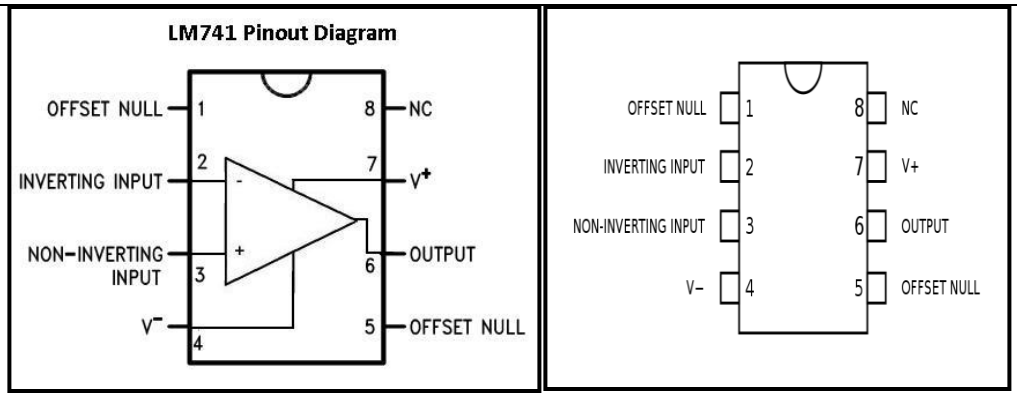
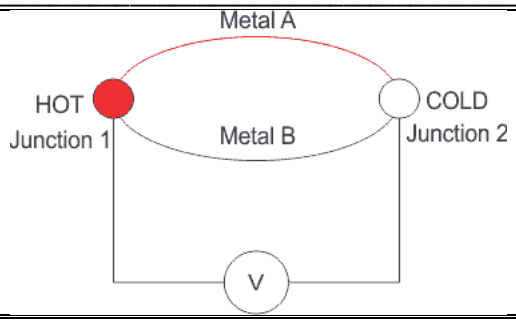
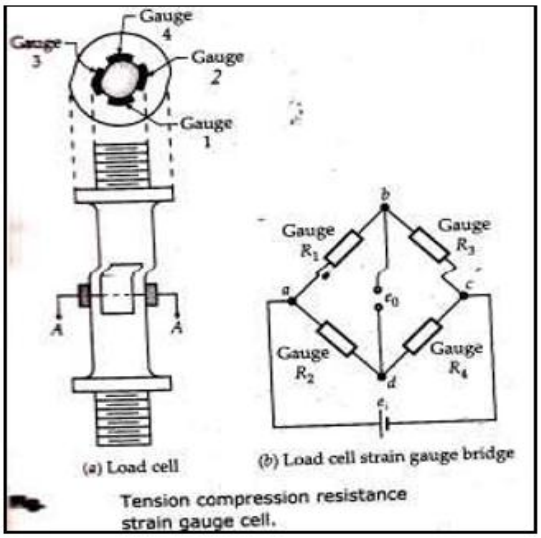
WINTER– 16 EXAMINATION (Subject Code: 17414)

Model Answer

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. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any TEN of the following:**	**20-Total Marks**
1	**a)**	**Draw and label pins of IC 741.**	**2 M**
	Ans:		**Diagram :2M**
	b)	**Define range and span.**	**2 M**
	Ans:	**Range:** It is defined as the difference between Greatest and Smallest value of the data. **Span:** It is defined as the algebraic difference between the upper and lower range values	**1 Mark each**
	c)	**State seebeck effect.**	**2 M**
	Ans:	The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances. If the two conductors or semiconductors are connected together through an electrical circuit, direct current (DC) flows through that circuit.	**State:2M**

			**(Diagram Optional)**
	d)	**State four points to be considered while selecting transducer.**	**2 M**
	Ans:	**(Any Four Points)** 1.Operating range 2. Operating principle 3. Sensitivity 4. Accuracy 5. Frequency response and resonant frequency 6. Errors 7. Environmental compatibility 8. Usage and ruggedness. 9. Electrical aspect. 10. Stability and Reliability 11. Loading effect 12. Static characteristics 13. General selection criteria	**1 point 0.5 M**
	e)	**State working principle of A/D converter. ?**	**2 M**
	Ans:	• An A/D converter converts the analog signal which is measured by sensors to its equivalent digital form. • The conversion of analog measurements to digital measurements involves three operations, namely sampling, quantization and encoding.	**1M for Each Point**
	f)	**Draw the diagram for force measurement using load cell.**	**2 M**
	Ans:		**Diagram:2 M**

g) State the difference between volumetric flow rate and mass flow rate. — **2 M**

Ans:

Volumetric Flow Rate	Mass Flow rate
1.Volumetric flow is the measure of a substance moving through a device over time. 2.Units of measure for volumetric flow rate are meters^3 /second, milliliters/second or feet^3/hour. 3.To measure Volumetric flow rate , positive displacement meters, turbine flow meters are used.	1. Mass flow rate is the amount of a mass moving through an instrument over time. 2. The unit of measure is mass (or weight) per unit of time. It can be expressed as pounds /hour or kilograms/second 3. To measure Volumetric flow rate , Coriolis flow meters, thermal mass flow meters, ultrasonic meters and rotameters.

(Any two difference 1 Mark for each difference.)

h) State any four objectives of DAS. — **2 M**

Ans :
1. To Acquire Data From physical Systems and devices.
2. To transmit it.
3. To Record the real time data to provide necessary signal conditioning.
4. To provide supervisory control whenever required.

(1 Mark for each objective. Consider any other relevant point.)

i) Define fidelity and measuring lag — **2 M**

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

Measuring Lag: It is the retardation or delay in response of the measurement system to the changes in the measured quantity.

(1 Mark for each definition)

j) Define supply voltage Rejection Ratio and Output voltage Swing. — **2M**

Ans: **Supply Voltage Rejection Ratio**: It is defined as the ratio of change of input offset voltage to the change in one supply voltage while keeping other supply voltage constant.
Ideally, SVRR=0

Output Voltage Swing: It is defined as the maximum unclipped peak to peak **output voltage** that an OPAMP can produce. Since the quiescent **output** is ideally zero, the ac **output voltage**

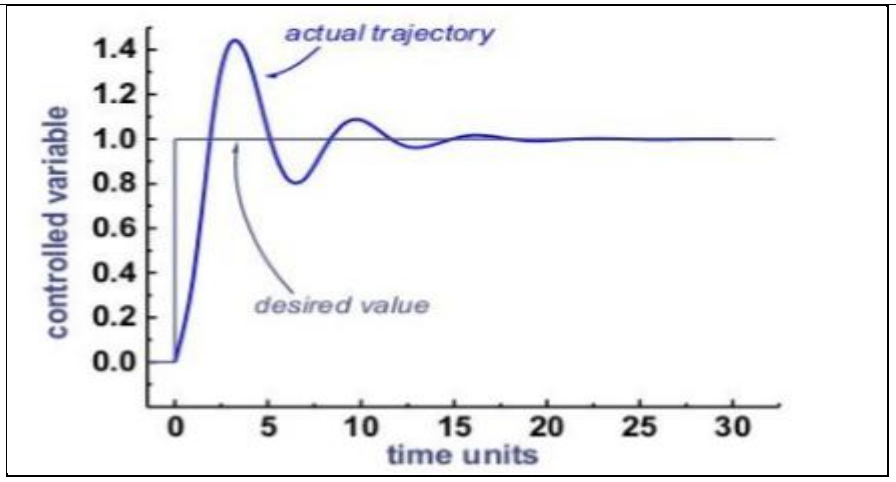
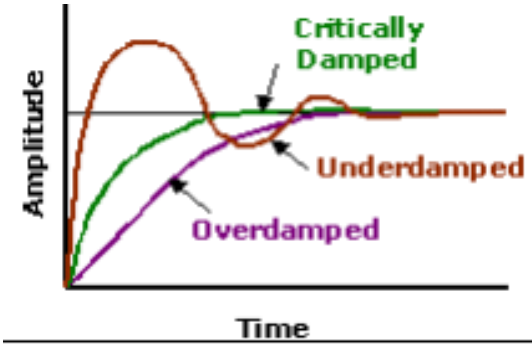
(1 Mark for each definition)

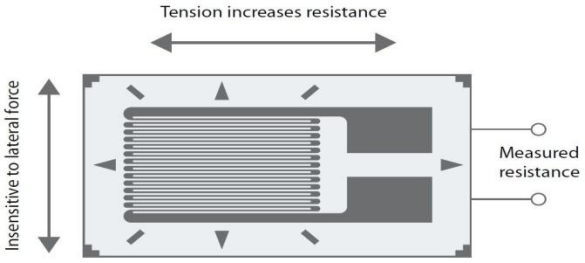
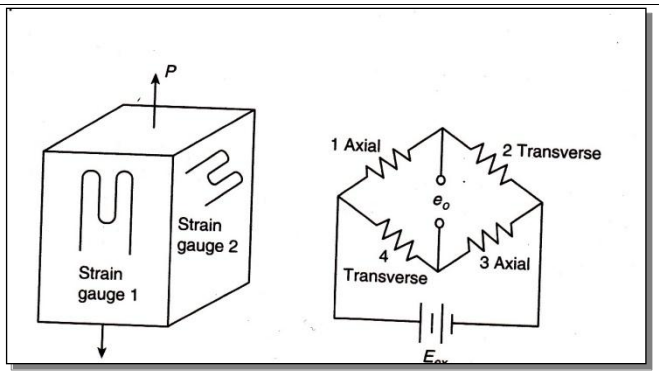
h) Compare NTC and PTC thermistor (two points). — **2M**

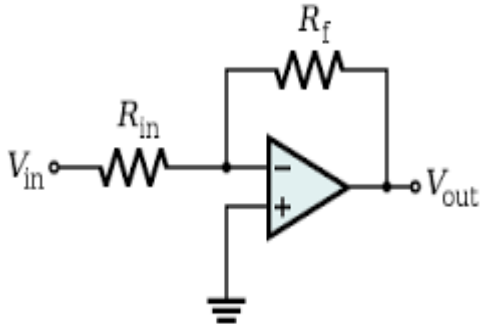
Ans:

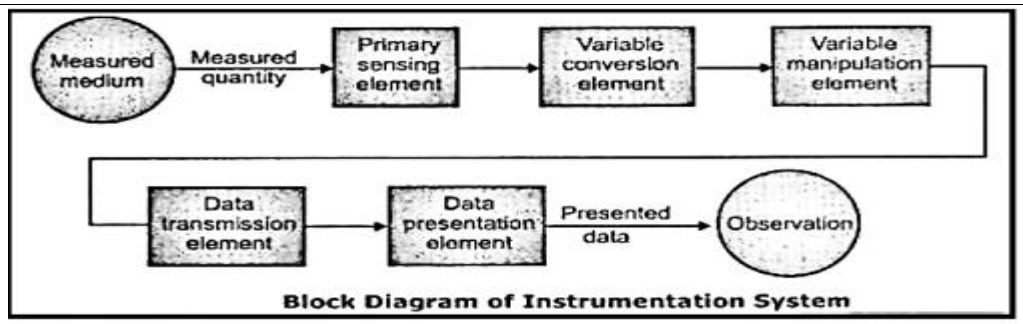
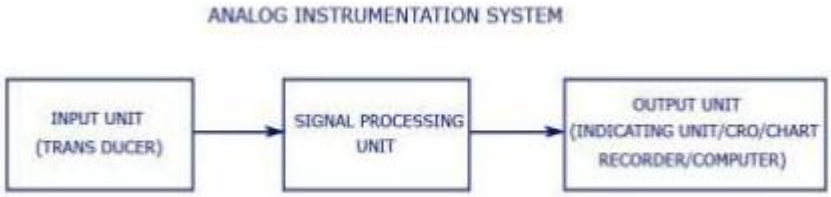
NTC Thermistor	PTC Thermistor
1.NTC Thermistor means Negative temperature Coefficient 2. NTC means resistance of thermistor Decreases as temperature rises. 3. NTC thermistors are made from a pressed disc, rod, plate, bead or cast chip of semiconducting material	1. PTC Thermistor means Positive temperature Coefficient 2. . PTC means resistance of thermistor increases as temperature rises. 3. PTC thermistors are made from doped polycrystalline ceramic (containing bari

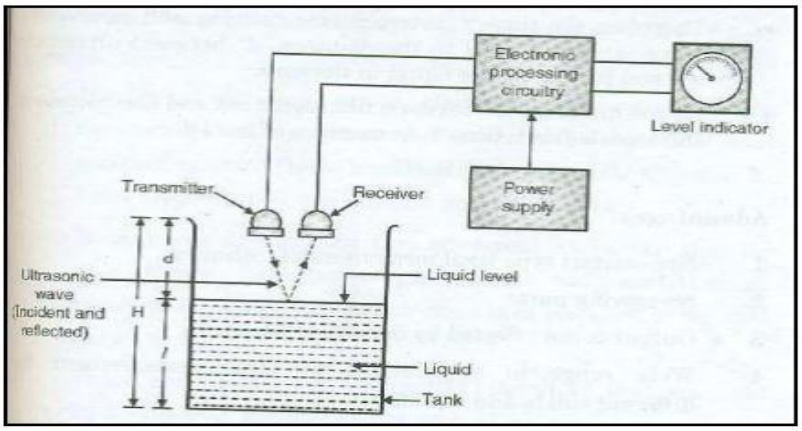
(1 Mark for each difference)

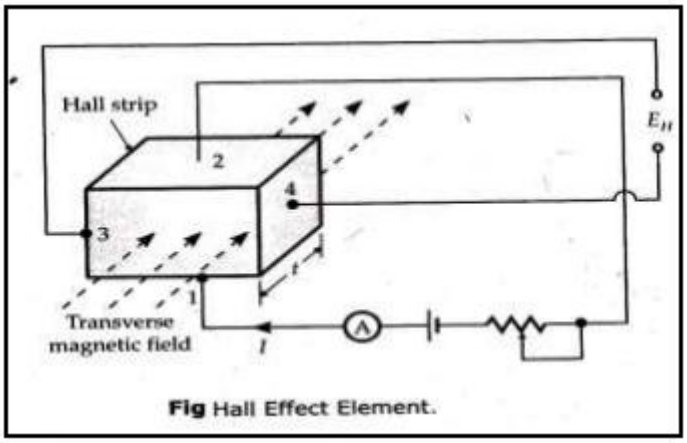
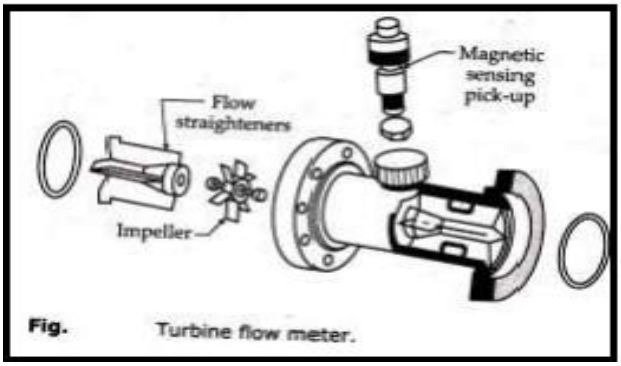
		such as sintered metal oxides. 4.NTC Thermistors characteristics are nonlinear in nature.	um titanate ($BaTiO_3$) 4. PTC Thermistor are comparatively linear in nature.	
	i)	**List four different units of pressure.**		**2M**
	Ans:	Units of Pressure: 1.Pascal, 2. Newton per sq. meter, 3.bar, 4.pounds per sq.inch, 5. Torr.		**0.5M for Each type**
Q 2		**Attempt any FOUR of the following**		**16**
	a)	**Draw and explain response of second order system for step input.**		**4M**
	Ans:	 **OR**  When the damping factor is less than 1 , system is underdamped with decresing oscillations. When damping factor is equal to 1, system is critically damped with exponential response. When damping factor is greater than 1, system is overdamped with slow exponential response.		**(Explanation: 2 Marks,Diagram:2M)**

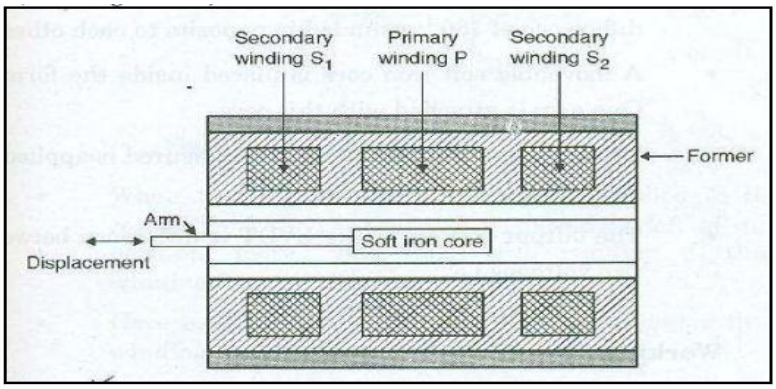
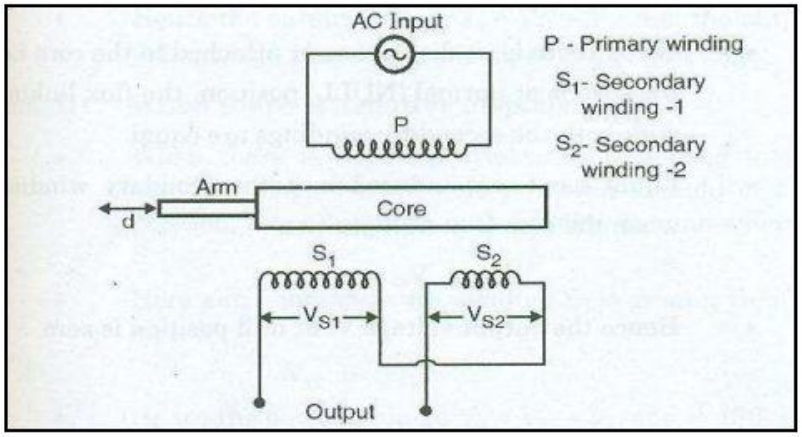
b)	**Define calibration. Explain process of calibration in detail.**	**4M**
	The process of deriving the value of a quantity by comparing that quantity with a standard quantity is called as calibration. Calibration of instrument is done to obtain correct unknown value of each scale reading on measuring instrument. There are 3 main reasons for having instrument calibration: • To ensure reading from an instrument are consistent with other measurements. • To determine the accuracy of the instrument reading. • To establish the reliability of the instrument i.e. it can be trusted.	**(Definition: 1Mark, Explanation : 3 Marks)**
c)	**Define gauge factor. Explain the working principle of strain gauge.**	**4M**
Ans:	**Gauge Factor:** It is the ration of per unit change in resistance to per unit change in length.  $G_f = \frac{\Delta R/R}{\Delta L/L}$ When force is applied to any metallic wire its length increases due to the strain. If L_1 is the initial length of the wire and L_2 is the final length after application of the force, the strain is given as: $\varepsilon = (L_2 - L_1)/L_1$ Further, as the length of the stretched wire increases, its diameter decreases. so that resistance of the conductor is the direct function of the length. As the length of the conductor increases its resistance increases. This change in resistance of the conductor can be measured easily and calibrated against the applied force. Thus strain gauges can be used to measure force and related parameters like displacement and stress. The input and output relationship of the strain gauges can be expressed by the term gauge factor or gauge gradient, which is defined as the change in resistance R for the given value of applied strain ε.	**(Definition; 1 Mark, Diagram: 1 Mark, Working principle: 2 Marks)**
d)	**State working principle of column type load cell and state its any four applications.**	**4M**
Ans:	 Load cell is an elastic member as the primary transducer and strain gauge is the	**Working:2 M & application: 2M (Diagram-Optional)**

	secondary transducer. When this combination is used, it is called load cell. In this case an axial compressive load causes a negative strain in vertical gauges. The two strains are not equal in this case. These are related to each other by Poisson's ratio and a force is measured. Application: (consider any other relevant application) 1. It is used in aerospace, medical, and automation measurement platforms. 2. It is used to measure pressure in machine tool application. 3. It is used for weighing 4. It is used to measure torque force.	
e)	**Define transducer and give in detail classification.**	**4M**
Ans:	Transducer is defined as the device which converts one form of energy into other form. So transducer consists of two parts :i)Sensing Element, ii) Transducing element Transducer are classified as: 1. Primary Transducer and Secondary Transducer 2. Active transducer and passive transducer 3. Mechanical transducer and Electrical transducer 4. Analog transducer and digital transducer. 5. Transducer and Inverse transducer.	**Definition:2 M & Classificatio n:2M**
f)	**Explain in brief the concept of virtual ground in op-amp.**	**4M**
Ans:	In ideal op-amp gain(a) is infinity... a=Vo/Vi, which means Vo/Vi=infinity then Vi=0 , ast V1-V2=0 in an op-amp V1=V2(V1 IS GROUNDED).so, V1=0(ACTUAL GROUND) n V2=0(VIRTUAL GROUND). when one terminal is grounded the other terminal is assumed to be at ground potential n  that is virtual ground concept of op-amp..	**Explanation :4M Diagram: Optional**

Q. 3		Attempt any FOUR of the following:	16- Total Marks
	a)	**Draw and explain block diagram of instrumentation system.**	4M
	Ans:	 **Fig. Block diagram of instrumentation system** **Primary Sensing Element:** primary sensing element of system is that which first receives energy from the measured medium and produces an output depending in some way on the value of measured quantity. **Variable Conversion Element:** A variable conversion element merely converts the output signal of the primary sensing element into a more suitable variable or condition useful to the function of the instruments. Variable Manipulation Element: It manipulates the signal represented by some physical variable, to perform the intended task of an instrument. In the manipulation process, the physical nature of the signal is preserved. **Data Transmission Element**: It transmits the data from one element to other element. **Data presentation Element:** It performs the translation function, such as the simple indication of a pointer moving over a scale or recording of a pen moving over a chart. **OR**  **The Primary Element/Transducer**: The input receives the quantity whose value is to be measured and is converted into its proportional incremental electrical signal such as voltage, current, resistance change, inductance or even capacitance. Thus, the changed variable contains the information of the measured variable. Such a functional element or device is called a transducer. **The Secondary Element/Signal Processing Unit** :The output of the transducer is provided to the input of the signal processing unit. This unit amplifies the weak transducer output and is filtered and modified to a form that is acceptable by the output unit. Thus this unit may have devices like: amplifiers, filters, analog to digital converters, and so on. **The Final Element/Output Unit:** The output from the signal processing unit is fed to the input of the output unit. The output unit measures the signal and indicates the value to the reader. The indication may be either through: an indicating instrument, a CRO, digital computer, and so on.	(Diagram :2 Marks,Explaination:2 Marks)
	b)	**b) Define following term: (i) Precision (ii) Drift (iii) Static error (iv) Dead zone**	4M
	Ans:	**(i)Precision:** It is the measure of consistency or repeatability of measurements. **OR**	(Each term: 1 Mark)

	The closeness with which the individual measurements are departed or distributed about the average of number of measured value. **(ii) Drift:** Drift means that with a given input the measured values changes with time. Perfect reproducibility means that the instrument has no drift. **(iii) Static Error**: Static error is defined as the difference between the measured value and the true value of the quantity. **(iv) Dead Zone:** Dead zone is the largest range of value of measured variable to which instrument does not respond. It is mainly due to friction in the instrument.	
c)	**Define: (i) Gauge pressure (ii) Atmospheric pressure (iii) Differential pressure**	**4M**
Ans:	**(i) Gauge pressure:** Gauge pressure is defined as the difference between actual pressure and atmospheric pressure. Gauge pressure= $P_{absolute} - P_{atmospheric}$ **(ii) Atmospheric pressure:** Atmospheric pressure is also called as barometric pressure, is the pressure exerted by the weight of air in the atmosphere. **(iii) Differential pressure:** Differential pressure is a pressure that is measured relative to the pressure in the atmosphere around it. It shows the difference between two pressures of the same unit.	**(Each Definition: 1 marks)** **(Equation: 1 Mark)**
d)	**Draw and explain ultrasonic method of liquid level measurement.**	**4M**
Ans:	 It operates by generating an ultrasonic wave or pulse and measuring a time it takes for the echo to return. There are two way of measurement of liquid level: • Doppler Type • Time difference type The ultrasonic waves generated by transmitter and directed towards the liquid surface in the tank which is to be measure. These waves get reflected from the surface of the liquid and are received by the receiver. The time take by the wave is a measure of the distance travelled by the wave. Therefore the time 't' between transmitting and receiving a wave is proportional to the distance 'd' between ultrasonic set and surface of the liquid in the tank. As the distance 'H' between ultrasonic set and the bottom of the tank is fixed time 't' is measure of level 'l'	**(Diagram :2 Marks, Explanation :2 Marks)**
e)	**State principle of hall effect transducer and explain its working in detail.**	**4M**
Ans:	**Principle:** The principle of working of a Hall Effect Transducer is that if a strip of conducting material carries' a current in the presence of a transverse magnetic field, a difference of potential is produced between the opposite edges of the conductor. The	**(Principle:1 Mark, (Diagram :**

		magnitude of the voltage depends upon the current, the strength of magnetic field and the property of the conductor called Hall Effect.  **Fig** Hall Effect Element. Current is passed through leads 1 and 2 of the strip. The output leads connected to edges 3 and 4 are at the same potential when there is no transverse magnetic field passing through the strip. When a transverse magnetic field passes through the strip, an output voltage appears across the output leads. This voltage is proportional to the current and the field strength. The output voltage is, $E_H = K_H I B / t$ where K_H = Hall effect coefficient ; V - m /A- Wb m-2 t = thickness of strip; m, and I and B are respectively the current in ampere and flux density in Wb/m2. Thus the voltage produced may be used for measurement of either the current I or the magnetic field strength B.	**1 ½ Marks, Explanation : 1 ½ Marks)**
f)		**Draw a neat diagram of turbine flow meter and explain its working.**	**4M**
Ans:		 **Fig.** Turbine flow meter. • **Principle:** The flowing fluid impinges on the turbine blades (rotor), imparting a force to the blade surface which causes the rotation of the rotor. The speed of the rotation is directly proportional to the fluid velocity. The rotor consists of small permanent magnets. When rotor rotates this magnetic field also rotates. The speed of rotation monitored in most of the meters by magnetic pickup coil, which generates pulses. Total number of pulses gives the total flow. So the amount of emf induced depends upon the flow rate. • **Explanation: -** Turbine flow meters are volumetric flow meters and are available in wide ranges. The output is usually in the form of a digital electrical signal whose frequency is directly proportional to flow rate and whose total count is proportional to	**(Diagram :2 Marks, Working:2 Marks)**

		flow rate and whose total quantity, as each pulse represents a discrete volume. A feature of this turbine meter is a hydraulically supported turbine rotor. A permanent magnet sealed inside the rotor body is polarized at 90 degree to the axis of the rotation. As the rotor rotates so does the magnet and therefore rotating magnetic field is produced. This produces an a.c voltage pulse in the pick-up coil located external to the meter housing. The frequency of this voltage is directly proportional to the rate of flow. The pulse can be totalized by a counter to give the value of total flow over a particular interval of time.	
Q. 4		**Attempt any FOUR of following:**	**16 M**
	a)	**With the help of neat labeled describe how pressure can be measure using LVDT.**	**8M**
	Ans:	 **OR**  **Working:** **Case I:** When there is no displacement. When there is no displacement attached to the core the core is at normal position, the flux linking with both the secondary winding are equal. Equal e.m.f. is induced in both secondary winding when the core is at null position: VS1=VS2 Hence the output voltage Vo at null position is zero. **Case II:** 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 S1 than winding S2 Here e.m.f. induced with winding S1 is greater than winding S2 that is VS1>VS2 Hence the output voltage Vo= VS1-VS2 and the output voltage is in phase with the input	**(Diagram :4 Marks, Working:4 Marks)**

primary voltage.

Case III: When there is negative displacement

When there is negative displacement applied to the core i.e. the core is moved to right of null position, more flux links with winding S2 than winding S1.

Here e.m.f. induced with winding S2 is greater than S1 that is VS2>VS1 Hence the output voltage Vo= VS1-VS2 and is 180 degree out of phase with the input primary voltage.

b) Compare: (i) RTD and Thermistor (any four points). (ii) Active transducer and Passive transducer (any four points). **8 M**

Ans:

(i) RTD and Thermistor (any four points). **(Each point 1 Mark)**

Sr. No.	RTD	Thermistor
1	Made of metals which are good conductors of electricity e.g. copper, platinum Nickel	Made of metallic oxides such as cobalt, manganese, nickel etc.
2	Positive temperature coefficient of resistance.	PTC and NTC both types are available
3	Temperature range: -100 C to 650 C.	Temperature range: -50 C to 300 C
4	It has linear temperature versus resistance curve.	It has nonlinear temperature versus resistance curve.
5	As made of metal they are more stable.	As made of metal oxide they are less time stable.
6	They have better reproducibility and low hysteresis.	They have less reproducibility and more hysteresis.
7	Relatively bigger in size.	Thermistors are quite small in size.
8	Cost is high	They are not costlier as compared to RTD

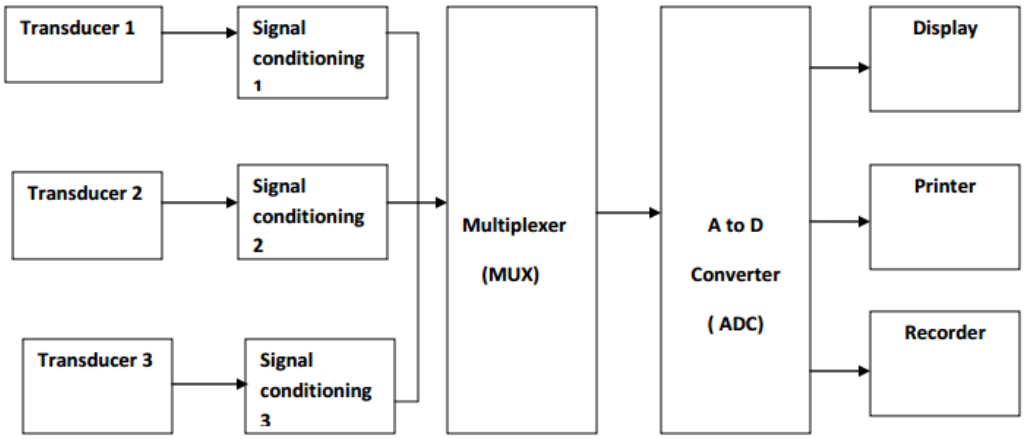
(ii) Active transducer and Passive transducer (any four points). **(Each point 1 Mark)**

Sr. No.	Active Transducer	Passive transducer
1	Don't require external power for operation.	Require external power supply for operation.
2	It is also called self-generating transducer.	It is also called Externally powered transducer.

3	Circuit is simple.	Circuit is complex.
4	Active bridge is not required.	Active bridge is required.
5	Operate under energy conversion principle.	Operate under energy controlling Principle.
6	Ex-Thermocouple, piezoelectric.	Ex Thermistor, Strain Gauges.

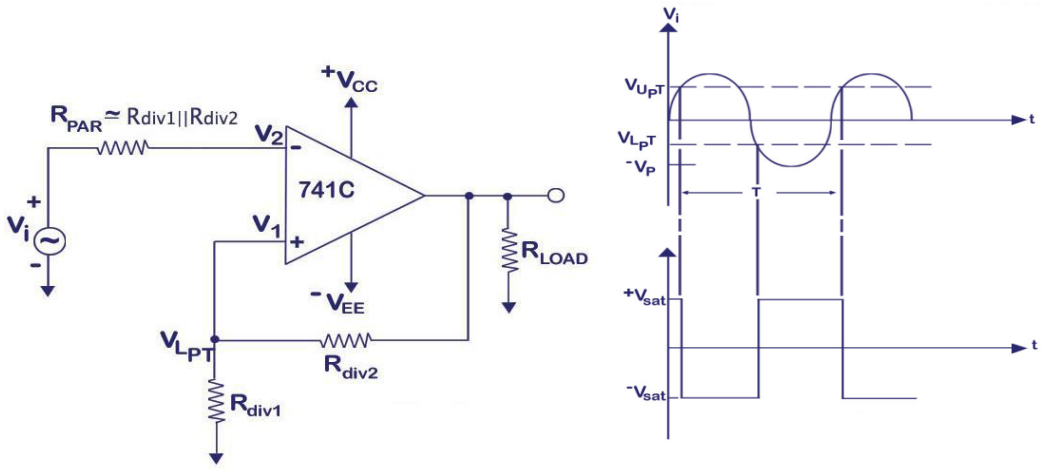
c) **Draw the block diagram of multichannel data acquisition system and explain in detail.** **8 M**

Ans:



(Diagram :4Marks, Explaination:4 Marks)

- A data acquisition (DAQ) system is used for the measurement and processing of plant signal data before it is displayed on the operator desk or permanently recorded. A block diagram of a PC (computer) based data acquisition is shown in figure . It consists of individual transducers (sensors) for measurement of physical plant parameters (such as temperature, pressure, flow, etc.). After measurement, the transducer data is fed to the signal conditioning device to bring the signal level up to a sufficient value to make it useful for conversion, processing, indicating and recording. Signal conditioner is used to amplify, modify or select certain portion of signals.
- The output of the signal conditioner is fed to the multiplexing (telemetry) device. With the help of multiplexing all individual signal data (called lower bandwidth communication channels) are combined and transmitted over a higher bandwidth channel. At the receiving end, de-multiplexing recovers the original lower bandwidth channels. It scans across a number of analog signals and time-sharing them sequentially into a single analog output channel. The multiplexed data is converted into digital signal with the help of analog-to-digital converter. The converted digital signals are fed to the computer for further processing, mathematical computation, storage, etc. The final and processed data is either displayed on electronic digital display panel or recorded on magnetic media and/or chart recorders.

Q.5		Attempt any TWO of following:	16 M
	a)	**Explain the concept of comparator. Draw and explain the working of Schmitt trigger.**	**8 M**
	Ans:	A comparator circuit compares two voltages and outputs either a 1 (the voltage at the plus side; VDD in the illustration) or a 0 (the voltage at the negative side) to indicate which is arger. Comparators are often used, for example, to check whether an input has reached some predetermined value.  Fig shows an inverting amplifier with positive feedback. This circuit converts irregular shaped waveform to a square wave or pulse. The circuit is known as Schmitt trigger or squaring circuit. The input voltage Vi triggers (changes the state of) the output Voltage Vo every time it exceeds the certain voltage levels called Upper threshold voltage (V_{UpT}) and Lower threshold voltage (V_{LpT}). These Threshold voltages are obtained by using the voltage divider R_{div1} and R_{div2}, where the voltage across R_{div1} is fed back to the positive input. The voltage across R_{div1} is a variable reference threshold voltage that depends on the value and polarity of output voltage Vo. When $V_o = +V_{sat}$, The voltage across R_{div1} is called upper threshold voltage (V_{UpT}).The input voltage Vi must be slightly more positive than V_{UpT} in order to cause Output Vo to switch from $+V_{sat}$ to $-V_{sat}$.	**Diagram:4 M & Concept:2 M & Working:2 M**
	b)	**State and explain different signal conditioning techniques used in DAS.**	**8 M**
	Ans:	Signal conditioning is the technique of making a signal from a sensor or transducer suitable for processing by data acquisition system. Types of Signal Conditioning **Amplification:** Amplification increases a voltage signal to a level suitable for digitization by the DAQ equipment. Typically a data acquisition device is calibrated for input voltages in the 0 to 10 V range. A small voltage, such as that coming from a thermocouple or strain gauge bridge may need to be amplified 1000 times to make it between 0 and 10 V. **Excitation:** Many transducers, like strain gauges and RTDs (resistance temperature devices), need a power supply. The signal from these transducers is either a voltage or a mA current. For many transducers the supply will be low voltage DC, but for transducers based on capacitance measurement an AC supply may be required. Excitation is commonly needed for measuring force, pressure, relative humidity, temperature, level, light level,	Explanation :8M

concentration and vibration.

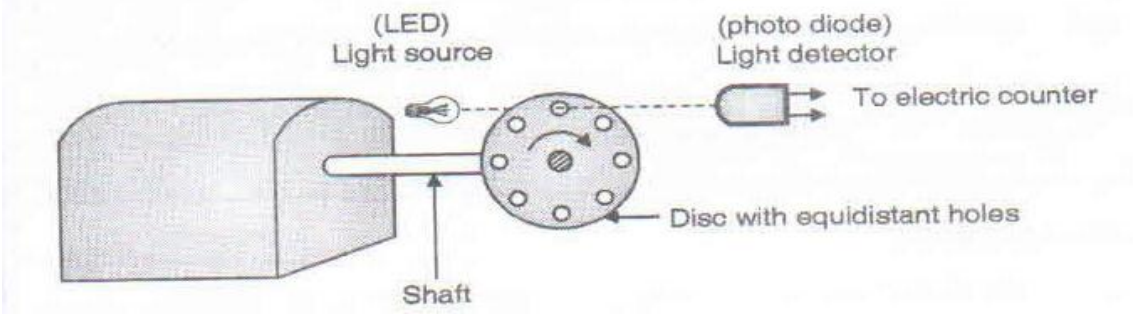
Linearisation:
Linearisation is needed when the signals produced by a sensor don't have a straight-line relationship with the physical measurement, as is the case when using thermocouples to measure temperature. Linearisation is achieved using signal conditioning.

Filtering:
Filtering reduces noise errors in the signal. For most applications a low-pass filter is used. This allows through the lower frequency components but attenuates the higher frequencies. The cut-off frequency must be compatible with the frequencies present in the actual signal (as opposed to possible contamination by noise) and the sampling rate used for the A-D conversion. A low-pass filter that's used to prevent higher frequencies, in either the signal or noise, from introducing distortion into the digitised signal is known as an anti-aliasing filter. These generally have a sharper cut-off than the normal low-pass filter used to condition a signal. Anti-aliasing filters are specified according to the sampling rate of the system and there must be one filter per input signal. They are commonly used when measuring, for example, vibration.

Isolation:
A high transient voltage at one input may damage not only the input circuit, but an also propagate to other equipment connected to that input. You can prevent this type of damage by providing isolation between inputs.

High Impedance:
Certain types of transducer have a very high output impedance and are not able to supply enough current to use a normal voltage input. When connected to a normal amplifier, the currents drawn from the transducer can seriously distort the input signal. Typically glass electrodes used to measure pH, or gas concentration probes, are of this type.

c)	**Explain the measurement set up used for speed measurement using non-contact type of transducer.**	**8 M**
Ans:	***Note: Any one type can be considered.*** **There are two types of non-contact types of tachometer** **i) Photoelectric Tachometer:**	**Digram:4M & Explanation:4M**



Working:
Working principle: The light passes through the holes available on the rotating disc with a specific interval, depends on the angular speed of disc having equidistant holes. The frequency of this light pulses is measure of angular speed of the disc.

It consists of an opaque disc on the rotating shaft. The disc has a number of equidistant holes on its periphery. At one side of the disc a light source is fixed like LED and on other side of the disc, and on the line of the light source, alight sensor like phototube or some photosensitive semiconducting device is placed.

When a hole appears between two, the light following upon the sensor produces an output pulse.

The frequency at which the pulses are produced depends on the number of holes in the disc and its speed of rotation. Hence the speed is given by

N= f/Hs
N=speed
f=frequency
H_s=holes on the disc

OR

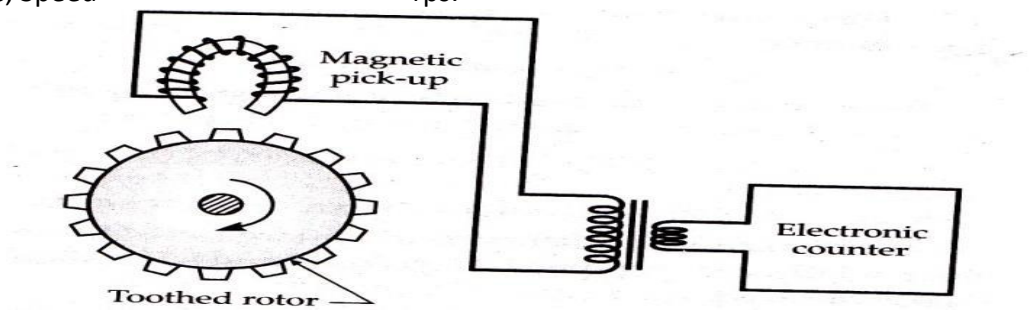
ii) Toothed rotor variable reluctance Tachometer (Magnetic Pick up)

It consists of a housing containing a small permanent magnet with a coil wound round it. When rotor rotates, the reluctance of the air gap between pickup and the toothed rotor changes giving rise to the induced e.m.f in the pickup coil. This output is in the form of pulses, with variety of wave shapes.

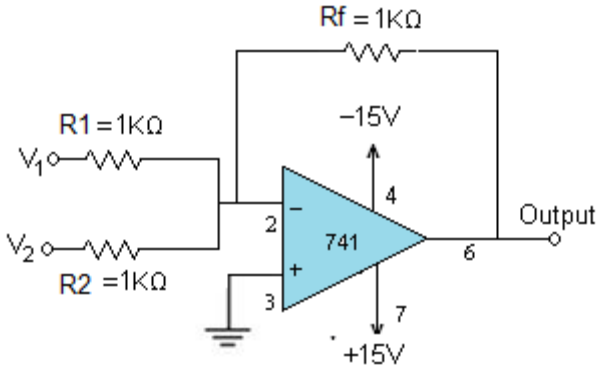
The frequency of the pulses of induce voltage will depend upon the number of teeth of the rotor and speed of rotation.

Number of pulses per revolution= T

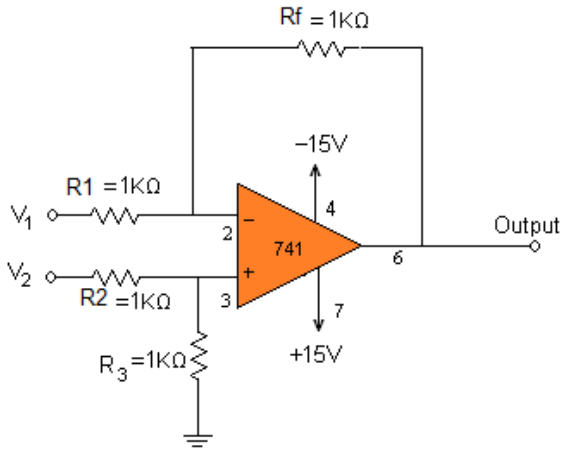
Thus, Speed = $\frac{pulses\ per\ second}{number\ of\ teeth} = \frac{P}{T}$ = rps.

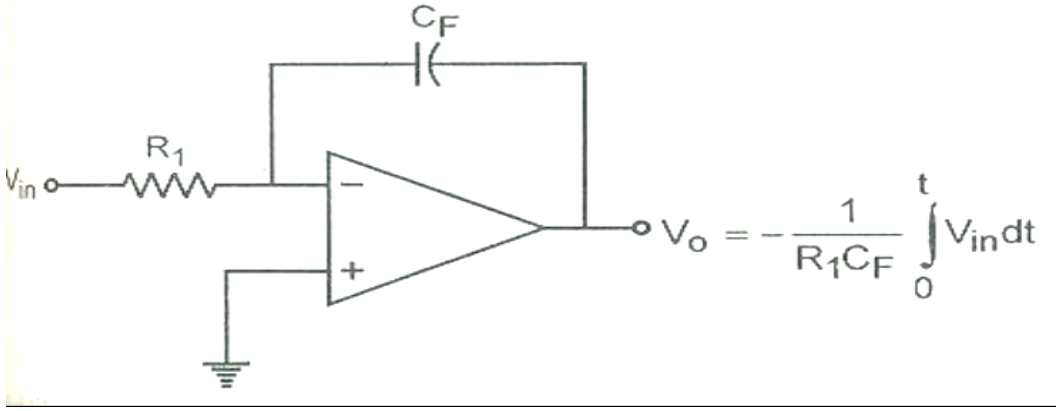


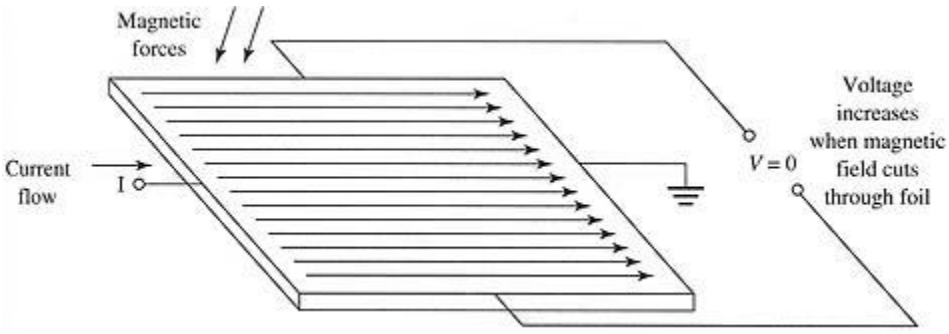
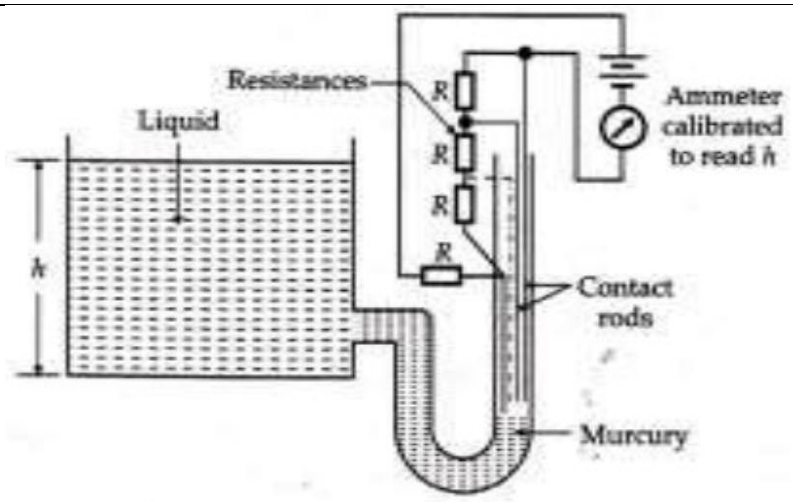
Q.6		Attempt any FOUR of following:	16 M
	a)	Draw: (i) Adder (ii) Subtractor circuit using op-amp.	4 M
	Ans:	1) Adder :	Digram:2M Each

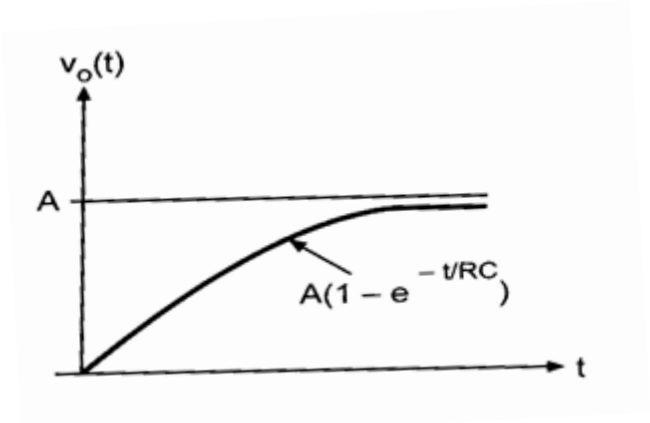


Subtractor:



b)	**Explain op-amp as a integrator.**	**4 M**
Ans:	 The operational amplifier integrator is an electronic integration circuit. Based on the operational amplifier (op-amp), it performs the mathematical operation of integration with respect to time; that is, its output voltage is proportional to the input voltage integrated over time. By integration we get, $vo = \frac{1}{RC}\int v1\, dt$	**Diagram:2 M & Expalnation:2M**
c)	**Explain working rotary encoder.**	**4 M**
Ans:	• A rotary encoder, also called a shaft encoder, is an electro-mechanical device that converts the angular position or motion of a shaft or axle to an analog or digital code. • There are two main types: absolute and incremental (relative). The output of absolute encoders indicates the current position of the shaft, making them angle transducers. The output of incremental encoders provides information about the motion of the shaft, which is typically further processed elsewhere into information such as speed, distance and position. • Rotary encoders are used in many applications that require precise shaft unlimited	**Expalnation:4 M**

	rotation—including industrial controls, robotics, special purpose photographic lenses, computer input devices (such as opto-mechanical mice and trackballs), and rotating radar platforms.	
d)	**Explain how AC current is measured using hall effect transducer.**	**4 M**
Ans:	This type of sensor works on a simple electromagnetic principle.  In above diagram of the Hall effect. A current is conducted through a thin piece of foil from terminal I and ground. When a magnetic field is brought perpendicular to the foil, a small voltage called the Hall-effect voltage is produced at the terminals attached to the opposite sides of the foil.	**Diagram:2 M & Explanation:2M**
e)	**Explain liquid level measure by resistive sensor.**	**4 M**
Ans:	 **Fig.** Measurement of level of liquids by resistive method. This method uses mercury as a conductor. A number of conduct rods are placed at various liquid levels. As head h increases, the rising level of mercury above the datum, shorts successive resistors R and increases the value of h directly.	**Explanation:- (02M) & Digram:2M**

	f)	**With the help of mathematical expression describe dynamic response of first order instrument.**	**4M**
	Ans:	The response is shown in fig.  The T.F. of First order system is , $\frac{V_0(s)}{V_i(s)} = \frac{1}{1+sRC}$ For Unit Step input $V_i(s) = \frac{1}{s}$ So, $V_0(s) = \frac{1}{s(1+sRC)} = \frac{A'}{s} + \frac{B'}{1+sRC}$ Where : A' = 1 and B' = - RC $Vo(s) = \frac{1}{s} - \frac{RC}{1+sRC} = \frac{1}{s} - \frac{1}{s} + \frac{1}{RC}$ Taking Laplace inverse, $Vo(t) = 1 - e^{\frac{-t}{RC}} \Rightarrow Css + ct(t)$ $Css = 1$ and $ct(t) = -e^{\frac{-t}{RC}}$ The response is purely exponential	**Response :2M Explanation: 2M**