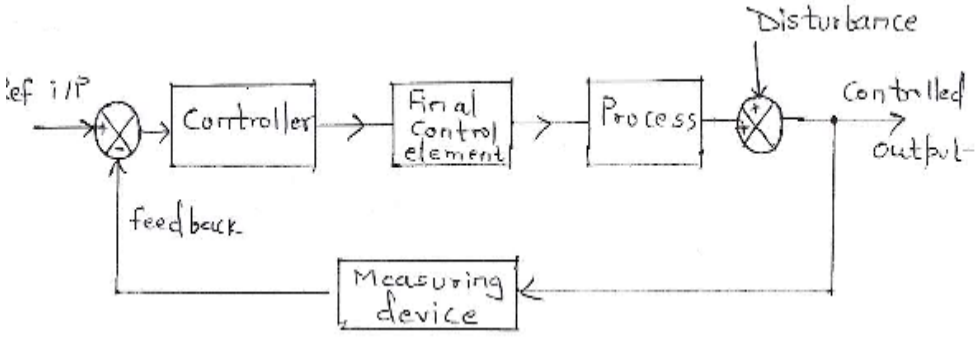
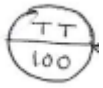
WINTER – 2014 EXAMINATION

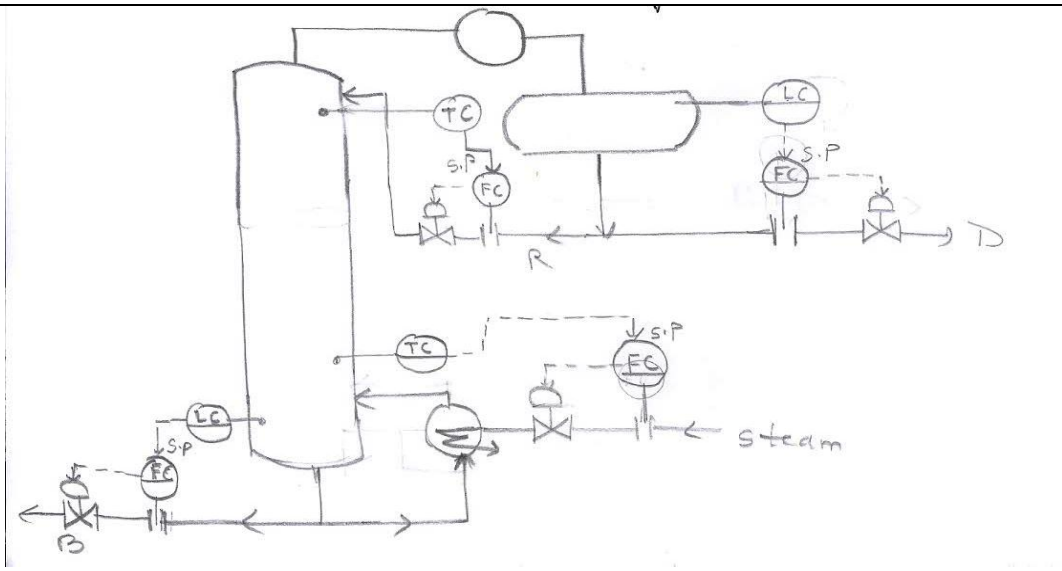
Subject Code: **12285** **MODEL ANSWER**

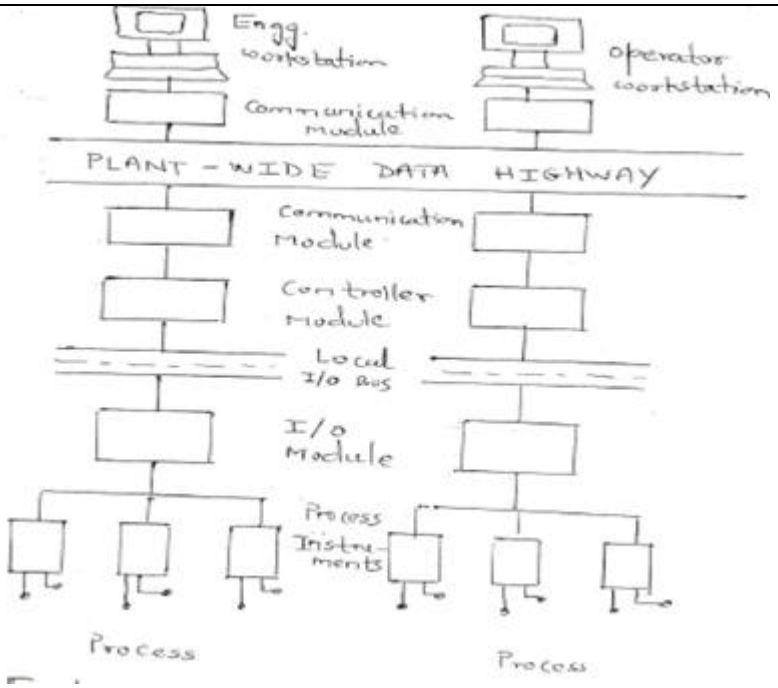
Important Instructions to examiners:

1) The answers should be examined by keywords 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 judgments 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.

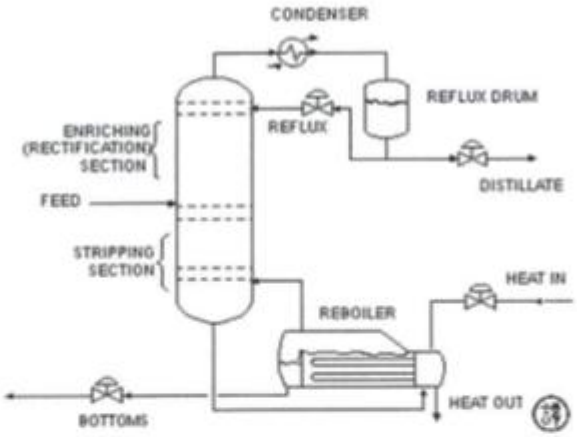
Q.no	Questions and Answers:	Remarks	Total marks
1.A	**Attempt any THREE**		**12**
a.	**Draw block diagram of feedback control system. State function of each block.**		**04**
Ans:	 • Controller: It is a device which compares the reference input to the actual o/p (feedback signal) and generates actuating signal for the final control element	02 marks for diagram 02 marks for	

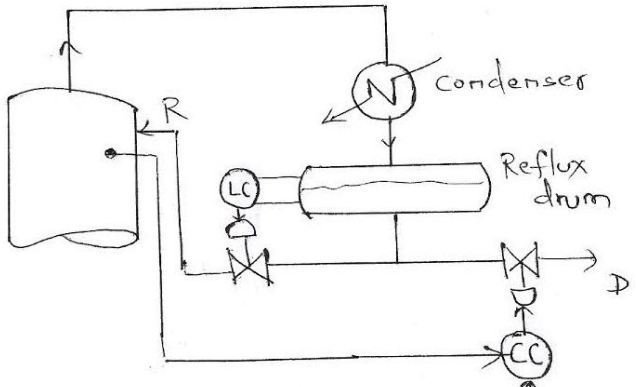
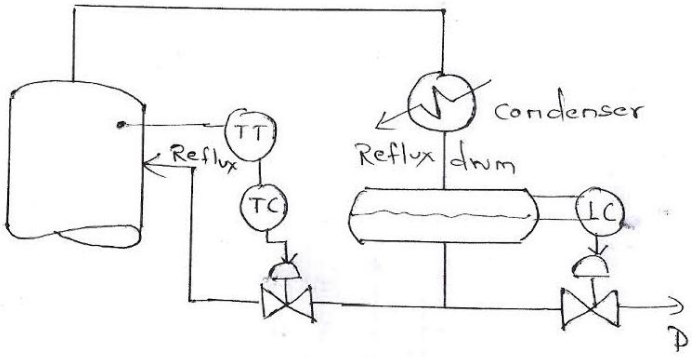
	• Final control element: the component of the control loop which directly changes the value of manipulated variable. • Process: Collection of equipment and materials that is related to some manufacturing operation. • Measuring device: Also called a sensor or a transducer, which converts physical quantity into electrical signal.	function	
b.	**Define the terms :** **1.Valve flow co efficient Cv** **2. Rangeability R**		**04**
	1. Valve flow co efficient Cv: It is defined as the gallons per minute of water at 60°F that the control valve will pass with 1 Psi pressure drop across the valve. 2. Rangeability: it is the ratio of maximum controllable flow to minimum controllable flow. it is expressed as : $R=\frac{Q_{max}}{Q_{min}}$	02 marks for each definitio n	
c.	**State the meaning of the following P ID symbol:** **1.**  **2.** 		**04**
Ans:	 TT: temperature transmitter Continuous line represents panel mounted 100: tag number / process identification 	02 marks for each	

	FC: flow controller Dashed line: behind the panel mounted 20: tag number/loop identification/ process identification		
d.	**Draw cascade control system for distillation column process. Explain it**		**04**
Ans:	 Cascade control of distillate: The level control loop for reflux is the primary loop whereas the flow control loop of distillate is the secondary loop. The O/P of level controller acts as set point for the flow controller. Thus, any changes in the level of reflux drum or flow of distillate will affect the distillate rate. 2. Cascade control of reflux: the primary loop is the temperature control loop and secondary loop is the flow control loop of reflux. Any change in temperature of the top plate indicates that purity (composition) has changed and therefore reflux rate has to be manipulated. Thus, the flow control valve on the reflux line manipulates the flow rate when either temperature or reflux flow changes. 3.Cascade control of bottom flow rate:	2 marks for any one cascade control loop for distillation column 02 marks for suitable explanation	

	Primary control loop: level in the bottom reboiler. Secondary control loop: flow rate of the bottom product. The O/P of level controller in the bottom reboiler acts as set point for the flow controller. Thus, any changes in the level of bottom reboiler or flow rate of secondary controller will affect the flow rate of bottom product 4.Cascade control of steam flow rate : Primary control loop: temperature loop Secondary control loop: steam flow rate.		
B	**Attempt any ONE**		**06**
a.	**Draw a neat diagram of DCS architecture. State function of each component of DCS system.**		**06**
Ans:	 1. I/O Module: They are the main interface between the DCS and process being controlled. They perform the function of converting process inputs into digital form, signal filtering, signal conditioning, alarming etc.	03 marks for diagram 03 marks	

	2. Local I/O bus: It is the interference between the I/O modules and controller modules. It an provide serial as well as parallel communication. 3. Controller modules: They use updated information from I/O module and perform complex logic to keep the process variable at the desired value. 4. Communication modules: it manages the flow of information between data highway and controller and between data highway and user interface to the main computer. 5. Plant wide data highway: it is active component through which information regarding the complete plant flows on a real time basis. 6. User interface: these are HMI, and permit access to measured variables throughout the plant. They have data base and can carry out several functions at a time. Event logging or recording goes on in the back ground when the operator is using the interface.	for description	
b.	**Explain the working of distillation column process. Draw feedback control scheme for it. (any two variables)**		**06**

Ans:	Distillation is defined as a process in which a liquid or vapour mixture of two or more substances is separated into its component fractions of desired purity, by the application and removal of heat, based on difference in their volatility. Main Components of Distillation Columns Distillation columns are made up of several components, as shown below  Basic Operation and Terminology The liquid mixture that is to be processed is known as the feed and this is introduced usually somewhere near the middle of the column to a tray known as the feed tray. The feed tray divides the column into a top (enriching or rectification) section and a bottom (stripping) section. The feed flows down the column where it is collected at the bottom in the reboiler. Heat is supplied to the reboiler to generate vapour. The source of heat input can be any suitable fluid, although in most chemical plants this is normally steam. The vapour raised in the reboiler is re-introduced into the unit at the bottom of the column. The liquid removed from the reboiler is known as the bottoms product or simply, bottoms. As the vapour moves up the column, it is enriched in More Volatile Component (MVC) and as it exits the top of the unit, it is cooled by a condenser. The condensed liquid is stored in a holding vessel known as the reflux drum. Some of this liquid is recycled back to the top of the column and this is called the reflux. The condensed liquid that is removed from the system is known as the distillate or top product.	03 marks for operation with diagram	

	 Scheme 1 : Composition control for distillate  Scheme 2 : Composition control using Reflux Rate Manipulation	03 marks for the feedback control scheme (any two variables)	
2.	**Attempt any four**		**16**
a.	**Why there is a need of valve positioners in control valves**		**04**
Ans:	**Necessity of Valve Positioner:** 1. To overcome friction on valve stem through high open loop gain. 2. To increase speed of response when the distance between controller and Valve is large by dead ended controller. 3. To achieve faster response speed. 4. To provide reverse action of signal pressure. 5. To provide heat range application. 6. Delaying or slowing valve action. 7. Reduces valve hysteresis.	**04 Marks for any 4 Points**	

	8. Large varying fluid pressures. 9. It can modify valve characteristics.		
b.	**State the selection criteria for PLC modules**		**04**
Ans:	**Selection of PLC module:** 1. Number of channels required for input and output depending on process I/O counts. 2. Types of input-output Analog/ Digital / Special I/O Modules RTD or Thermocouples. 3. Types of I/O signal level. 4. Types of isolation required for I/O's. 5. Type of power supply required. 6. Scan time 7. Cost 8.Manufacturer	04 marks for any 4 points	
c.	**State important features of DCS system**		**04**
Ans:	**Features for DCS :** 1. Modular system development capability 2. Build schematic display develop control program 3. Interoperability. 4. Support for standards. 5. Location independence 6. Increased service reliability and support for Fallback. 7. Optimized throughput. 8. Monitoring and Instrumentation capability. 9. Redundancy and other fail safe techniques. 10.Data highway and transmission, communication capability	04 Mark for any 4 Points	
d.	**Compare feedback control system with feed forward control system. (any 4 points)**		04

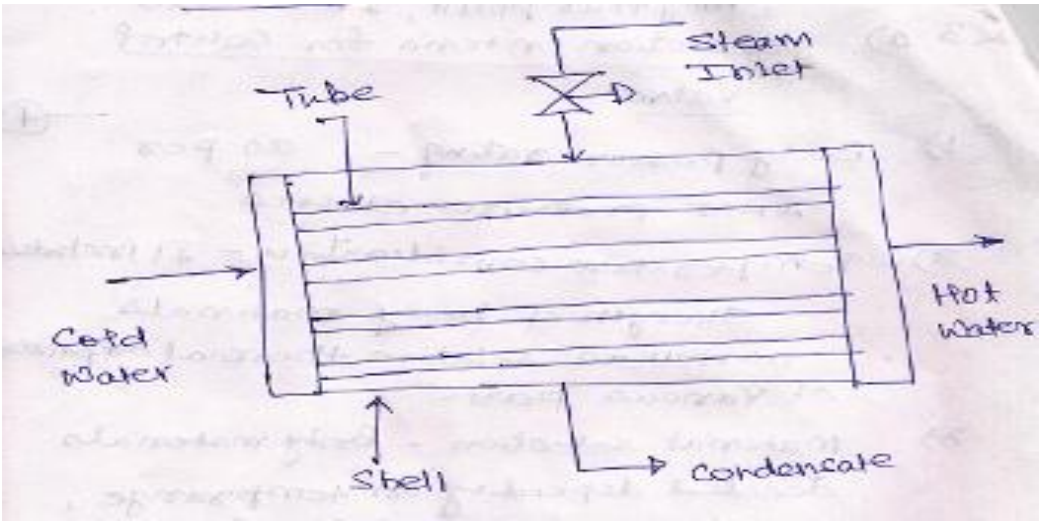
Ans:

Sr. No.	Feedback control system	Feed forward control system
1	It acts before the effect of disturbance has been felt by the system.	It waits until the effect of the disturbances has been felt by the system before that control action is taken.
2	It is good for slow systems (multi capacity) or with significant dead time.	It is unsatisfactory for slow processes or with significant dead time.
3	It does not introduce in the close loop response.	It may create instability in the closed loop response.
4	It does not require identification and measurement of any disturbance.	Requires identification of all possible disturbances and their direct measurement.
5	It is insensitive to the process parameter changes	It is sensitive to the process parameter changes.

04 marks for any 4 points

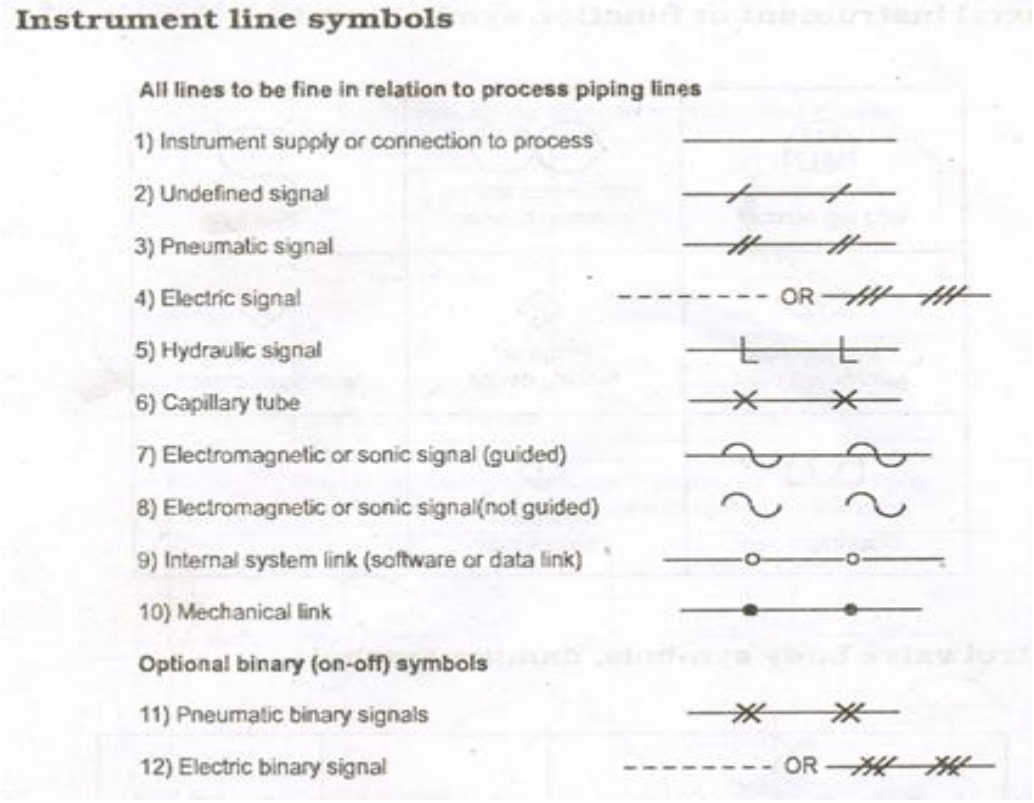
e **Explain shell and tube type heat exchanger with neat diagram.** **04**

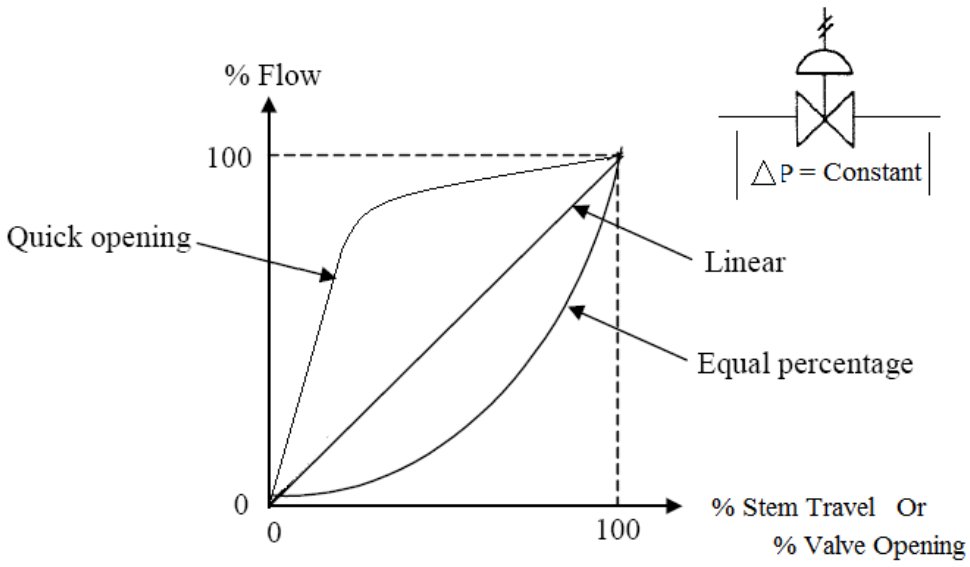
Ans:



02 marks for diagram

It consists of number of parallel tubes. Entire tube bundle is enclosed within shell. One of the fluid flows through the tube and the other fluid flows through the space created between tubes and shell.

	They contain a large number of tubes, packed in a shell with their axes parallel to the shell. Heat transfer takes place as one fluid flows inside the tubes while the other flows outside the tubes through the shell.	02 marks for relevant explanation	
f.	**Draw a P & ID for all types of lines**		**04**
Ans:		04 Marks	
3	**Attempt any FOUR.**		16
a.	**Explain the inherent characteristics of control valve.**		04

Ans:	 Inherent flow characteristics of control valve The inherent flow characteristic of control valve is the relationship between the changes in the valve's opening (or stem travel) and the changes in flow through the valve, when pressure drop across it is kept constant. However, after installation of control valve in pipeline, this characteristic gets changed. Three basic inherent flow characteristics are quick opening, linear, and equal percentage. The control valve with quick-opening characteristic is predominantly used for on/off control applications. A relatively small movement of the valve stem causes the maximum possible flow rate through the valve. For example, a quick-opening valve may allow 85 percent of the maximum flow rate with only 25 percent stem travel. The control valve with inherently linear characteristic has a flow rate that varies linearly with the stem travel. This relationship can be expressed as follows: $\frac{Q}{Q_{max}} = \frac{X}{X_{max}}$ Where,	2 marks for diagram 2 marks for brief explanation	

Q = flow rate

Q_{max} = maximum flow rate

X = stem travel

X_{max} = maximum stem travel

Equal percentage is the characteristic most commonly used in process control valve. The equal percentage valve is manufactured so that for equal increments of stem travel, will ideally give equal percentage changes in the flow rate.

b. Distinguish between Continuous process and Batch process.

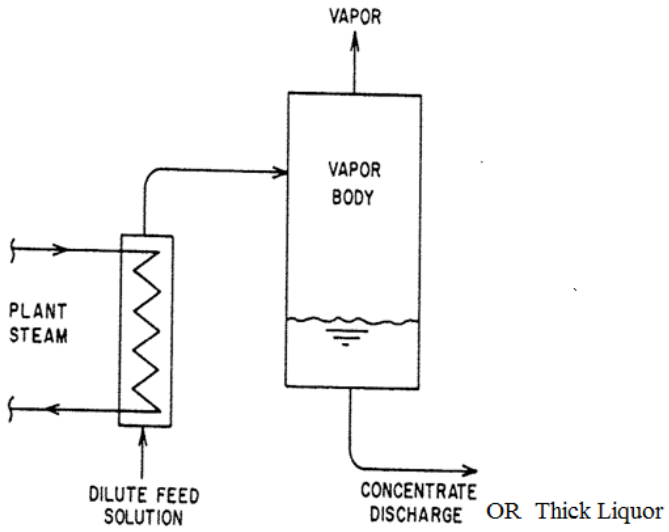
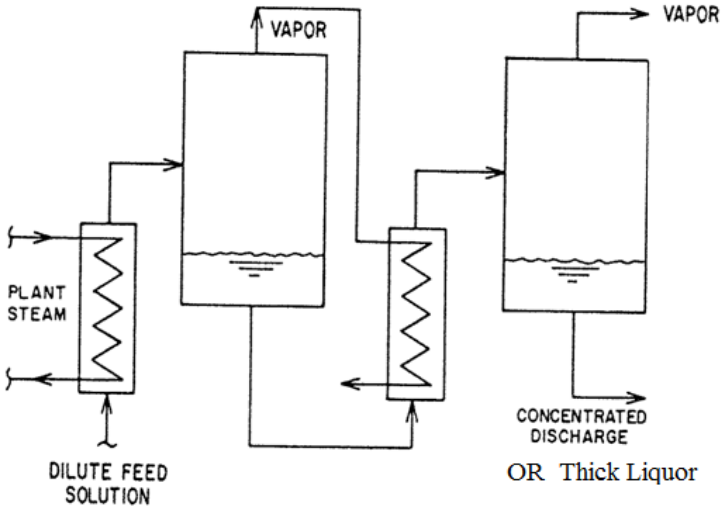
Ans:

Continuous Process	Batch Process
The continuous process consists of raw materials entering the plant and following a number of operations emerges as a new product in continuous manner.	The batch process consists of raw materials transformed into a new product according to a batch recipe and a sequence.
Cost of factory equipment-High	Cost of factory equipment-Low
Rate of production-High	Rate of production-Low
Shut-down times-Rare	Shut-down times-Often
Workforce- Few people needed	Workforce- Many people needed
Ease of automation- Relatively easy	Ease of automation- Relatively difficult
Bulk chemicals, gasoline, kerosene, natural gases, electricity, wood pulp are a few of categories of products produced using continuous	Food, beverages, pharmaceutical products, paint, fertilizer, and cement are a few of the categories of products produced using batch

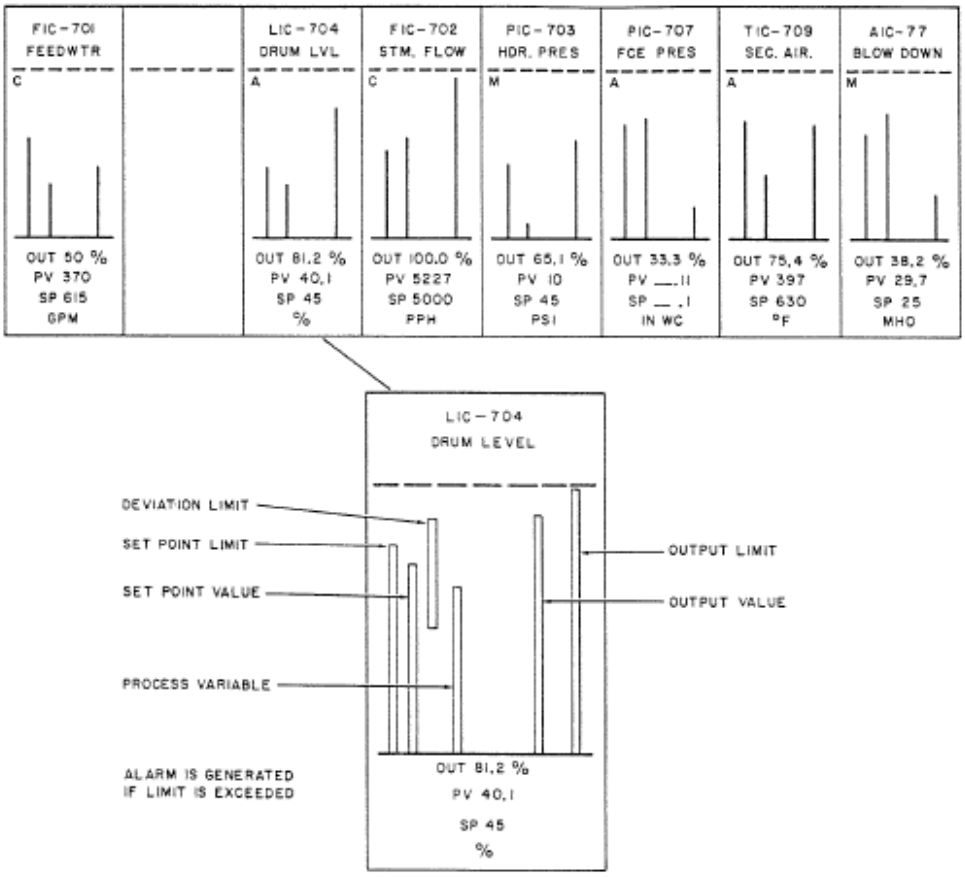
Any four points : (Each point carries o1 mark)

04

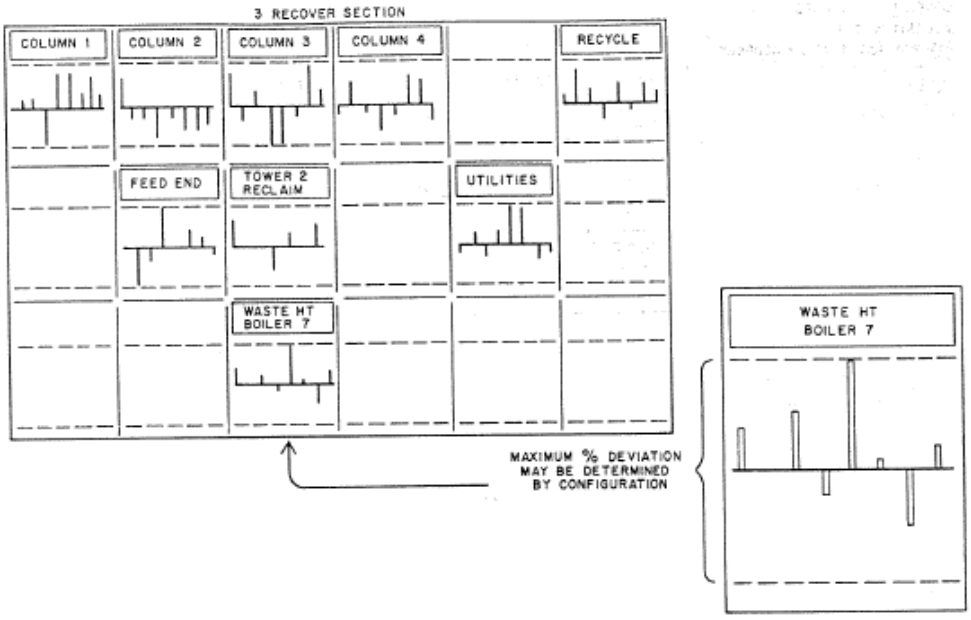
	processes. Domestic appliances- air conditioners and refrigerators involve continuous processes.	processes. Domestic appliances- Washing machines and Microwave ovens involve batch processes.	
c	**Explain with neat diagram working of evaporation process.**		04
Ans:	**Explanation** – Evaporation definition and explanation of single effect & multi-effect evaporation processes **Neat labeled diagrams** of i) Single effect evaporation and ii) Multi-effect evaporation processes. **Evaporation** is a process of concentrating a dilute solution by vaporizing a portion of solvent (water) to produce a concentrated solution or thick liquor. Evaporation is one of the most important unit operations in food processing and sugar industries. Large quantities of fruit and vegetable juices, sugar, and syrups are concentrated in several types of commercial evaporators. Evaporation process is carried out by two methods- i) Single effect evaporation and ii) Multi-effect evaporation **Single effect evaporation:** It occurs when a dilute solution is contacted only once with a heat source to produce the concentrated solution. The vapors from boiling liquid are discarded away. Although it is simple but it utilizes steam ineffectively.	2 marks explanation of any one method	

	 i) Single-effect Evaporation **Multi- effect evaporation:** It uses the vapor generated in one effect as the energy source to an adjacent effect. The double & triple effect evaporators are the most common. Six effect evaporator can be found in paper industry and as many as twenty effects evaporator can be found in desalinization plant.  ii) Multi-effect Evaporation	02 marks diagram	
d.	**Enlist different DCS displays. Explain any two of them.**		4
Ans:			

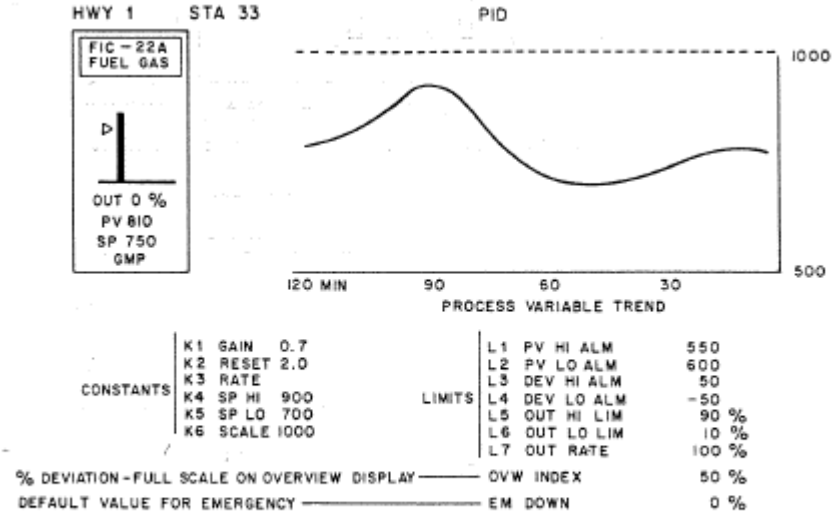
	List of DCS displays **Different DCS displays:** 1.Group display, 2.Overview display, 3.Detail display, 4.Graphic display, 5.Trend display. **i) Group display:** It shows the operating parameters of 8, 12 or 16 control loops, arranged in rows so that they look like faces of instruments on an instrument panel. Each of the control loops is represented by a rectangle with bar graphs to indicate values of process variable, set-point, output signal and their limits. **ii) Overview display:** It shows the bare essentials of a number of groups, each group in a separate rectangle. The set-point is shown as a straight line and deviation of process variable from set-point appears as vertical bar. **iii) Detail display:** It is specific to single control loop. It shows the same bar graph representation like group display, but it includes additional information defining controller parameters, alarm limits and other characteristic of control loop. **iv) Graphic display:** It shows pictorial representation of plant under control. This display includes process and control information and it can be interactive and real time information. Some displays are capable of showing movement in pipeline, tank and reactors as well. **v) Trend display**: It shows real-time trend graphs of process variable, set-point, and controller output over a period of time	**1 mark for list of DCS display** **03 marks for Explanation of any two DCS displays**	



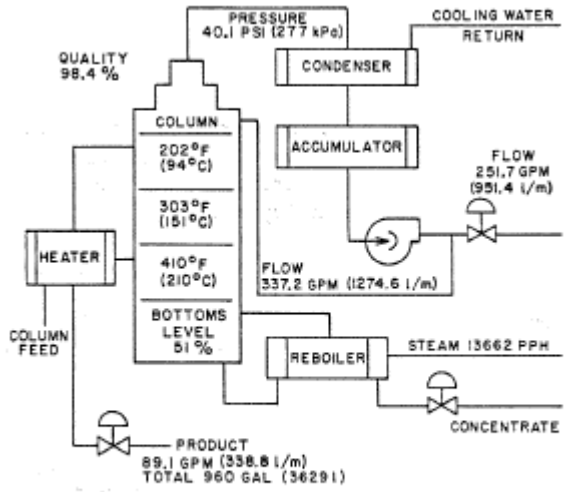
i) Group display



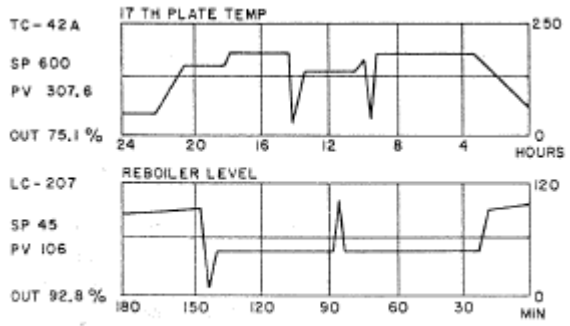
ii) Overview display



iii) Detail display

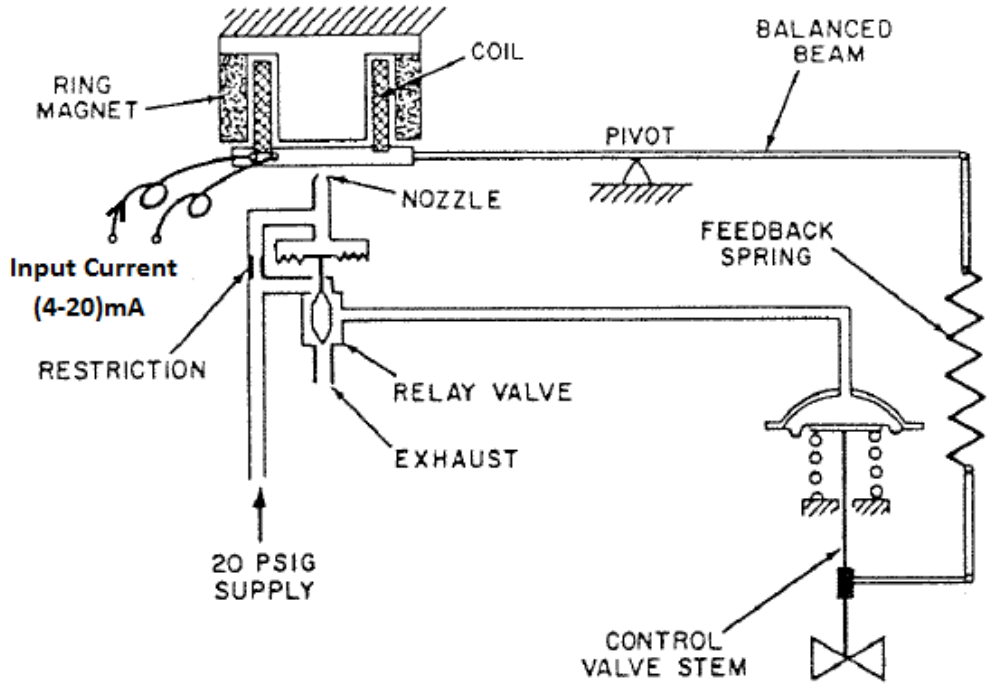


iv) Graphic display



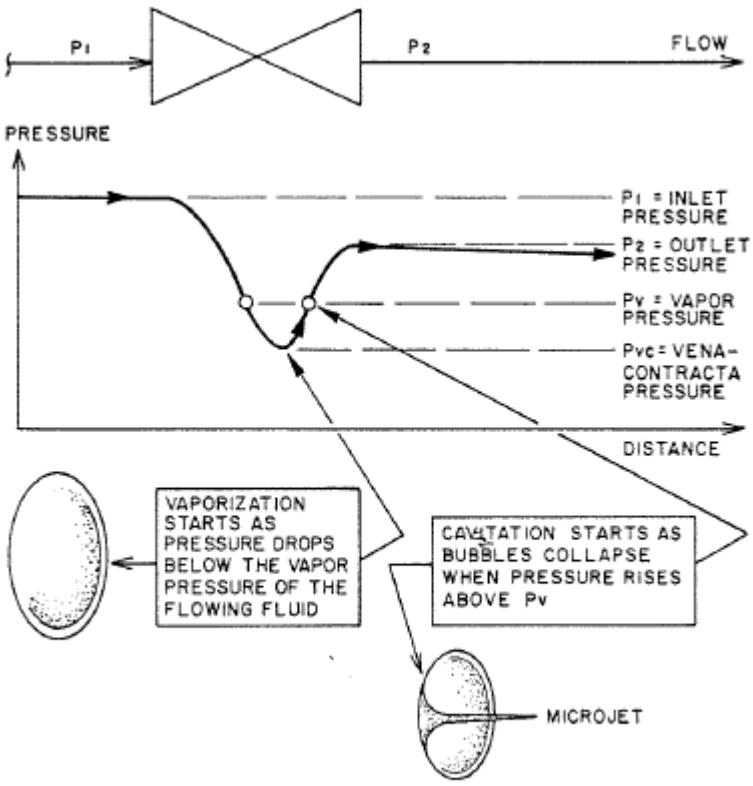
v) Trend display

e.	**Explain features of ISA S88.01 standard.**		04
Ans:	**ANSI/ISA S88.01 standard** is developed for batch process control. This international standard on batch control provides standard models and terminology for defining the control requirements for batch manufacturing plants. This standard covers four basic concepts: i) How to depict what you have in the plant (physical model). ii)How to define what you would like to accomplish in the plant (recipe). iii)Implementation of what you can do in the plant (equipment logic). iv)How to put the three pieces mentioned above together in an intelligent, reusable and successful way.	**Features of ISA S88.01 standard (any four)**	

4.A	**Attempt any THREE.**		12
a	**Draw neat diagram of Electro-pneumatic valve positioner. Explain it.**		04
Ans:	 Electropneumatic force balnce type valve positioner **Electro-pneumatic valve positioner:** The **valve positioner** is a high gain proportional controller which measures the valve stem position and compares it against its set-point (controller output signal) and if there is a difference, corrects the error by adjusting stem position. The main purpose of valve positioner is to guarantee that valve does move to the position where controller wants it to be.The valve positioner can correct many variations including changes in packing friction due to dirt, corrosion, or lack of lubrication; variations in the dynamic forces of the process; dead band ;or non-linearties in the valve actuator. There are two basic designs of valve positioners- i)Force-balance valve positioners ii)Motion-balance valve positioners	02 marks for neat diagram 02 marks for brief explanation	

<table>
<tr><td></td><td>The electro-pneumatic force-balance type valve positioner is shown in figure. It has a force balance mechanism consisting of electromagnetic coil, flapper-nozzle system, relay, balanced beam, and feedback spring. This mechanism compares the force generated by the input current signal, (4-20) mA with the force generated by the feedback spring connected to the valve stem. If some imbalance is there, it is corrected by adjusting valve stem position</td><td></td><td></td></tr>
<tr><td>b</td><td>State important features of MODBUS.</td><td></td><td>04</td></tr>
<tr><td>Ans:</td><td>The MODBUS is a transmission protocl for process control systems.
<table>
<tr><td>Features</td><td>MODBUS Protocol</td></tr>
<tr><td>Initiators</td><td>Gould-Modicon
Gould, AEG</td></tr>
<tr><td>Definition</td><td>Protocol</td></tr>
<tr><td>Cable</td><td>Not specified</td></tr>
<tr><td>Topology</td><td>Bus</td></tr>
<tr><td>Length</td><td>15 m, RS-232C
1200 m, RS-422
1000 m, current loop</td></tr>
<tr><td>Interface</td><td>RS-232C, RS-422,
20 mA current loop</td></tr>
<tr><td>Power supply</td><td>Electrically isolated</td></tr>
<tr><td>Transmission rate kbps</td><td>0.6 to 19.2</td></tr>
<tr><td>No. of devices</td><td>1 master; max 247 slaves</td></tr>
<tr><td>Bus access</td><td>Master-slave</td></tr>
<tr><td>Transmission method</td><td>Not specified</td></tr>
<tr><td>Coding</td><td>Configurable, ASCII or RTU</td></tr>
<tr><td>Address range</td><td>247</td></tr>
<tr><td>Data security</td><td>RTU: HD 4
ASCII: HD 4</td></tr>
<tr><td></td><td></td></tr>
</table></td><td>Any eight features of MODBUS (each feature carries ½ mark)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>c.</td><td>Define the terms:
1) Cavitation
2) Flashing
w.r.t. pressure recover characteristics</td><td></td><td></td></tr>
</table>

Ans:



Cavitation : Pressure Recovery Diagram

Cavitation:

Cavitation is a phenomenon that occurs only in liquid services. It is two stage phenomenon-vaporization and implosion of vapor cavities.

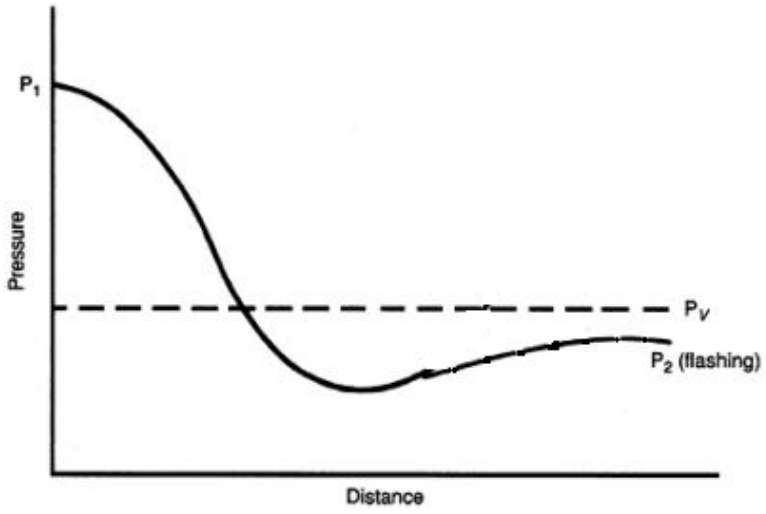
When liquid flows through a narrow restriction, the local pressure (P_1) falls to vapor pressure (P_v), vapor bubbles are formed. As the flow continues past the vena contracta, the velocity decreases as the flow area expands and pressure builds again. The resulting pressure recovery increases the pressure of the fluid above the vapor pressure. When these bubbles travel to an area of higher pressure, the bubbles collapse with phenomenal force and great localized stress. It is the violent collapse of these vapor bubbles near valve components or downstream piping surfaces, which cause cavitation damage and subsequent performance degradation.

Flashing :

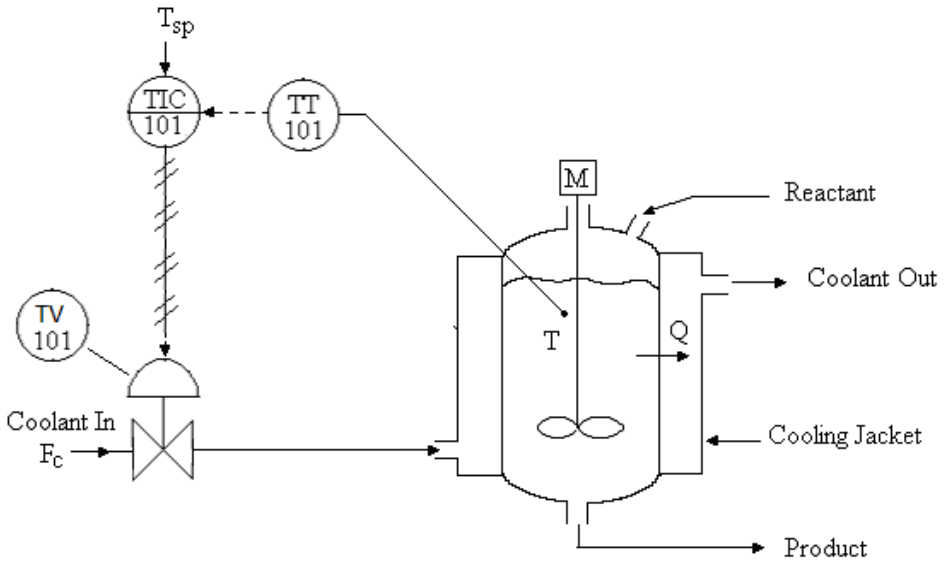
In liquid applications, when the downstream pressure (P_2) is equal to or less than the vapor pressure (P_v), the vapor bubbles generated at the

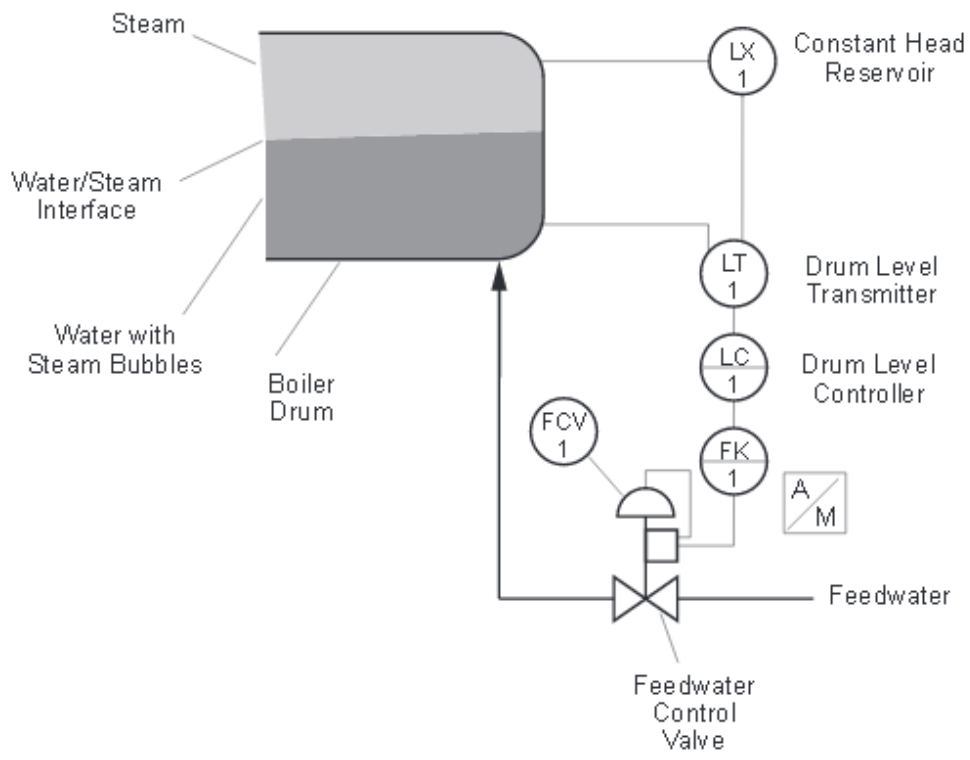
02 marks for definati on

02 marks for explanat ion

	vena contracta stay intact and do not collapse. This happens because the pressure recovery is high enough for this to happen. This phenomenon is known as flashing. When flashing occurs, the fluid downstream is a mixture of vapor and liquid moving at very high velocities, resulting in erosion in the valve and in the downstream piping.  Flashing : Pressure Recovery Diagram		
d	**Draw feedback control system for chemical reactor and explain**		04
Ans:	**Feedback control system for chemical reactor /CSTR:** Consider the Continuous Stirred Tank Reactor (CSTR). The reaction is exothermic and the heat generated by the chemical reaction is removed by the coolant, which flows in the jacket around the tank. The control objective is to keep the reactor temperature close to a desired value. Possible disturbances include the variations in feed temperature and the coolant temperature, but these are considered as smaller and transient. Feedback control scheme for CSTR is shown in figure. Here, controlled variable is reactor temperature(T) and the manipulated variable is flow of coolant(F_c) into the jacket. This control scheme continuously measures T and compares against desired reactor	02 marks for diagram	

	temperature, T_{sp}. Further feedback (PID) controller processes error signal and manipulates process input, F_c to maintain the reactor temperature at desired value. This scheme is suitable for transient and minor variation in disturbances(loads). **Feed Water Control / Drum Level Control Systems** are used extensively throughout the Process industries and the Utilities to control the level of boiling water contained in boiler drums on process plant and help to provide a constant supply of steam. If the level is too high, flooding of steam purification equipment can occur. If the level is too low, reduction in efficiency of the treatment and recirculation function. Pressure can also build to dangerous levels. A drum level control system tightly controls the level whatever the disturbances, level change, increase/decrease of steam demand, feed water flow variations. Three types of drum level control schemes / feed water control schemes are: i. Single-element drum level control system; ii. Two-element drum level control system; or Three-element drum level control system.	02 marks for explanation	

	 Feedback Control Scheme for Chemical Reactor (CSTR)		
4.B	**Attempt any ONE**		06
a	**Draw control scheme for feed water control and explain.**		06
Ans:	controller is fed to the feed water control valve (FCV-1). If the feed water valve is pneumatic, an l/P (current-to-pressure) converter is required to change the controller current output to accommodate the pneumatic valve. Auto/Manual transfer of the feed water control valve is accomplished via FK-1.	03 marks for diagram 03 marks for explanation of any one method	



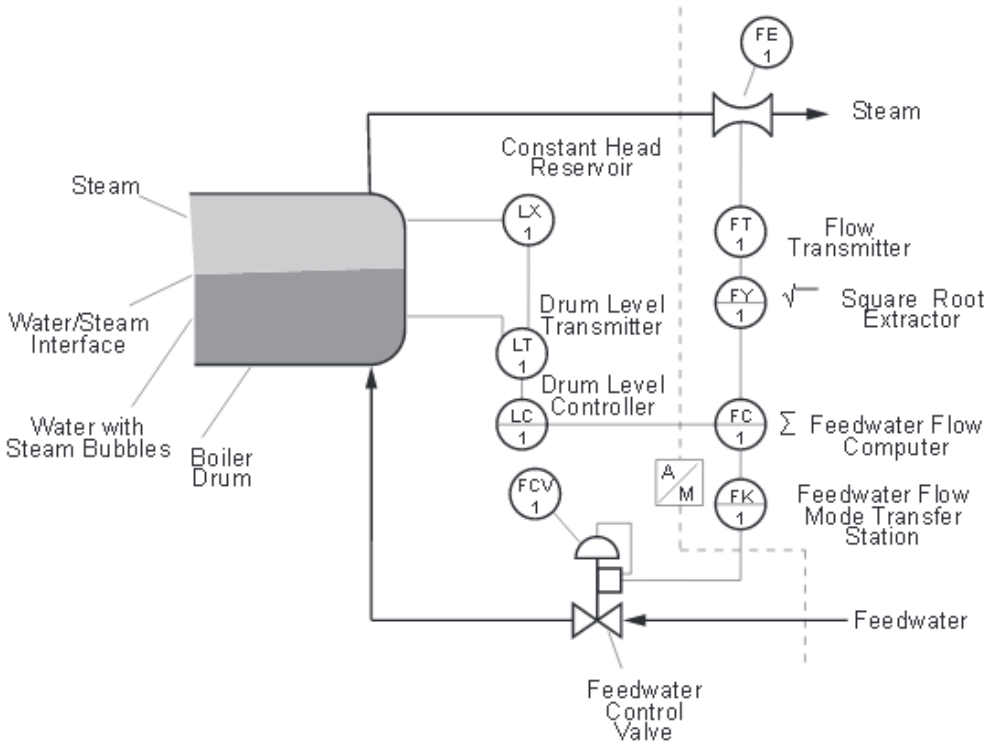
Single-element drum level control system

Two-element drum level control system:

The term 'two-element' is derived from measurement of two variables: steam flow and drum level that influence on the feed water valve position. It is sometimes referred as a combination 'feed-forward-feedback' system because the steam flow demand is fed forward and the drum level signal becomes the feedback for controlling/manipulating feed water to boiler drum.

The two-element drum level control shown in following figure. Steam flow is measured by the steam flow transmitter (FT-1), its signal is fed to the feed water flow computer (FC-1) after processing through the square root extractor (FY-1). As in the single-element level control, the drum level is measured by the level transmitter (LT-1) and its signal is transmitted to the drum level controller (LC-1). In the drum level controller, the process signal is compared to the drum level set-point, where a required corrective output signal to maintain the drum level is produced. This corrective signal is sent to the feed water flow computer. The

feed water flow computer combines the signal from the two variables, and produces an output signal to the feed water control valve (FCV-1). Auto/Manual transfer of the feed water control valve is accomplished via FK-1.



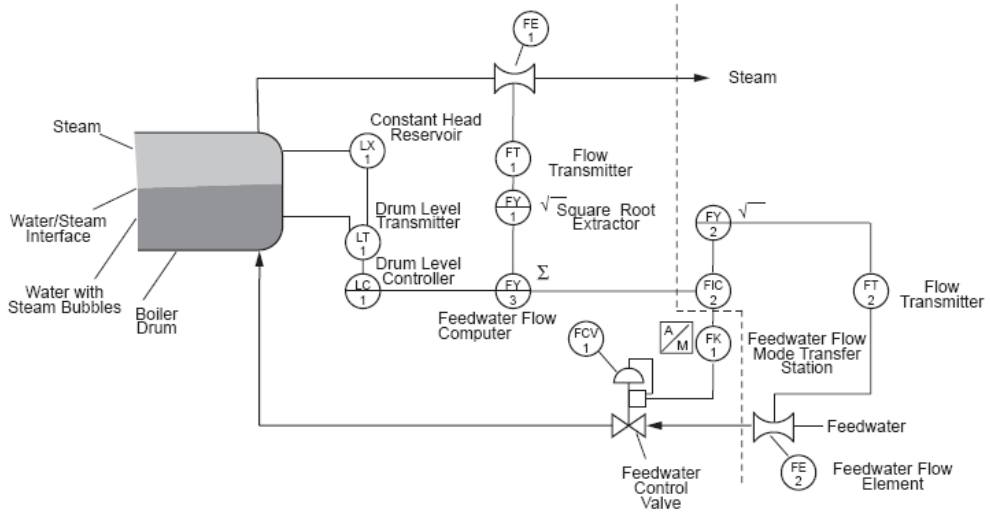
Two-element drum level control system

Three -element drum level control system:

The term 'three-element' is derived from measurement of three variables: steam flow, drum level and feed water flow that influence on the feed water valve position.

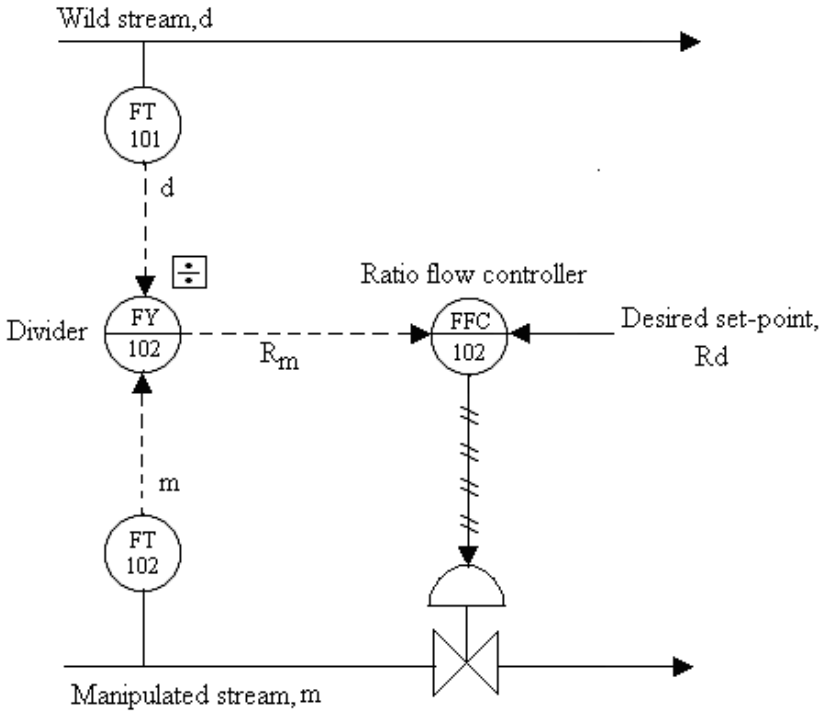
Figure below shows the control scheme for three-element drum level control. To the left of the dotted line, the instrumentation is the same as that for the two-element drum level control, with one exception: the output of the feed water flow computer now becomes the set-point of the feed water flow controller (FIC-2). Equipment required to complete our three-element drum level control scheme includes an additional flow device (FE-2) and differential pressure transmitter (FT-2).

The area to the left of the dotted line in following figure functions the same as that of a two element drum level control. We can pick up the operation for this scheme where the output signal of the feed water

	flow computer (the combination of steam flow and drum level) enters the feed water controller (FIC-2). This in effect becomes the set-point to this controller. Feed water flow Is measured by the transmitter (FT-2). The output signal of the feed water flow transmitter is linearized by the square root extractor, (FY-2). This signal is the process variable to the feed water controller and is compared to the output of the feed water flow computer (set-point). The feed water flow controller produces the necessary corrective signal to maintain feed water flow at its set-point by the adjustment of the feedwater control valve (FCV-1).  *Three-element drum level control system*		
b.	**With the help of neat diagram explain ratio control scheme.**		06
Ans:	**Ratio control scheme:** ➢ Ratio control is a special type of feed-forward control. ➢ The objective of a ratio control scheme is to keep the ratio of two process variables at a specified value. ➢ The two process variables are usually flow rates of a manipulated stream(m) and a disturbance stream(d).Here, the disturbance stream is also referred to as wild or load stream. ➢ Thus, the ratio (R) of two variables, m and d **R = m / d** is controlled rather than controlling the individual variables. **There are two ways to implement ratio control scheme.** ***i)*** **Ratio control scheme using Divider**	03 marks for explaination 03 marks for diagram	

ii) **Ratio control scheme using Multiplier**

i) Ratio control scheme using Divider:



Ratio control scheme using Divider

Here the manipulated stream (m) is under standard feedback control. The flow of the wild stream(d) is measured using flow transmitter(FT-101) and sent to a 'multiplier' (FY-102) which multiplies the signal by the desired ratio(R_d) yielding the set-point for the flow controller(FC-102).The flow controller then adjusts the flow rate of manipulated stream(m).

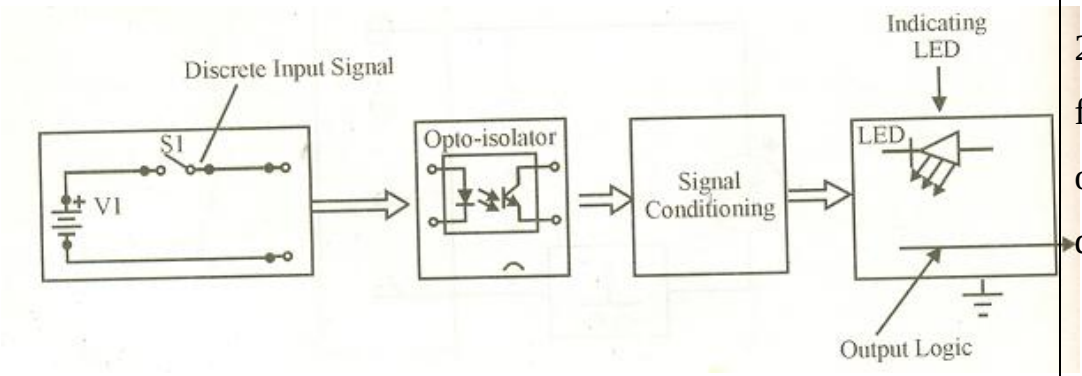
The main advantage of this method is that the process gain remains constant because divider is not used.

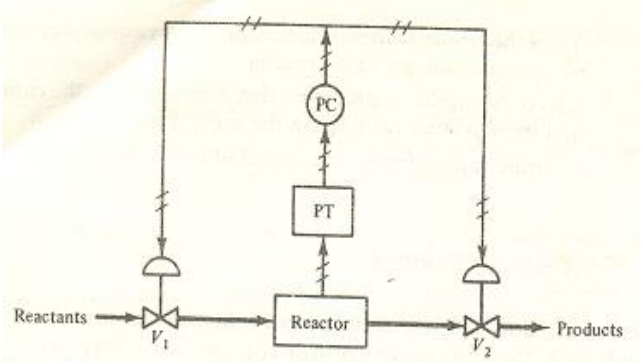
Applications of Ratio control scheme:

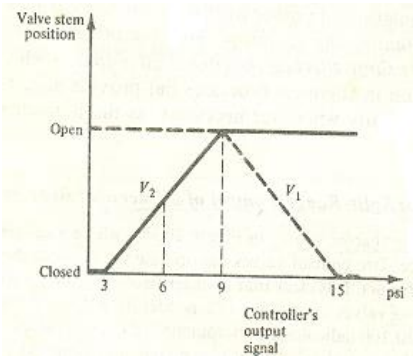
1. Blending two or more flows to produce a mixture with specified composition e.g water wastewater treatment plants.
2. Maintaining a stoichiometric ratio of reactants to a reactor e.g. A ratio control scheme is to be used to maintain a

	stoichoimetric ratio of H2 and N2 as the feed to an ammonia synthesis reactor. 3. Keeping a specified reflux ratio for a distillation column. 4. Maintaining the fuel-air ratio to a furnace at the optimum value.		
5	**Attempt any 4**		**16**
a	**State important features of PROFIBUS**		**04**
Ans:	**Features of Profibus** Communication Methods: Master/Slave, Multi-Master/Slave; Publisher/Subscriber Network Speed: 9.6kbit/s – 12,000kbit/s Data Transfer Size: Up to 244 Bytes Transmission Media/Technologies: Maximum No. Nodes: RS-485 STP Copper: 126; Fiber Optic: 126; IR: 126; RF: 126; Slip Ring: 126; MBP-IS: Depends on Power Budget Maximum Distance: RS-485 STP Copper (Segment/With 9 Repeaters): 9.6kbit/s: 1,000m/10,000m; 12,000kbit/s: 100m/1,000m Fiber Optic (Between Fiber Optic Repeaters): Plastic: 50m; Multi-Mode Glass: 400m; Single-Mode Glass: 15km IR & RF: Varies With Vendor Product MBP-IS: 31.25kbit/s: 1.9km Max. Depending on Cable Type Diagnostics: Standard: 6 Bytes Detailed: Up to 238 Bytes Total: Device-Related; Module-Related; Channel-Related	1 Mark each for any four features with minimum detailing	
b	**Explain different safety interlocks in boiler processes.** **Safety interlocks in boilers:** The basic Safety interlocks are as follows.		4

	1. Purge interlock: Prevents fuel from being admitted to an unfired furnace until the furnace has been thoroughly air-purged. **2**. **Low air flow interlock and /or fan interlock:** Fuel is shut off upon loss of air flow and /or combustion air fan or blower. **3. Low fuel supply interlock**: Fuel is shut off upon loss of fuel supply that would otherwise result in unstable flame conditions. **4. Loss of flame interlock**: All fuel is shut off upon loss of flame in the furnace and/or fuel to an individual burner is shut off upon loss of flame to that burner. **5. Fan interlock:** Stop forced draft upon loss of induced draft fan **6. Low water interlock(optional):** Shut off fuel on low water level in boiler drum **7. High combustibles interlock (optional):** Shut off fuel on highly combustible content in the flue gases	1 Mark each for any four points	
c	**Find the proper valve size in inch and cm for pumping a liquid flow rate of 600 gal/min with maximum pressure difference of 55 psi , liquid specific gravity is 1.3. find valve size**		04
Ans:	**Data given:** Q = 600 gal/min, ΔP = 55 Psi, G = 1.3 Equation for flow rate, $Q = C_V\sqrt{\frac{\Delta P}{G}}$ Therefore, $C_V = Q\sqrt{\frac{G}{\Delta P}}$ Substituting we get, $C_V = 600\sqrt{\frac{1.3}{55}} = 92.24$	2 Marks for formula & substitution 1 Mark each for	

	For a C_V of 92.24, the required valve size is 3 inches. (Refer table) The valve size in cm = 3x2.54 = 7.62 cm	answer in inches & cm	
d	**Enlist different types of i\o modules . explain any one**		4
Ans:	**Types of I/O modules:** 1. Serial I/O 2. Parallel I/O 3. Discrete I/O 4. Analog I/O 5. Special I/O **Discrete input module:** Discrete input signals from the field devices can be either DC or AC. **Discrete Dc input module**: Fig.1 below shows the schematic diagram of discrete DC input module. Signal from the field is isolated optically from the CPU circuit. The signal is conditioned, sent to the processor and indicating LEDs simultaneously.  Fig.1	2Marks for listing 2 Marks for any one type detailed	
e.	**Explain split range control system with neat diagram**		4
Ans:	**Reactor system with split range control**		





2M arks (any application diagram may be considered)

4

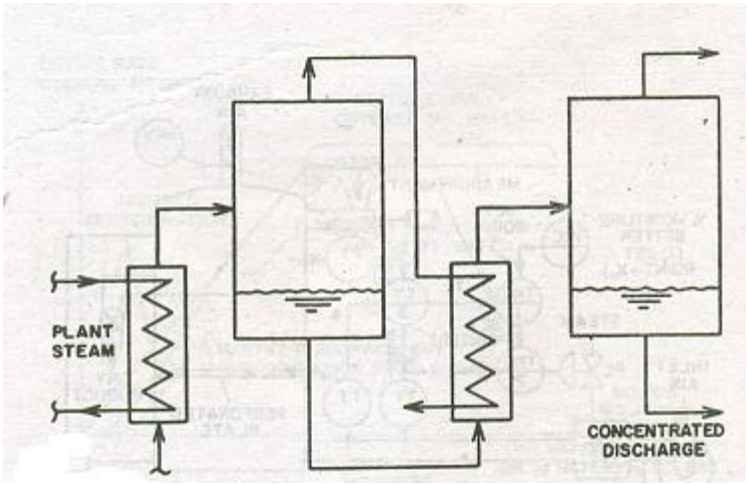
Split range control: split range control is a type of control configuration in which one can control a single process output by coordinating the actions of several manipulated variables, all of which have the same effect on the controlled output.

Consider the reactor shown in fig.2(a), where a gas-phase reaction takes place. Two control valves manipulate the flows of the feed in order to control the pressure in the reactor.

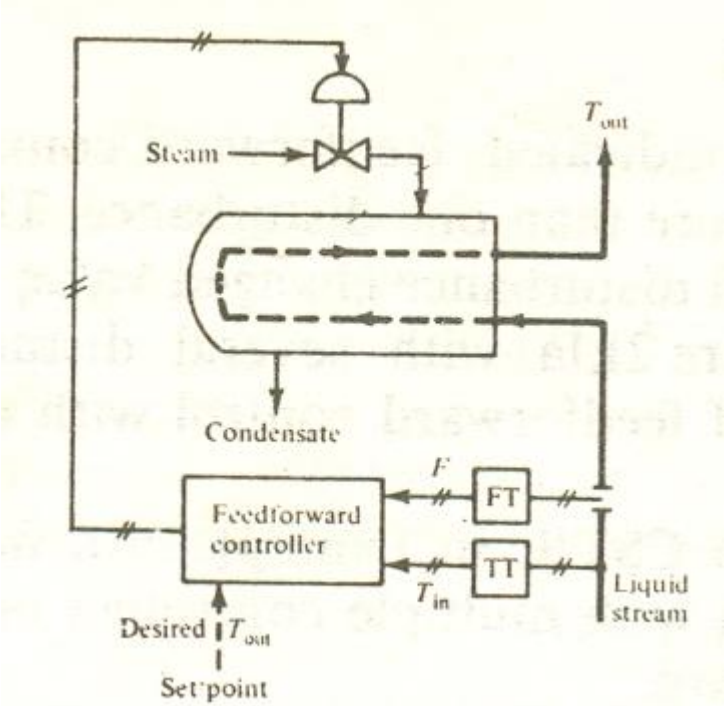
2 Mark

1. As the controller output increases from 6 psig to 9 psig, valve V_2 opens continuously while V_1 remains completely open [fig2(b)]. Both actions lead to a reduction in the pressure.

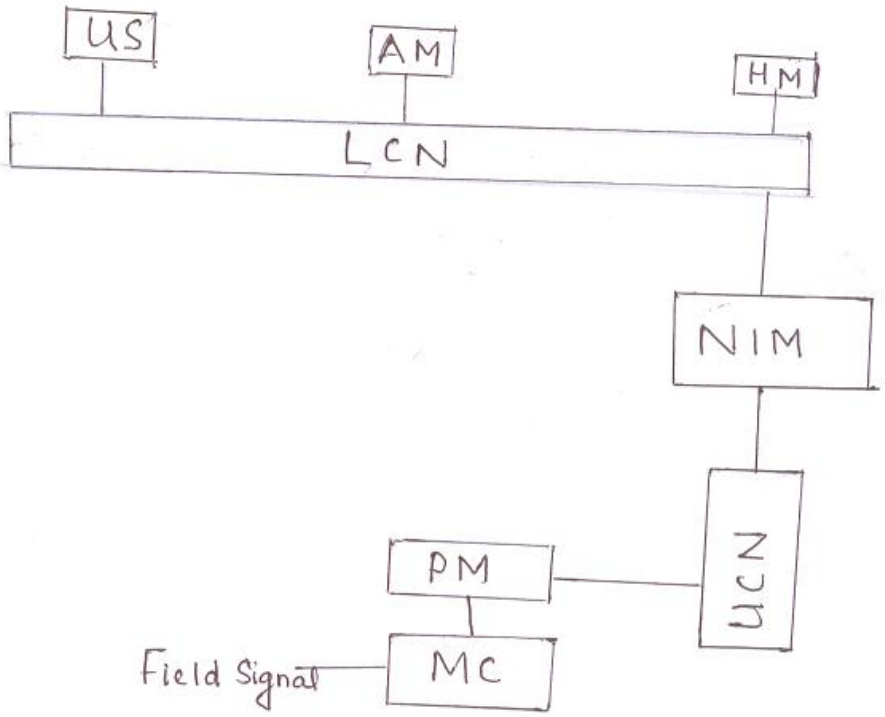
2. For large increases in reactor pressure the control output may exceed 9 psig. In such a case valve V_2 completely open while V_1 starts closing. Both actions again lead to a reduction in the pressure

	until the reactor has returned to the desired operation.		
f	**Draw the multiple effect evaporator and explain it**		4
Ans:	**Diagram of multiple effect evaporator:**  Fig.3 **Description:** In a multiple-effect evaporator, water is boiled in a sequence of vessels, each held at a lower pressure than the last. Because the boiling temperature of water decreases as pressure decreases, the vapor boiled off in one vessel can be used to heat the next, and only the first vessel (at the highest pressure) requires an external source of heat. Double and triple-effect evaporators are most common. Six feet evaporation can be found in the paper industry, where kraft liquor is concentrated. As many as 20 effects can be found in desalinization plants.	2 Marks 2 Marks	4
6	**Attempt any four**		16
a	**State Selection criteria for control Valve for suitable application**		4

6a	**Selection criteria for control Valve:** 1. Body pressure rating: It must be as per the ANSI pressure classes. 2. Temperature considerations: It includes strength of body materials as well as relative thermal expansion of various paths. 3. Material selection: Body materials are to be decided depending on temperature range and erosive qualities of fluid. 4. Flow characteristics: Characteristics may have strong influence on stability of process. Accordingly, choice may be quick opening, linear or equal percentage. 5. Rangeability: Wide rangeability may be required according to the process load change. 6. Pressure drop: Maximum pressure drop a valve can tolerate at fully shut off and partly open or fully open. 7. Cost Vs capacity: For larger lines, over size valves are required and cost increases.	1 Mark each for any four points.	4
b	**Draw feed- forward control system of heat exchanger process. Explain it.**		4
Ans:	**Diagram of feed- forward control system of heat exchanger**:	2 marks for diagram	4

	 **Description:** The objective of a feed-forward control system is to measure disturbances and compensate for them before the controlled variable deviates from the set point. In case of heat exchanger, the exit temperature of the liquid is maintained constant by manipulating the steam pressure. The two principle disturbances measured are the inlet liquid flow rate and temperature (FT, TT). The feed forward controller calculates the error and sends a corrective signal to the steam flow valve.	2Marks	
c	**Draw typical DCS structure of TDC 3000 system in detail**		
		4 Marks for the detailed diagram	4

Structure of TDC (Total Distribution Control) 3000



MC - Marshalling Cabinet
PM - Process Manager
UCN - Universal Control Network
NIM - Network Interface Module
LCN - Local Control Network
HM - History Module
AM - Application Module
US - Universal Station

<table>
<tr><td>d</td><td>Compare RS 232 & Rs 485 data communication stanadards (any 4 points)</td><td></td><td></td></tr>
<tr><td>Ans:</td><td>Comparison between RS 232 & Rs 485:
<table>
<tr><th>Parameter</th><th>RS232</th><th>RS485</th></tr>
<tr><td>Cabling</td><td>single ended</td><td>multi-drop</td></tr>
<tr><td>Number of Devices</td><td>1 transmit 1 receive</td><td>32 transmitters 32 receivers</td></tr>
<tr><td>Communication Mode</td><td>full duplex</td><td>full duplex, half duplex</td></tr>
<tr><td>Max Distance</td><td>50 feet at 19.2 Kbps</td><td>4000 feet at 100 Kbps</td></tr>
<tr><td>Max. Data Rate</td><td>1Mpbs for 50 feet</td><td>10 Mpbs for 50 feet</td></tr>
<tr><td>Signaling</td><td>unbalanced</td><td>balanced</td></tr>
<tr><td>Mark (data 1)</td><td>-5 V min. -15 V max.</td><td>1. 5 V max. (B>A)</td></tr>
<tr><td>Space (data 0)</td><td>5 V min. 15 V max.</td><td>1. 5 V max. (A>B)</td></tr>
<tr><td>Input Level Min.</td><td>+/- 3 V</td><td>0.2V difference</td></tr>
<tr><td>output current</td><td>500 MA</td><td>250 MA</td></tr>
</table></td><td>1 mark each for any four points</td><td></td></tr>
<tr><td>e</td><td>Enlist type of recipe management. Explain any one</td><td></td><td>4</td></tr>
<tr><td>Ans:</td><td>Types of Recipe for recipe management:
1. General Recipe
2. Site Recipe
3. Master Recipe
4. Control Recipe
Description:</td><td>½ marks for each</td><td>4</td></tr>
</table>

	1. General Recipe: The general recipe is an enterprise level recipe that serves as the basis for lower-level recipes. The general recipe is created without specific knowledge of the process cell equipment that will be used to manufacture the product. It identifies raw materials, their relative quantities, and required processing, but without specific regard to a particular site or the equipment available at that site. It provides a means for communicating processing requirements to multiple manufacturing locations. It may be used for production planning and for information to customers and authorities. **2. Site Recipe:**The site recipe is specific to a particular site. It is usually derived from a general recipe to meet the conditions found at a particular manufacturing location and provides the level of detail necessary for site-level, long term production scheduling. Typically, the site recipe is the output of a local "site focused" process development function. There may be multiple site recipes derived from a general recipe, each covering a part of the general recipe that may be implemented at a specific site. **3. Master Recipe:**The master recipe is that level of recipe that is targeted to a process cell or a subset of the process cell equipment. A master recipe can be derived from a general recipe or a site recipe. It can also be created as a stand-alone entity if the recipe creator has the necessary process and product knowledge. **4. Control Recipe:**The control recipe starts as a copy of a specific version of a master recipe and is then modified as necessary with scheduling and operational information to be specific to a single batch. It contains product-specific process information necessary to manufacture a particular batch of product. It provides the level of detail necessary to initiate and monitor equipment procedural entities in a process cell.	2 Marks for any one recipe	