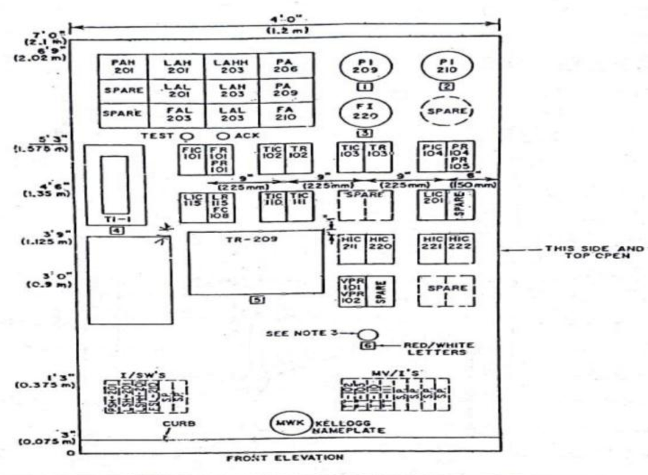
WINTER – 19EXAMINATION

Subject Name: Process Instrumentation **Model Answer** Subject Code: 22542

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 tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues 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 FIVE of the following:**	**10-Total Marks**
	a)	**Define** **i. Controlled variable** **ii. Manipulated variable**	**2M**
	Ans:	i. **Controlled Variable:** It is that variable in a process which is measured, monitored and controlled. The level is the tank is an example of controlled variable is also known as dynamic variable. ii. **Manipulated variable:** It is that variable in a process, which is manipulated in order to maintain the controlled variable at the set point.	**1M** **1M**
	b)	**Explain Live zero concept.**	**2M**
	Ans:	**Live Zero:** It is a term applied to measuring system whose output is not zero for the zero input quantity. The Live zero makes it possible to distinguish between 'True zero' signal and 'Dead zero' signal. i.e. The signal due to dead instrument or broken wire. In electronic transmission system, 4mA is Live zero, whereas, in pneumatic transmission system it is 3 psi.	**2M**
	c)	**State the need of DAS.**	**2M**
	Ans:	**The DAS is needed for: (** (any two similar points can also be considered)**)** 1) To acquire the process variable from dynamic process in real time. 2) To monitor and display process variables. 3) To keep record of specific process variables. 4) To provide interface between the real world of physical parameters, which are analog, and digital computation and control.	**1M each**
	d)	**Draw the diagram of flat type control panel**	**2M**

	Ans:		2M
	e)	**Give the meaning of IP 54.**	2M
	Ans:	**I:** Ingress **P:** Protection **5:** Protection against dust , limited ingress (No harmful deposit). **4:** Protection against water sprayed from all directions, limited ingress permitted.	2M
	f)	**Explain any one process characteristics.**	2M
	Ans:	**Process characteristics:** **i) Process Equation:** A process control loop regulates some dynamic variables in a process. This controlled variable, a process parameter, may depend on many other parameters in the process and suffer changes from many different sources. We have selected one of these other parameters to be our controlling parameter. If a measurement of controlled variable shows a deviation from the setpoint, then the controlling parameter is changed which in urn changes the controlled variable. As an example consider the control of liquid temperature in a tank, as shown in figure. The controlled variable is the liquid temperature, *Tt*. This temperature depends on many parameters in the process e.g. the liquid input flow rate via pipe *A*, the output flow rate via pipe *B*, the ambient	Any one 2M

temperature, *Ta*, the steam temperature, *Ts*, inlet temperature, *To*, and the steam flow rate, *Qs*. In this case the steam flow rate is the controlling parameter chosen to provide control over the variable (liquid temperature). If any one of the other parameter changes results in a change in temperature. To bring the temperature back to the setpoint value, we change only the steam flow rate i.e. heat input to the process. This process could be described by a process equation where liquid temperature *Tt* is a function as

$$Tt = F\ (Qa, Qb, Qs, Ta, Ts, To)$$

Where, *Qa, Qb* = flow rates in pipe A and B

Qs = steam flow rate

Ta = ambient temperature

To = inlet fluid temperature

Ts = steam temperature

To provide control via *Qs*, we do not need to know the functional relationship exactly, nor do we require linearity of the function. The control loop adjusts *Qs*, and thereby regulates *Tt*, regardless of how the other parameters in equation above vary. In many cases, the relationship of equation above is not even analytically known.

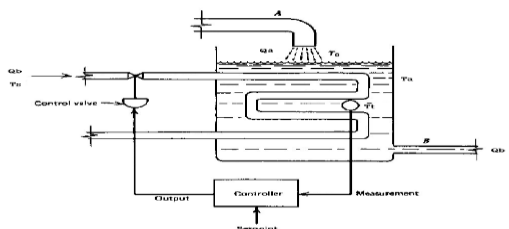


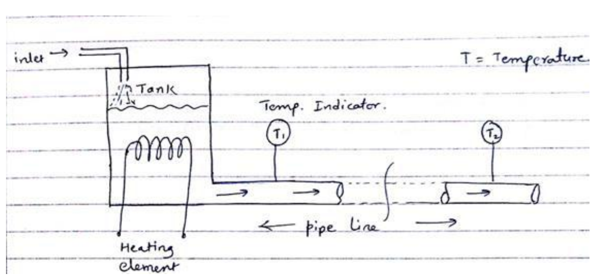
Fig. Control of temperature by process control

OR

ii) Process Load:

From the process equation, or knowledge of and experience with the process, it is possible to identify the set of values for the process parameters that results in the controlled variable having the setpoint value. This set of parameters is known as a nominal set. The term process load

		refers to this set of all parameters, excluding the controlled variable. When all parameters have their nominal values, we speak of nominal load on the system. The required controlling variable value under these conditions is the nominal value of that parameter. If the setpoint is changed, the controlled parameter is altered cause the variable to adopt this new operating point. The load is still nominal, however because the other parameters are assumed to be unchanged. Suppose one the parameters changes from nominal, causing a corresponding shift in the controlled variable. We then say that a process load change has occurred. The controlling variable is adjusted to compensate for this load change and its effect on the dynamic variable o bring it back to the setpoint. In the example of figure, a process load change is caused by a change in any of the five parameters affecting liquid temperature. The extent of load change on the controlled variable is formally determined by process equation such as equation. In practice, we are concerned only that variation in the controlling parameter bring the controlled variable back to the setpoint. We are not necessarily concerned with the cause, nature, or extent of the load change. **OR** **iii) Process Lag:** Process control operations are essentially a time variation problem. At some point in a time, a process load change or a transient causes a change in the controlled variable. The process control loop responds to ensure that, some finite time later, the variable return to the setpoint value. Part of this time is consumed by the process itself and is called the process lag. Thus, referring to figure above, assume the inlet flow is suddenly doubled. Such a large process load change radically changes (reduces) the liquid temperature. The control loop responds by opening the steam inlet valve to allow more steam and heat input to bring the liquid temperature back to the setpoint. The loop itself reacts faster than the process. In fact, the physical opening of the control valve is the slowest part of the loop. Once steam is flowing at the new rate, however, the body of liquid must be heated by the steam before the setpoint value is reached again. This time delay or process lag in heating is a function of the process, not the control system. Clearly, there is no advantage in designing control systems many times faster than the process lag. **OR**	

		iv) Self Regulation: A significant characteristic of some process is the tendency to adopt a specific value of the controlled variable for nominal load with no control operations. The control operations may be significantly affected by such self regulation. The process in figure above has self regulation as shown by the following argument. 1. Suppose the steam valve is fixed at 50% and open the control loop so that no change in valve position is possible. 2. The liquid heats up until the energy carried away by the liquid equals that input energy from the steam flow. 3. If the load changes, a new temperature is adopted (because the system temperature is not controlled). 4. The process is self regulating, however, because the temperature will not "run away", but stabilize at some value under given conditions.	
	g)	**Classify the following into appropriate hazardous area:** **i. Hydrogen** **ii. Coal**	**2M**
	Ans:	**I: Hydrogen : Class I , Group B, Division I hazardous area.** **II. Coal : Class II, Group F, Division I hazardous area.**	**1M** **1M**
Q.2		**Attempt any <u>THREE</u> of the following:**	**12- Total Marks**
	a)	**Define** **i)Dead time** **ii)Inertia** **iii)Resistance lag** **iv)Capacitance lag**	**4M**
	Ans:	**i) Dead time:**  A phenomenon often encountered during transfer of mass or energy is called dead time.it is also called transportation lag. Consider the above System where hot	**1M each**

water is to be passed through a tube having uniform cross section. In this system, when hot water is transferred from one point to another no process action takes place, which creates the dead time in the process.

ii) Inertia:

Inertia is a property of matter that causes it to resist changes in velocity (speed and/or direction). According to Newton's first law of motion, an object with a given velocity maintains that velocity unless acted on by an external force. Inertia is the property of matter that makes this law hold true.

iii) Resistance Lag:

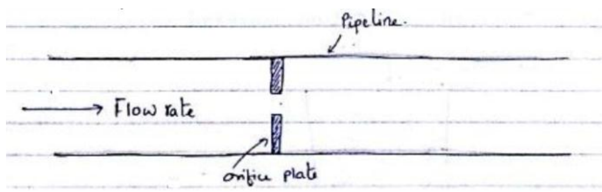
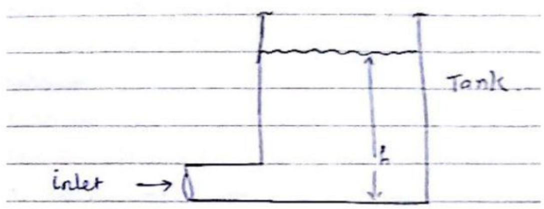


Figure shows the section of a pipeline in which the orifice plate is inserted .the insertion of orifice plate creates the obstruction to fluid. This resists the flow rate of fluid in the pipeline. Therefore in this system has resistance lag.

iv) Capacitance Lag:

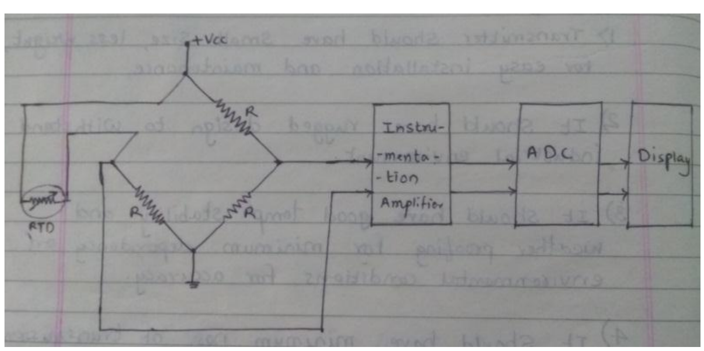
NOTE:(Any other relevant diagram may be considered)



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.

b)	**Describe the working of temperature transmitter**	**4M**

Ans: **Diagram:** **2M**



2M

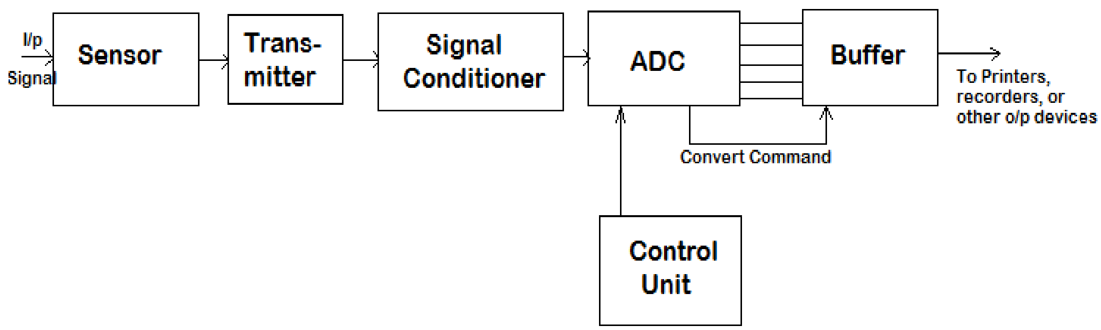
Explaination: As shown in above figure, the Electronic Temperature transmitter can be made with RTD connected to the wheatstone's bridge followed by instrumentation amplifier.

RTD is a temperature measuring transducer which is kept in contact with the medium whose temperature is to be measured. Whenever there is a change in temperature , the resistance of RTD changes. This change in the resistance , unbalances the wheatstone's bridge and hence the potential difference is created in the bridge which is considered as the output of wheatstone's bridge.

The output of wheatstone' bridge is proportional to the change in temperature. This output of bridge is given to instrumentation amplifier. Now, by proper adjustment of Span and zero, by adjusting some resister values , 4-20mA range process signal is obtained.

c) **Draw the block diagram of single channel DAS.Explain it in brief.** **4M**

Ans: **Diagram:** **2M**



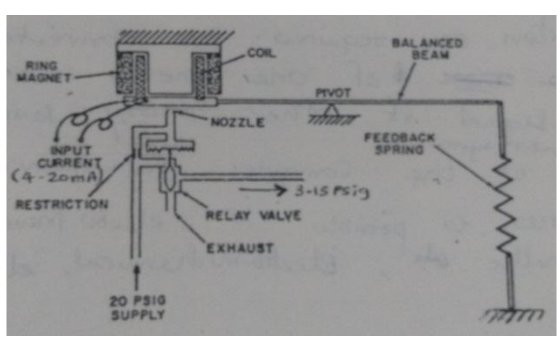
Explaination: **2M**

Above figure shows the diagram for Single channel DAS. In single channel DAS, only one process variable sensed by the sensor, This process variable is passed through the transmitter which produces the standardise signal (4-20mA). This signal is given to signal conditioner ckt (amplifier) and then fed to analog to digital convertor (ADC) to get digital signal.

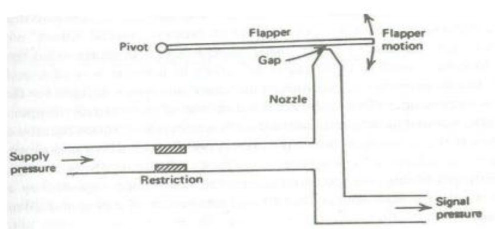
Here, ADC is of dual slope type or successive approximation type for high speed and resolution. After the ADC the signal is passed to recorder or printer for storage of data. The buffer ckt is used to provide isolation between output device and ADC signal.

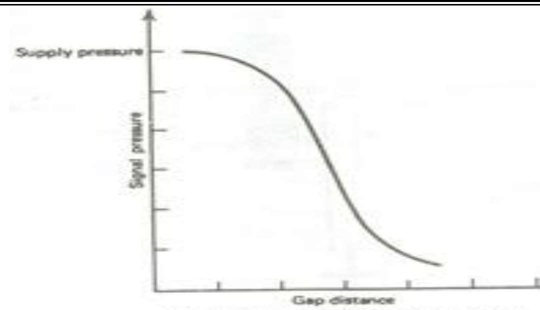
d) **Explain current to pressure converter with neat diagram.** **4M**

Ans: **Diagram:** **2M**



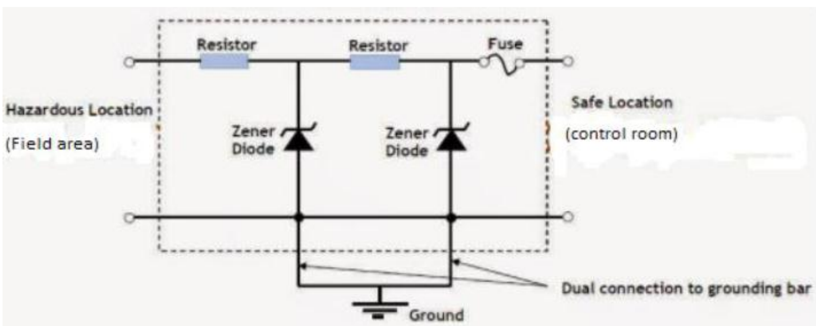
Operation: **2M**

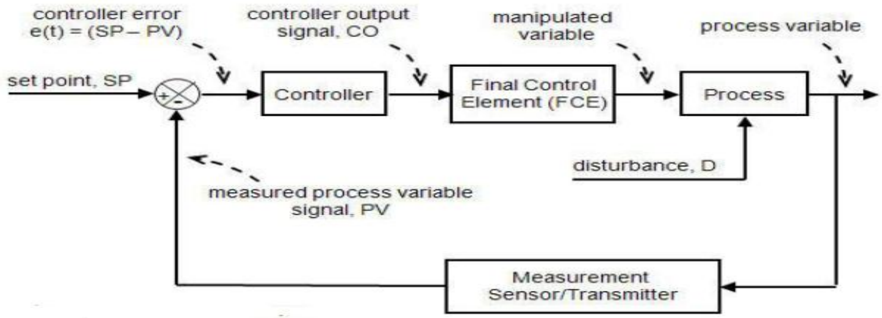
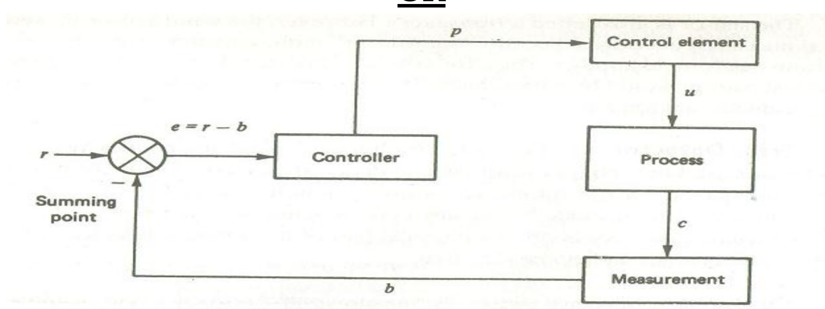
		The I to P convertor uses an electromagnetic force balance principle to change electrical signals into pneumatic signals. Typically, 4-20 mA input is converted into a 3-15 psig output. As shown in above figure input signal is given to ring magnet which is closed to the one end of balanced beam. The distance between balanced beam and ring magnet changes depending upon the intensity of input current. The other end of balanced beam is fixed to the surface. The distance between Flapper and nozzle is proportional to the movement of balanced beam. Based on the distance of flapper –nozzle , the back pressure is generated which is in the range of 3 to 15 psig.	
Q.3		**Attempt any <u>THREE</u> of the following:**	**12-Total Marks**
	a)	**Describe the operation of flapper-nozzle mechanism.**	**4M**
	Ans:	**Diagram:** **<u>(Note: diagram is desirable)</u>**  	**1M**
		Working: The flapper nozzle mechanism consists of a movable flapper which is positioned against an open nozzle. The force from the sensor, which is a measure of the quantity under measurement, is acted upon the flapper. The flapper moves according to the changes in physical quantity. This movement of the flapper increases or decreases the distance between flapper and nozzle. The nozzle is supplied with the constant air pressure of 20 psi through orifice 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 As the flapper approaches the nozzle, restriction to the flow of air through the nozzle increases and thus the nozzle back pressure 'Pb' also increases (distance 'x' is reduced). If the nozzle is completely closed by the flapper the nozzle back pressure becomes equal to the air supply pressure 'Ps'. The device is calibrated to give 3psi, when the value of measured quantity is minimum and 15 psi when maximum. Figure below shows the graph between signal pressure and gap distance.	**3M**



Signal pressure versus gap distance

b)	**Name the documents needed to design a control panel. Explain any one in brief.**	**4M**
Ans:	1. General: Definition of the design drawing specification and codes furnished by the purchaser that the panel manufacturer is to follow. 2. Engineering: Description of the extend and type of engineering. 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, and 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.	**Listing-3M Description of any one-1M**
c)	**Describe any four ergonomic considerations of control room environment.**	**4M**
Ans:	A control room of modern design should be large enough to avoid any crowding of operating equipment, chairs, tables and auxiliary devices. The size is related to the process but in no case should it be smaller than 25sq m. The design of room must meet the following specific environmental conditions. 1) **<u>Climate control:</u>** Temperature and humidity should conform to ANST/ISA-S71.01 environmental conditions for process measurement and control systems; temperature and humidity. Air filtration should conform to ANSI/ISA-S71.04, environmental conditions for process measurement and control systems; airborne contaminants. Air intake ducts for the room must be carefully designed so as not to drop in contaminants from the process area. It is preferable to maintain the room at a slight positive pressure (0.08 inches of water), as heavy traffic may cancel out the effects of environmental	**1M each** **(Any other relevant points may be considered)**

		control. 2) **Audible noise reduction:** Acoustic treatment should be provided to reduce noise. A level of 55 dB is desirable. 3) **Electrical interference (noise) reduction:** The room should be located away from high voltage electrical rooms, high voltage cable and other possible electromagnetic interference (EMI). Where this is not possible, suitable protection using high permeability metallic screening should be provided. Radio frequency interference (RFE) from radio telephones (walkie talkies) and similar devices must be avoided. 4) **Lighting control:** In most cases control room is no single but two. Adjacent to a control room is an equipment room containing process control cabinets, cable termination cabinets, computers and their associated devices and any other instrument that not need to be accessed continuously. Adequate lightening is essential for good operator comfort in all the areas. Three lighting levels needed are, a) For video display areas: a controllable level of 100-450 lux of indirect non glare, incandescent lights. b) Control panel areas, printers, recorders: a level of about 650 lux. c) For equipment maintenance, room cleaning etc.: a level of 1200 lux	
	d)	**Describe the intrinsic safety technique using zener barrier circuit.**	**4M**
	Ans:	**Diagram of Redding Zener diode barrier circuit:**  Figure shows the diagram of a Redding zener barrier circuit for 28V 93mA barrier. It consists of, 1) A wire wound resistor 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. Once fuse is blown off, the entire circuit is replaced by new one. Proper grounding of installation is necessary in this case. It is simple to construct, maintain and economical.	**1M** **Description-3M**

Q.4		Attempt any **THREE** of the following :	12-Total Marks
	a)	**Draw the block diagram of process control system. Explain each block in brief.**	4M
	Ans:	**Block diagram:**  **OR**  1. **Process-** A process consists of an assembly of phenomena that relate to some manufacturing sequence. Many variables may be involved in a process which requires regulation accordingly the process may be called multivariable process or single variable process. 2. **Measurement (feedback)**–Initially the measurement of the variable to be controlled is done by the sensor. Further signal conditioning and conversion is required to complete the measurement & feedback function. 3. **Error detector**-Often the error detector is an integral part of the controller and determines the deviation of the measured signal from the set point (e= $r \pm b$). 4. **Controller**- Examining the error and taking the proper action on that to drive the controlled variable to the set point is done by the controller. In modern control systems, the operations of the controller are performed by micro-processor based computers. The controller requires an input of both the measured value and the set point value of the variable under control 5. **Final Control Element**- The final control element along with the actuating element executes the operation on the process. The actuator receives the signal from the controller and converts into a larger energy action on the control element. The control	Diagram-2M Description-2M

element operates on the process to change the controlling variable, so that the controlled variable can be set to the set point.

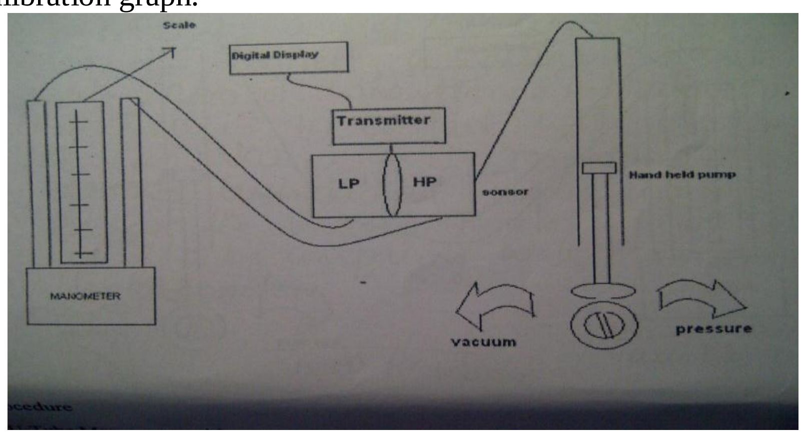
b) **Describe the calibration procedure of DP transmitter.** **4M**

Ans: **<u>The procedure of calibration (bench) is as under:</u>**

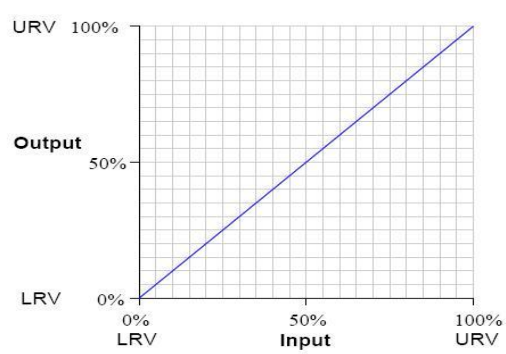
Apparatus required:
Hand pump, pressure gauge, Digital multi meter, power supply module (24V).
Procedure:

1) Make the set up as per the diagram.
2) Apply the 0% (LRV) pressure to the transmitter's High side, and the transmitter's low side vented to atmosphere so that there is no differential pressure acting across the DP cell.
3) Adjust the ZERO screw on the transmitter while observing the current meter to cause the indication to be 4m A, which is the transmitters LRV output.
4) Next, pressurize the high side of the DP transmitter to cause the pressure applied to the high side to increase to the 100 percent value (URV) of the calibration range.
5) Adjust the SPAN screw while observing the meter's current indication to cause the meter to indicate 20 mA, which is the 100% (URV) output value signal for the DP transmitter.
6) Continue the procedure for other pressure values like 25%, 50%,75%(five point calibration)
7) Draw the calibration graph.

Description-2M



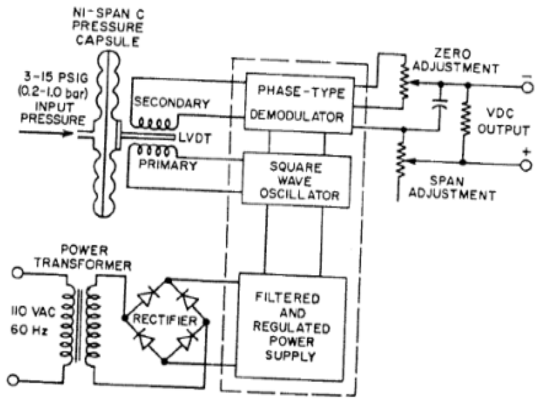
Calibration set up



Calibration graph

Diagram-2M

(Any other relevant diagram may be considered)

	c)	**Explain pressure to current converter with neat diagram.**	**4M**
	Ans:	**Diagram of P/I converter:**  **Description:** The input pressure to be converted is applied to a 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 the 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 square wave oscillator. The dc o/p voltage of Phase detector circuit is connected with zero adjustment and span adjustment circuit.	**2 M** **2 M**
	d)	**Explain the purging protection method used in hazardous area.**	**4M**
	Ans:	Purge is a concept that allows lesser rated equipment to be used in hazardous areas by segregating the equipment from the hazardous material. It is the process used to remove any potentially hazardous gas from the interior of the enclosure prior to pressurization. A protective gas—air or inert gas—is fed inside the enclosure with a pressure slightly greater than the one of the external atmosphere. The following three types of protection (X, Y and Z) are identified in relation to the hazardous-location classification and the nature of the apparatus. **i.** **Type X:** reduces the inside of the enclosure from Division 1 to a non-hazardous state that requires an automatic shutdown of the system in case of pressure loss. **ii.** **Type Y:** reduces the inside of the enclosure from Division 1 to Division 2. **iii.** **Type Z:** reduces the inside of the enclosure from Division 2 to a non-hazardous state, requiring alarm signals only.	**4M**
	e)	**Compare pneumatic and electronic signal transmission systems.(four points)**	**4M**

Ans:

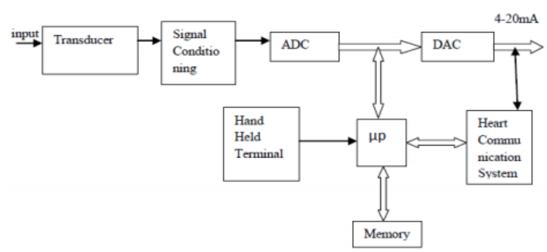
Pneumatic	Electronic
1) Signal is dry air	1) Electrical signal is used as medium
2) Output is 3-15psi	2) Output is 4-20mA,0-10v, ±10v, 0-5v
3) Tubing is used for signal transmission	3) Wires are used for signal transmission
4) More maintenance is required	4) less maintenance is required
5) Not preferred for long distance transmission	5) Preferred for long distance transmission
6) Preferred for hazardous area	6) Less used in hazardous area(used with protection)

4M- for any four points

Q.5		**Attempt any TWO of the following**	**12 Total Marks**
	(a)	**Draw the block diagram of SMART transmitter. Explain its working.**	**6M**

Ans: **(NOTE: Any other suitable explanation can be considered.)**

Diagram: **2M**



(Any other relevant diagram can be considered.)

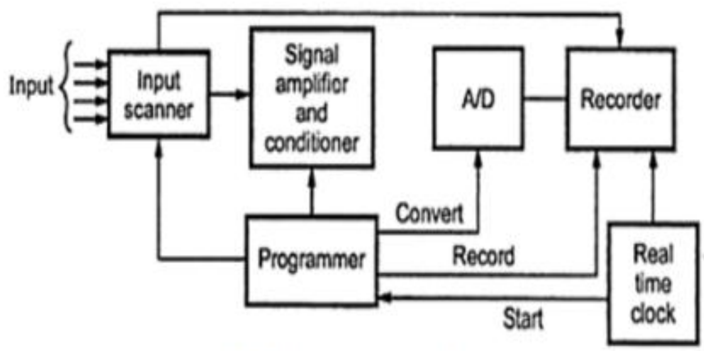
Working:

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 given below:

1. 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.

4M

		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 data are all done through the communicator. The display allows the technician to see the information.	
	(b)	**Describe the working of data logger with diagram. List its application. (Any two)**	**6M**
	Ans:	 **Block Diagram of Data Logger** Data logger is a digital recording system that automatically makes a record of the readings of instruments located at different parts of the plant. It measures and record data effortlessly, quickly and accurately. It can measure electrical output of any sensor. Various functions include, 1) Scan channels sequentially 2) Accept input from any electrical sensor 3) Eliminate error 4) Log the data in scientific units The input scanner is operated by a scanner drive for selecting the input channels in sequence. The signals are conditioned to match the output of transducer to that of the ADC input requirements. ADC convert analog signal from the scanner into digital, which are compatible to programmer. The programmer does control of the overall operation from scanner to recording data. Recorder permanently records the digital data by any type of recorder. Data may be printed on paper or recorded in digital form. **Applications:** Data loggers are used to scan and record data at a fast rate in: 1) Power generation plants 2) Petrochemical installations 3) Continuous process plants 4) Engine testing 5) Component evaluation	**2M** **3M** **1M (any two)**
	(c)	**Explain the meaning of hazardous area. Give the classification of hazardous area according to the material.**	**6M**
	Ans:	**Hazardous area** are defined as places where fire or explosion hazards may exist due to flammable gases, flammable liquid–produced vapors, combustible liquid–produced vapors, combustible dusts, or ignitable fibers/flyings present in the air in quantities sufficient to produce explosive or ignitable mixtures. Hazardous Zone categories: (IEC classification): For Gases &Vapour	**1M**

Area Designation	Area Description
Zone 0	Ignitable concentrations of flammable gases or vapors are present continuously or present for long periods of time. Examples include, · Interior of tanks · Locations near vents
Zone 1	There may be ignitable concentrations during normal operating conditions or concentrations exist frequently from repair or maintenance of the equipment. Examples include, · An area where the breakdown of equipment could lead to a release · Remember that pumps and compressors can have small leaks
Zone 2	There may be ignitable concentrations during temporary situations. Examples include, · Storage where hazardous materials are in containers. · Areas adjacent to Zone 1 with no hazards of its own · Ventilation could prevent the hazard, but it could fail during a leak

For dust particles

Area Designation	Area Description
Zone 20	A place in which an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently
Zone21	A place in which an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally
Zone22	A place in which an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but if does occur, will persists for a short period only.

(OR)

NEC Classification

Area Designation	Area Description
Class I	Locations made hazardous by flammable gases or vapour
Class II	Locations made hazardous by combustible dusts
Class III	Locations made hazardous by combustible fibers & flying

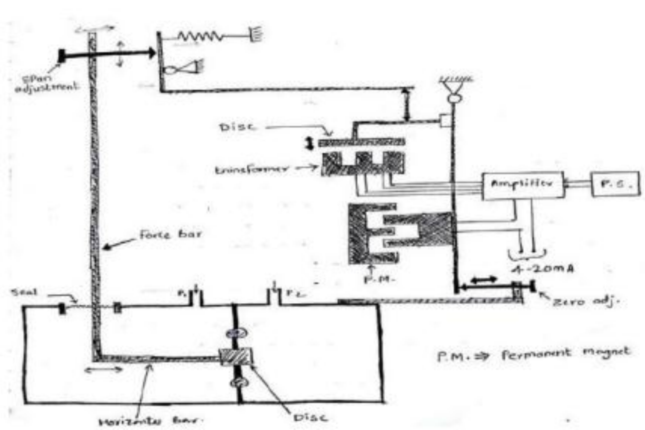
5M

Mark can be given for ANY of the classifications among these two

Division I	Locations which may contain hazardous mixtures under normal operating conditions.
Division II	Locations in which the atmosphere is normally non-hazardous but may become hazardous under abnormal circumstances such as equipment failure, failure, failure of ventilating systems.
Group A	Atmosphere containing acetylene.
Group B	Atmosphere containing hydrogen or equivalent gases or vapors of manufactured gas having an equivalent hazard.
Group C	Atmosphere containing ethyl/ether vapours, ethylene or cyclopropane.
Group D	Atmosphere containing gasoline, hexane, benzene, butane, propane, alcohol, acetone, benzol, lacquer solvent. Natural gas.
Group E	Atmosphere containing metal dust, including aluminium, magnesium or other metals of similar hazard.
Group F	Atmosphere containing carbon black, coal or coal dust.
Group G	Atmosphere containing flour, starch, grain dust

Q.6		**Attempt any TWO of the following:**	**12Total Marks**
	(a)	**Explain the working of force balance type pressure transmitter with diagram.**	**6M**

Ans: **Diagram:**

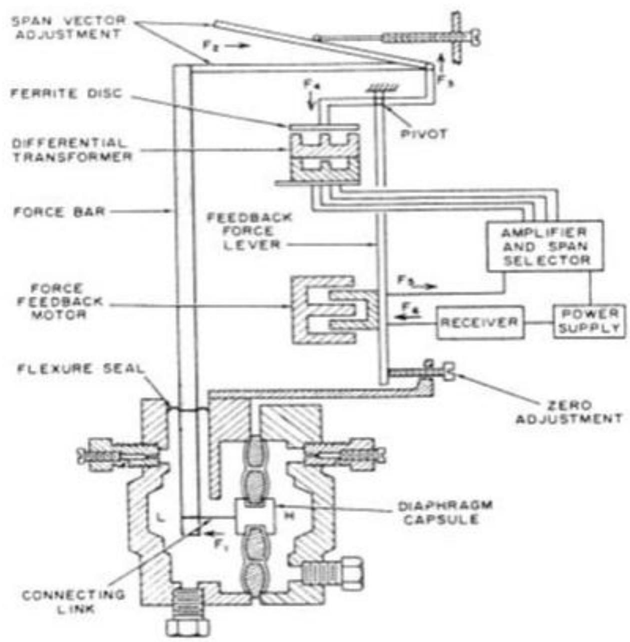


Working:

A DP cell senses an increasing pressure on the "High pressure" input port. As the pressure here increases, the large diaphragm capsule is forced to the right. The same effect would occur if the pressure on the "Low pressure" input port were to decrease. This is a differential **2M** pressure transmitter, so what it responds to is changes in pressure difference between the two input ports. This resultant motion of the capsule tugs on the thin flexure connecting it to the force bar. The force bar pivots at the fulcrum (where the small diaphragm seal is located) in a counter-clockwise rotation, tugging the flexure at the top of the force bar. This motion causes the range bar to also pivot at its fulcrum (the sharp-edged “range wheel”), moving the baffle closer to the nozzle. As the baffle approaches the nozzle, air flow through the nozzle becomes more restricted, accumulating backpressure in the nozzle. This backpressure rise is sensed by a highly sensitive electromagnetic sensor and converted to current. This current is amplified by the amplifier, which sends current signal both to the output line and to the electromagnetic coil at the bottom of the range bar. This current in electromagnetic coil causes it to apply force which push harder on the bottom of the range bar, negating the initial motion and returning the range bar (and force bar) to their near-original positions.

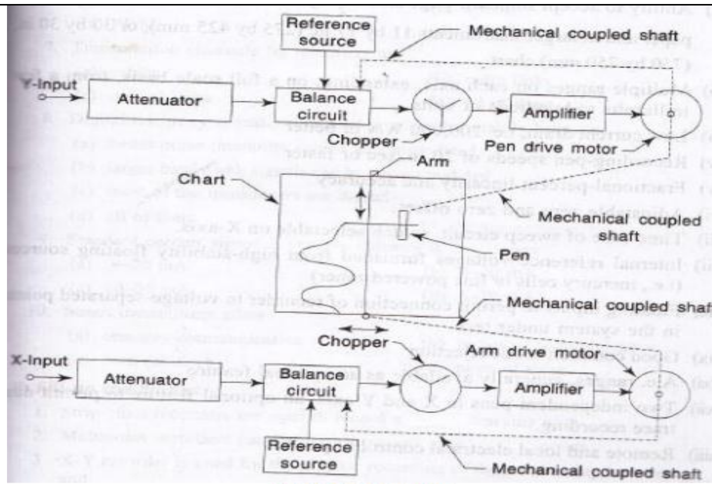
(Any other relevant diagram may be considered)

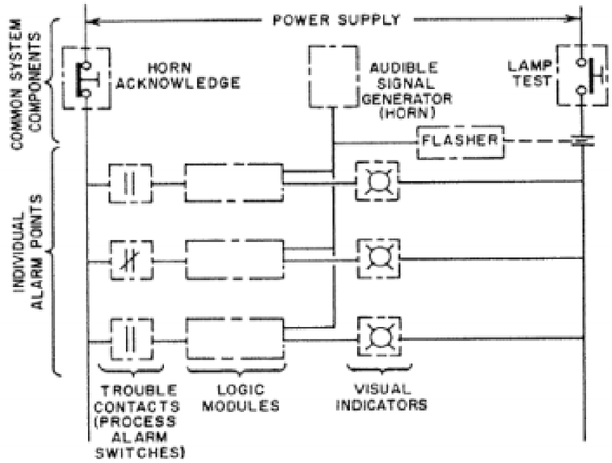
OR



4M

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.

	(b)	**Explain the working of X –Y recorder with diagram. State its any two applications.**	**6M**
	Ans:	 **Fig: XY recorder**	**2M**
		1. An X-Y recorder is an instrument for the graphic recording of the relationship between two variables. 2. The signal enters each of the two channels through input attenuators where they are adjusted to the inherent recorder. 3. The signal then passes through a balance circuit where it is compared with an internal ref. signal (voltage or source) 4. The error (difference) signal is fed to a chopper or vibrator which converts d.c signal into ac signal. 5. The signal is then amplified in order to drive a servomotor which is used to balance the system. 6. The servomotor holds it in balance, as the value of the quantity being measured changes. 7. Thus a record is made of one variable w.r.t another, i.e a function is plotted on a graph paper.	**2M**
		Applications: 1. To plot speed torque characteristic of motor 2.To plot diode characteristic	**2M**
	(c)	**State the need of alarm annunciator. Draw its schematic and describe its operational sequence.**	**6M**
	Ans:	Alarm annunciator is a system used to bring the attention of the operator to some unsafe operating condition in the plant. Hard-wired switches are arranged to operate when a process condition enters an abnormal state (such as high temperature, low pressure, loss of cooling water flow, or many others). **Diagram:**	**1M** **2M**

		 *FIG. Elements of basic annunciator system.* **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. **(Any other relevant diagram may be considered)**	**3M**