WINTER– 14 EXAMINATION

Subject Code: **17442** **Model Answer** Page No: 1/25

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.

Q1.A) Attempt any SIX (12)

a) List any four biomedical signals.(2)

---ECG (Electrocardiography)

---EEG (Electroencephalography)

---EMG (Electromyography)

---PCG (Phonocardiography)

--- BP(Blood Pressure)

b) State the objectives of medical instrumentation system.(2)

-To provide the basic platform of instruments for the medical field to work with.

-To help the healthcare sector at various stages, like diagnosis, treatment, post treatment.

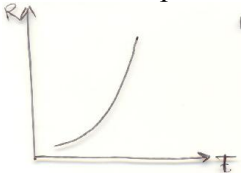
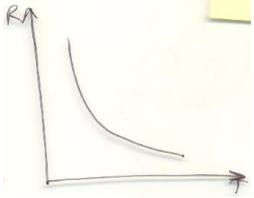
-To help the personal in research and studies by collecting and maintaining the patients data for some predetermined time.

-To built an environment in conjunction with electrical and mechanical field that supports the medical field.

c) State Faraday's law of electromagnetic induction.(2)

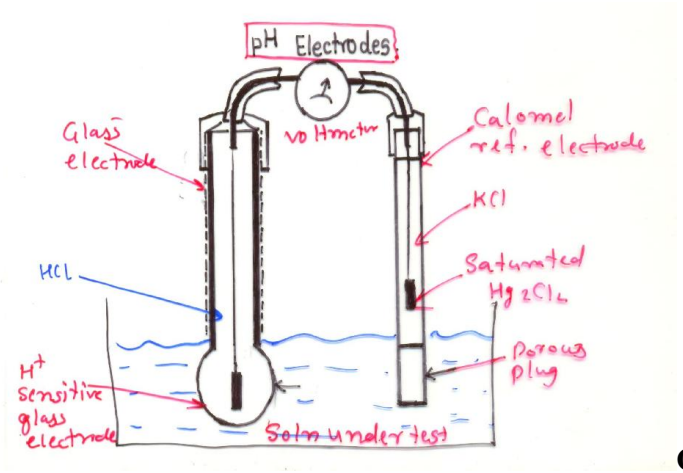
-Faraday's Law of Electromagnetic Induction state that whenever a conductor are placed in a varying magnetic field emf are induced which is called induced emf, if the conductor circuit are closed current are also induced which is called induced current.

d) Differentiate between PTC and NTC of temperature transducer (Give two point answer).(2)

-PTC	NTC
• resistance versus temperature plot  • Applications • PTC thermistors were used as timers in the degaussing coil circuit of most CRT displays.	• resistance versus temperature plot  • Applications • For monitoring the temperature of an incubator. • For Food Handling and

• for over current in telecommunication applications • for motor starting	Processing industry • For Consumer Appliance industry for measuring temperature. Toasters, coffee makers, refrigerators, freezers, hair dryers, etc. all rely on thermistors for proper temperature control. • For automotive applications

e) Draw a labeled diagram of pH electrode.(2)



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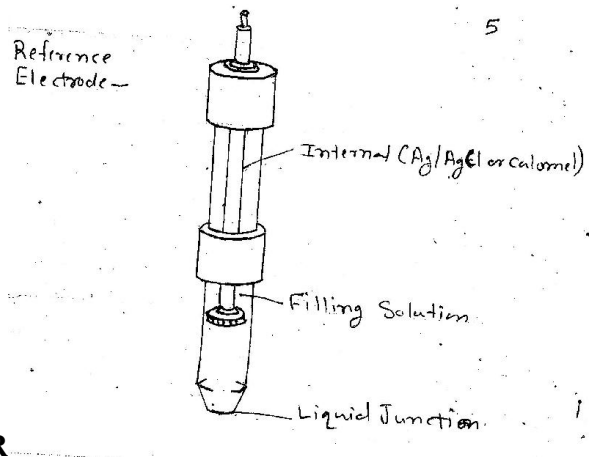


(Or any other relevant diagram)

f) Define polarizable and non-polarizable electrodes. (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.

g) State the working principle of photomultiplier tube. (2)

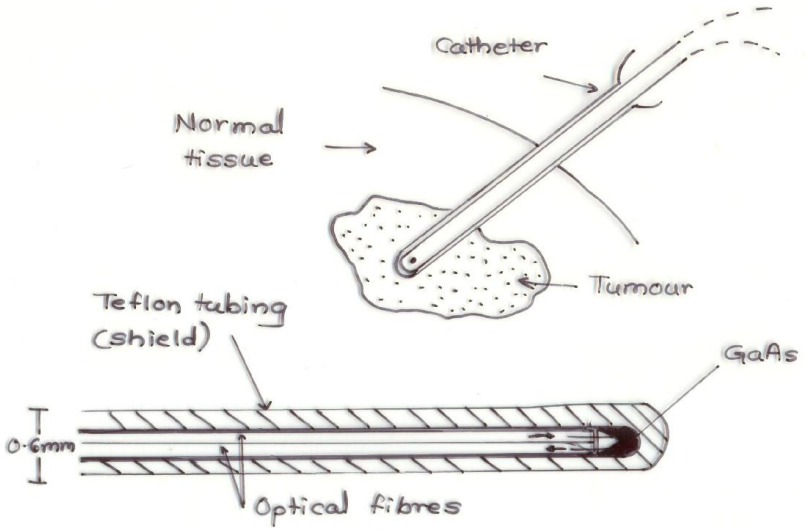
-A photomultiplier tube is a vacuum tube consisting of an input window, a photocathode, focusing electrodes, an electron multiplier and an anode usually sealed into an evacuated glass tube.
Light which enters a photomultiplier tube is detected and produce an output signal through the following processes,

1) Light passes through the input window.
2) Light excites the electrons in the photocathode so that photoelectrons are emitted into the vacuum (external photoelectric effect).

3) Photoelectrons are accelerated and focused by the focusing electrode onto the first dynode where they are multiplied by means of secondary electron emission. This secondary electron emission is repeated at each of the successive dynodes.

4) The multiplied secondary electrons emitted from the last dynode are finally collected by the anode.

h) Draw a neat sketch of fiber optic sensor for temperature measurement.(2)



1. B) Attempt any TWO (8)

a) List and define any two static and two dynamic characteristics of the transducer.(2+2)

-Static Characteristics

-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.

-Precision: It refers to the degree of repeatability of the 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.

-Dynamic characteristics

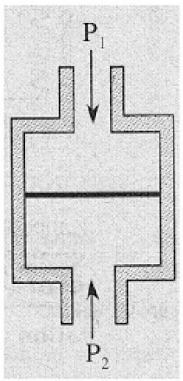
Fidelity: It is defined as the degree of closeness with which the transducer indicates or records the input parameter which is impressed upon it.

Speed of response: It is defined as the rapidity with which a transducer responds to a change in the value of parameter under measurement.

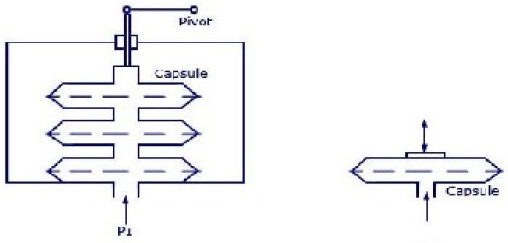
Dynamic error: It is defined as the difference between the indicated value and the true value of the time varying quantity.

Dead time: It is defined as the time required for the transducer to begin to respond to change in the measuring quantity.

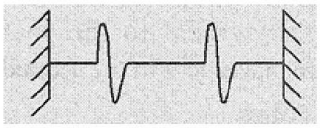
b) Draw the constructional sketch of flat, diaphragm corrugated, diaphragm capsule and bellows.(1mark for each)



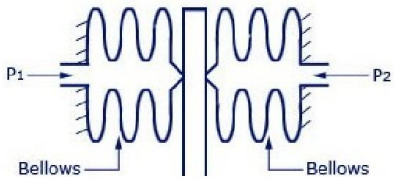
Flat diaphragm



Capsule



Corrugated diaphragm

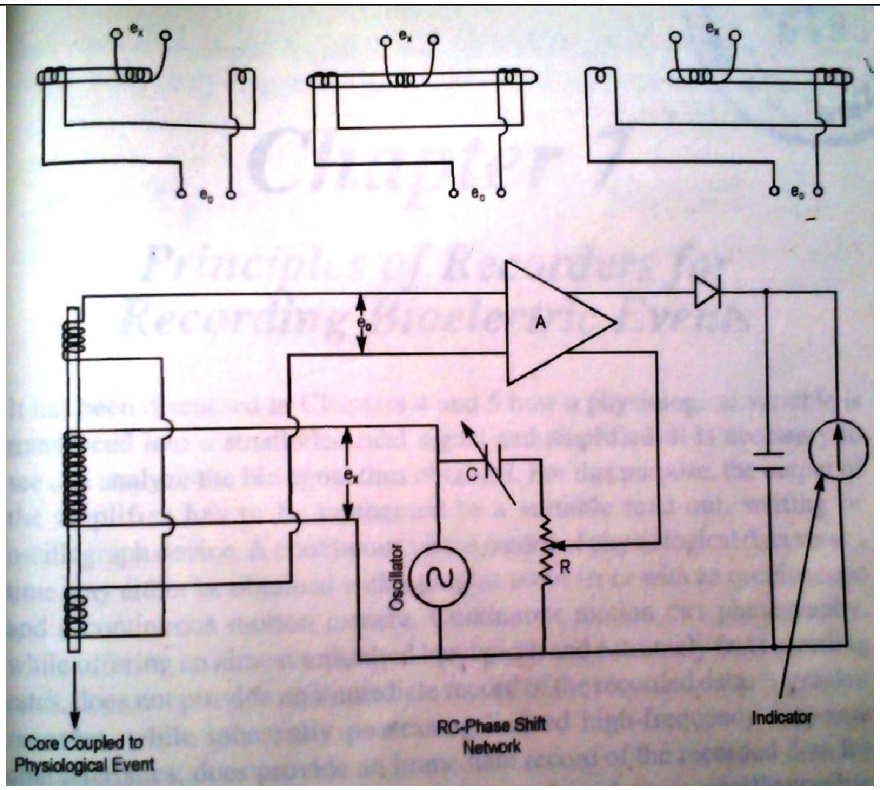


Bellows

c) Draw and explain phase sensitive amplifier. (4)

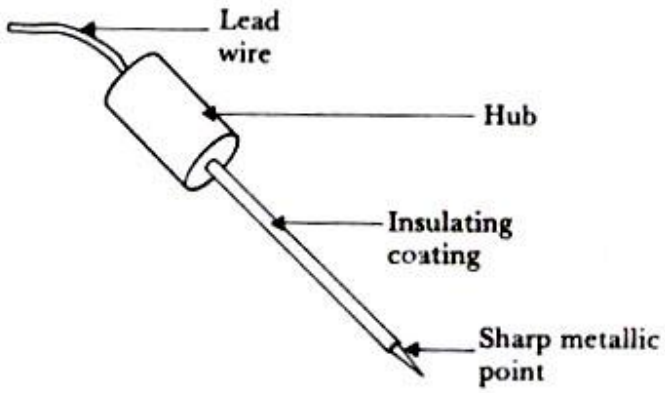
The use of phase sensitive detector permits setting the LVDT core to its center position and determining directional changes regardless of which side of the center the core is displaced.

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.



Q2) Attempt any FOUR. (16)

a) Describe needle electrodes with the help of suitable diagram. (2+2)



needle electrode

Needle electrodes are used to pick up very smaller amplitude signals. The sensitivity of the needles electrodes is generally higher than the surface electrodes.

-It is used to penetrate the skin to record bio-potential.

-It is made up of stainless steel.

-Available in diameter ranging from 25 to 125 μm

-No electrolyte gel is required.

-It can be used to record EEG potential from a local region of the brain.

-It can be used to record EMG potentials from a specific group of muscles.

b) With the help of characteristics curve of thermistor explain working of thermistor. Also state the material used for construction.(4)

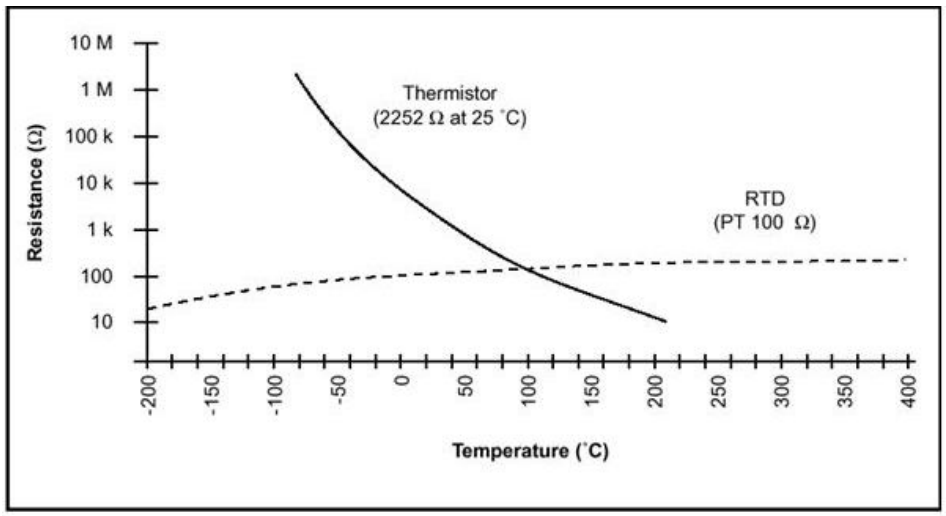
- The resistance of the NTC thermistors decreases with the increase its temperature. The resistance of thermistor is given by:

$R = R_o e^k$
$K = \beta(1/T - 1/T_o)$
Where R is the resistance of the thermistor at any temperature T in ^oK (degree Kelvin)
R_o is the resistance of the thermistors at particular reference temperature $T_o$in ^oK
e is the base of the Naperian logarithms

β is a constant whose value ranges from 3400 to 3900 depending on the material used for the thermistors and its composition.

The thermistor acts as the temperature sensor and it is placed on the body whose temperature is to be measured. It is also connected in the electric circuit. When the temperature of the body changes, the resistance of the thermistor also changes, which is indicated by the circuit directly as the temperature since
resistance is calibrated against the temperature. The thermistor can also be used for some control which is dependent on the temperature.

Materials Used: The thermistors are made up of ceramic like semiconducting materials. They are mostly composed of oxides of manganese, nickel and cobalt



c) Draw MAN-Instrument system and describe its blocks.(2+2)

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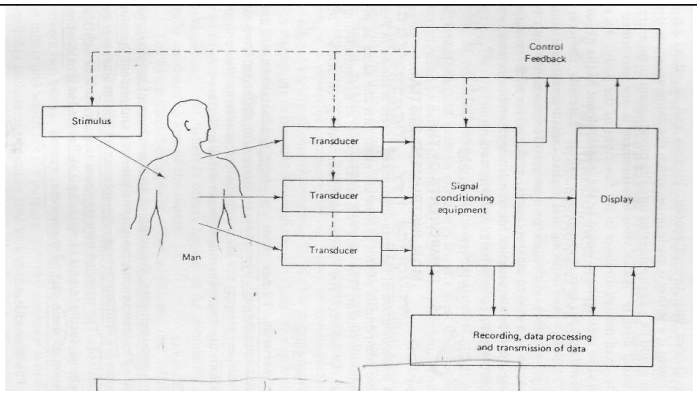


System components are given below:-

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 phenomenon. Transducer may measure temperature, pressure, flow or any other variables found in body.

iv) 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.

v) 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.

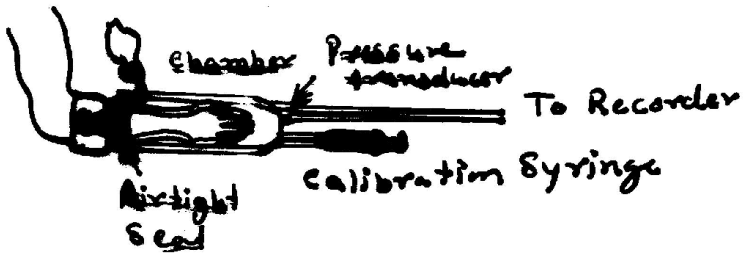
vi) Recording Data – Processing & Transmission equipment -

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.

vii) 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) With the help of suitable diagram describe the working of plythesmography.(2+2)



-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.

e) Define active and passive transducer. Give two examples of each type.(2+2)
-Active transducer: Transducer that converts one form of energy directly into another that is it does not require external power supply. It is self generating transducer. This transducer develops their own voltage and current. The energy required for production of an output signal is obtained by physical phenomena being measured.

Example 1) Photovoltaic cell 2) thermocouple etc.

-Passive Transducer: The transducer which requires energy to be put it in order to translate changes due to measurand. It requires external power supply.

Example 1) LVDT 2) Strain gauge etc.

f) Describe blood glucose sensor with neat diagram.(2+2)

-The blood glucose sensor has an electroenzymatic approach, which means that it takes advantage of glucose oxidation with a glucose oxidase enzyme. The presence of glucose oxidase catalyzes the chemical reaction of glucose with oxygen, which causes an increase in pH, decrease in the partial pressure of oxygen, and increase of hydrogen peroxide because of the oxidation of glucose to gluconic acid: The test strip (sensor) measures changes in one or several of this components to determine the concentration of glucose. The strips used in this design have three terminals or electrodes. Figure 2 shows the test strip terminals:

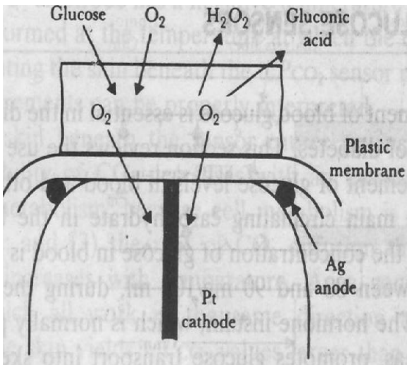
• Reference electrode

• Working electrode

• Trigger electrode

A negative voltage of –0.4 V is applied at the reference electrode. When blood or a glucose solution is placed in the strip, a chemical reaction occurs inside it, generating a small electrical current proportional to the glucose concentration. This current is constantly monitored while the strip is in place, allowing the

device to monitor when blood is placed. After the chemical reaction stabilizes, 5 s, the voltage is read by the ADC and compared using a look-up table to obtain the proportional glucose value in mg/dL. This value is sent to the host computer to inform the glucose value.



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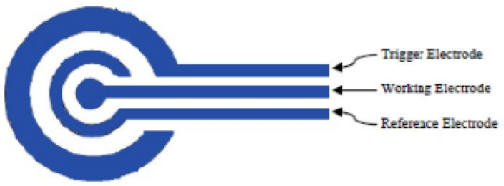


3. Attempt any FOUR 16

(a) State any four constraints in design of MIS.

Ans. General constraints in design of MIS are as follows(4)
1) Inaccessibility of the signal source.
2) Variability of Physiological parameters.
3) Interference among physiological System.
4) Transducer interface problem.

(b) Draw instrumentation amplifier with the help of three op-amp. State any four requirement of instrumentation amplifier.(2+2)

Ans.

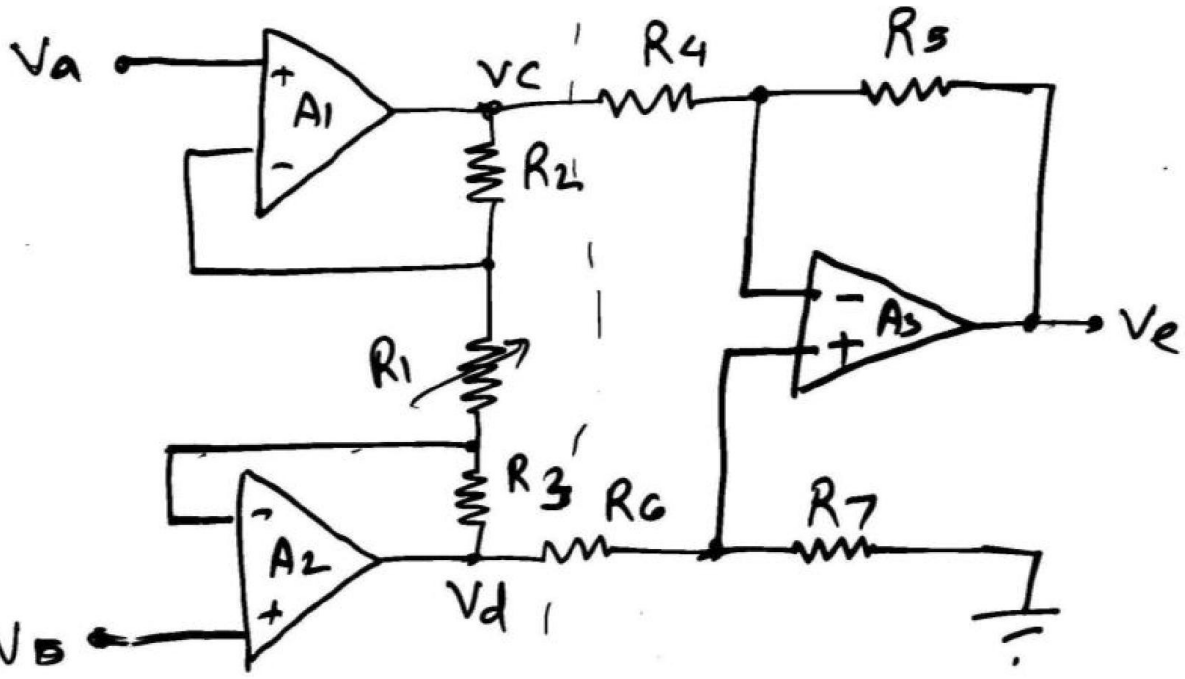


Diagram of Instrumentation Amplifier.

Requirements of instrumentation amplifier:

1) Instrumentation amplifier is a optimized for a high input impedence

2) High common mode rejection ratio.

3) Low input impedence.

4) Large common mode voltage.

5) High gain.

(c) Explain electrode skin interface with the help of neat diagram.(4)

Ans. Electrode-skin interface:

-In coupling an electrode to the skin, we generally use a transparent electrolyte gel. Therefore there are two interfaces one is in between electrode and electrolyte (gel) and the other is in between electrolyte and tissue.
-Ehe: half cell potential of electrode-electrolyte interface.
Cd,Rd: Represents impedance of interface (electrode-electrolyte).
Rs: Resistance of electrolyte (Gel).
-Epidermis is semipermeable to ions, so if there is difference on ionic concentration across this membrane, there is potential difference called Ese.
-Parallel combination of Ce and Re is represented electric impedance of epidermis. This impedance reduces fro, 200kΩ at 1Hz to 200Ω at 1MHz.

-Rs Is the pure resistance of dermis and subcutaneous layer.

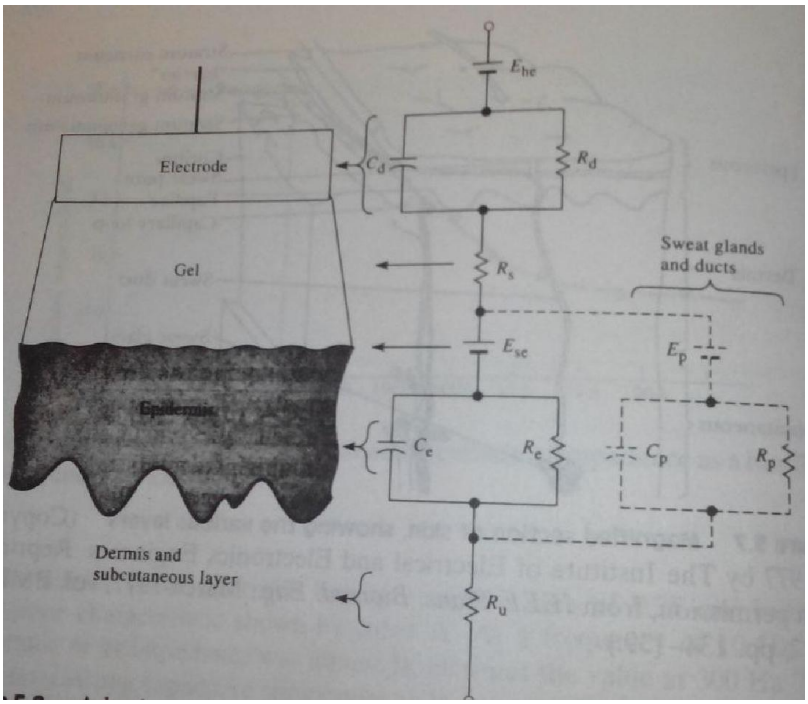
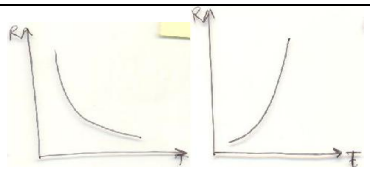
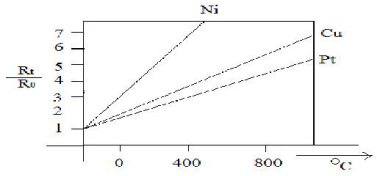


Diagram of Electrode-skin interface.

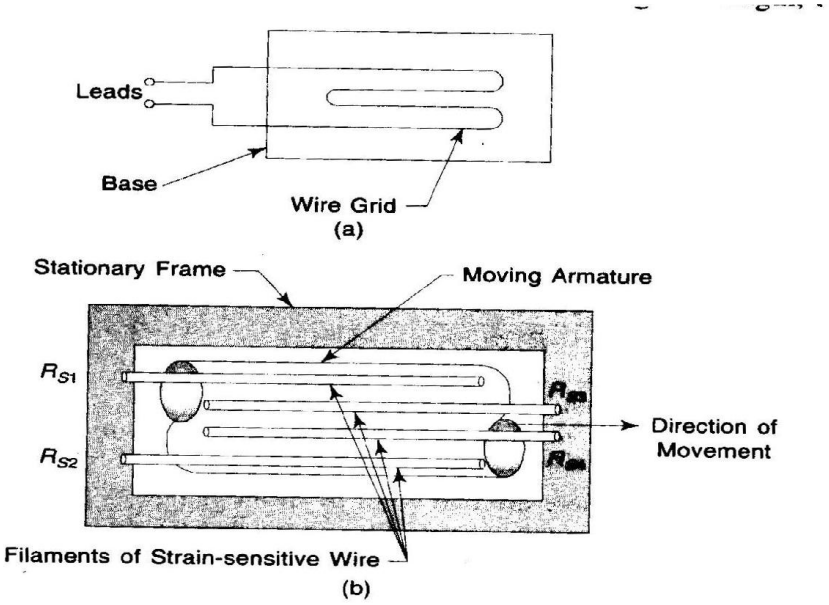
(d) Compare thermistor and RTD with the reference of (1) characteristics, (2) material used (3) range of temp. (4) Applications.

Ans.

Parameter	Thermistor	RTD
Characteristics	 Thermistor is the PTC (positive temperature coefficient) and NTC (positive temperature coefficient).	 RTD is the PTC (positive temperature coefficent).
Material used	Manganese, cobalt, iron oxides	Platinum, tungsten, copper, nickel etc.
Range of temperature	-150 ^{0}C to 300 ^{0}C	-270 ^{0}C to 2800 ^{0}C
Application	It is used for temperature measurement in baby incubator.	It is used for measurement of radiant energy in the industry.

(e) Draw and define bonded and unbounded strain guage.(4)

Ans.



(a) Bounded strain gauge (b) Unbounded strain gauge.

Bounded strain gauge: In bounded strain gauge(Fig. a), a grid of fine wire is cemented to a thin paper sheet or very thin Bakelite sheet, and covered with a protective sheet of paper or thin Bakelite. The paper sheet is bounded with an adhesive material to the structure under study.

When the surface to which the strain gauge is bounded is disturbed because of an applied force (or load), the strain gauge is also strained. The resistance of the wire changes on account of change in length and diameter of the wire.

The size of the grid varies with the application. They can be as small as 3mm* 3mm square. Usually they are larger, but seldom more than 2.5 cm long and 1.25 cm wide.

The strain gauge is useful only for measuring very small displacements. However, larger displacements can be measured by bounding the gauge to flexible element such as a thin cantilever beam and applying the unknown displacement to the end of the beam.

Unbonded strain guage:

Unbounded strain gauge: The unbounded strain gauge (Fig. b)consists of a stationary frame and an armature that is supported in the centre of the frame. The armature can move only in one direction and its travel is that direction is limited by four filaments of strain-sensitivity wire wound between rigid insulators that are mounted on the frame and on the armature. The filaments are of equal length.

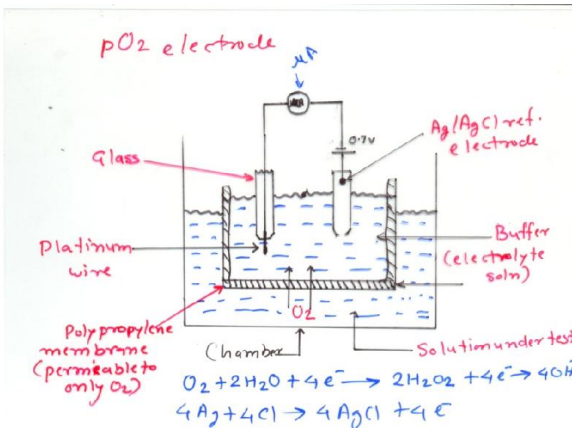
When an external force is applied to the strain gauge, the armature moves in the direction indicated. The filaments R_{s1} and R_{s2} increase in length, whereas the filaments R_{s3} and R_{s4} decrease in length. The resistance change of the four filaments is proportional to their change in length, and this change can be measured with a Wheatstone bridge. The unbalance current indicated by galvanometer is calibrated in term o f the magnitude of displacement of the armature. A linkage pin can be attached to the armature in order to measure displacement directly.

A change in temperature causes a change in resistance of the filament therefore temperature compensation must be provided. In some case of dummy filament is cemented to a piece of the same material as the active filament so as to assume the same temperature. The dummy gauges and active gauges are placed in adjacent legs of a Wheatstone bridge. Thus any change in temperature affects the two gauges equally and therefore, there are no errors caused by change in resistance due to temperature.

The unbounded strain gauge transducer can be constructed in a variety of configurations, depending on the requirement. They are mainly used in force and pressure transducer and accelerometers.

(f) With the help of neat sketch explain PO_2 electrode.(2+2)

Ans.



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:

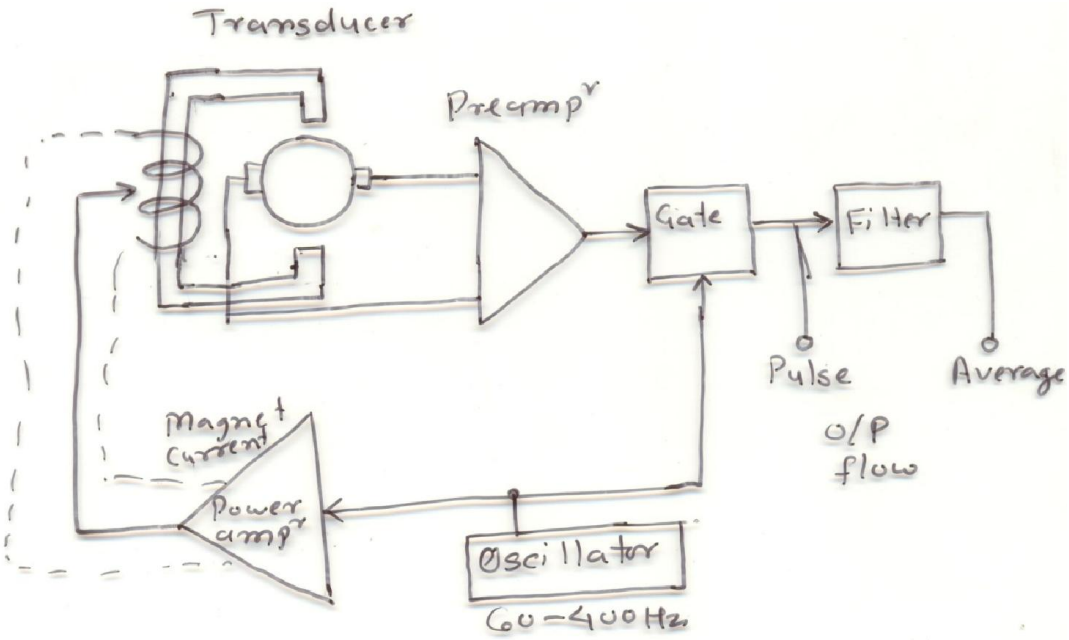
$$O_2 + 2H_2O + 4e^- \rightarrow 4[OH]^+$$

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.

4. Attempt any FOUR: 16

(a) Draw Electromagnetic blood flowmeter and state its working principle.(2+2)

Ans.



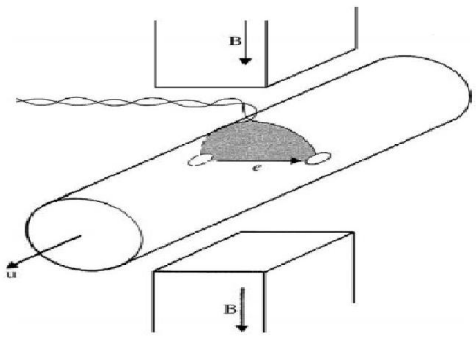
Electromagnetic blood flow meter.

OR

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

where

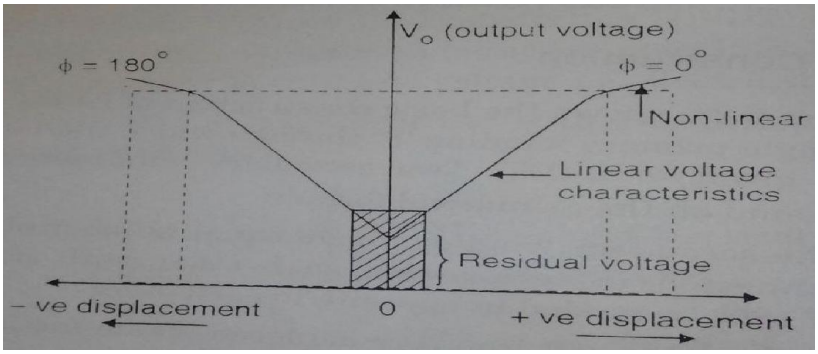
B = magnetic flux density, T
L = length between electrodes, m
u = instaneous velocity of blood, m/s



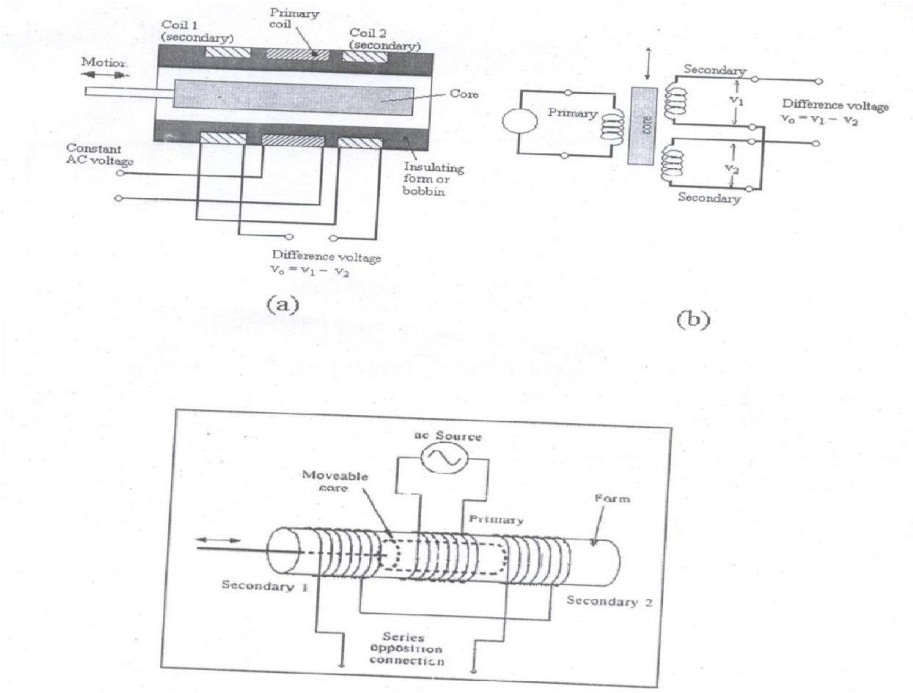
The electromagnetic flow meter measures instantaneous pulsatile flow of blood. It operates with any conductive liquid, such as saline or blood. The meter is placed such that the part of body through which the blood is to be determine like limb is subjected to the electric field. The flow meter depends 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.

(b) With the help of characteristic curve and constructional diagram explain the working of LVDT.(4)

Ans.



Characteristics curve of LVDT.



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Constructional diagram LVDT.

Working:

Case 1: When there is no displacement.

When there is no displacement attached to the core i.e. the core is at normal (NULL) positoon, the flux linking with both the secondary windings are equal.

Equal e.m.f. are induced in both secondary windings when the core is at null position:

$$V_{s1} > V_{s2}$$

Hence the output voltage v_o at null position is zero.

Case 2: When there is positive displacement:

When there is positive displacement applied to the core i.e. the core is moved to left of null position, more flux links with winding S_1 than winding S_2.

Here e.m.f. induced with winding S_1 is greater than winding S_2, that is

$$V_{s1}>V_{s2}$$

Hence the output voltage $V_o=V_{s1}-V_{s2}$ and the output voltage is in phase with the input primary voltage.

Case 3: When there is negative displacement

When there is negative displacement applied to the core. The core is moved to right of null position, more flux links with winding S_2 than winding S_1.

Here e.m.f. induced with winding S_2 is greater than S_1. That is

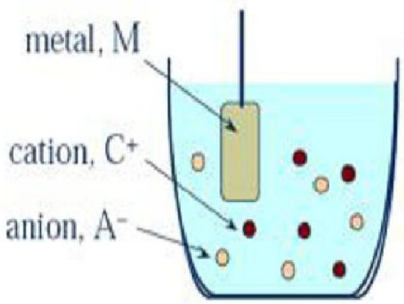
$$V_{s2}>V_{s1}$$

Hence the output voltage $V_o=V_{s2}-V_{s1}$ and is 180^0 out of phase with the input primary voltage.

(c) Describe electrode electrolyte interface.(4)

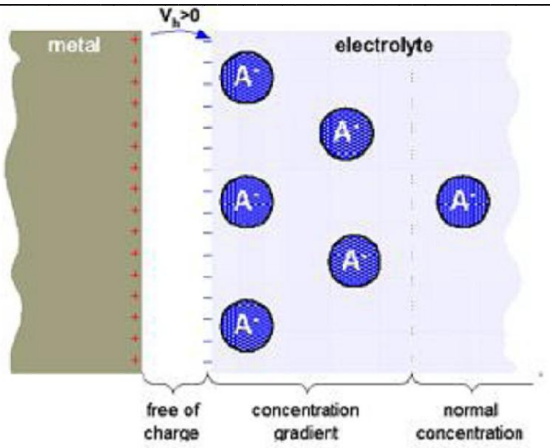
Ans. At an electrode electrolyte interface Electrode discharges some metallic ions into electrolytic solution this can results in two different conditions either Increase in free electrons in electrode and increase in positive cations (electric charge) in solution or ions in solution combine with metallic 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.



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

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



(d) Describe the working of radiation thermometry.(4)

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

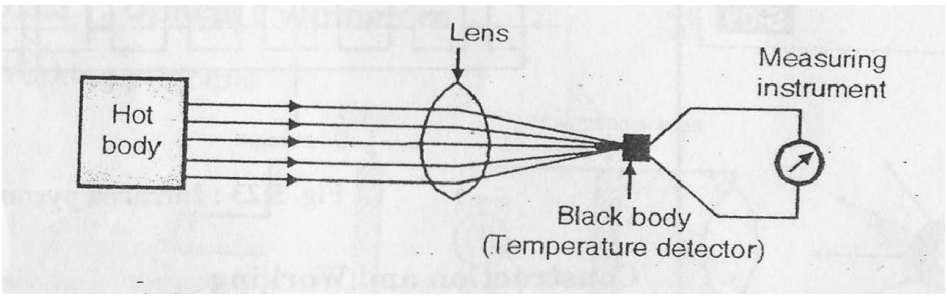


Diagram of radiation thermometry.

(e) Define(4)

(a) Sensitivity

(b) Accuracy

(c) Repeatability

(d) Reproducibility in connection in transducer

Ans. (a) Sensitivity- It describes the transfer ratio of output to input.

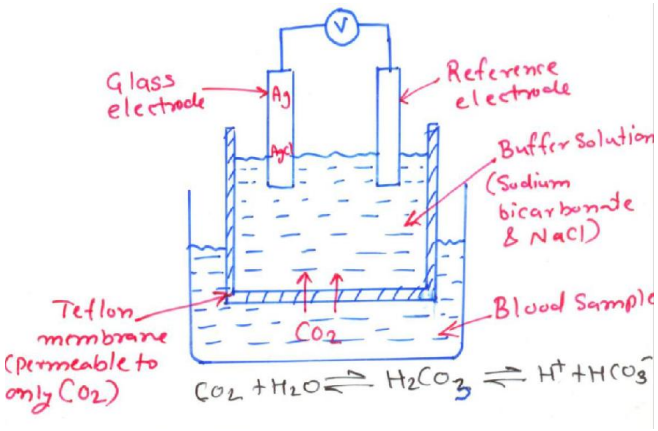
(b) Accuracy- It is the algebraic difference between the indicated value and the true or theoretical value of the measurement. Practically it is expressed as percentage of full scale output.

(c) Repeatability- Repeatability is the degree to which instrument can be accurately reproduced or replicated.

(d) Reproducibility in connection in transducer- The ability of an instrument to give some output for equal input applied over some period of time is called reproducibility.

(f) Draw a neat sketch of PCO_2 electrode and describe its working.(2+2)

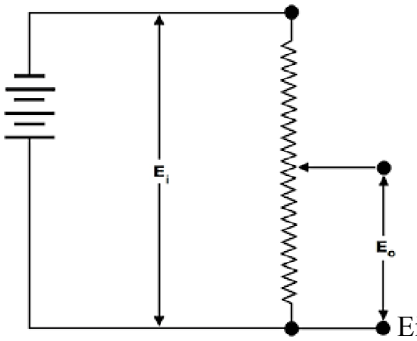
Ans.



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 ions.

Q5 Attempt any four 16

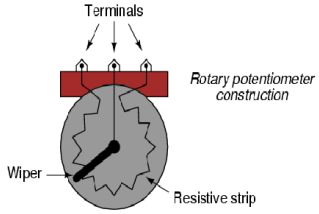
a) Draw labelled diagram of linear and angular potentiometer. State one application of each potentiometer.(2m+2m)
Ans.1) Linear potentiometer



Ei-Input voltage, Eo-output voltage

Application:1) MRI tables 2)CAT Scan tables3)Spray painting robots 4)Railroad Track laying tracking 5)Linear track systems (any other relevant applications)

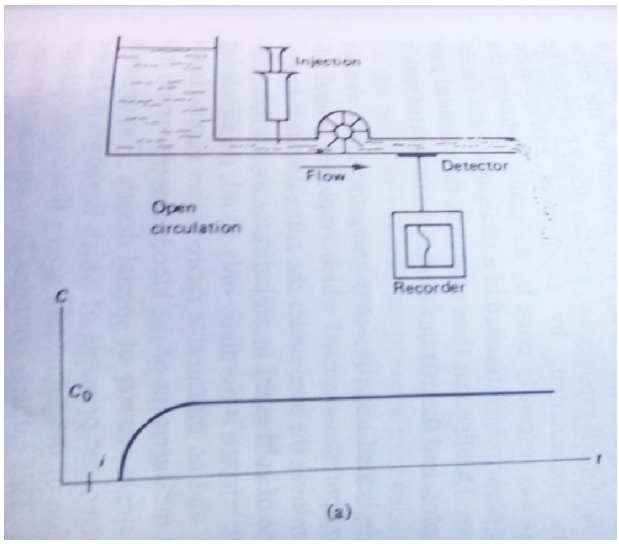
2)Angular potentiometers



Application: Rotary position sensors provide electrical outputs relative to shaft rotation in order to precisely measure angles. These devices are used in multiple position sensing applications, including:
1)gear position
2)automotive position sensing, including throttle position, steering wheel position, and pedal position
3)industrial control
4)valve control

b) Describe flow measurement by indicator dilution.(Description-4m)

Ans: Diagram:



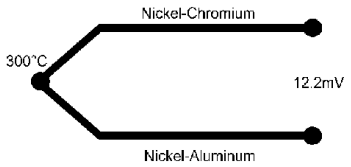
The indicator or dye dilution method

The indicator or dye dilution methods are the only methods of blood flow measurement that really measure the blood flow and not the blood velocity.The principle of dilution method is shown in the figure. The upper left drawing shows a model of a part of the blood circulation under the assumption that the blood is not recirculated. The indicator is injected into the flow continuously, beginning at time t, at a constant infusion rate I (grams per minute).A detector measures the concentration downstream from the injection point. Figure a shows the output of recorder that is connected to the detector. At a certain time after the injection, the indicator begins to appear, the concentration increases, and finally, it reaches a constant value,Co(milligrams perliter).From the measured concentration and the known injection rate,I (in milligram per minute), the flow can be calculated as

F(liters per minute) = I (milligrams per minute) / Co(milligramsper liter)

c) Draw constructional diagram of thermocouple with neat label. State "see beck effect". State any three types of thermocouple.(1m+2m+1m)

Ans: Diagram:



When any conductor is subjected to a thermal gradient, it will generate a voltage. This is now known as the thermoelectric effect or See beck effect or The use of thermoelectric effect to convert from thermal to electrical energy is called Seebeck effect .

Types of thermocouples: a) Nickel alloy thermocouples-type E(cromel-constantan),type J(Iron –contantan), type K(cromel alumel),type M ,type N(Any other releveant types)

d) State and explain basic requirements of biomedical amplifier(4m)

Ans:T he basic requirements that a biopotential amplifier has to satisfy are:

1) The physiological process to be monitored should not be influenced in any way by the amplifier

2) The measured signal should not be distorted

3) The amplifier should provide the best possible separation of signal and interferences

4) The amplifier has to offer protection of the patient from any hazard of electrical shock

5)The amplifier itself has to be protected against damages that might result from high input voltages

as they occur during the application of defibrillators or electrosurgical instrumentation

e) Give classification of transducers.(4 marks)

Some of the common methods of classifying transducers are given below

1)Based on their application.

2)Based on the method of converting the non-electric signal into electric signal.

3)Based on the output electrical quantity to be produced.

4)Based on the electrical phenomenon or parameter that may be changed due to the whole process. Some of the most commonly electrical quantities in a transducer are resistance, capacitance, voltage, current or inductance. Thus, during transduction, there may be changes in resistance, capacitance and induction, which in turn change the output voltage or current.

5)Based on whether the transducer is active or passive.

1. Passive Type Transducers

a. Resistance Variation Type

Resistance Strain Gauge

Resistance Thermometer

Photoconductive Cell .

Thermistor .

Potentiometer Type .

b. Capacitance Variation Type

Variable Capacitance Pressure Gauge

Dielectric Gauge

Capacitor Microphone.

c. Inductance Variation Type

Eddy Current Transducer

Variable Reluctance Type

Proximity Inductance Type

Differential Transformer

Magnetostrictive Transducer

d. Voltage and Current Type

Photo-emissive Cell .

Hall Effect – The voltage generated due to magnetic flux across a semi-conductor plate with a movement of current through it is known by its corresponding value of magnetic flux or current.

Ionisation Chamber – The electron flow variation due to the ionisation of gas caused by radio-active radiation is known by its corresponding radiation value.

2. Active Type

Photo-voltaic Cell .

Thermopile .

Piezoelectric Type

Moving Coil Type

f) Define: 1)Static characteristics 2)Dynamic characteristics 3)Biometrics 4)pH(definition -1 mark each)

Ans. The performance characteristics may be broadly divided into two groups, namely ‘static’ and ‘dynamic’ characteristics.

1)Static characteristics :The performance criteria for the measurement of quantities that remain constant, or vary only quite slowly.

2) Dynamic characteristics: The relationship between the system input and output when the measured quantity (measurand) is varying rapidly.

3)Biometrics-The branch of science that includes the measurement of physiological variables and parameters is known as Biometrics.

4) pH - pH is measure of the acid base balance of a fluid. Or pH is a measure of the hydorgen ion concentration of a solution. Solutions with a high concentration of hydrogen ions have a low pH and solutions with a low concentrations of H+ ions have a high pH. This may seem like a confusion way to express these reationships, and it is, until you understand what pH stands for. The equation that defines pH is given as follows:

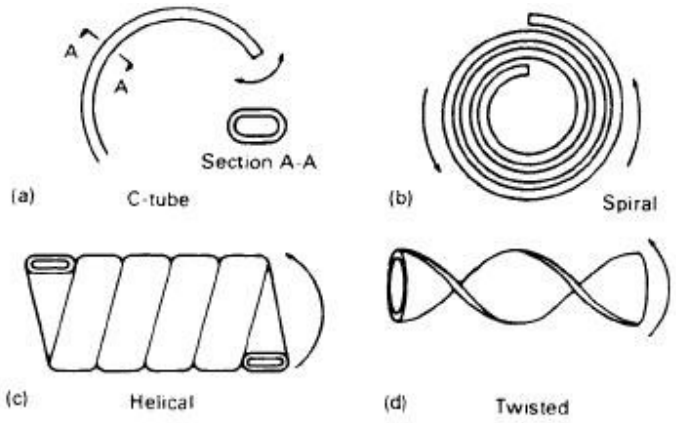
pH = -log[H+] concentration,

which is read: the pH is equal to minus the log of the H+ concentration.

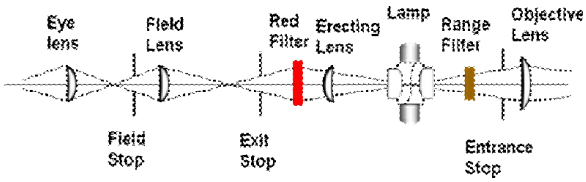
Q6 Attempt any four 16marks

a) Draw a neat sketch of C shape ,spiral ,helical and twisted type Bourdon tube.(Diag-1 mark each)

Ans:



b) Describe optical pyrometer with neat sketch.(sketch 2m+describe2m)



Optical pyrometers

(OR any other relevant diagram)

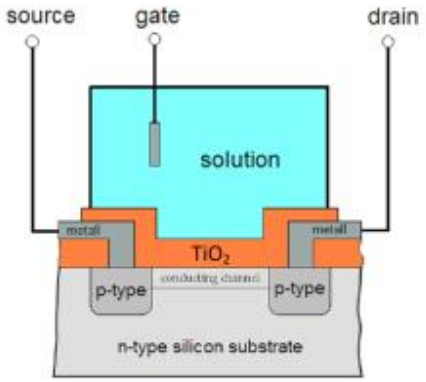
The Optical Pyrometer is a highly-developed and well accepted noncontact temperature measurement device

Optical Pyrometers work on the basic principle of using the human eye to match the brightness of the hot object to the brightness of a calibrated lamp filament inside the instrument. The optical system contains filters that restrict the wavelength-sensitivity of the devices to a narrow wavelength band around 0.65 to 0.66 micons (the red region of the visible spectrum).
Other filters reduce the intensity so that one instrument can have a relatively wide temperature range capability. Needless to say, by restricting the wavelength response of the device to the red region of the visible, it can only be used to measure objects that are hot enough to be incandescent, or glowing. This limits the lower end of the temperature measurement range of these devices to about 700 °C.

c) Describe working of flow measurement by thermal convection.(4m)
Ans: A hot object in a colder flowing medium is cooled by thermal convection. The rate of cooling is proportional to the rate of the flow of the medium. A thermistor in a blood stream is kept at a constant temperature by a servo system. The electrical energy required to maintain this constant temperature is a measure of the flow rate. In another method an electric heater is placed between two thermo couples or thermistors that are located some distance apart along the axis of the vessel. The temperature difference between the upstream and down stream sensor is a measureof blood velocity.

d)With the help of suitable diagram state the working of ISFET(ion sensitive field effect transistor)(diag 2m+working2m)

Diagram:



ISFET(ion sensitive field effect transistor)

An ISFET's source and drain are constructed as for a MOSFET. The gate electrode is separated from the channel by a barrier which is sensitive to hydrogen ions and a gap to allow the substance under test to come in contact with the sensitive barrier. An ISFET's threshold voltage depends on the pH of the substance in contact with its ion-sensitive barrier.

WORKING: An ISFET is an ion-sensitive field-effect transistor used for measuring ion concentrations in solution; when the ion concentration (such as H^+)changes, the current through the transistor will change accordingly. Here, the solution is used as the gate electrode. A voltage between substrate and oxide surfaces arises due to an ion sheath.The surface hydrolysis of Si–OH groups of the gate materials varies in aqueous solutions due to pH value. Typical gate materials are SiO_2, Si_3N_4, Al_2O_3 and Ta_2O_5.The mechanism responsible for the oxide surface charge can be described by the site binding model, which describes the equilibrium between the Si–OH surface sites and the H^+ions in the solution. The hydroxyl groups coating an oxide surface such as that of SiO_2 can donate or accept a proton and thus behave in an amphoteric way as illustrated by the following acid-base reactions occurring at the oxide-electrolyte interface:

$$—Si–OH + H_2O \leftrightarrow —Si–O^- + H_3O^+$$
$$—Si–OH + H_3O^+ \leftrightarrow —Si–OH_2^+ + H_2O$$

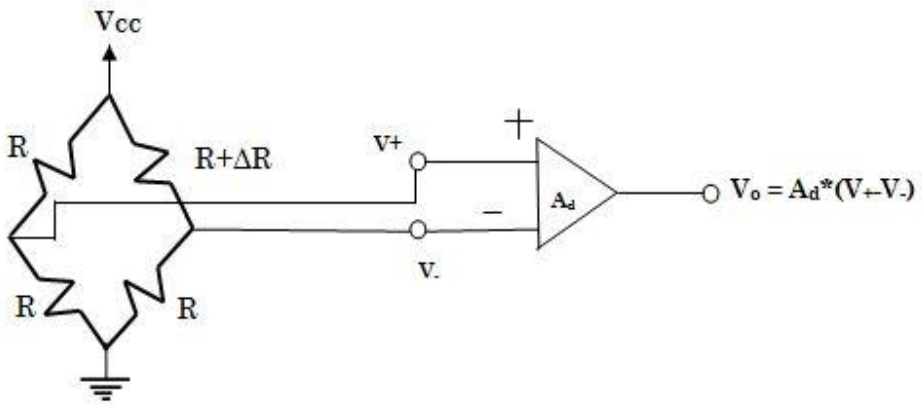
e) Explain the difference between skin interface and motion artifact.(2m+2m)

Ans : The term artifact refers to any component of a signal i.e. extraneous to the variable represented by the signal. Thus random noise generated within the measuring instrument , cross talk and unwanted variations in the signal are considered as artifacts. Major source of artifacts in the measuring of a living system is the movement of the subject, which in turn results in movement of measuring device. **The movement of the subject often produces variations in the output signal these are called as artifacts generated due to motion.**
Motion artifact includes the range of signals that can be produced during any motion, which act to mask signals of interest. Motion artifact has many sources, the following indicates one of commonly encountered artifacts:

Electrode-electrolyte-skin surface junctions
The multiple junctions in the electrode-electrolyte-skin interface all cause potentials. These potentials are sensitive to motion artifacts. When an electrode is pushed against the skin, the potential changes can easily approach 1mV in magnitude. With electrode side to side motion against the skin, potentials of around 500uV are easily obtained thus produce artifacts when mechanically disturbed.

f) Draw bridge amplifier using op-amp. State the equation used for balancing of bridge.(2m+2m)

Ans:



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

$$\mathbf{V_o = A_d*(V_+-V_-)}$$

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.