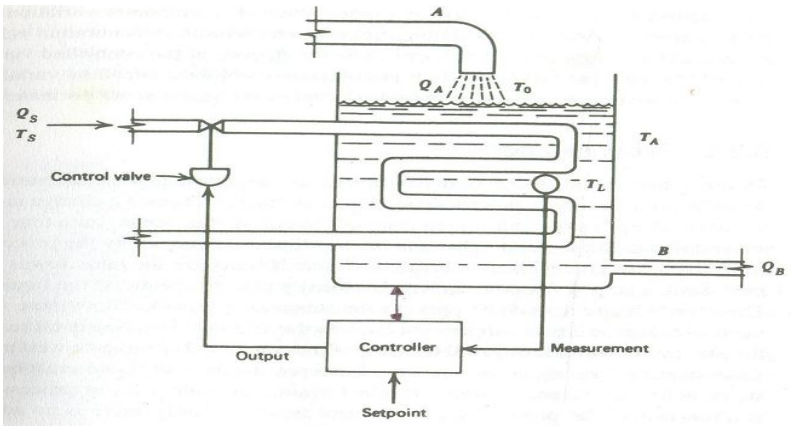
MODEL ANSWER

WINTER– 17 EXAMINATION

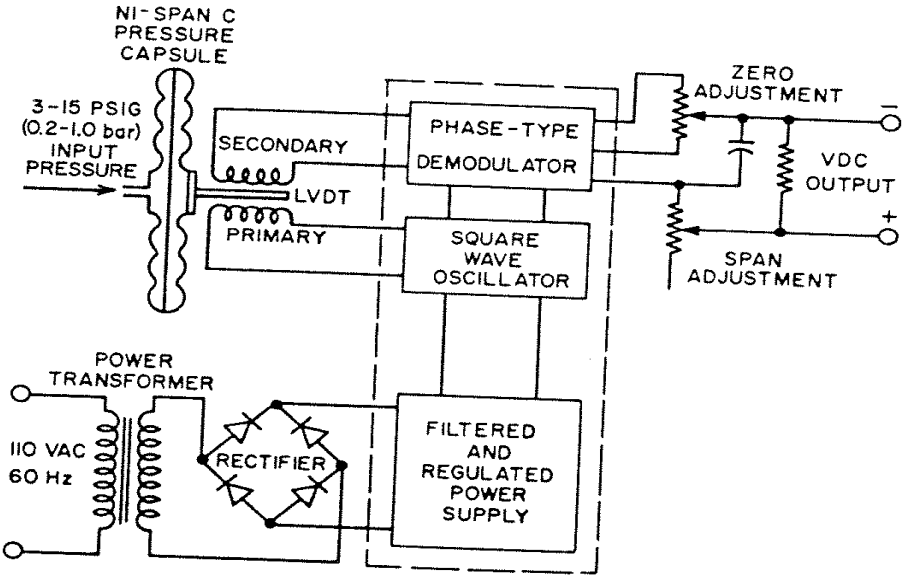
Subject Title: Process Instrumentation Subject Code: 17540

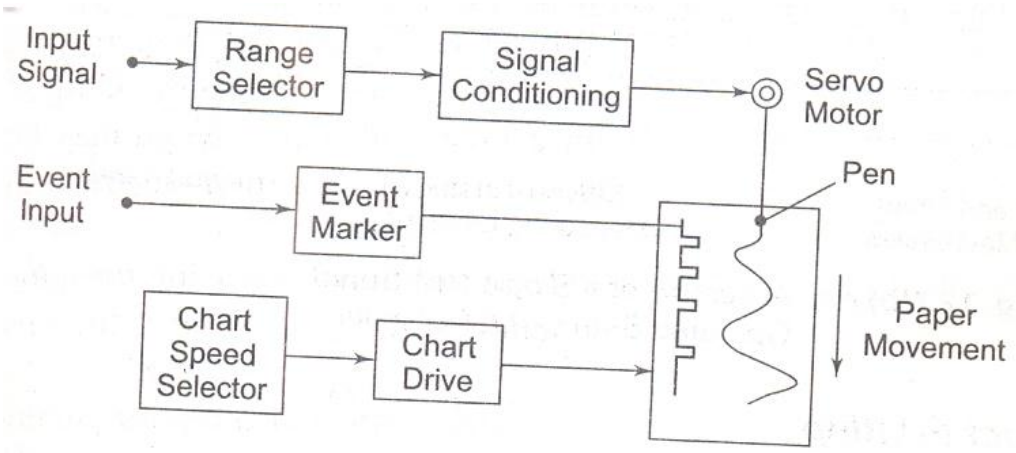
Important Instructions to examiners:

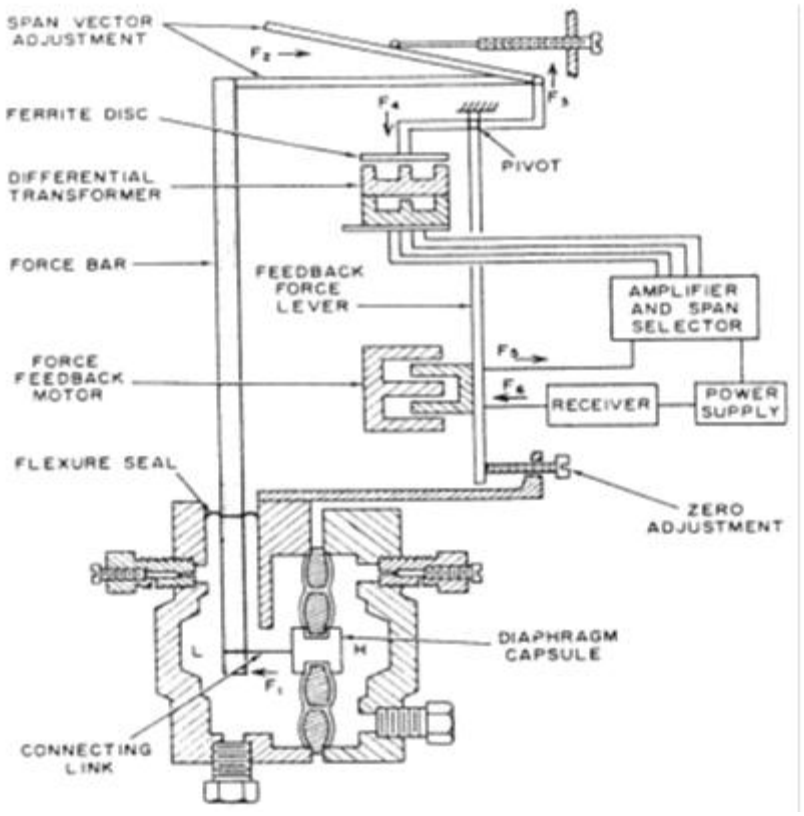
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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	(A)	**Attempt any 3 :**	**12-Total Marks**
	a)	**List 3 different types of process characteristics. State the meaning of anyone.**	**4M**
	Ans:	1. **Process equation**: The equation which describes the relation the controlled variable has with the other dynamic parameters of the system is called the process equation. For example the temperature control system shown below has a process equation,  $T_L = F(Q_A, Q_B, Q_S, T_A, T_S, T_O)$ T_L – liquid temperature	**Listing of any three - 2M** **Description of any one - 2M**

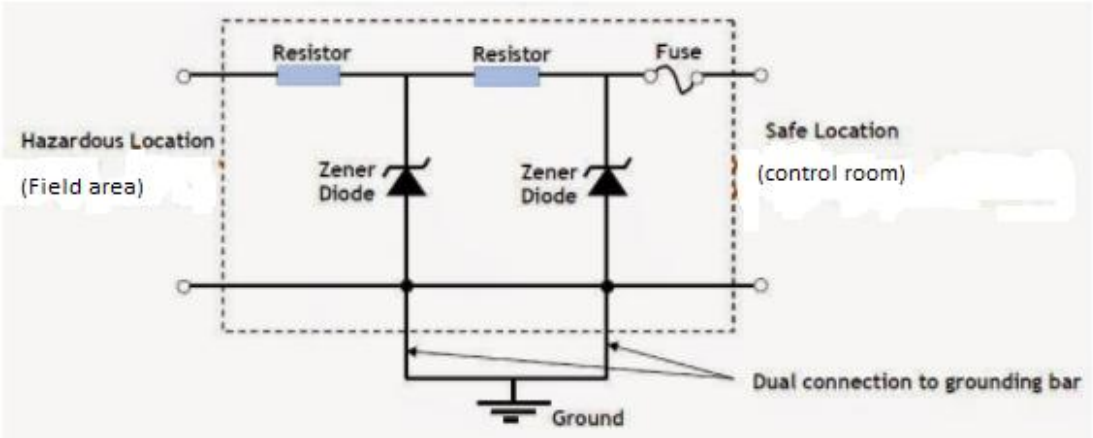
		Q_A, Q_B – flow rates in pipe A & B Q_S – steam flow rate T_A – ambient temperature T_S - steam temperature T_O - inlet fluid temperature 2. **Process load**: process load refers to the nominal set of parameters, excluding the controlled variable. Nominal set is the set of values for the process parameters that results in the controlled variable having the set point value. If any of these parameters changes to cause a change in the controlled variable, then it is considered to be a load change. Another type of load change is a transient, which indicate a temporary change in nominal parameters. 3. **Process Lag**: During the process control operations, a process load change or a transient causes a change in the controlled variable. The process control loop responds and some finite time later, the variable returns to the set point. Part of this time is consumed by itself and is called process lag. **4. Self- Regulation**: Some process has a tendency to adopt a specific value of the controlled variable for nominal load with no control operation. This particular characteristic of a process to regulate a variable by itself is called self-regulation.	
	b)	**Define calibration. State the need of calibration of instruments. (any 2 points).**	**4M**
	Ans:	**Definition of calibration:** Calibration is the process of adjusting the instruments output signal to match a known range of inputs, corresponding to a standard reference. **Need of calibration:** 1) To remove errors from instruments systems such as gross error, systematic errors etc. 2) To reset the instrument after cleaning, replacement of any part / element, range change etc. 3) To correct the instrument against any drift in operation with time due to use, wear and tear. 4) In order to maintain accuracy of system with specification. 5) To ensure/guarantee that instruments operates with required accuracy and specification.	**2M** **Any two points - 2M**
	c)	**State the need of converters in process industry (any 2 points).**	**4M**
	Ans:	**Need of converters:** 1. For forming a link between electronic and pneumatic system . 2. If field devices are pneumatic operated and controllers are electronic type in nature. 3. If field control signal feedback is pneumatic and interfaced with DCS/PLC in control room.	**4M for correct answer(any 2)**

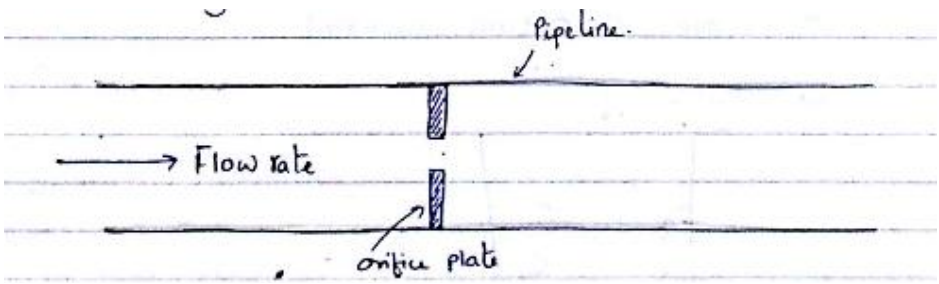
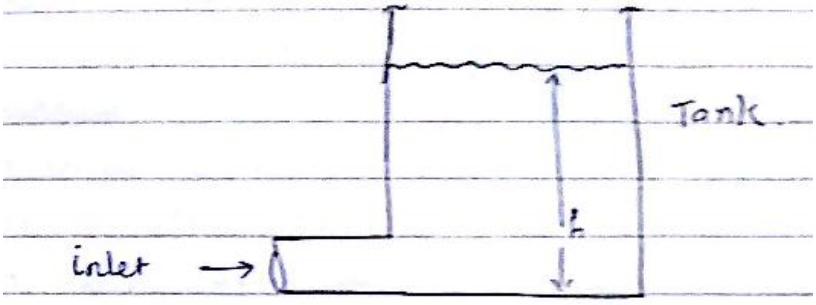
		4. Transmission of signal over large distance. 5. If field area is hazardous in nature. 6. Input to electronic controller	
	d)	**State the need and applications of recorders in process industries.**	**4M**
	Ans:	**Need of recorders:** In a measurement system, recorders are used to store information for later use. It provides an instantaneous indication for monitoring as well as a permanent record for later use. As the process complexity increases, the need of visualization and analysis increases. Hence such data helps in easy maintenance and provide data for research and development. It also allows man-less monitoring of remote locations. **Applications of recorders:** 1) Speed –torque characteristics of motors 2) Lift drag wind tunnel tests 3) Plotting of characteristics of vacuum tubes, Zener diodes, rectifiers and transistors. 4) Regulation curves of power supplies 5) Plotting stress- strain curves **6)** Electrical characteristics of materials such as resistance Vs temperature.	**2M** **2M**
	B)	**Attempt any one :**	**6-Total Marks**
	a)	**Draw the diagram of pressure to current converter. Explain in brief.**	**6M**
	Ans:	**Diagram of P/I converter:**  	**3M**

		Description: The input pressure to be converted is applied to corrugated type capsule pressure sensor. It gives mechanical deformation of free end when input pressure applied increases. As the free end is connected to core of LVDT, the displacement of capsule sensor displaces core. Primary winding of LVDT is excited by square wave oscillator. The o/p voltage between two secondary windings of LVDT is given to phase detector circuit. The reference signal for this circuit is given from a square wave oscillator. The dc o/p voltage of Phase detector circuit is given to zero adjustment and span adjustment circuit. Excitation or carrier frequency should be around ten times the frequency of the motion to be detected. Demodulator extracts the output corresponding to the detected motion from the modulated carrier output of LVDT.	**3M**
	b)	**Draw the diagram of strip chart recorder. Explain its working.**	**6M**
	Ans:	**Diagram:**  **Working:** A strip chart recorder records variations of one or more variables with respect to time. Fig. above shows the basic arrangement of a strip chart recorder. A pen (stylus) moving systems moves the pen on a paper, according the variations in the quantity under measurement. The applied input signal is conditioned before being applied to the moving system. A range selector may be used to properly match the input with the pen driving system. A chart drive vertically moves the paper roll at a constant speed. The speed of the paper drive is adjusted according to the frequency of variation of the input signal. Pen moving system uses either PMMC principle or self-balancing methods. Chart paper drive system consists of stepper motor with speed selector switch.	**3M** **3M**
Q.2		**Attempt any 2 :**	**16-Total Marks**
	a)	**Draw the neat diagram of force balance type pressure transmitter. Explain its working.**	**8M**

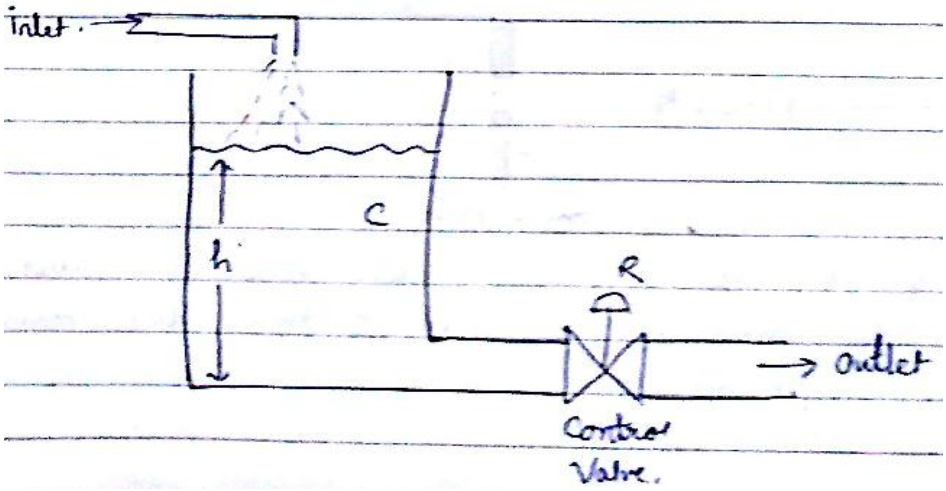
	Ans:	**Diagram:**  **Working:** Fig. above shows a force-balance differential pressure transmitter, in which the measurement that produces a force tends to move the top of the force bar. The differential pressure is applied across a pair of opposing liquid - filled diaphragms welded on the opposite sides of a capsule. The applied pressure produces a force to move the top of the force bar. The diaphragm seal acts as a fulcrum for the bar. This tiny motion acting through levers moves the ferrite disc closed to the differential transformer changing its output. This changes the output of the LVDT, which is rectified and then amplified to generate a DC milli-ampere signal for transmission. This output signal is fed back through the voice coil on the armature of a force motor (A coil with a permanent magnet) which is in series with the output terminals. When this feedback moment (F5) becomes equal to the moment created by the measurement force (F2) the force bar is again in its original position and the amplifier signal stabilizes.	**4M** **4M**
	b)	**Describe any four documents required for designing the control panel in detail.**	**8M**
	Ans:	**1. General:** Definition of the design drawing specification and codes furnished by the purchaser that the panel manufacturer is to follow.	**Any four - 2M Each**

		2. Engineering: Description of the extend and type of engg. Drawings to be developed by the panel manufacturer, including whether "as- built" drawings are required. **3. Construction**: Description of the type of panels and their fabrication. This includes NEC area classification, ambient conditions, and similar requirements. **4. Design**: Specification of methods of installing wiring and piping systems. This includes a listing of materials of construction for wire, pipe, tubing, ducts, name-plate inscriptions. **5. Materials**: Complete description of the all materials to be used. **6**. **Cost:** The specification should direct the bidder to delineate various costs, so that additions and deletions to the contract can be negotiated easily. **7. Inspection**: Delineation of the number and types of inspections planned, which may include preliminary inspections during specific stages of construction, section of the specification should also describe the extent of inspection required, such as visual, point-to-point cheeks or functional testing. **8**. **Shipping**: Specification of the type of conveyance used to ship the panel to the plant site, type of crating and protection requirements. **9. Guarantees:** Conditions under which a panel or equipment may be rejected and the length of time during which the panel is covered by the manufacturer's warranty.	
	c)	**Name the protection methods used in hazardous area. Define intrinsic safety. Explain how it can be achieved with zener barrier.**	**8M**
	Ans:	**<u>Methods of Protection for hazardous area:</u>** 1) **Isolate the source of ignition**: The most obvious way is to remove the source to a location where there is no combustible material. This is the method recognized by NEC. **2) Apply Intrinsic Safety:** **3) Apply forced ignition or ignition permitted:** a) Using a continuous source of ignition, such as continuous pilot to localize combustion in gas appliance under well-controlled conditions so that no significant damage results. b) Explosion proof enclosures contain an explosion so that it does not spread into the surrounding atmosphere. c) Enclosed break device in which the enclosed volume is so small that the explosion cannot escape. **4) Preventing Ignition:** a) Preventing accumulation of combustible material by pressurizing the instruments. b) By maintaining the explosive material concentration above the upper explosive limit to avoid explosion. c) Blanketing of tanks with nitrogen or carbon dioxide and rock dusting of coal mine galleries and shafts are known as inerting. d) The other method to prevent ignition from happening is to isolate the ignition source, like Oil immersion to prevent contact between the atmosphere and the ignition source, and sand filled equipment.	**Methods - 3M**

		5) Increased Safety **6) Use of Non Sparking apparatus and Non Incentive apparatus** **7) Restricted breathing** **Intrinsic Safety:** NEC defines intrinsically safe equipment and wiring as incapable releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. i.e., practically there is no source of ignition. **Redding Zener barrier circuit:**  **Explaination-** It consists of, 1) Resistors for limiting the current 2) Redundant zener diodes for limiting the voltage 3) A fuse in series with the resistors If a high voltage other than (-0.7v to 30v) appear across terminals 1&2, the zener diode starts conducting. If the fault voltage is high enough and appears for a longer period, the current through the diode D_1 increases until the fuse blows. If the fuse does not blow immediately and the power dissipation of D_1 is exceeded, the zener is designed to short circuit before the fuse opens. With shorting D_1 current will rise rapidly, blowing the fuse. Thus an excess current is always diverted to the ground by the barrier and is never allowed to reach the hazardous area.	**2M** **Diagram-1M** **2M**
Q. 3		**Attempt any 4 :**	**16-Total Marks**
	a)	**List 3 different types of process dynamics. State the meaning of any one.**	**4M**
	Ans:	The mathematical modeling and theoretical analysis of processes depends on certain dynamics that describe a process. Every process contains one or more such dynamic elements. Therefore the different elements with which a mathematical model may be formulated	**1M for types.**

		for a process are: 1.resistance element 2.capacitance element 3.time constant element 4.oscillatory element 5.dead time element **1) <u>Resistance Element :</u>**  figure shows the section of a pipeline in which the orifice plate is inserted .the insertion of orifice plate creates the obstruction to fluid. This resists the flow rate of fluid in the pipeline. Therefore in this system is resistance element system. **<u>OR</u>** **2)<u>Capacitance Element:</u>**  Capacitance is the ability of a system to store charge, mass or energy. An example of capacitance element is a tank with inlet as shown. The flow of the fluid into the tank is the output. This ability of the tank to store liquid is capacitance. **<u>OR</u>**	**3 M for explanation of any one.**

3)Time Constant Element:



A combination of a resistance and capacitance element result in a time constant process. Those parts of the process that have the ability to store energy are termed as capacitance element and those parts that resist the transfer of energy or mass are termed as resistance element.

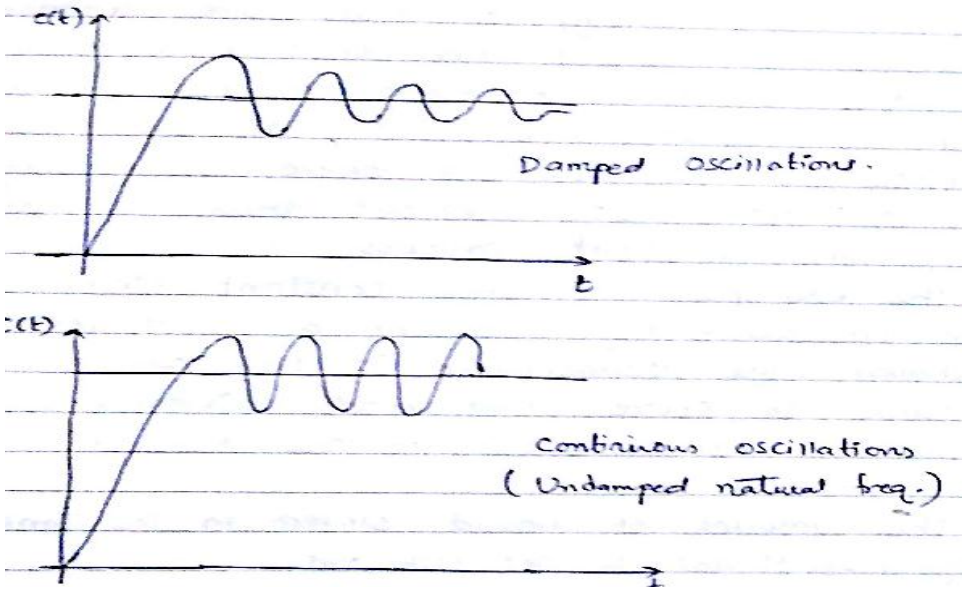
Hence in a process if there is a combination of both these elements then it is called a time constant process.consider a liquid level system as shown.the capacitance is the ability of the tank to store fluid and resistance element is introduced at the outlet in the form of control valve.

The amount of liquid stored is proportional to net flow.

OR

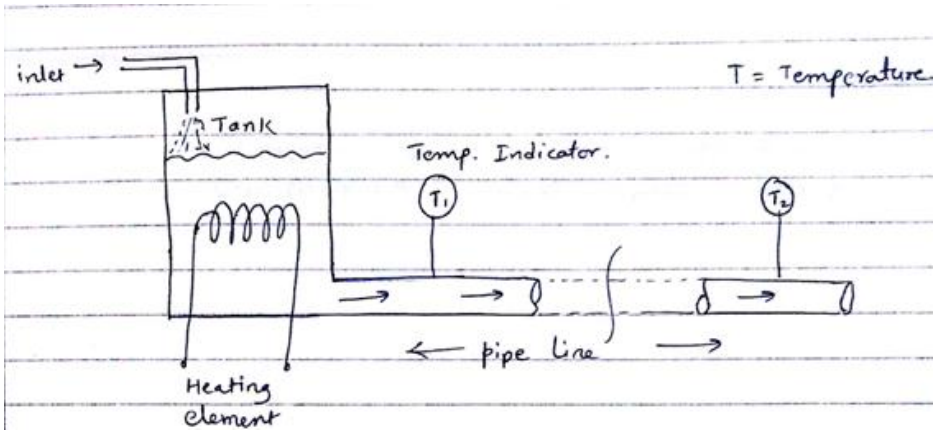
4) Oscillatory Element:

This element is a typical characteristic of a higher order system. It can be proved that the response of a second order system show oscillations about the steady state value of input. fig is an example of an oscillatory element system.



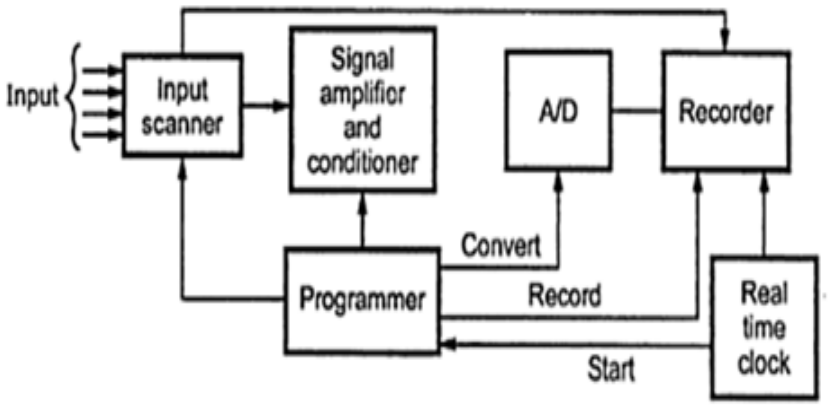
OR

5)Dead Time Element:

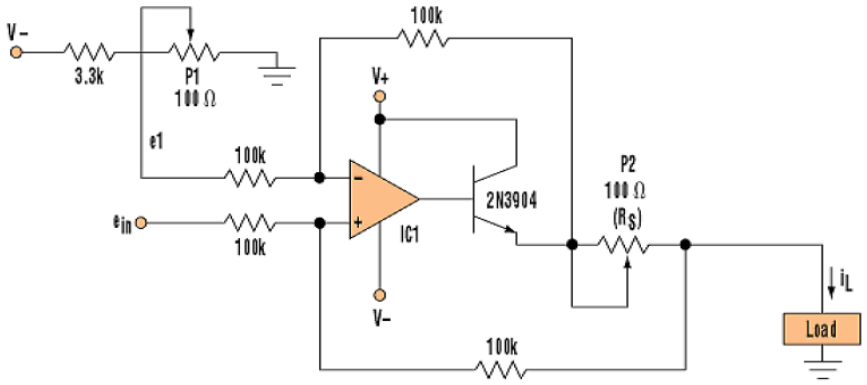


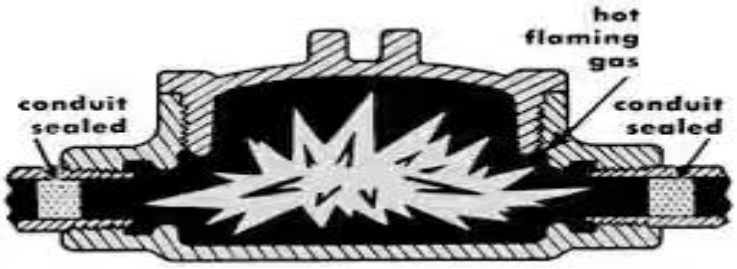
A phenomenon often encountered during transfer of mass or energy is called dead time.it is also called transportation lag. Consider the foll. System where hot water is to be passed through a tube having uniform cross section. In this syste , when hot water is transferred from one point to another no process action takes place, which creates the dead time in the process.

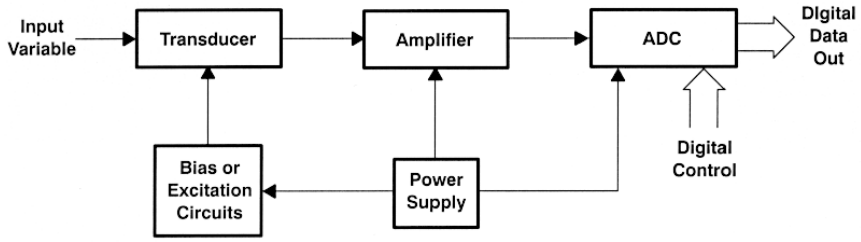
	b)	**State the need of DAS. Name the types of DAS. State any 2 applications of DAS.**	**4M**
	Ans:	**Need of DAS :** 1) Collecting information (Average and statistics).2)Converting data into useful form.3)Using data for controlling process.4)Performing repeated calculations.5)Generating information for display.	**1M for need, 1M for type,**

		Types of DAS : 1)Single channel DAS.2)Multichannel DAS. **Application of DAS: (Any two)** 1) It can be used for measurement of different variable such as temp, pressure, level, flow, speed torque etc for display & averaging purpose. 2) It can be use for control of variables such as temp, pressure, flow level in different process industry. 3) It can be use in laboratory research, quality control for accurate measure and analysis of important variables. 4) It can be used in aircraft control system, electrical power system and industrial process control system.	**2M for application**
	c)	**Give the meaning of IP 34 and 65.**	**4M**
	Ans:	**IP 34:** Protected against solid objects over 2.5mm (tools and wires). Protection against water sprayed from all directions **IP 65:** Totally protected against dust, Protected against low pressure jets of water from all directions	**2M for each**
	d)	**Classify the following materials into appropriate hazardous area of class and group.** **1) Acetylene** **2) Aluminium dust.**	**4M**
	Ans:	1) Acetylene: class 1, group A 2) Aluminium dust: class II, group E	**2M for each**
	e)	**Draw the block diagram of Data logger and explain its working.**	**4M**
	Ans:	**Block Diagram:**  Block Diagram of Data Logger	**2M**

		Description: It is a highly advanced DAS. **I/P Signals:** Variety of signals is recorded by data logger like o/p of transducer, pressure, temperature, AC signals, Digital, Pneumatic signals etc. **I/P Scanner:** it is multi way switch which is operated by scanner drive unit for selecting i/p channel. It selects each input signal in sequence, so require only one signal conditioner circuit and ADC. Modern i/p scanner have scan rate of 150 inputs per sec. **Signal amplifier and filter circuit:** It linearizes the o/p of nonlinear transducer or signals. Low level signals are amplified. Noise and harmonics are removed by filter. **ADC:** It convert analog signal from scanner into digital, which are compatible to programmer. More the number of digital o/p bits, higher the resolution of ADC. **Programmer:** It is a processor which does the control of overall operation from scanner to recording data, like setting of amplifier gain, linearization etc. It sets high, low level for alarm unit that will initiate audio or video indication when variable crosses the set limit. It gives command to recorder for displaying and recording of data. **Recorder**: It permanently records the digital data by any type of recorder. Data may be printed on paper or recorded in digital signal form.	**2M**
Q. 4	A)	**Attempt any 3 :**	**12-Total Marks**
	a)	**State the ranges of standard signals of pneumatic and electronic transmission system. State the significance of live zero.**	**4M**
	Ans:	**Standard range :** 1. Standard range of electronic signal transmission: 4-20mA 2. Standard range of pneumatic signal transmission: 3-15psi **Live Zero:** A live zero is a loop signal where the zero value is some number higher than zero. 4-20 mADC, 1-5 VDC, 10-50mV, etc., are all examples of live zero. The significant advantage of a live zero is it allows the control room staff to distinguish between a valid process condition of 0% and a disabled transmitter or interrupted pressure line or a broken wire or a failed power supply by seeing that the loop reading is zero.	**1M for each range** **2M for description**
	b)	**Draw and explain voltage to current converter. State its significance.**	**4M**

	Ans:	**Diagram:**  **Explanation:** This conventional circuit gives 4 to 20 mA of output for an input of 0 to 1V. First adjust P1 for zero (4mA), then P2 for span (20mA). The circuit needs a positive and negative supply (+,-15v). At the input, ein - e1 = IL RS Therefore, the load current is: $$I_L = \frac{e_{in} - e_1}{R_s} = \frac{e_{in}}{R_s} - \frac{e_1}{R_s}$$ The first term is proportional to the input voltage ein, and the second term is a constant. Here, e1 is derived from the negative power-supply through a potentiometer: IL = ein/RS + (-e1)/RS RS is selected so that the first term (ein/RS) gives 16 mA for full-scale input voltage, and the potentiometer is adjusted so that the second term provides a constant 4 mA. In effect, the output ranges from 4 to 20 mA corresponding with zero to full input voltage. 2N3904 is a NPN BJT acting as a low power (100mA) switch. **Significance:** **1)** For transmission of signal over large distance.2) To provide input to standard receiving devices such as electronic controller accepting current signal. ***Note: Any relevant diagram can be considered***	**1M** **2M** **1M**

	c)	**State the need of control panels in process industry (any four).**	**4M**
	Ans:	**Need of control panels:(Any four)** 1)The basic function and purpose of the control panel is to provide a means of communication between the process and process operator. 2)It contains the instrumentation network which gathers processes, control and display technical data necessary for efficient and safe plant operation. 3)The control panel serves as the nerve counter for the reception and dispatching of information relative to plant operation. i.e, panels are required for the production monitoring and control of many operations going on in a factory at the floor level from a remote control room. 4)Due to reduction of size of individual instrument they can be mounted together. 5)Due to increase in quantity of instrument in large scale process application. 6)Because of availability of new hardware. ***Note-Any other relevant point can be considered***	**Each point 1M**
	d)	**Explain how explosion proofing method of protection is used in hazardous area.**	**4M**
	Ans:	**Diagram:**  **Explaination-** 1. The principle behind explosion-proof transducers and wiring is that any ignition of flammable material that occurs within the transducer or wiring will be contained. The hot gasses and flames will not be allowed to escape into the hazardous area and further propagate the fire or explosion. 2. All circuit wiring is run in conduit and junction boxes approved for explosion-proof installation. Explosion prevention is always preferable to explosion protection, particularly where an explosion is likely to result in emission of toxic material. 3. The material released from an explosion relief vent typically includes quantities of the original, unburnt substance in addition to combustion products. Alternative mitigation measures are available, including explosion suppression, or building the plant strong enough to withstand the anticipated explosion pressures. ***Note-Any other relevant point can be considered***	**1M Diagram** **3M**

	B)	**Attempt any one :**	**6-Total Marks**
	a)	**Draw the neat diagram of electronic temperature transmitter. Explain its working in detail.**	**6M**
	Ans:	**Temperature transmitter block Diagram:**  **Explaination-** 1. A temperature transmitter combines a temperature sensor like RTD or thermocouple and transmitter in the same instrument. 2. The sensor measure temperature while transmitter amplifies and transmits the signal to the monitoring system or a control room. 3. A temperature transmitter measure temperature and convert it into a current signal of 4-20 mA that is proportional to temperature measured. 4. The two wire temperature transmitter accept a thermocouple or 3 wire PT-100 input and convert temperature into 4-20 mA current signal. **5.** The transmitter usually require a 24 V DC power supply. 6. The temperature signal is amplified by amplifier. **7.** The amplified temperature signal can be transmitted via long cable or converted into a digital format using analog to digital convertor. ***Note-Any other relevant diagram can be considered***	**3M** **3M**
	b)	**Draw the block diagram of XY recorder. Explain its working.**	**6M**
	Ans:	**Diagram:**	**3M**

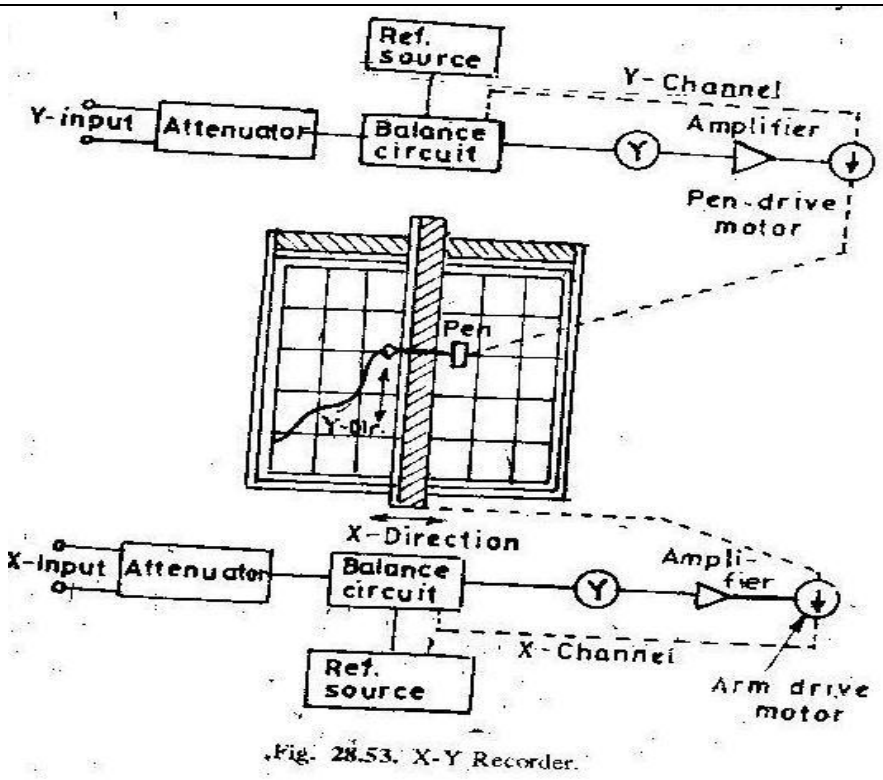


Fig. 28.53. X-Y Recorder.

Explanation -

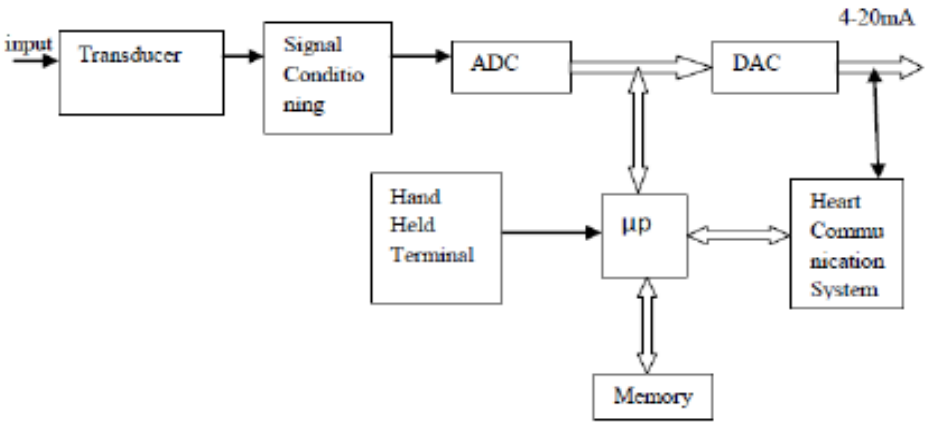
A strip chart recorder records the variations of a quantity with respect to time while X-Y recorder is an instrument which gives a graphic record of the relationship between two variables. **3M**

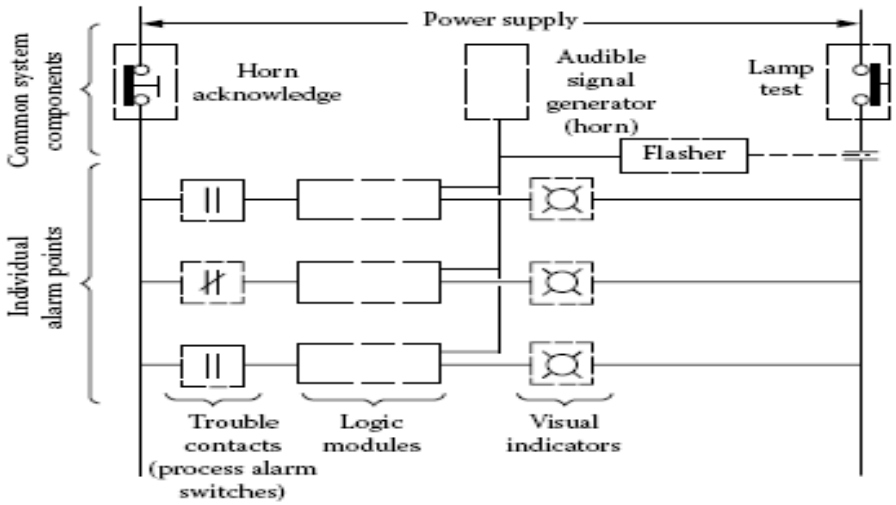
In strip recorders, usually self-balancing potentiometers are used. These self-balancing potentiometers plot the emf as a function of time. In X-Y recorders, an emf is plotted as a function of another emf. This is done by having one self-balancing potentiometer control the position of the rolls. While another self-balancing potentiometer controls the position of the recording pen.

In some X-Y recorders, one self-balancing potentiometer circuit moves a recording pen in the X direction while another self-balancing potentiometer circuit moves the recording pen in the Y direction at right angles to the X direction, while the paper remains stationary.

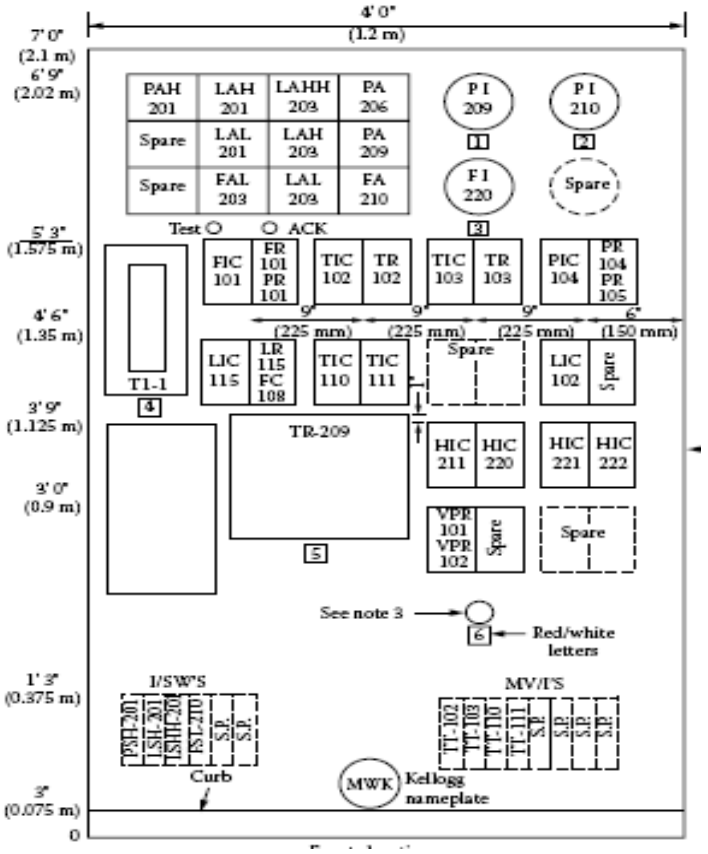
There are many variations of X-Y recorders. The emf, used for operation of X-Y recorders, may not necessarily measure only voltages. The measured emf may be the output of a transducer that may measure displacement force, pressure, strain, light intensity or any other physical quantity. Thus with the help of X-Y recorders and appropriate transducers, a physical quantity may be plotted against another physical quantity.

Q.5		**Attempt any Two :**	**16-Total Marks**

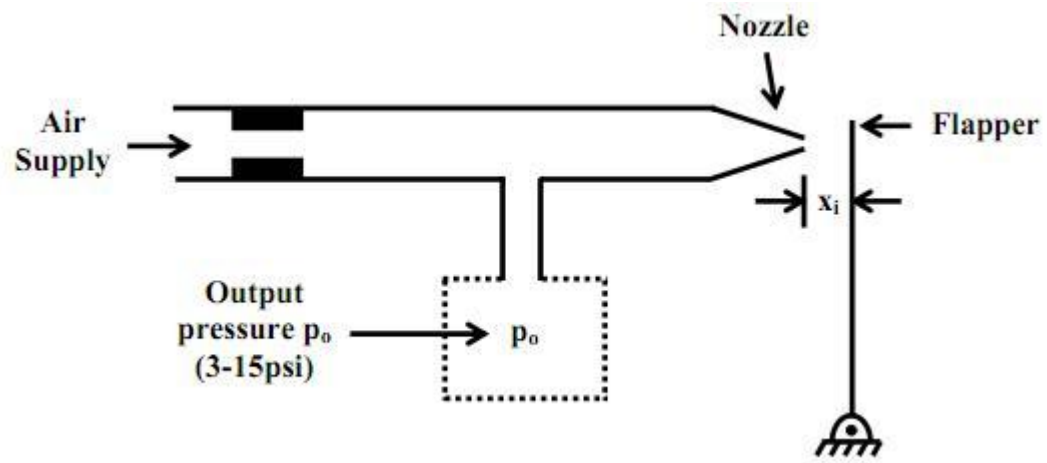
	a)	**Draw the block diagram of SMART transmitter. Explain its working: State any 2 features of SMART.**	**8M**
	Ans:	**Diagram-**  **Working:** **SMART(Single Module Auto Ranging Transmitter):** It is a transmitter which uses a microprocessor along with a sensor/ transducer combined with a processing unit and a communication interface. The working of the functional blocks are as under. 1.Sensor or Transducer: connected directly to the process, it detects and converts the process variable in to a suitable electrical quantity. 2. Signal conditioning and ADC: Signal conditioning circuit does common signal modification or conditioning techniques like, filtering, amplification and linearization as per the input requirement of ADC. ADC converts the signal into digital for effective transmission. 3. Microprocessor with memory: These components provide SMART features, which makes it different from other analog transmitters. It conditions the signal remotely before converting into standard form. For example, it can normalize gain and offsets, linearize sensors having known nonlinearities by converting to digital and processing with arithmetic algorithms in the µp. 4. DAC: It converts the output of microprocessor back to analog for transmitting the signal on the loop as a standard current. 5. Communicator: It allows data transfer between the transmitter and control room. In a HART communicator system, the communication channel allows both analog and digital versions of the measured variable to be transmitted over the twisted pair wires, as well as control signals and diagnostic data relevant to the transmitter. 6. Hand held communicator: A hand –held device allows digital instructions to be delivered to the smart transmitter. It can be connected directly to the transmitter, or in parallel anywhere on the loop (remotely).Testing, configuring, supply or acquiring	**2M** **4M**

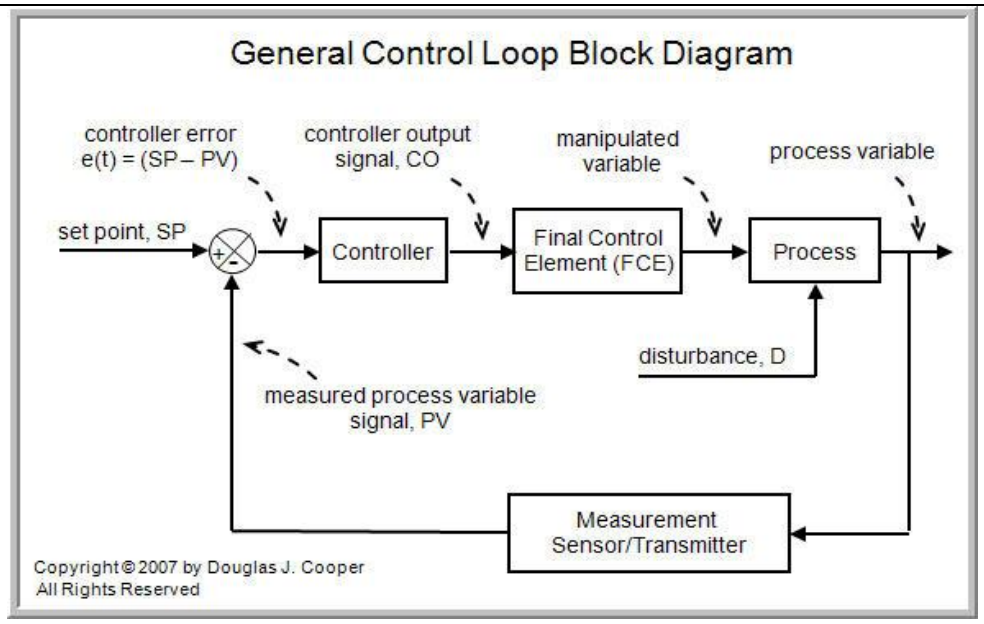
		data are all done through the communicator. The display allows the technician to see the information. **<u>Features(any two):</u>** 1. Can change engineering units, zero, span and range. 2. Allows 2-way communication with the control room. 3. Inclusion of control functions and other algorithm due to microprocessor in the SMART. 4. They can memorize and recall tag number, location and specification of transducers. 5. Measurement data can be expressed in engineering unit. 6. Linearization, characterization and correction of the characteristic of transducer are possible due to the microprocessor	**2M**
	b)	**What is Alarm Annunciator ? List its different types, also mention its operational sequence in different modes.**	**8M**
	Ans:	The purpose of an alarm system (annunciator) is to bring attention to an abnormal or unsafe operating condition in the plant. The annunciator system consists of multiple alarm points. Each alarm circuit includes a trouble contact (alarm switch), a logic module, and a visual indicator. The individual alarm points are operated from a common power supply and share a number of annunciator system components, including an audible signal generator (horn), a flasher, and acknowledge and test pushbutton. **<u>Diagram:</u>**  	**Definition: 1 M** **2M**

		Types of Annunciator- 1) Pneumatic type 2) Recording type 3) Vocal type 4) Relay type 5) Aaudiovisual annunciator a. Integral b. Remote **c.** Semigraphic **Operational Sequence-** **Normal**: During normal, all visual and audible devices are quiescent. **Alert**: Upon an abnormality (off normal or alarm condition), an audible device, such as horn will sound. The horn thus advices an attendant or operator that an alert condition exists. The name plates that flash direct the attendant to their specific points which are in the alarm stage. Each alarm point is synonymous with the circuit it is monitoring and the associated nameplate with its engraved message-describing the function being monitored. **Acknowledge**: Attendant response to the foregoing events involves pressing an acknowledgement push button. This results in silencing the horn as well as changing the flashing lights to a steady on state. The later will remain illuminated as long as the point remains off-normal. If the new points are alarmed, the horn will sound again and the back lighted windows associated with their alarm will flash. Note that the flashing mode distinguishes newly alarmed point from those off normal points acknowledged previously and whose lights remain steady on. **Return to Normal**: Upon acknowledgement, once again the audible device is silenced and all points which remain steady on lights. ***Note: Operational sequence diagram is optional***	**Types-1M** **Operational sequence 4M**
	c)	**a) Discuss the different requirement of design of control panel. Draw the front view of flat panel.** **b) Explain any four NEMA types of enclosures.**	**8M**
	Ans:	**a) Design requirements of Control Panel (Any 2 points)-** 1.Typically document that are required for designing of control panel are **Panel layout drawing, Schematic wiring diagram, Module wiring diagram**,**Panel layout drawing** contains the front view, rear view, side view, top view & bottom view of panel. It covers all dimensional requirements from all side of the panel. It also clarify cable entry either top or bottom with all dimensions Panel layout shows all MCB, TB position also cable tray layout with dimensions. 2. **The schematic wiring diagram** splits into power wiring and control wiring. It shows actual wiring connection from MCB to terminal block. It covers wiring gauging	**Design requirement-2M**

		or specification for individual connection 3. **Module Wiring diagram** specifies detail wiring of module or device which is placed in or on the panel. It cover both power and control wiring details 4. Control panel design based on shape, size, color and general layouts. Some of the guidelines are as follows: 1. Panel must be free standing usually color shall be green. 2.instrument should be arranged so that they are readable to operator Controllers : middle level Recorders: lower level 3. Important switches should easily be assessed. 4. Optimum spacing between instruments for maintenance purpose. 5. Fans and blowers for high density instrumentation. **Front view of Flat Panel –** **Diagram-**  ***Note: 1.The instrument type and tag numbers may be different. Student should know the location of each category of Instrument on the panel.*** ***2. The dimensions may be in any one unit***	**2M**

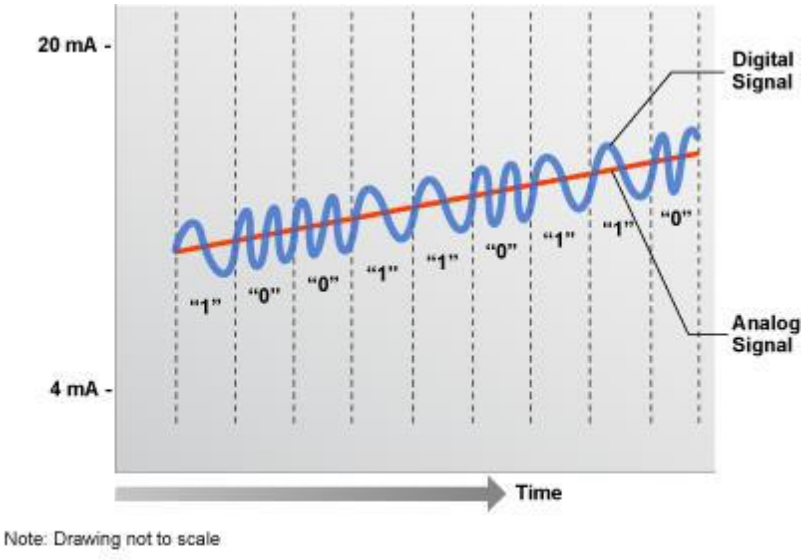
		b) <u>Any four types of NEMA enclosures</u> **NEMA 1** enclosures are typically used for protecting controls and terminations from objects and personnel. NEMA 1 enclosures are used in applications where sealing out dust, oil, and water is not required. **NEMA 2** enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt. **NEMA 3** enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, sleet, and external ice formation. **NEMA 3R** enclosures are typically used in outdoor applications for wiring and junction boxes. This style of enclosure provides protection against falling rain, sleet, snow, and external ice formation. Indoors they protect against dripping water. . **NEMA 3S** enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, sleet, and to provide for operation of external mechanisms when ice laden. **NEMA 4** enclosures are used in many applications where an occasional washdown occurs or where machine tool cutter coolant is used. They also serve in applications where a pressurized stream of water will be used. NEMA 4 enclosures are gasketed and the door is clamped for maximum sealing. **NEMA 4X** enclosures are made of stainless steel, aluminum, fiberglass, or polycarbonate. NEMA 4X enclosures are used in harsh environments where corrosive materials and caustic cleaners are used. **NEMA 5** enclosures are intended for indoor use primarily to provide a degree of protection against settling airborne dust, falling dirt, and dripping non-corrosive liquids. **NEMA 6** enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against the entry of water during occasional, temporary submersion at a limited depth. **NEMA 6P** enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against the entry of water during prolonged submersion at a limited depth. **NEMA 11** enclosures are intended for indoor use primarily to provide, by oil submersion, a degree of protection to enclosed equipment against the corrosive effects of liquids and gases. **NEMA 12** enclosures are intended for indoor use to provide a degree of protection against drips, falling dirt, and dripping non-corrosive liquids. **NEMA 12K** enclosures with knock-outs are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids other than at knock-outs. **NEMA 13** enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and non-corrosive coolant.	**1M for each (any Four)**

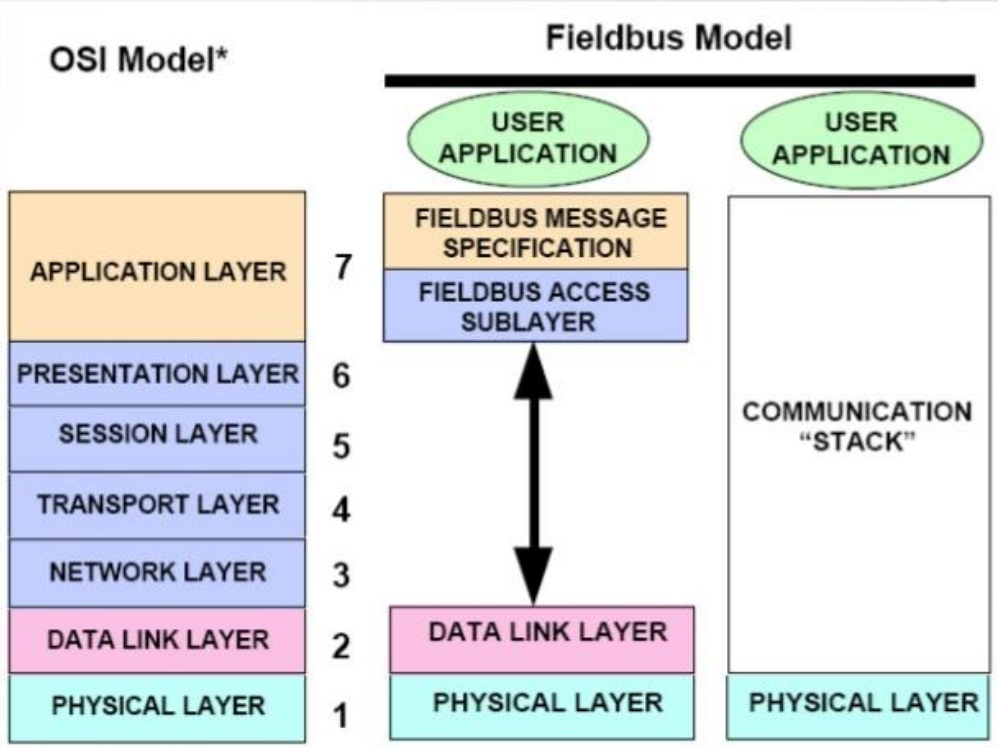
Q.6		Attempt any 4 :	16-Total Marks
	a)	**Draw the diagram of flapper-nozzle mechanism. Explain its working.**	4M
	Ans:	**Diagram -** 	2M
		Working- The flapper nozzle assembly consists of movable flapper which is positioned against open nozzle. The measured physical quantity is supplied to flapper. The flapper moves according to change in physical quantity. This movement of the flapper increases or decreases the distance between flapper and nozzle. The nozzle is supplied with fixed air pressure of 20 psig through a restriction.Based on the change in the value of measured physical quantity, flapper moves near and away from the nozzle; which decreases or increases the distance between the flapper and nozzle. i.e when the value of measured quantity is minimum, the flapper is away from nozzle,which generates very low back pressure. This back pressure is adjusted to 3psgi o/p pneumatic signal. When value of measured quantity is maximum, flapper comes very near to nozzle which generates very high back pressure. This back pressure is adjusted to15 psi o/p pneumatic signal ***Note: Drawing characteristics is optional***	2M
	b)	**Draw the block diagram of process control system. Explain each block.**	4M
	Ans:	**Diagram-**	**Diagram- 2M** **Description (4 blocks- 1/2 mark each)**

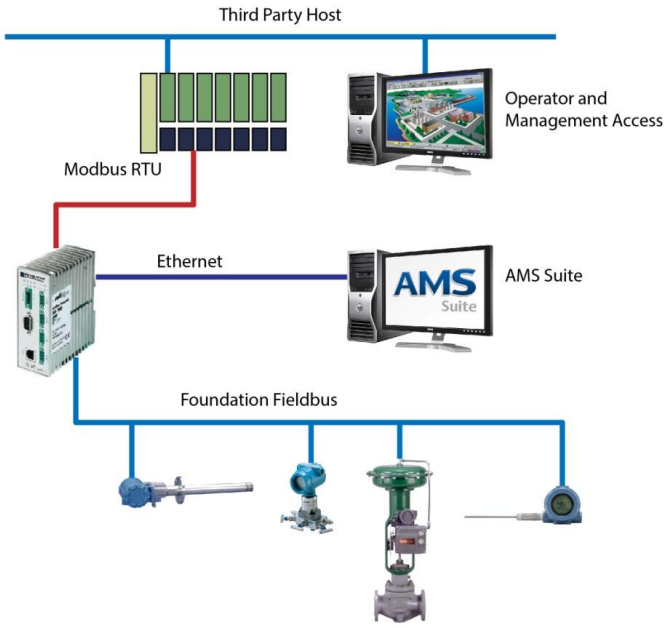


- **Process :** Some complex manufacturing sequence or system which we wish to control
- **Measurement**: Information of the variable of the process. Measurement refers to the conversion of the element into corresponding analog signal so that that is used by other elements in the system. A **sensor**/Transducer is a device that performs the initial measurement and converts the variable into analogous electric or pneumatic signal
- **Controller**: This signal output of **Error detector** is used by the controller to generate the control action. Error detector determines whether the variable which we wish to control (Process Variable or **PV**) is above or below the desired value, called set point or reference value
- **Final Control Element**: The control element directly influences the process
- It takes input from the controller and transforms it into some proportional operation to be performed on the process.
- In most of the process control loops it is a control valve which is commonly called as Final Control Element

	c)	**Explain the HART protocol for digital communication.**	**4M**
	Ans:	**<u>Description-</u>** "HART" is an acronym for Highway Addressable Remote Transducer. It is the global standard for sending and receiving digital information across analog wires between SMART devices and control or monitor systems. It is the bidirectional communication protocol that provides data access between intelligent field instruments and host systems. The HART system (and its associated protocol) was originally developed by Rosemount and is regarded as an open standard, available to all manufacturers.	**3M**

		Its main advantage is that it enables the retention of the existing 4-20mA instrumentation cabling while using, simultaneously, the same wires to carry digital information superimposed on the analog signal. HART is a hybrid analog and digital system, as opposed to most field bus systems. It uses a Frequency Shift Keying (FSK) technique based on the Bell 202 standard to superimpose digital communication signals at a low level on top of the 4-20 mA . Two individual frequencies of 1200 and 2200 Hz representing digits „1" and „0" respectively, are used. The average value of the sine wave superimposed on the 4-20mA signal is zero; hence, the 4-20mA analog information is not affected. **Diagram-**  Digital over Analog	**1M**
	d)	**State any 4 environmental consideration of a control room.**	**4M**
	Ans:	**Any four of the following-** 1) There should be sufficient light for better visibility of panel and its equipment's for an operator. Some panels are indicating devices may require lower light intensity better readability, in case of LCD , LED display 2) There should not be any reflections n the front face of the panel displays 3) Back side of panel should also be lighted. 4) The signal cables, power cables, control cables are to be grouped together which are of same nature. Each group of Cable should be in enclosed piping with fire proof, withstanding with atmospheric condition changes. 5) There should be Fans and good ventilation for maintaining Temperature of control room in safe limit 6) There should be minimum required spacing between devices for maintenance	**1M for each point**

		7) Control room should not act as a passageway. 8) In case of location in hazardous area, the control room should be pressurized.	
	e)	**Draw the architecture of foundation field bus. Explain in brief.**	**4M**
	Ans:	**Diagram-**  **Description-** Each layer in the communication system is responsible for a portion of the message that is transmitted on the fieldbus. User Layer: The user layer provides the interface for user interaction with the system. The user layer uses the device description to tell the host system about device capabilities. The user layer defines blocks and objects that represent the functions and data available in a device. The user layer for one device consists of the resource block, and one or more transducer blocks and function blocks. Physical Layer: Translating messages into physical signals on the wire - and vice versa. The physical layer also provides the common electrical interface for all FOUNDATION fieldbus devices. Data Link & Application Layers: It combines several technologies that together control transmission of data on the fieldbus. The data link and applications layers provide a standard way of "packaging" the data, as well as managing the schedule for communication and function-block execution. They enable process control while providing standardization and interoperability.	**2M** **2M**

		1. **User Layer**: It enables user to interact with the other layers and with other applications. The user layer contains Resource blocks - describes characteristics of the fieldbus device such as device name, mfr. and serial number, etc. **OR**  ***OR*** ***Note-Any other relevant diagram with description***	