SUMMER– 15 EXAMINATION

Subject Code: 17442 **Model Answer** Page No: 1/ 23

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.

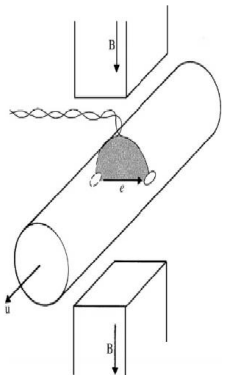
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.

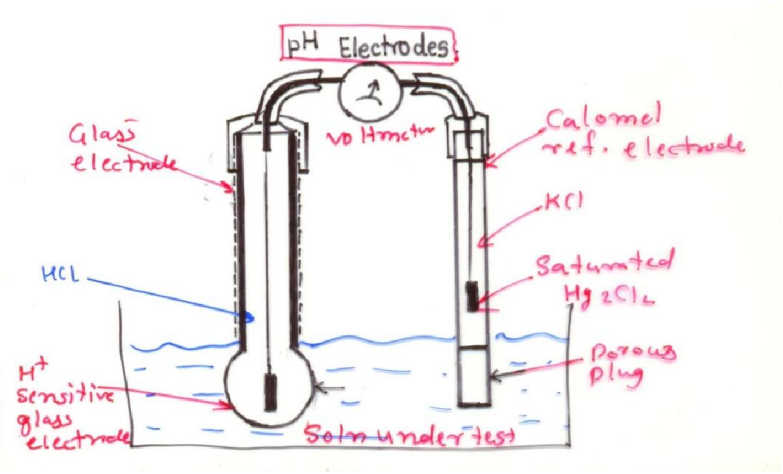
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

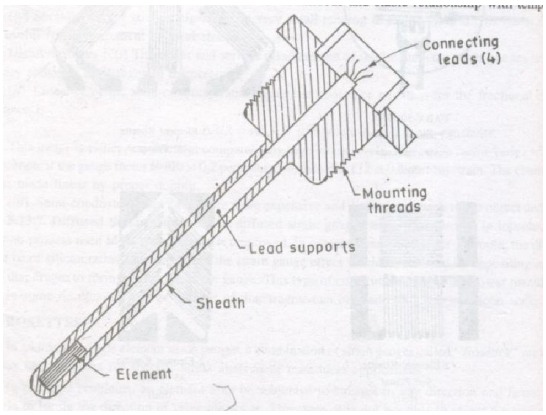
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

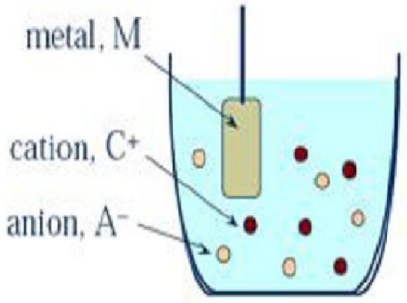
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

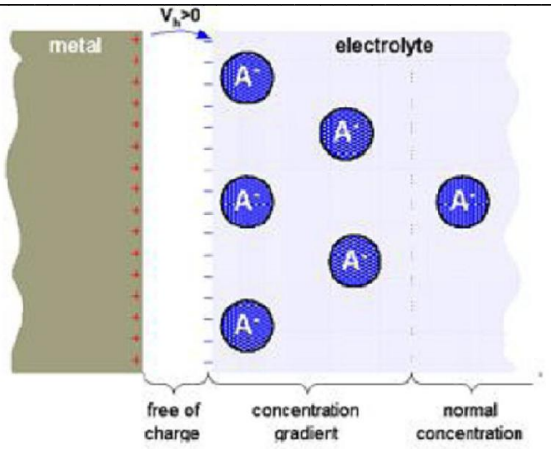
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1.	**Attempt any six of the following**	**12**
a)	**Define Biometrics. List any two biosensors.(1m +1m)** Ans: The branch of science that includes the measurement of physiological variables and parameters is known as biometrics. Biosensors are 1.Resistance Temperature Detector 2. Thermocouple. 3 Bourdon tube (or any other sensors related to temperature, flow, pressure)	02
b)	**List four constraints of Man Instrumentation System**. Ans : General constraints in design of Man 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
c)	**Describe the principle of Electromagnetic blood flow meter with the help of Faradays law of electromagnetic Induction** Ans : 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  	02

	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.	
d)	**State four materials used for manufacturing of thermistor.** Ans: Materials Used: The thermistors are made up of ceramic like semiconducting materials. They are mostly composed of oxides of manganese, nickel and cobalt	02
e)	**Draw a labeled diagram of PH meter** . Ans:  Fig:PH-meter OR ANY OTHER RELEVANT DIAGRAM	02
f)	**State function of electrode jelly used to place an electrode on the patients body.** **Ans:-** 1. Jellies have been used to facilitate a more intimate contact between the subject's skin and the recording electrodes. 2.Thus reducing the skin contact impedance.	02
g)	**State seebeck effect.** Ans: When any conductor is subjected to a thermal gradient, it will generate a voltage. This is now known as the thermoelectric effect or Seebeck effect or The use of thermoelectric effect to convert from thermal to electrical energy is called Seebeck effect .	02

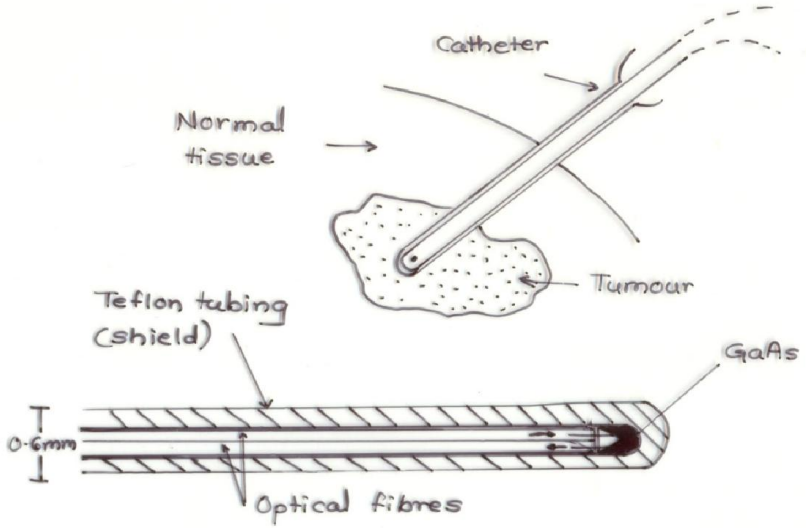
h)	**Draw the constructional diagram of RTD** Ans:  **Fig:RTD**	02
(B)	**Attempt any two**	**08**
a)	**Distinguish between Active and Passive transducers.**(Any two points of each) Ans: - **Active transducer:** 1 Transducer that converts one form of energy directly into another that is it does not require 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
b)	**Describe working of piezoelectric transducer** **Ans**:Assymetrical crystalline materials such as :Quartz, Rochelle salt, Barium Titanate and PZT(Lead Zirconate Titanate) produce an EMF when they are placed under stress. This property is used in piezoelectric transducers where a crystal is placed between a solid base and force summing member. When an external force appears on the top the crystal, it produces an EMF across the crystal, which is proportional to the magnitude of the applied pressure. This is self generating type of transducer.	04
c)	**State the basic requirements of bio-amplifier (any eight points)** **Ans:** Amplifier is an important part of modern instrumentation systems for measuring biopotentials. Such measurements involve voltages that often are at low levels, have high source impedance or both. Amplifiers that have been designed specifically for this type of	04

	processing of biopotentials are known as biopotential amplifiers. Basic requirements of biopotential amplifiers 1. Biopotential amplifiers must have high input impedance so that they provide minimal loading of signal being measured. Input impedance that least 10 M ohm 2. Biopotential amplifiers should have isolation and protection circuitry, so that the current through the electrode circuit can be kept at safe levels and any artifact generated by such current can be minimize. 3. Output Impedance of amplifier must be low with respect to the load impedance, and the amplifier must be capable of supplying the power required by load. Load is usually an indicating or recording device. 4. Biopotential amplifiers must have high gains of the order of 1000 or greater biopotential signals usually have amplifiers of the order of few miili volts or less such signals must be amplified to levels compatible with recording & display devices. 5. Biopotential differential amplifier must have high common mode rejection ratio to minimize artifact due to the common mode signal. 6. Final requirement for biopotential amplifiers that are used both in medical applications & in the laboratory is that they make quick calibration possible. 7. BioAmplifiers are required to increase signals strength while maintaining fidelity. 8 Some biopotential amplifiers have additional requirements that are application specific.	
2.	**Attempt any four**	**16**
a	**Describe electrode electrolyte interface**. 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. - 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.  $M \rightarrow M^+ + e^-$ $C^+ + e^- \rightarrow C$	04



b) **With the help of neat labeled diagram give constructional details of GaAs semiconductor temperature probe.** **04**

(Diagram 2 marks + explanation 2 marks)

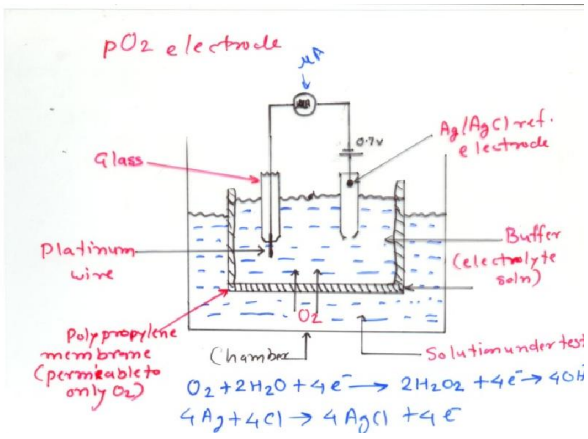


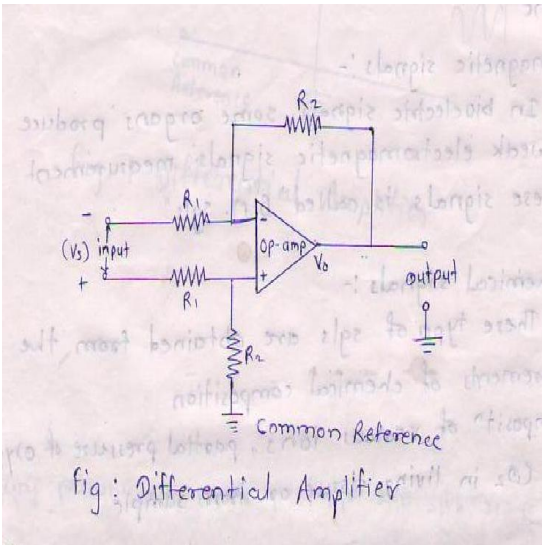
-The figure shows GaAs semiconductor temperature probe. Small prism shape sample of single crystal undopped GaAs is epoxid at the end of two side by side optical fibers. The sensors of fibers are quite small and compatible with biological implementation been sheathed. One fiber transmits light from a LED source where it is passed through GaAs and collected by other fiber for detection in the read out.

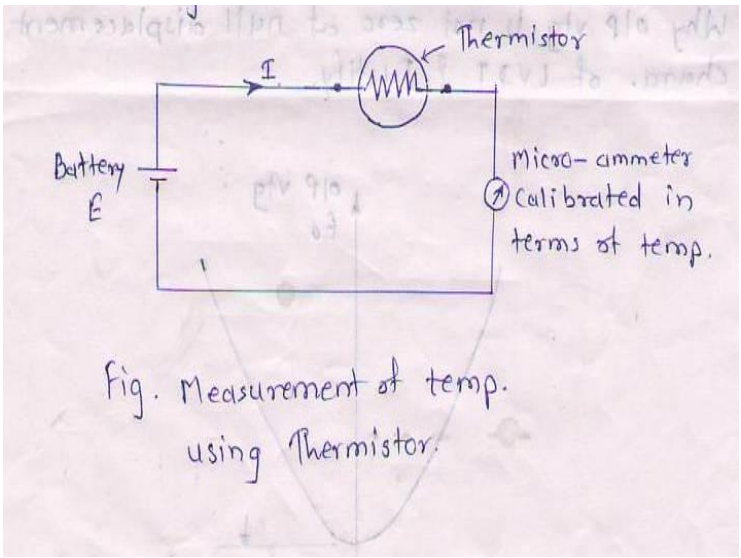
Some of the optical power travelling through semiconductor is absorbed by the process raising valance band electron across forbidden energy gap into the conduction band because the forbidden energy gap is a sensitive material for temperature. Amount of power absorbed is increased with temperature.

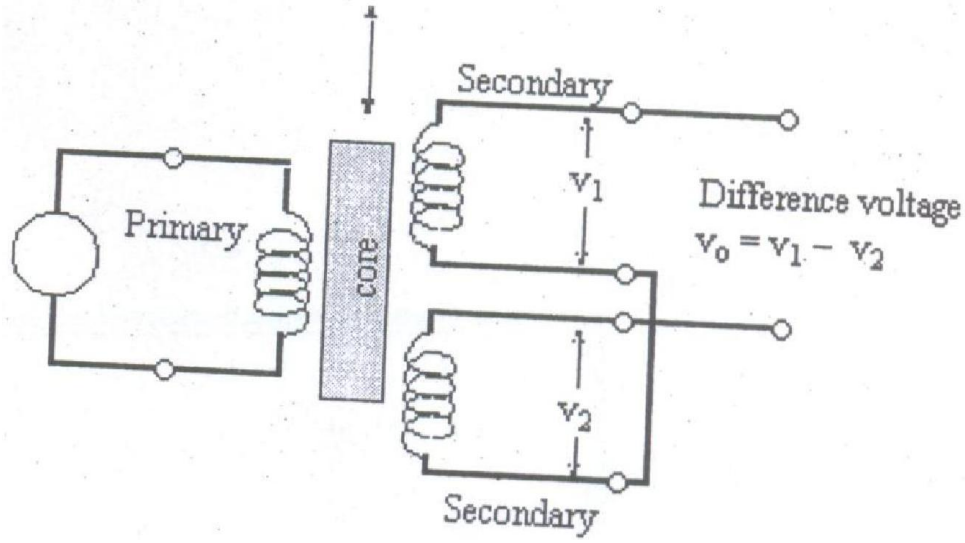
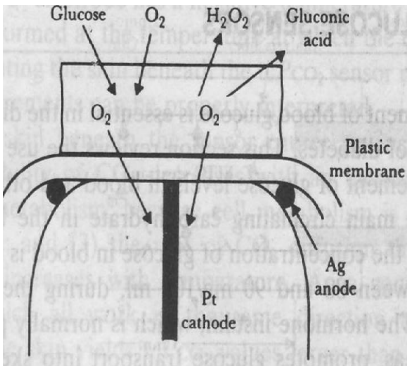
This non metallic probe is particularly suitable for temperature measurement in the strong electromagnetic heating field used in heating tissue for cancer therapy.

	Single sensor probe with an outer diameter of 0.6mm and 4 point temperature sensor probe of 1.1mm diameter based on this technique are commercially available.	
c)	**Describe any four factors that should be considered while designing any Man Instrumentation System.** Ans: Consider any 4 factors **1.Inaccessibility of variables to measurement** – It is one of the greatest problems in attempting measurements from a living system is the difficulty in gaining access to the variable being measured. e. g. In cases such as in measurement of dynamic nerochemical activity in the brain it is impossible to place suitable transducer in a position to make measurement. **2. Variability of the Data** – Measurements taken under a fixed set of conditions at one time will not necessarily be the same as similar measurements made under the same conditions at another time. Variability from one subject to another is even greater. **3. Lack of knowledge about relationship** – Variability in measured values could be better explained it more were known and understand about the interrelationship within the body. **4. Interaction among Physiological Systems** – Because of large number of feedback loops involved in the major physiological systems, a severe degree of interaction exists both within a given system and among the major systems. Result is that stimulation of one part of a given system generally affects all other parts of that system in some way. For this reason, 'cause and effect' relationships become extremely unclear and difficult to define. **5 Effect of transducer on measurement** – In many situation the physical presence of the transducer changes the reading significantly for e.g. a large flow transducer placed in a blood stream partially blocks. **6. Artifacts** – Artifacts refers to any component of a signal that is extraneous to the variable represented by the signal. Thus, random noise generated within the measuring instrument electrical interference (including 60 Hz pickup), cross talk, and all other unwanted variations in the signal are considered Artifacts. **7.Energy Limitations** – Many physiological measurement techniques require that certain amount of energy be applied to living system in order to obtain measurements. E.g. a resistance measurement requires the flow of electric current through tissue or blood being measured. In some cases this energy level is so low that its effect is insignificant. Energy concentration should also be avoided that might damage cells or affect the measurement.	**04**
d)	**Describe flow measurement by thermal convection.** Ans: Thermal velocity sensors depend on convective cooling of a heated sensor and are therefore sensitive only to local velocity. A hot object in colder-flowing medium is cooled by thermal convection. The rate of cooling is proportional to the rate of the flow of the medium. This principal is often used for measurement of blood velocity. In one of the method an electric heater is placed between two	04

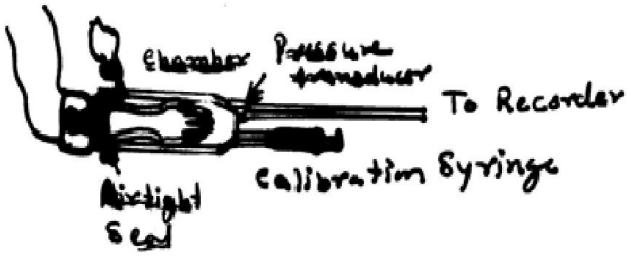
	thermocouples or thermistors that are located some distance apart along the axis of the vessel. The temperature difference between the upstream and the downstream sensor is a measure of blood velocity.	
e)	**An unbounded strain guage has resistance of 3000 ohms and Guage factor of 3.2,what will be the change in resistance due to 1500 micron strain.** **Ans: Given:** R = 3000 ohms Gf = 3.2 strain = Δ L/L = 1500 Δ R= unknown Fomula: $Gf = \frac{\Delta R/R}{\Delta L/L}$ 1mark $= \frac{\Delta R/3000}{\Delta L/L}$ $3.2 = \frac{\Delta R/3000}{1500}$ (1mark) Therefore Δ R = 3.2 x 1500 x3000 Change in resistance = 14.4 ohms 2marks	**04**
f)	**Describe electrode used to measure partial oxygen pressure in the blood with suitable diagram.** Ans  Fig:PO_2 Electrode The PO_2 electrode is known as Clark electrode after its inventor and it is an O_2 sensor for blood. The electrode arrangement consists of two chambers and they are separated by polypropylene membrane i.e. permeable to O_2. The blood sample is injected into lower sample chamber as shown in the figure. The upper chamber contains the electrode. The O_2 in the blood permits the polypropylene membrane and reacts chemically with a phosphate buffer contained in the upper chamber. The buffer maintains the solution pH at a constant level. The O_2 combines with water in the buffer producing electrons proportion to the number of O_2 molecules according to the	**04**

	formula: $O_2 + 2H_2O + 4e^- \rightarrow 4[OH]^+$ The electron current is measured by the ammeter. It is directly proportional to PO_2. Electrons on the left side of the equation are produced by a source voltage that polarizes the electrode and has value 0.7V. This voltage is called polorographic voltage. The electrode is called Clark's polorographic electrode. The meter scale is calibrated in units of PO_2 in the blood. This electrode current depends on current blood in the solution rather than membrane potential as it was in pH measurement.	
Q3)	**Attempt any four**	**16**
a)	**Define : (i) Bio-magnetic signals** **(ii) Bio-chemical signals** **(iii) Bio-mechanical signals** **(iv) Bio-acoustic signals** **(v) Bio-magnetic signals :-**In bioelectric signals, some organs produce very weak electromagnetic signals, measurement of these signals is called "Bio-magneticsignals." **(i) Bio-chemical signals :-** These types of signals are obtained from the measurements of chemical compositions. Eg- composition of various ions, partial pressure of oxygen or co2 in living tissues or from sample **(iii) Bio-mechanical signals :-**These signals are obtained from mechanical function of biological system it includes all types of motion and displacement signal.Eg.Motion of chest wall. **(iv) Bio-acoustic signals:** These signals are obtained from sounds created by Biological system and provide information about underlying phenomenon .Eg. Flow of blood in heart through valves, flow of air in lungs.	**04**
b)	**Draw a Differential Amplifier. State its importance.** **Ans:** **Diagram:**  fig : Differential Amplifier	**04**

	Importance:1)The signal from the transducer is a very low level signal. It has to be amplified using the differential amplifier. 2) all amplifiers used in biomedical application are isolation amplifiers. It is mandatory for any biomedical equipment for the purpose of patient safety to have isolation from the mains supply.	
c)	**Describe Polarizable and Non-polarizable electrodes.(2+2)** **Polarizable electrodes:** Perfectly Polarizable electrodes are those in which no actual charge crosses the electrode-electrolyte interface when a current is applied, acts like a capacitor Eg: Platinum electrode. **Non-polarizable electrodes:** Perfectly Non-polarizable electrodes are those in which current passes freely across the electrode-electrolyte interface, acts like a resistor.Eg: Silver Chloride electrode, Calomel electrode.	**04**
d)	**List four advantages of thermistor with a neat labeled diagram.(2+2)** -Thermistors are 1)Compact 2) Rugged 3)Inexpensive 4)Excellent long term stability characteristics 5) It requires simple circuitry 6) Available in various shapes. Eg. Beads, chips, rods, and washers. Diagram:  Fig. Measurement of temp. using Thermistor. (or any other relevant diagram)	**04**

e)	**Describe how displacement can be measured using LVDT with suitable diagram** **Ans:**  **Fig : LVDT** 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.	**04**
f)	**Describe Blood Glucose Sensor with neat labelled diagram.**  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 potatiomterrycynide 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	**04**

	terrycynide	
Q 4.	**Attempt any Four**	**16**
a)	**What is Plethysmography? Describe how it is useful to record blood volume.**	**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.

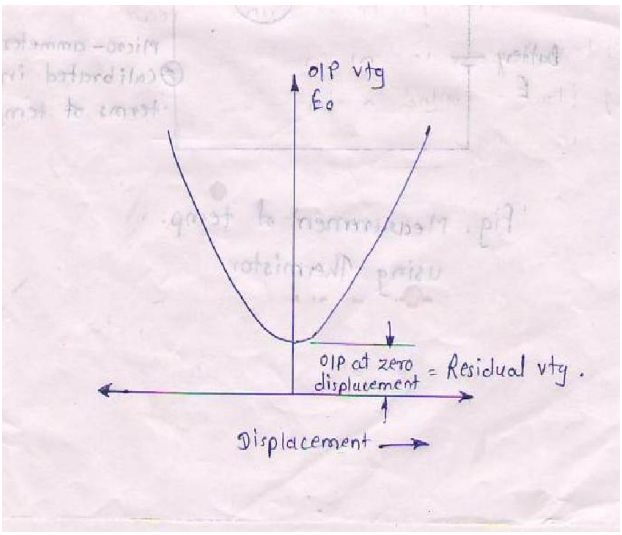
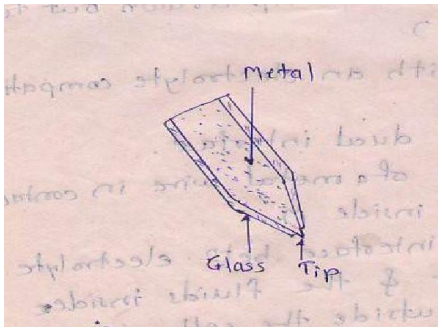
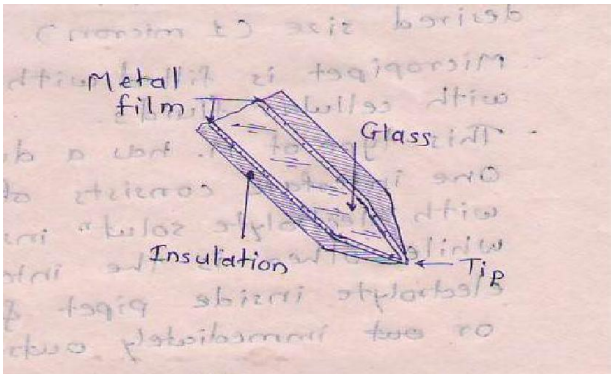
b)	**Why output voltage is not zero at null displacement in characteristics of LVDT? Justify.** Diagram:  Ideally the output voltage at null position should be equal to zero. But in actual practice there exists a small voltage at null position because of following reasons :- 1) Presence of harmonics in input supply voltage. 2) There may be either an incomplete magnetic or electrical unbalance. 3) Stray magnetic fields and temperature effects. 4) It is generally less than 1% of maximum output voltage.	**04**
c)	**Describe any two microelectrodes used for measurement of biopotential with the help of diagram.** **(2+2)** **Ans: Diagram** Metal micro electrode:  	**04**

	Fig: Metal micro Electrode They are formed by electrolytically etching tip of a fine tungsten or stainless steel wire to desired size.Then wire is coated almost to tip with an insulating material some electrolytic processing can also be performed on tip to lower impedance. The metal ion interface takes place where metal tip compact electrolytes either inside or outside the cell. Micropipet micro electrode:  Fig:Micropipet micro electrode It is a glass micro pipet with tip drawn out to desired size. Micropipette is filled with an electrolyte compatible with cellular fluids. This type of micropipette has dual interface. One interface consists of a metal wire in contact with electrolyte solution inside the micropipette while other is interfaced between electrolyte inside the pipet and the fluids inside or immediately outside the cell.	
d)	**Describe working of Radiation Thermometry with a neat diagram.** -Ans :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**

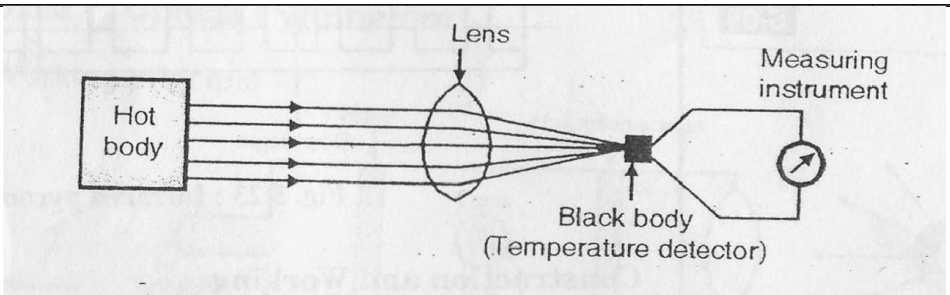


Diagram of radiation thermometry

e) **Define any four dynamic characteristics.** **04**

1)Speed of Response:- It is defined as the rapidity with which a measurement system responds to changes in the measured quantity.

2) Measuring Lag :- It is the retardation or delay in the response of a measurement system to changes in measured quantity. It is of 2 Types A) Retardation type B) Time delay type.

3)Fidelity :- It is defined as the degree to which a measurement system indicates changes in a measured quantity without any dynamic error.

4) Dynamic Error / Measurement Error :- It is the difference between true value of quantity (under measurement system if no static error is assumed.

f) **Describe importance of measuring electrode and reference electrode.** **04**

(Or consider any other electrode PO2, PCO2)

PH electrode:

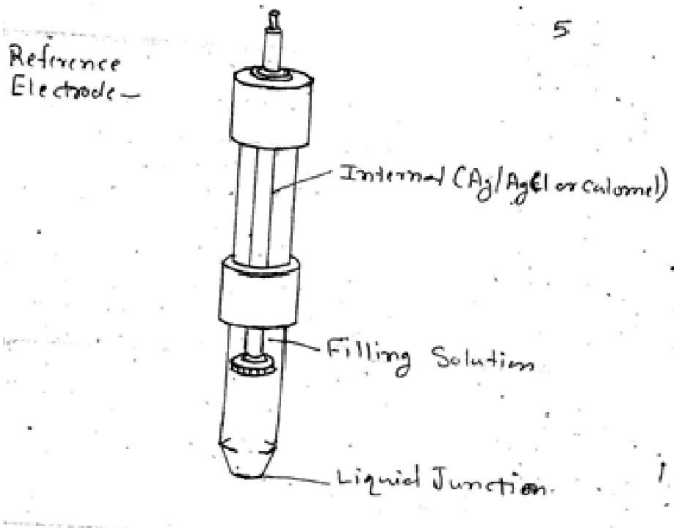


Fig: pH Electrode

- Ag/AgCl electrode:

In this electrode, the ionic side of interface is connected to the solution by an electrolyte bridge. For this a dilutee potassium chloride (KCl) filling solution which forms a liquid junction with the sample solution is used. The electrode can be used as reference electrode, if the KCl solution is also saturated with precipitate of silver chloride. The electrode potential for Ag/AgCl reference electrode depends on concentration of KCl. For electrode with a 0.01 mole solution of KCl has an electrode potential of 0.343V. Whereas for 1 mole solution the potential is only 0.236V.

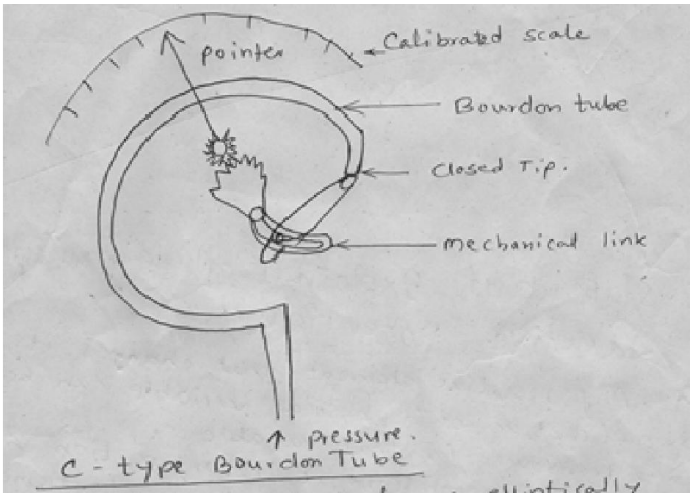
OR

Hg/HgCl (Calomel) electrode:

The calomael is another name of mercurous chloride. It is the chemical combination of mercury and chloride ions.The interface between mercury and mercurous chloride generates the electrode potential by placing the calomel side of interface in the KCl filling solution, an electeolytic bridge is formed in the sample solution from which measurement is to be made.
It is stable over a long period of time same as Ag/AgCl electrode. The electrode potential of calomel electrode is dependend on the concentration of KCl and electrode with a 0.01 mole solution of KCl has an electrode potential 0.300V whereas, a saturated KCl solution about 3.5 moles has a potential of only 0.247V.

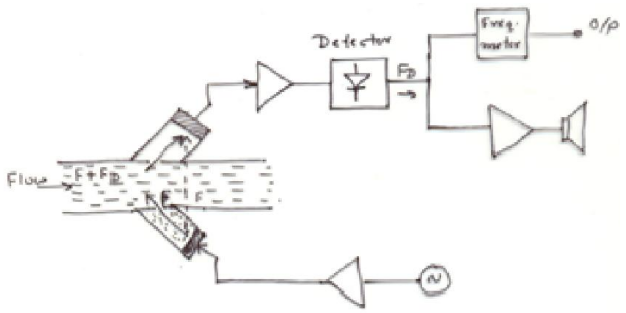
5)	**Attempt any four :**	**16**
a)	**Draw a labelled diagram of C shape Bourdon tube. Describe its working for pressure measurement. (Marks – Draw - 2, explanation - 2)**	**04**

Working principal of C type of Bourdon tube.



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. 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.

b) **Describe working of ultrasonic flow meter.** **04**



-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.

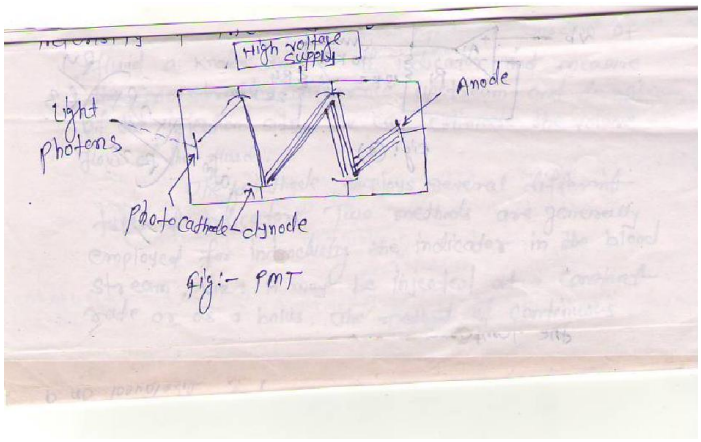
When blood flow in the direction of energy transmission the transmit time is shorted. If it flows in opposite direction the transmit time will be lengthen.

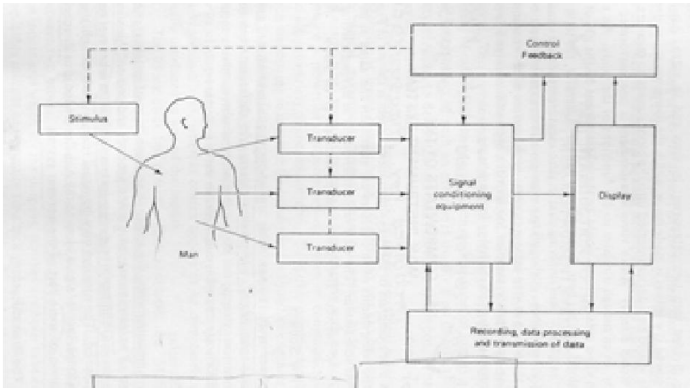
The ultrasonic flow meter based on Doppler principle and oscillator operating at frequency of several MHz excites piezoelectric transducer. This transducer is coupled through a wall of exposed blood vessels and sends the ultrasonic beam with frequency floating through blood.

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 + fd or f - fd depending on the direction of flow. The Doppler component fd proportional to the velocity of flowing blood A fraction of transmitted ultrasonic energy, however, reaches the second transducer directly, with the frequency being unchanged.

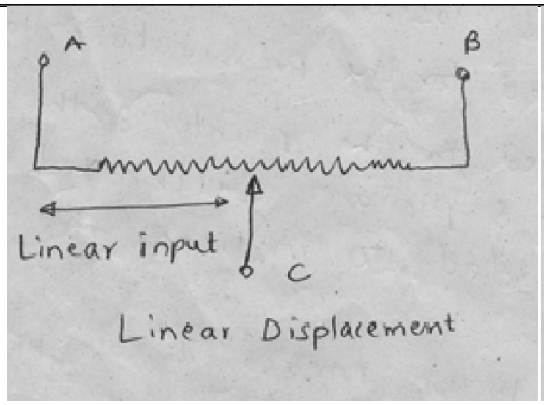
After amplification of the composite signal the Doppler frequency can be obtained at the output of the detector as the difference between direct and scattered signal components. With the blood velocity in the range normally encountered the Doppler signal is typically in the low frequency range.

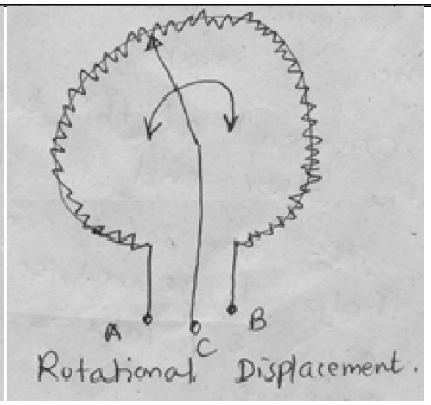
Because of the velocity profile of the flowing blood the Doppler signal is not a narrow band noise

	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.	
c)	**With help of a neat labelled diagram give constructional details of (Photomultiplier tube) PMT and describe its working.** **(Diagram 2 marks + explanation 2 marks)**  **Fig:The photo multiplier tube** The photo multiplier tube is the one part of detector .Which is used for convert light photons into electrons . The PMT consist of photocathode , dynodes, anode . The photocathode which is used for convert light photons into electrons and these electrons passes towards the dynodes .The dynodes are used for increases the number of electrons (multiplication of the electrons). The separate high voltage supply required for charging the dynodes .the dynodes are made of using metallic material and on which positive charge . finally all electrons passes toward the anode and generate electrical signal at the output of the anode.	**04**
d)	**Calculate the gain of the configuration shown in fig. (a) Also calculate the output voltage , if Va= 10 mV and Vb = 5 mV** **Solution:** The overall gain of the instrumentation amplifier is given by **AV= [1+2R1/R2] R4/R3** **1mark** Here, R1= 10kΩ , R2 = 2kΩ , R3 = 10kΩ , R4 = 22kΩ Gain Av = [1+2*10kΩ/2kΩ]22kΩ/10kΩ [1+10]*11/5 11*11/5 121/5 **AV = 24.2** **1mark**	**04**

	Calculate output voltage if Va = 10 mV and Vb = 5 mV **Solution: The output voltage** **Vo = AV*(Va –Vb) 1mark** = [1+2R1/R2] R4/R3 (Va –Vb) = 24.2(10 mV-5 mV) =24.2*5 mV **Vo = 121 mV 1mark**	
e)	**Define Accuracy , Sensitivity , Range , Linearity , with respect to measurement system.** **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. **Sensitivity:** It describes the transfer ratio of output to input. **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. **Range:** The range of an instrument is generally considered to include all the levels of input amplitude and frequency over which the device is expected to operate.	**04**
f)	**Draw block diagram of Man Instrumentation system. State function of any two blocks. (Marks – Draw and names – 2m and Function of two blocks – 2m)**  **Fig:Man Instrumentation system.** 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.	**04**

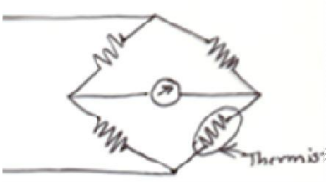
	iii) The Transducer – A device capable of converting one form of energy or signal to another. Here each transducer is used to produce an electrical signal that is analog of the phenomenon. Transducer may measure temperature, pressure, flow or any other variables found in body. iii) Signal condition equipment – 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.	
Q. 6)	**Attempt any four of the following.**	**16**
a)	**Describe how potentiometer can be used for the measurement of linear & angular displacement with suitable diagrams.** Ans :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 potentiometer can be used to convert linear displacement into a resistance change.	**04**





b) **Describe how Whetstone's bridge can be used for temperature measurement with a suitable diagram.** — **04**

(Diagram 2 marks + Explanation 2 marks)



To measure temperature with thermistor it is placed in the environment whose temperature is to be measured. As the temperature of substance increases the resistance of thermistor decreases and vice-versa.

Generally thermistor is placed as one leg of Wheatstone bridge at a balanced condition, when there is no change in the temperature, the galvanometer indicates zero. As temperature increases or decreases the resistance of thermistor increases or decreases. Due to which the Wheatstone

bridge circuit becomes unbalanced. Thus deflection of the galvanometer can be calibrated as temperature scale.

c)	**Describe indicator dilution method of flow measurement.**	**04**

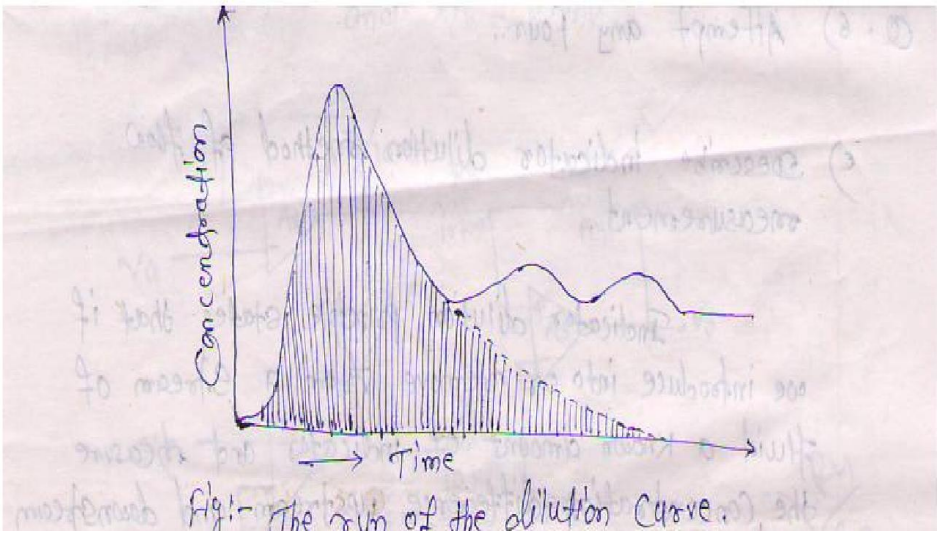
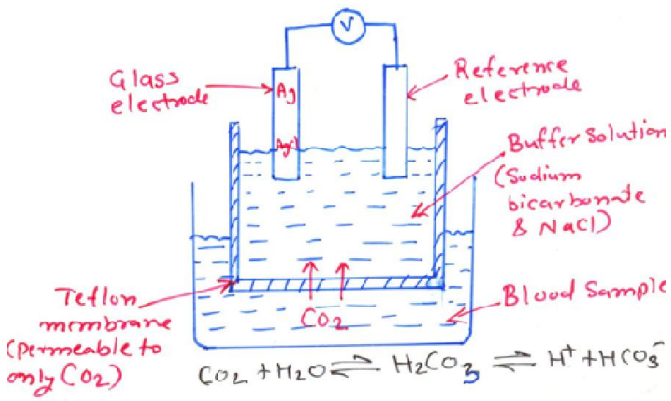


Fig :The run of dilution curve

Indicator dilution principle states that if we introduce into or remove from a stream of fluid a known amount of indicator & measure the concentration difference upstream & downstream of the injection site , we can estimate the volume flow of the fluid. Two methods are generally employed for introducing the indicator in the blood stream ,it may be injected at a constant rate or as a bolus. The method of continuous infusion suffers from the disadvantage that most indicators recirculate ,& this prevents a maxima from being achieved. In the bolus injection method , a small but known quantity of an indicator such as a dye or radioisotope is administered into the circulation. It is injected into a large vein or preferably into the right heart itself . After passing through the right heart ,lungs& the left heart. The indicator appears in the arterial circulation . The presence of an indicator in the peripheral artery is detected by a suitable (photoelectric) transducer &is displayed on a chart recorder.

This way we get the cardiac output curve shown in fig. This is also called dilution curve.

d)	**Describe PCO2 electrode with a neat labeled diagram .**	**04**



(Diagram 2 marks + Explanation 2 marks)

The pH electrode is used as a component of a PCO2 electrode to measure the partial pressure of CO2 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 PCO2 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 CO2 into the solution. CO2 combines with H2O so as to produce free hydrogen ions.

e) **What are motion artifacts? How it can be reduced?** **04**

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. This motion artifact can be a serious cause of interference in the measurement of biopotentials.Motion artifacts must be as less as possible. Avoid the motion of the patient body. Also take precautions for no movement of the electrodes. Improper anesthesia may cause unwanted changes in the human body. Muscle tremors also can cause artifacts.

f) **A platinum RTD has a resistance of 100Ω at 25°c.** **4**

(a) Find its resistance at 50°c. The resistance temperature coefficient of platinum is 0.00392Ω/Ω°c.

(b) If the RTD has resistance of 120 Ω ,calculate the temperature .

Solution:(a) using the linear approximation , the resistance at any temperature Θ°C is

$Rt=Ro(1+ \alpha \Delta t)$ **1mark**

Given , Resistance at 50°C is ,

R50 =100 [1 + 0.00392 (50-25)]

R50 = 109.8 Ω **1 mark**

Solution:(b) Suppose t is the unknown temperature ,

120 = 100 [1+0.00392 (t - 25)] **1 mark**

120 = 100 [1+0.00392t - 0.098]

120 = 100 [0.902 + 0.00392t]

120 =90.2 +0.392t 29.8 = 0.392t

t=76.02 °c **1 mark**