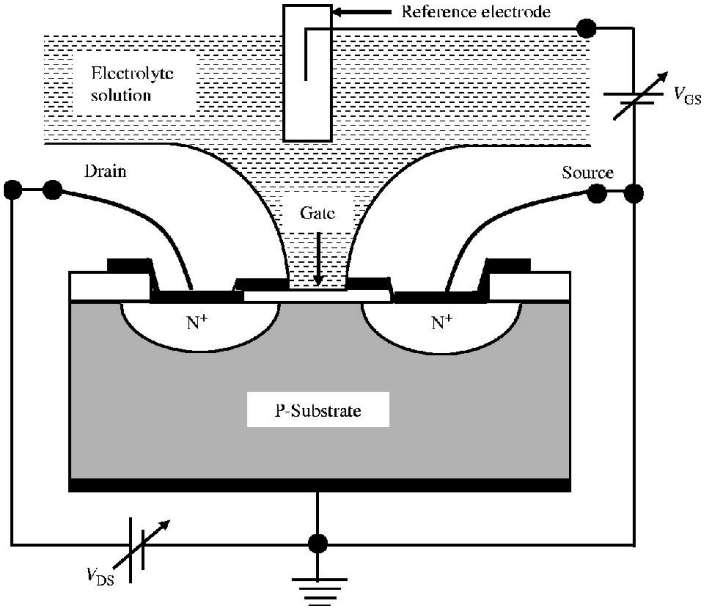
Ans:-

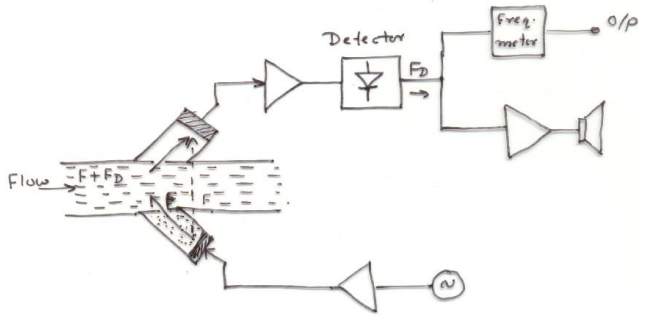
Electrodes can be placed within the body for bio-potential measurements. These electrodes are generally smaller than skin surface electrodes and do not require special electrolytic coupling fluid, since natural body fluids serve this function. There are many different designs for these internal electrodes. Basically these electrodes can be classified as needle electrodes, which can be used to penetrate the skin and tissue to reach the point where the measurement is to be made, or they are electrodes that can be placed in a natural cavity or surgically produced cavity in tissue. A catheter tip or probe electrode is placed in a naturally occurring cavity in the body such as in the gastrointestinal system. A metal tip or segment on a catheter makes up the electrode. The catheter or, in the case where there is no hollow lumen, probe, is inserted into the cavity so that the metal electrode makes contact with the tissue. A lead wire down the lumen of the catheter or down the center of the probe connects the electrode to the external circuitry. **02**

Types of Internal Electrode:-

1) Probe electrode

	2) Needle electrode 3) Coaxial electrode 4) Coiled electrode 	**02**
d)	**State Seebeck effect. Write any two construction material for** **i) RTD** **ii) Thermocouple** **iii) Thermistor** **Ans:-**  The operation of the thermocouple is based on the seebeck effect. When the heat is applied to junction (hot junction) of two dissimilar metals, an emf is generated which can measured at the other junction (cold junction). The two dissimilar metals form an electric circuit, and a current flows as a result of the generated emf. This current will continue to flow as long as $T_1 > T_2$. Metal B is describe as –ve with respect to a metal A if current flows into it at the cold junction. The emf produces is function of the difference in temperature of hot and cold junctions and is given by: $E = a\triangle\theta$ Where $\triangle\theta$ = difference between temperatures of hot and cold junctions. 1) RTD – Platinum, Copper, Gold, Silver, Nickel wire	**04** **01** **01**

	2) Thermocouple – Iron, Constantan, Copper, Chromel, Platinum, Tungsten, rhodium, Silver, Manganese, Alumel	**01**
	3) Thermistor – Manganese, Nickel, Cobalt, Copper, Iron	**01**
e)	**Describe Ion sensitive field effect transistor (ISFET) with neat labeled diagram.** **Ans:-**  **OR**  An ISFET (Ion Sensitive Field Effect Transistor) is used for measuring ion concentration in the solution. When the ion concentration such as H^+ changes, the current through the transistor will change accordingly. Here the solution is used as Gate electrode. A voltage between substrate and oxide surfaces arises due to an ion sheath. An ISFET's source and drain are constructed as for MOSFET. The gate electrode is separated from the channel by a barrier which is sensitive to hydrogen ion and a gap to allow the substance under test to come in contact with sensitive barrier. An ISFET's threshold voltage depends on the pH of the substance in contact with its ion-sensitive barrier.	**04** **02** **02**

f)	**Describe ultrasonic flow meter with a neat labeled diagram.**	**04**
		**02**
	-In ultrasound blood flow meter a beam of ultrasonic energy is used to measure velocity of flowing blood. This can be done in two ways. In transist time ultrasonic flow meter pulsed beam is directed to a blood vessel through a shallow angle and it's transmit time is measured. When blood flow in the direction of energy transmission the transmit time is shorted. If it flows in opposite direction the transmit time will be lengthen. The ultrasonic flow meter based on Doppler principle and oscillator operating at frequency of several MHz excites piezoelectric transducer. This transducer is coupled through a wall of exposed blood vessels and sends the ultrasonic beam with frequency floating through blood. Small part of transmitted energy is scattered back and is received by second transducer arranged opposite to first one. Because the scattering occurs mainly as a result of moving blood cells, reflected signal has a different frequency due to Doppler Effect. This frequency is either f + f_d or f - f_d depending on the direction of flow. The Doppler component f_d proportional to the velocity of flowing blood A fraction of transmitted ultrasonic energy, however, reaches the second transducer directly, with the frequency being unchanged. After amplification of the composite signal the Doppler frequency can be obtained at the output of the detector as the difference between direct and scattered signal components. With the blood velocity in the range normally encountered the Doppler signal is typically in the low frequency range. Because of the velocity profile of the flowing blood the Doppler signal is not a narrow band noise therefore from the loud speaker or earphone the Doppler signal of pulsation blood flow can be heard as characteristics swish. When the transducers are placed in a suitable mount which defines the area of blood vessels frequency meter is used to measure Doppler frequency can be calibrated in flow rate units.	**02**