SUMMER– 18 EXAMINATION

Model Answer Subject Code: 17442

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.

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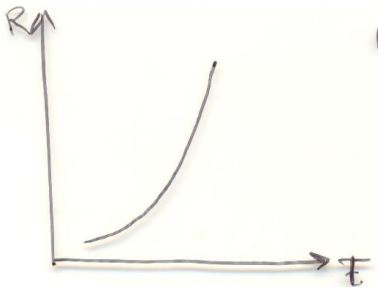
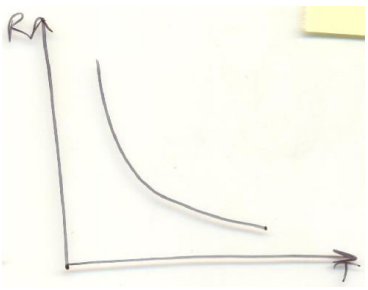
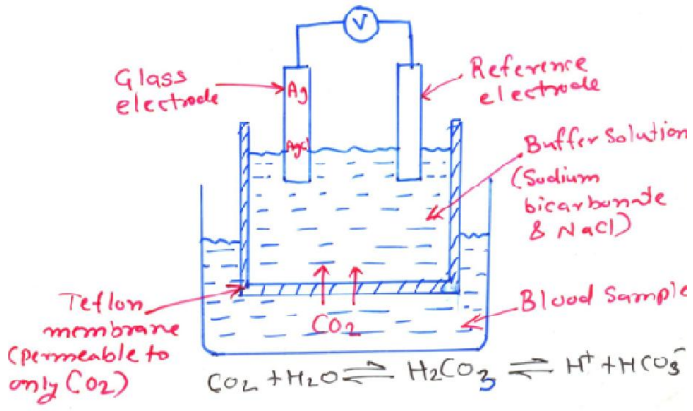
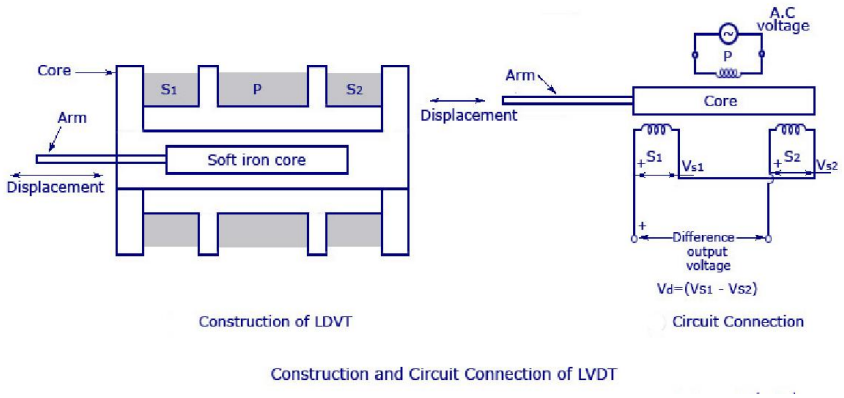
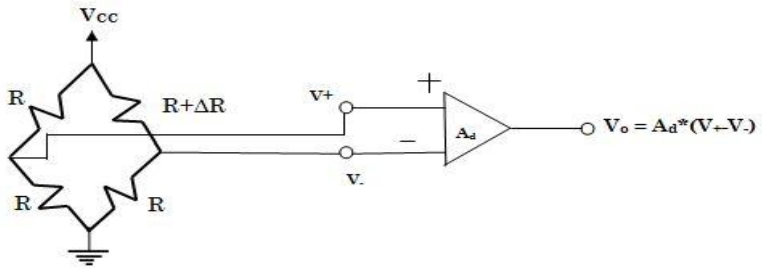
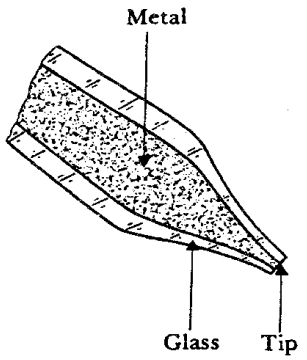
Q. No.	Sub Q.N	Answer	Marking Scheme
Q. 1	**a) i)**	**Attempt Any Six of the Following.** **List any 2 sources of biomedical signal.** **Ans :** - ECG (Electrocardiography) - EEG (Electroencephalography) - EMG (Electromyography) - PCG (Phonocardiography) - BP (Blood Pressure) - ERG (Electroretinography)	**12** **1 mark each**
	ii)	**Write 4 constraints in design of medical 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.	**1/2 mark each**
	iii)	**Write 2 advantages of thermocouple.** **Ans :** - Low cost. - It has rugged construction. - Temperature range -270 to 2700 ℃. - Bridge circuits are not needed for measurement. - It offers good reproducibility. - Speed of response is high. - Measurement accuracy is quite good.	**1 mark each**
	iv)	**Draw characteristics of NTC and PTC thermistor.** **Ans :**  PTC  NTC	**2 marks**

	v)	**State 2 advantages of RTD.** **Ans :** - High accuracy - Low drift - Wide operating range - Suitability for precision applications - Linear Response. - High Repeatability and good precision. - It is suitable for remote indication. - It can be easily installed and replaced.	**2 marks**
	vi)	**Draw diagram of pCO_2 electrode.** **Ans :**  **Fig : pCO_2 electrode.**	**2 marks**
	vii)	**State principle of 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 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.	**2 mark**
	viii)	**List different surface electrodes.** **Ans :** I) Surface electrodes: a) Metal plate electrode -Metal disc electrode -Disposable electrode b) Suction electrode c) Floating electrode.	**2 marks**

	b)	**Attempt any TWO of the following :**	**8 Marks**
	i)	**List 4 dynamic characteristics of transducer.** **Ans :** 1)Speed of Response 2) Measuring Lag 3) Fidelity 4) Dynamic Error / Measurement Error	**1 mark each**
	ii)	**Draw and explain LVDT.** **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.	**Diagram = 2 marks** **Working = 2 mark**
	iii)	**Describe Bridge amplifier with neat diagram.** **Ans:**  **Fig : Bridge Amplifier** In the figure shown above the resistance shown as R+ΔR can be any sensor such as platinum resistor, strain gauge, thermistor, e.t.c . The resistors labeled as R are reference resistors with which the varying resistance can be measured. Since the opamp is in open loop configuration the output of opamp is given as	**Diagram = 2 marks** **Working = 2 mark**

		$V_o = A_d*(V_+-V_-)$ Where A_d is open loop differential gain of opamp. The current flowing through the input terminals of an op amp will be zero(except for small bias currents) due to infinite input resistance of opamp. let $\Delta R/R = \delta$,The output voltage of op amp reduces to $V_o = A_d*V*(-\delta)/4$. When all the resistors are matched i.e. $\delta=0$, output voltage goes to zero.	
Q.2	**a)**	**Attempt any FOUR of the following :** **Describe metal micro electrode with neat diagram.** **Ans :**  **Fig : Micro electrode.** 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.	**16 Marks** **Diagram = 2 marks** **Description = 2 marks**
	b)	**Write four advantages of optical fibre sensor.** **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.	**1 mark each**
	c)	**Draw and describe Man Instrumentation system.** **Ans :** 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. 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	**Description = 2 marks**

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 may 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.

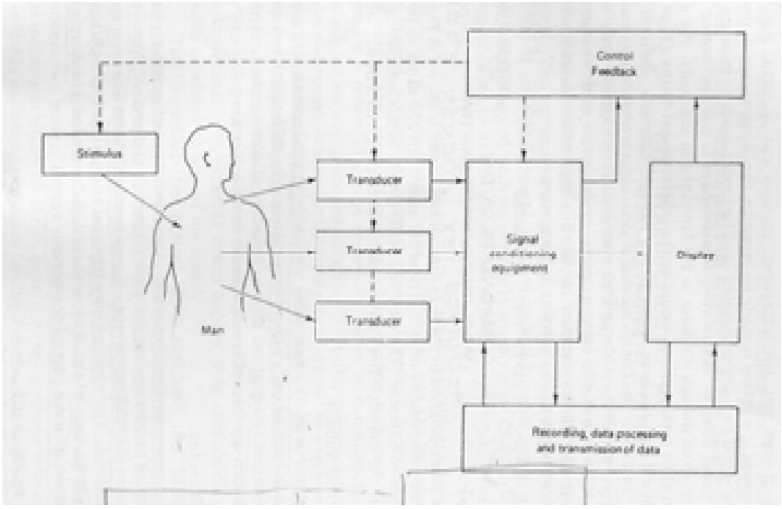


Fig : Man Instrumentation system.

Diagram = 2 marks

d) Draw and explain electromagnetic flow transducer.

Ans :

$$e = \int_0^{L_1} \mathbf{u} \times \mathbf{B} \cdot d\mathbf{L}$$

where

B = magnetic flux density, T
L = length between electrodes, m
u = instaneous velocity of blood, m/s

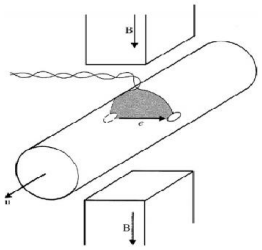
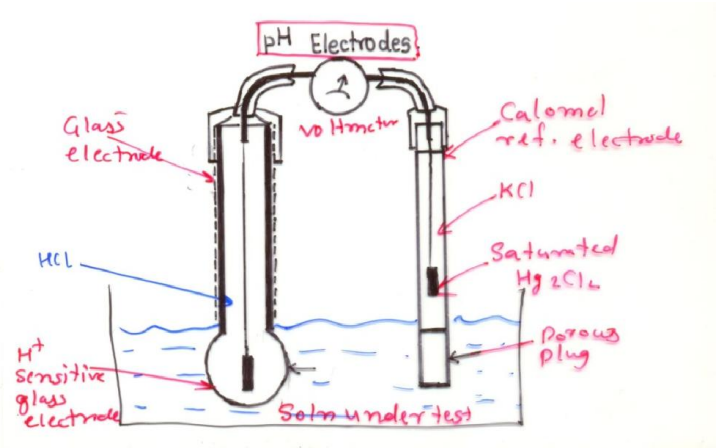
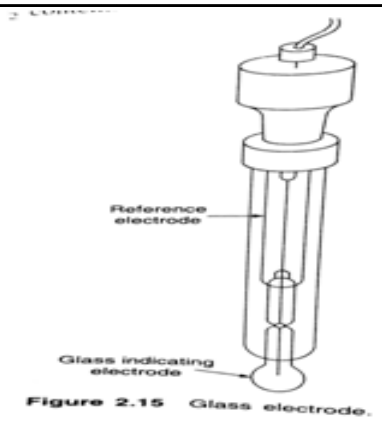
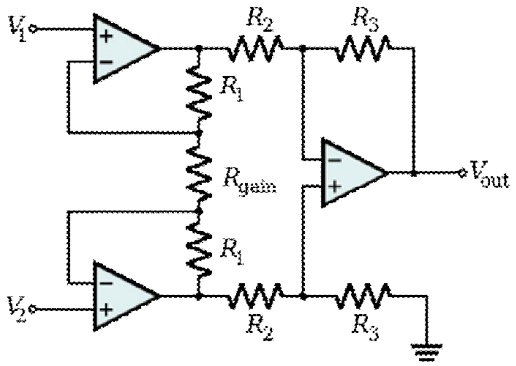


Diagram = 2 marks

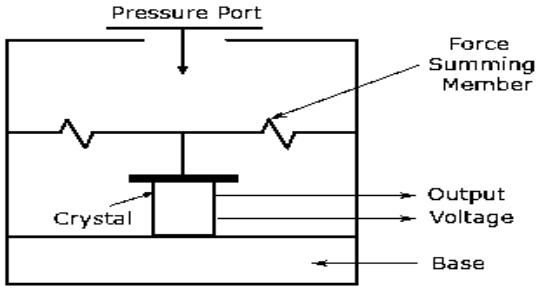
		The electromagnetic flow meter measures instantaneous pulsatile flow of blood. It operates with any conductive liquid, such as saline or blood. The meter is placed such that the part of body through which the blood is to be determine like limb is subjected to the electric field. The flow meter depends 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.	**Description = 2 marks**
	e)	**A unbounded strain guage has a resistance of 5KΩ and gauge factor of 3.6, what will be the change in resistance due to 3000 micro strain?** **Ans:** **Given,** R = 5000 Gf = 3.6 strain = Δ L/L = 3000 Δ R= unknown Fomula: $Gf = \frac{\Delta R/R}{\Delta L/L}$ $3.6 = \frac{\Delta R/5000}{\Delta L/L}$ $3.6 = \frac{\Delta R/5000}{3000}$ Therefore Δ R = 3.6 x 3000 x 5000 Change in resistance = 54000000 micro ohms **OR** Change in resistance = 54 ohms	**(1 mark)** **(1 mark)** **(2 marks)**
	f)	**Draw and explain pH electrode.**  **OR**	**Diagram = 2 marks**

		 **Figure 2.15** Glass electrode. (OR any other relevant diagram) Glass electrode is normally used as a pH electrode.fig shows the glass electrode consists of spherical bulb of 0.5cm diameter. The membrane of thin glass bulb permits the passage of only hydrogen ions in the form of H_2O^+ .Inside the glass bulb Ag/Agcl electrode is immersed in chloride buffer solution. The other side of the bulb is kept at the other solution unknown pH. The measuring circuit and solution being measured is closes through potassium chloride salt bridge and calomel electrode. In this case two arrangements are required one for reference and the other for unknown solution. Nowadays glass electrode and reference electrode are available in the same enclosure.	**Explanation= 2 marks**
Q.3	**a)**	**Attempt any FOUR of the following :** **Define :** **(i) Bio-magnetic signals** **(ii) Bio-chemical signals** **(iii) Bio-mechanical signals** **(iv) Bio-acoustic signals** **Ans :** **(i) Bio-magnetic signals :** some organs produce very weak electromagnetic signals; measurement of these signals is called "Bio-magnetic signals. Ex. Brain, heart and lungs are organs producing magnetic signals **(ii) Bio-chemical signals :** These types of signals are obtained from the measurements of chemical compositions. Ex- 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. Ex. Motion of chest wall. **(iv) Bio-acoustic signals :** These signals are obtained from sounds created by Biological system and provide information about underlying phenomenon .Ex. Flow of blood in heart through valves, flow of air in lungs.	**16 Marks** **1 mark each**

	b)	**Draw and explain instrumentation amplifier.** **Ans :**  **Fig : Instrumentation amplifier** Instrumentation amplifier is a kind of differential amplifier with additional input buffer stages. The addition of input buffer stages makes it easy to match (impedance matching) the amplifier with the preceding stage. Instrumentation are commonly used in industrial test and measurement application. The instrumentation amplifier also has some useful features like low offset voltage, high CMRR (Common mode rejection ratio),high input resistance, high gain etc. A circuit providing an output based on the difference between two inputs (times a scale factor) is given in the above figure. In the circuit diagram, opamps labelled A1 and A2 are the input buffers. Anyway the gain of these buffer stages are not unity because of the presence of R1 and Rg. Op amp labelled A3 is wired as a standard differential amplifier. R3 connected from the output of A3 to its non inverting input is the feedback resistor. The voltage gain of the instrumentation amplifier can be expressed by using the equation below. Voltage gain (Av) = Vo/(V2-V1) = (1 + 2R1/Rg) x R3/R2	**Diagram =** **2 marks** **Explanation=** **2 marks**
	c)	**Describe Polarizable and Non polarizable electrodes.** **Ans :** **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.	**2 marks** **2 marks**
	d)	**List 4 advantages of Thermistor.** **Ans :** -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.	**1 mark each**

e) Draw and explain piezoelectric transducer.

Ans :



Piezo-Electric Transducer

Diagram = 2 marks

Asymmetrical 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.

Explanation = 2 marks

f) Describe Blood glucose sensor with diagram.

Ans :

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 terrycynide

$$\text{Glucose} + O_2 \xrightarrow[\text{Glucose oxidase}]{} \text{Gluconic acid} + H_2O_2$$

Explanation = 2 marks

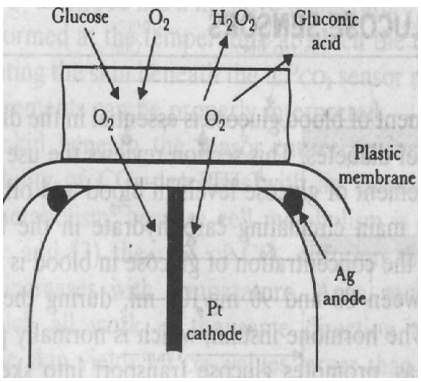
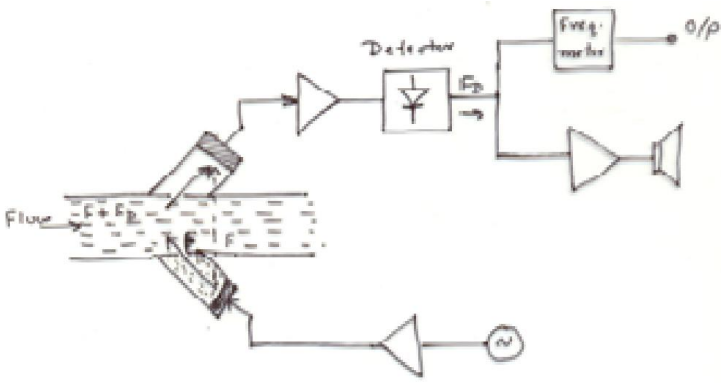


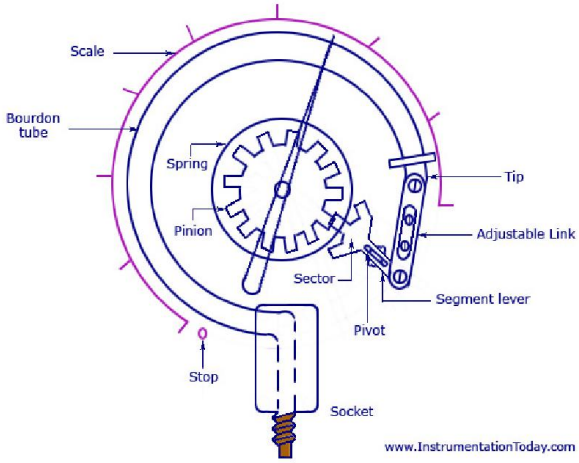
Fig : Blood glucose sensor

Diagram = 2 marks

Q.4	a)	**Attempt any FOUR of the following :** **Draw and explain ultrasonic flow transducers.** **Ans :**  **Fig : Ultrasonic flow transducer.** 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.	**16 Marks** **Diagram = 2 marks** **Explanation = 2 marks**

b) Draw C shaped Bourdon tube and explain it.

Ans :



Bourdon Tube Pressure Gauge

Diagram = 2 marks

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 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.

Explanation = 2 marks

c) Describe electrode electrolyte interface with neat diagram.

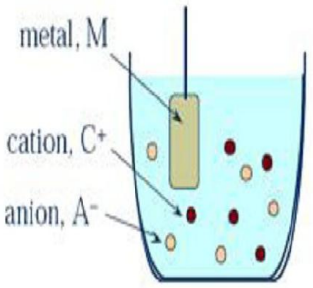
Ans :

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.

Explanation = 2 marks



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

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

Diagram = 2 marks

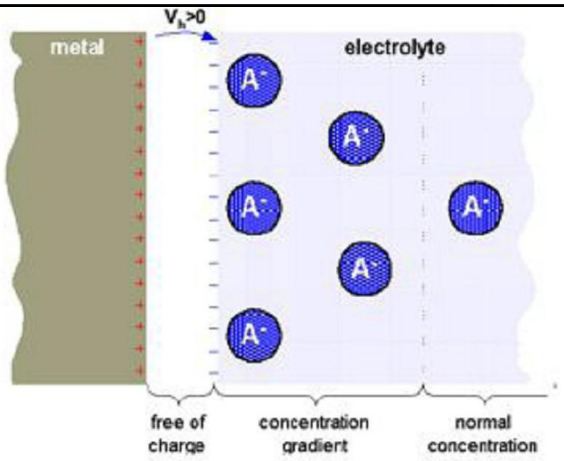


Fig : Electrode electrolyte interface

d) Describe Radiation Thermometry with a neat diagram.

Ans :

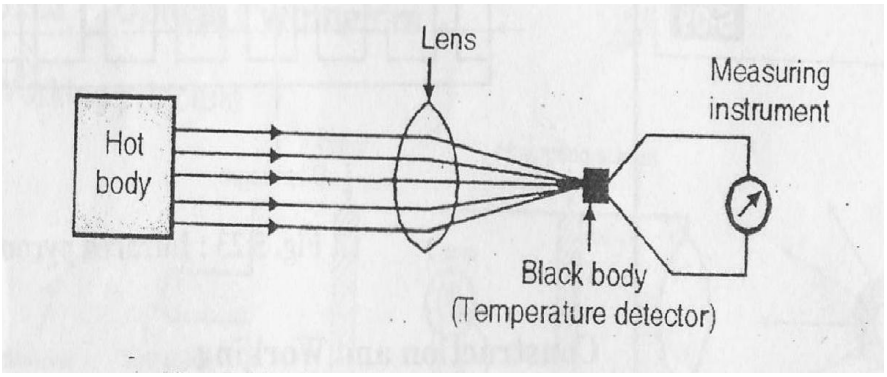


Fig : Radiation Thermometry

Diagram = 2 marks

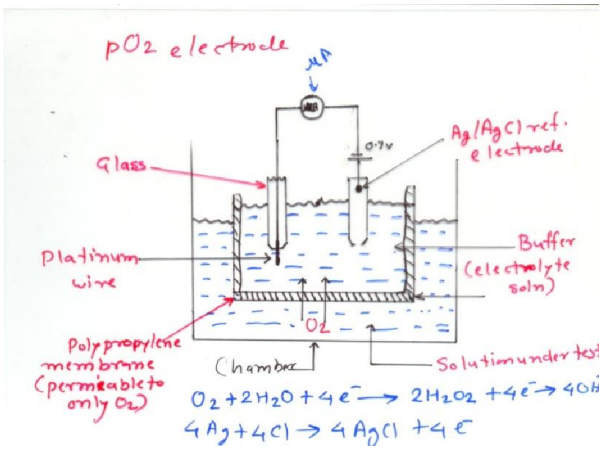
The basis of radiation thermometry is that there is a known relationship between the surface temperature of an object and its radiant power. This principle make it possible to measure the temperature of body without physical contact with it.

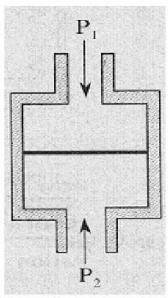
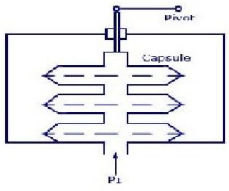
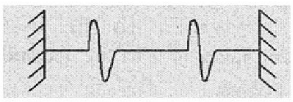
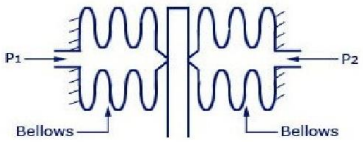
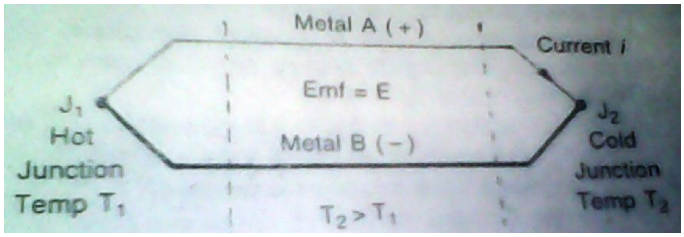
When physical contact with the medium to be measured is not possible or impractical due to very high temperature (above 1400° C), Radiation Thermometry are used for temperature measurement.

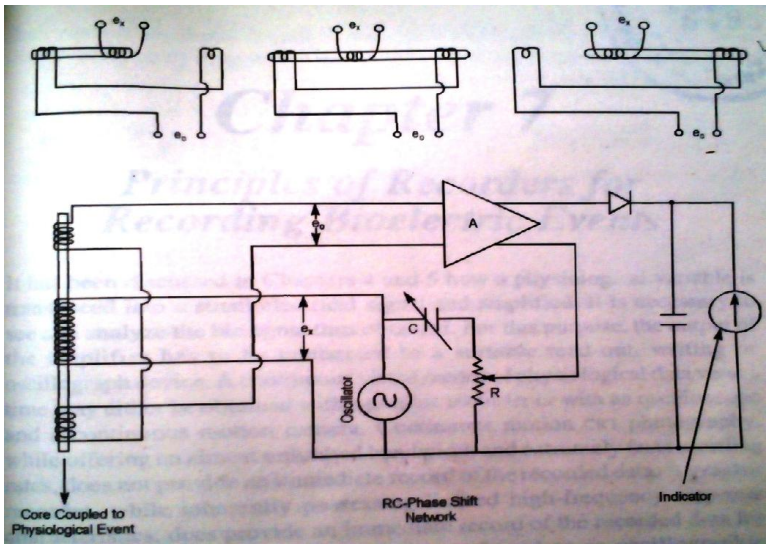
- The operation of pyrometer is based on the principal of thermal radiation. Radiation pyrometer measured the radiant heat emitted of reflected by hot object.
- Thermal radiation is electromagnetic radiation emitted as a result of temperature.
- In industry where the high temperature of vapors or liquids 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.

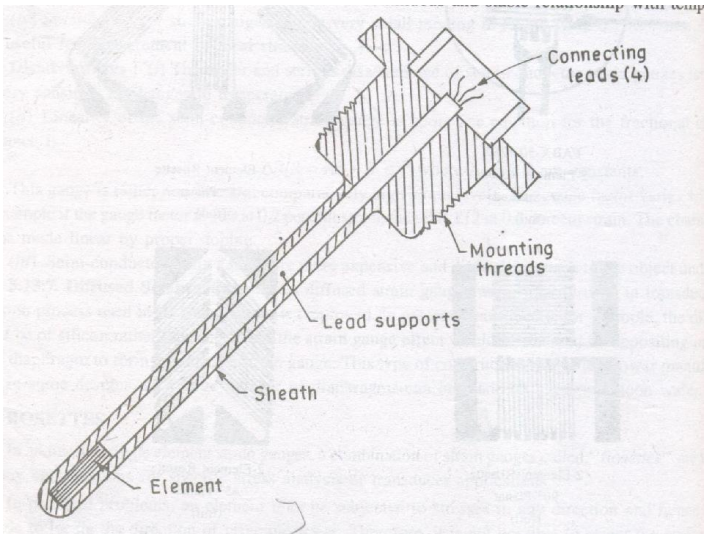
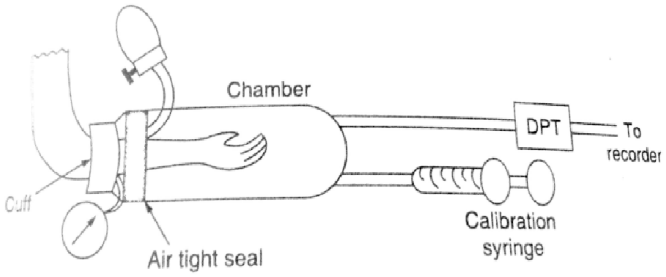
Explanation = 2 marks

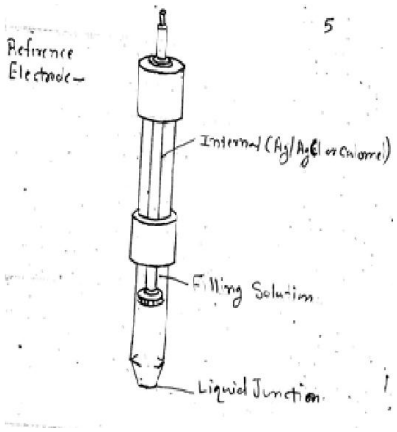
	e)	**Differentiate between Active and Passive transducers.** **Ans : -** **Active transducer:** 1 Transducer that converts one form of energy directly into another that is it does not require external power supply. It is self generating transducer. 2 This transducer develops their own voltage and current. The energy required for production of an output signal is obtained by physical phenomena being measured. 3. Ex. Photovoltaic cell, thermocouple etc. **-Passive Transducer:** 1 The transducer which requires energy to be put it in order to translate changes due to measurand. 2.It requires external power supply. 3. Ex: LVDT, Strain gauge.	**Any 2 points of each type.**
	f)	**Draw and explain PO_2 electrode.** **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 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.	**Diagram = 2 marks** **Explanation = 2 marks**

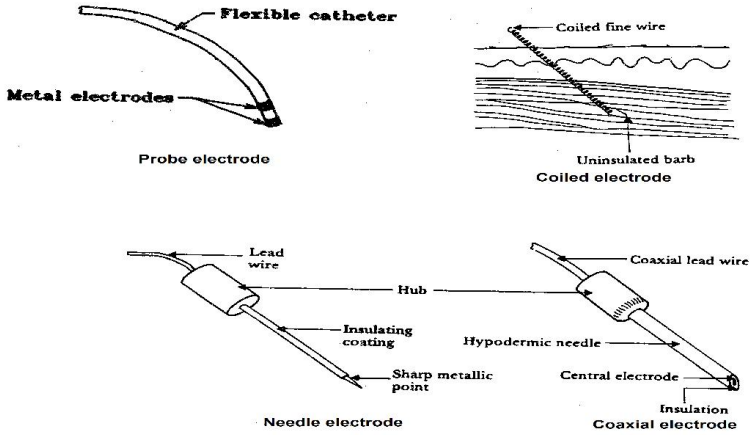
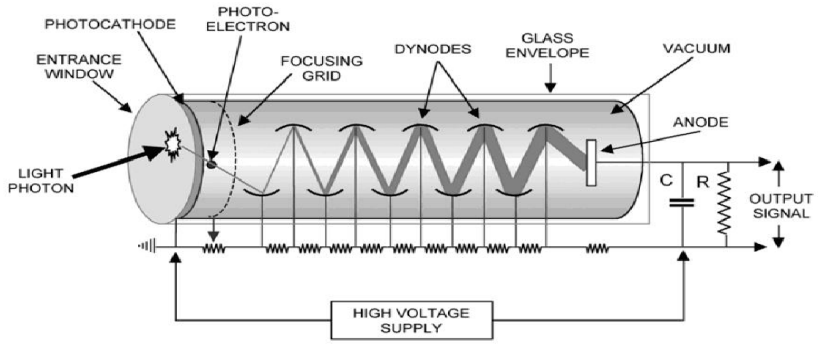
Q. 5	**a)**	**Attempt any Four of the following :** **Draw diagram of flat, corrugated, capsule and bellow type diaphragm.** **Ans:**  Flat diaphragm  Capsule   Corrugated diaphragm  Bellows **Fig : Types of diaphragm**	**16 Marks** **1 mark each**
	b)	**Explain flow measurement by Indicator dilution method.** **Ans :** 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. This is also called dilution curve.	**4 marks**
	c)	**What is seebeck effect. Explain working principle of thermocouple.** **Ans :** **Seebeck effect :** 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 . **Working principle of thermocouple :**  	**2 marks**

		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.	**2 marks**
	d)	**Draw and explain phase sensitive amplifier.** **Ans :**  **Fig : Phase sensitive amplifier.** 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.	**Diagram = 2 marks** **Explanation = 2 marks**
	e)	**Classify transducers on physical or chemical principle used.** **Ans :** The transducer can be classified in many ways, such as i) By the process used to convert the signal energy into an electrical signal. For this , transducer categorized as: Active Transducer- A transducer that converts one form of energy directly into another. For example: Photovoltaic cell in which light energy is converted into electrical energy. Passive Transducer- A transducer that requires energy to be put into it in order to translate changes due to the measurrand. For example: Thermistor , RTD ii) By the physical or chemical principle used. example for physical principle – variable resistance devices, Hall effect and optical fiber	**04 marks**

		transducer. example for Chemical principle – $p0_2$, Pco_2 electrodes. iii) By application for measuring a specific physiological variable. For example: flow transducer, pressure transducer, temperature transducer.	
	f)	**Write specifications of MIS.** **Ans :** **Consider any Medical Instrument for Medical Instru. System and write down its specifications** **specification :** For Ex. X-Ray Machine Specification: YZ 300C, 300mA MIDICAL DIAGNOSTIC X-RAY MACHINE with fixed Table MAIN TECHNICAL PARAMETER 1. Single bed with single tube 2. Rotary anode X-ray tube unit tangential annular tubes 3. Single-phase full-wave rectification high-voltage generator 4. Power volage(V) photograph kilovolt(kV), infinitely variable control and electric mechanism 5. Be equipped with the manostat for the filament of X-ray tube and space charge complementor 6. Photographic volume, kV, mA and s, subsection, grading and interlock protection 7. Adopt the digital circuit timer. Grading according to R10 pririty coefficient, which is exact in time control. 8. High-voltage primary uses the zero controlled circuit of silicon-controlled rectifier of large power 9. Photographic bed can move in length and breadth. 10 The photographic bed, upright and vibrating ray-filter are in a whole without top and bottom track	**1 mark each**
Q.6		**Attempt any <u>FOUR</u> of the following:**	**16 Marks**
	a)	**Explain the principle of capacitive transducer.** **Ans :** In a capacitance transducer , the variable to be measured is converted into change in capacitance. A capacitor basically consist of two conductor (two plates) separated by dielectric medium (insulator).The variable to be measured will cause an effect either by increasing the distance between two plates or by changing the dielectric constant. Capacitance of parallel plate capacitor whose plates are displaced by a distance d is given as $C = \varepsilon_0 \varepsilon_r A/d$ Where A is the area of cross-section of the plates, ε_0 ε_r are absolute relative dielectric constant of the medium respectively and d is distance between the two plates in m.	**4 marks**

	b)	**Draw the construction of RTD and explain it.** **Ans :**  **Fig : Constructional diagram of RTD** The RTD is a wire resistor enclosed in a 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 are Platinum , Nickel , Copper , Tungsten. The construction is typically such that the wire is wound on a form (in a coil) on notched mica cross frame to achieve small size, improving the thermal conductivity to decrease the response time and a high rate of heat transfer is obtained. In the industrial RTD's, the coil is protected by a stainless steel sheath or a protective tube. So that, the physical strain is negligible as the wire expands and increase the length of wire with the temperature change. If the strain on the wire is increasing, then the tension increases. Due to that, the resistance of the wire will change which is undesirable. So, we don't want to change the resistance of wire by any other unwanted changes except the temperature changes.	**Diagram = 2 marks** **Explanation = 2 marks**
	c)	**Draw and explain concept of plethysmography.** **Ans :**  **Figure 5.34** Plethysmograph. 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 volume changes or providing outputs that can be related to them are called	**Diagram = 2 marks**

		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 inflat 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.	**Explanation = 2**
	d)	**Draw and explain reference electrode.** **Ans :**  Fig: Reference 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	**Diagram = 2 marks** **Explanation = 2**

		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.	
	e)	**Describe internal electrodes with neat diagram.** **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. **Types of Internal Electrode:-** 1) Probe electrode 2) Needle electrode 3) Coaxial electrode 4) Coiled electrode  	**Explanation = 2** **Diagram = 2 marks**
	f)	**Draw and explain photo multiplier tube.** **Ans :**  	**Diagram = 2 marks**

OR

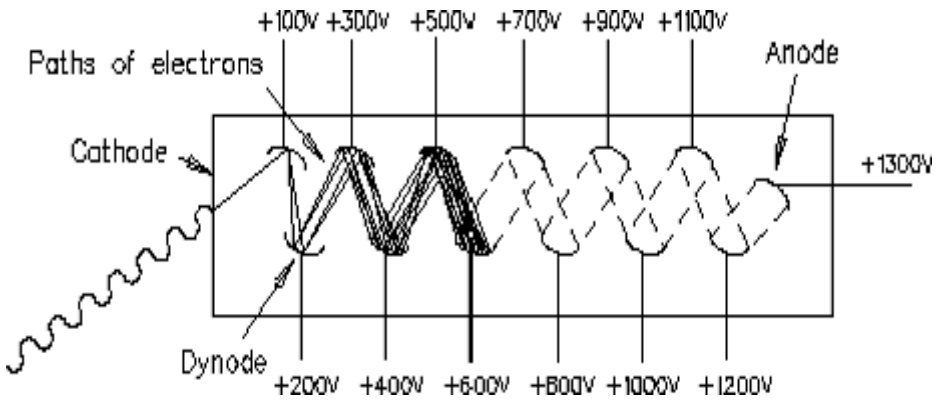


Fig:The photo multiplier tube

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.

Explanation = 2