Subject Code: 17663   **Model Answer**

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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 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.

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Q. No.	Question & its Answer	Remark	Total Marks
1 (a)	**Attempt any THREE of the following**		**12**
(i)	**Compare human aided control system with automatic control system (Four points).**		**04**
Ans.	(table below)	**01 mark each (Any four point)**	
(ii)	**Explain the ratio control system with the help of suitable diagram.**		**04**

Human aided control:	Automatic process control:
Human being are required in control operation	No human being is required in control operation
Human cant not work beyond certain time if efficiency is less	Efficiency is excellent in this sysytem
More errors occurs.Hence accuracy is less.	Less error exist.Hence accuracy is more.
They are easy to install	They are difficult to install
They cannot be used in hazzardous	It is used in hazzardous area.
Safety of human is major concern	Machine can work safely.
Quality of product is not good.	Quality of product is good.

(Any other relevant point may also be considered)

| Ans.	**Ratio control system:**	**02 Marks**	
	• 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& 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 ii) Ratio control scheme using Multiplier **Dia. of ratio control:** **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(Rd) 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	**for** **Explanation** **02 Marks** **for diagram**	

	not used. **(Any one of the system may be considered.)**		
(iii)	**List any four advantages of DCS system.**		**04**
Ans.	**Advantages of DCS:** 1. Overall cost of the installation is lower. 2. Less wiring required due to serial communication. 3. Panel space is reduced. 4. Allows inter-controller communication. Hence programming can be done from any location. 5. Flexible and relatively easy to expand. 6. It allows duplicate storage of data. 7. High reliability. 8. Application program can be easily developed. 9. Interface with the process is improved. 10. Advanced control technique. 11. Provision of redundancy. 12. Optimum utilization of available man-power. 13. Minimum data losses & errors. 14. Reduces manpower requirement.	**01 Mark Each(Any four Points)**	
(iv)	**Explain the feed back control scheme for batch process.**		**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 to reactor temperature close to desired value. Possible disturbances included the variation in feed temperature and the coolant temperature, but these are considered as smaller and transient. Feedback control scheme for CSTR is shown in fig. Here, controlled variable is reactor temperature(T) and the manipulated variable is flow of coolant(F_c) into the jacket. This control scheme continuously measure T and compares against desired reactor temperature, $T_{sp.}$ Further feedback(PID) controller processes error signal and manipulates process input, F_c to maintain the reactor temperature at the desired value.	**02 Marks for explanation**	
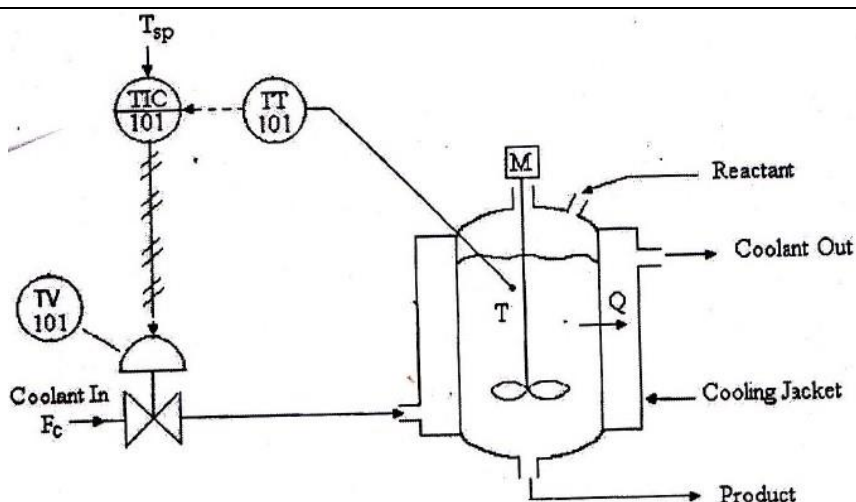
	(Any other relevant process diagram also be considered)	**02 Marks for diagram**	
b)	**Attempt any ONE of the following**		**06**
(i)	**What is instrument Index sheet? State its importance in project and prepare a sample instrument index sheet.**		**06**
Ans.	**Definition:** It is consolidated list of all instrument which are used in the plant. It consists of the following details: i) Type of instrument ii) Location of instrument iii) Installation details **Importance:** 1) It serves as a basis to prepare I/O list by extracting only the tag number 2) Searching, Listing or fitering a tag number can be done with the help of instrument index sheet. **Instrument Index Sheet:**	**02 Marks for Definition** **02 Marks for importance** **02 Marks for Instrument Index Sheet**	

Instrument Index Sheet:

Sr. No	Tag no.	Loop no.	Instrument type	Location	I/O type	Hook up drg. no
1	PSV-1113	P-1113	Pressure safety value	Field	-	C-ABC-0001 sheet 4
2	FT-1002	FT-1002	Flow transmitter-electromagnetic	Field	AI	J- XYZ HDK-15216 Sheet 4

Note: (Sample Instrument Index Sheet with-At least 6 headings with one entry)

(ii)	**What is heat exchange? How are they classified? Explain any one heat exchanger in detail.**		**06**
Ans.	A heat exchanger is a device built for efficient heat transfer from one medium to another. The medium may be separated by a solid wall, so that they never mix, or they may be indirect contact.	**01 mark for Definition**	

	Classification:
	1. Based on construction
	  a) Shell and tube
	  b) Plate type
	2. Based on flow direction/arrangement of shell side and tube side fluid
	  a) Concurrent flow
	  b) Counter current flow
		01 mark for classification	

	• **Shell and tube heat exchanger:** **Diagram:** 	**02 marks for diagram**	
	Explanation: A shell and tube heat exchanger is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. This type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The set of tubes is called a tube bundle, and may be composed of several types of tubes: plain, longitudinally finned, etc. In order to transfer heat efficiently, a large heat transfer area should be used, leading to the use of many tubes. In this way, waste heat can be put to use. This is an efficient way to conserve energy.	**02 marks for explanation**	
2	**Attempt any TWO of the following**		**16**
a)	**Define cavitation and flashing. Explain the remedies to avoid cavitation and flashing in control valve.**		**08**
Ans.	**Cavitation:**	**02 Marks**	

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As the fluid passes through the restriction, its velocity increases and pressure decrease. As the liquid passes through the low pressure of the liquid at that temperature. Some of the liquid then turns into vapor and form bubbles in the liquid. As the flow area returns to the original value and pressure increases, the bubbles collapse against the downstream liquid. This process is called cavitation(P2>Pv).

Flashing:

In liquid applications, when the downstream pressure (P2) is equal to or less than the vapor pressure(Pv), the vapor bubbles generated at the 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(P2<Pv). 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.
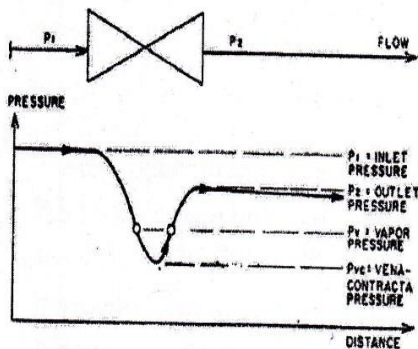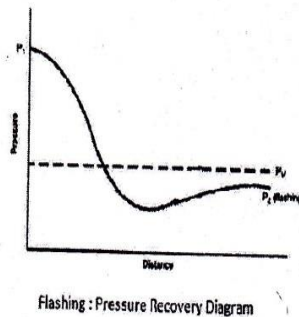
	02 Marks	

Fig: Caviation phenomenon

Fig: Flashing

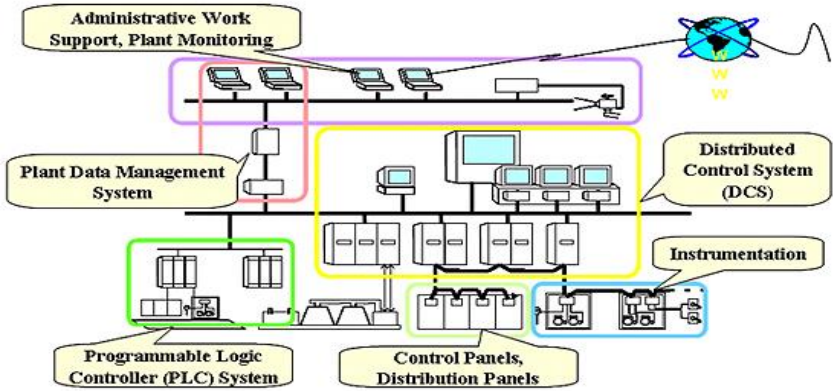Flashing : Pressure Recovery Diagram

phenomenon
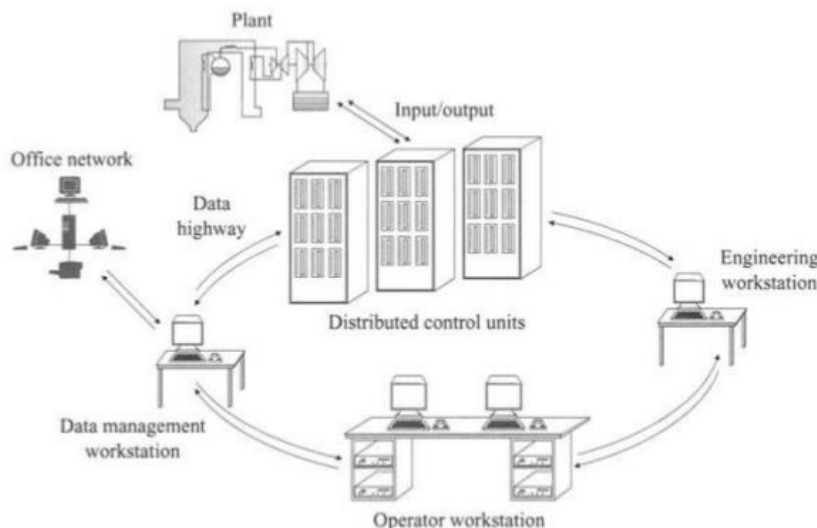
Remedies to avoid the problem of cavitation   **04 Marks**

1. Revised process condition:
   a) Reduction of operating temperature can lower vapor pressure.
   b) Increase in upstream and downstream pressure with Δp. unaffected.
2. Revised valve
   Type of valve in terms of pressure recovery characteristics.
3. Revised installation
   Two or more control valves installed in series as multistage control valve to handle huge pressure drop.
4. Gas injections
   Introduction of non condensable gas or air into the region where cavitation is anticipated.

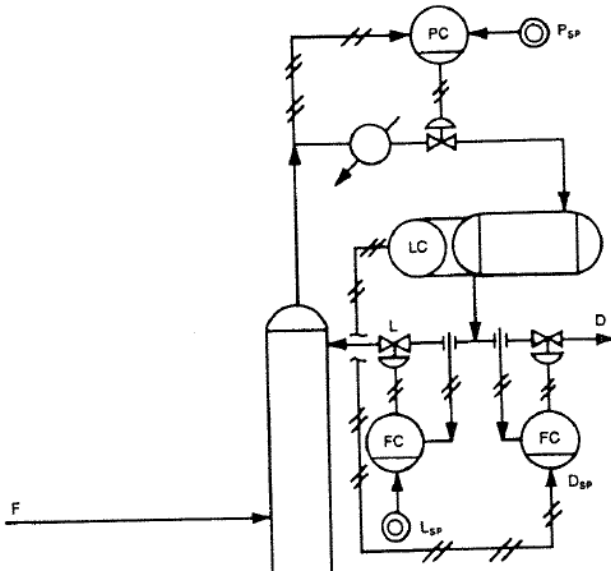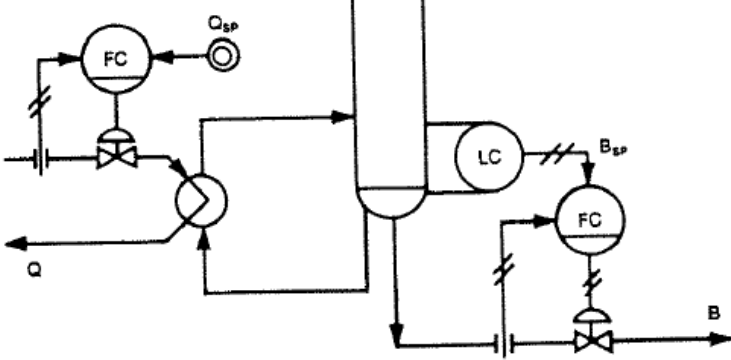|				
	Remedies to avoid the problem of flashing 1. The damage from flashing can be minimized by reducing velocity by using reduced port angle valve discharging directly into vessel or flash tank. 2. Using erosion resistant material such as ceramic material lining provided at downstream of control valve.			
b)	**Define evaporation. Explain the cascade control scheme for an evaporation with the help of neat diagram.**			**08**

Ans.	**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. Evaporation process is carried out by two methods-
	   i) Single effect evaporation and
	   ii) Multi-effect evaporation
	
	Fig. Cascade control scheme for evaporator
	
	The controlled variable is the density of the output product. A conventional feedback control scheme manipulates the steam flow rate based on density variations. Higher the density, lower is the steam flow rate to reduce the rate of evaporation. However, the response of the control loop can be improved by adding flow control loop of steam to the feedback loop.
	Thus, the primary loop is the loop which has density as the controlled variable and steam flow rate as the manipulated variable.
	The secondary control loop has the steam flow rate as the controlled variable and steam flow rate as the manipulated variable.
	The level controllers on each effect are for maintaining the mass
		01 mark for definition
		
		04 marks for diagram
		
		03 marks for explanation		

	balance on each effect. **(Any other relevant diagram also be considered)**		
c)	**With the help of neat labeled block diagram explain the use of DCS in Thermal Power plant**		**08**
Ans.	**DCS system architecture:** **OR** **Description of the system:** Managing a power plant involves the following activities, 1. Raw Material Transportation and Processing 2. Boiler Combustion (Pulverization of Coal / CFB)	**04 marks for diagram** **04 marks For description**	

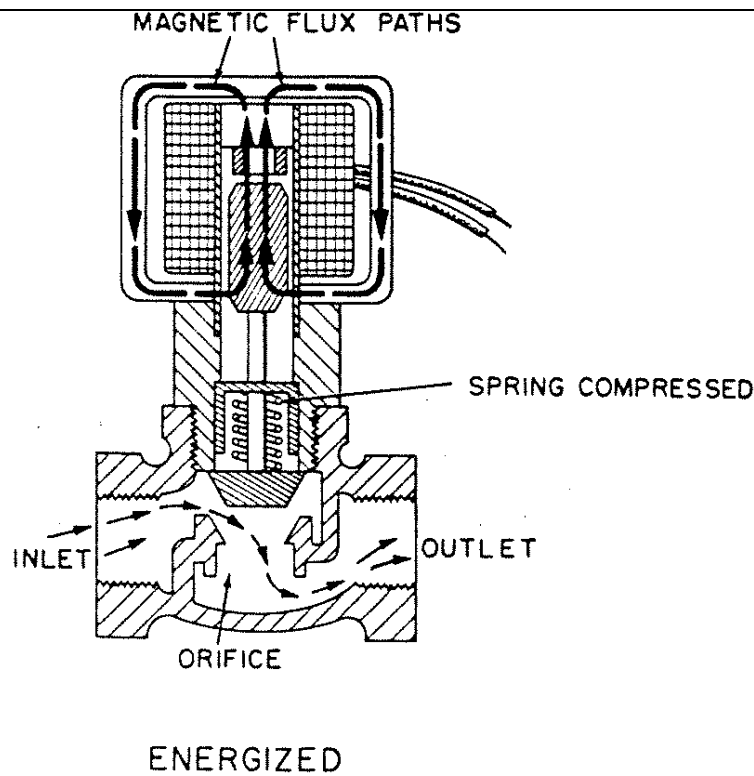|			
	3. Turbine (Steam Turbine and Heat Recovery) Monitoring and Control 4. Generator and Plant Electrical System Monitoring and Control 5. Waste and Exhaust Treatment. Like any other industrial control application, the subsystem of DCS are interconnected through network, using the standard Ethernet, serial line or point to point multidrop. In dual configuration, they may support high reliability networking using dual ethernet network topology. The automation and control logic are typically distributed among the various stations. The human machine interface functions are provided by DCS HMI operator stations. The connection to external systems is guaranteed by the OPC or MODBUS gateway functions. DCS used to control entire plant operation from CCR following major variables are measured and controlled. Input variables • Fuel flowrate • Combustion air. • Feed water flow • Steam flow / pressure Control variables: • Drum level • Steam pressure • Furnace draft • Waste gases composition Above variables are continuously monitored and controlled on DCS using different DCS displays such as • Graphic display • Group display • Trend display • Alarm display • Log and repeat display etc. **(Any other relevant diagram may also be considered.)**		
3	**Attempt any FOUR of the following**		**16**
a)	**Draw and explain feedback control scheme in distillation**		**04**

	column.		

Ans.	**Feedback Control Scheme in Distillation Column:**
	    1. In this system reflux flow and distillate flow can be maintained at the desired value (set point) given to the flow controller. Here a simple feedback control system is designed for controlling the top section of the distillation column.
	
	          OR
	
	    2. Similarly the control system is designed for controlling the bottom section of the distillation column, in which the flow rate of steam and the bottoms is controlled at a desired value by measuring their actual flow rates.
	
		02 marks-diagram
		
		02 marks-explanation	

b)	**State the principle of control valve and explain its construction.**		**04**

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Ans.	**Principle of Control valve:**	02 Marks- for principle
	A control valve is a final control device which is used to regulate the flow rate of fluid flowing through pipes in the system. This is accomplished by placing variable size restriction in the flow path as shown in following fig.	
	The control valve (final control element) manipulates a flowing fluid, such as gas, steam, water, or chemical compounds, to compensate for the load disturbance and keep the regulated process variable as close as possible to the desired set point. It works by fully or partially opening or closing in response to signals received from controllers. The opening or closing of control valves is usually done automatically by electrical, hydraulic or pneumatic actuators.	
	Construction:	02 marks for construction

DIRECT-ACTING ACTUATOR

LOADING PRESSURE CONNECTION
DIAPHRAGM CASING
DIAPHRAGM AND STEM SHOWN IN UP POSITION
DIAPHRAGM PLATE
ACTUATOR SPRING
ACTUATOR STEM
SPRING SEAT
SPRING ADJUSTOR
STEM CONNECTOR
YOKE
TRAVEL INDICATOR
INDICATOR SCALE

W0363-1

OR

PUSH-DOWN-TO-CLOSE VALVE BODY ASSEMBLY

BONNET GASKET
SPIRAL WOUND GASKET
CAGE GASKET
SEAT RING
VALVE PLUG STEM
PACKING FLANGE
ACTUATOR YOKE LOCKNUT
PACKING
PACKING BOX
BONNET
VALVE PLUG
CAGE
SEAT RING GASKET
VALVE BODY

W0989

Control valve are having following important parts:

	1. **Actuator Spring:** A spring, or group of springs, enclosed in the yoke or actuator casing that moves the actuator stem in a direction opposite to that created by diaphragm pressure. 2. **Actuator Stem:** The part that connects the actuator to the valve stem and transmits motion (force) from the actuator to the valve. 3. **Cage:** A part of a valve trim that surrounds the closure member and can provide flow characterization and/or a seating surface. It also provides stability, guiding, balance, and alignment, and facilitates assembly of other parts of the valve trim. The walls of the cage contain openings that usually determine the flow characteristic of the control valve. 4. **Diaphragm Plate:** A plate concentric with the diaphragm for transmitting force to the actuator stem. 5. **Diaphragm:** A flexible, pressure responsive element that transmits force to the diaphragm plate and actuator stem. 6. **Diaphragm Case:** A housing, consisting of top and bottom section, used for supporting a diaphragm and establishing one or two pressure chambers. 7. **Piston:** A movable pressure responsive element that transmits force to the piston actuator stem 8. **Plug:** A term frequently used to refer to the closure member. 9. **Seat:** The area of contact between the closure member and its mating surface that establishes valve shut-off. 10. **Stem Connector:** The device that connects the actuator stem to the valve stem.		
c)	**Compare feed forward control system with feedback control scheme (any four points)**		**04**
Ans	<table><tr><td>**Feed Forward Control**</td><td>**Feedback Control**</td></tr><tr><td>1.Acts before the effect of a disturbance is felt by the system, thus acts in anticipatory manner</td><td>1.Waits until the disturbance affects the system, thus acts in compensatory manner.</td></tr><tr><td>2.Good for slow system</td><td>2.Unsatisfactory for slow processes</td></tr><tr><td>3.Does not introduce instability in the closed loop response</td><td>3.Create instability in the closed loop response</td></tr><tr><td>4. Requires identification of all possible is disturbances and their direct measurement. Thus requires good knowledge of process model.</td><td>4.Does not require Identification and measurement of any disturbances</td></tr></table>	**01 mark for each point (any four points)**	

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	5. Sensitive to unmeasured disturbances	5. Insensitive to unmeasured disturbance		
	6. Sensitive to process Parameter variations	6. Insensitive to parameter changes		

(Any other relevant point may also be considered)

d)	**Explain the construction and working of solenoid valve.**		**04**
Ans.	**Construction**:	**02 marks for diagram**	

DIRECTION OF FLOW THROUGH VALVE

DE-ENERGIZED

OR

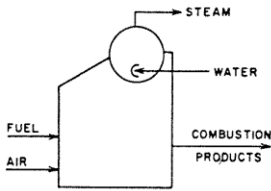|			
	 Working: A solenoid valve consists of the valve body, a magnetic core attached to the stem and disc and a solenoid. The magnetic core moves into a tube that is closed at top and sealed at bottom, allowing the valve pack less. A small spring assists the release and initial closing of valve. The valve electrically energizes to open. Solenoids (consisting of a soft iron core that can move within the field set up by surrounding coil) are used extensively for moving valve stems. Solenoid moves in straight line and therefore requires a cam or other mechanical part to operate rotary valve. Valve can open in 8 to 12 milliseconds. Figure shows fail to close solenoid valve which is closed in energized state. When valve is energized, magnetic field is developed in stationary core which ultimately create an electromagnetic effect to pull movable core (plunger) in core tube towards shading coil. As plunger is attached with valve stem it will uplift valve disc to open the valve.	**02 marks for explanation**	
e)	**Explain the selection criteria for DCS system.**		**04**
Ans.	1. **Nature of Manufacturing and type of product manufactured** • No. of Products manufactured : Single / Multiple		

• Recipe parameter : Constant or Variable • Procedure : Single or Different • Equipment Utilization : Fixed or Flexible • Frequency of changes to formula & Recipe : Never or Often • Regulatory / Analog loop control • Complex Batch Control **2. The value of the product being manufactured and the cost of downtime** • If the value of the batch is high, either in raw material cost or market value, & the downtime not only results is lost production but potentially dangerous and damaging conditions, the DCS should be selected 3. **. Factory environment: :** • The environment in process automation can be volatile & dangerous. • In this scenario, the HMI is a central control room console that provides the only complete "window" into the process, enabling operator to monitor & control the process which are occurring inside pipes & vessels located throughout the plant. 4. **Role of operator:** • The DCS plant requires an operator to make decision and continuously interact with the process to keep it running. • In fact, operators process knowledge is often critical to operational excellence & keeping the process running optimally **5. What system performance is required** • The speed of logic execution is a key differentiator between PLC and DCS. While fast scan rates are necessary to be able to effectively control the operations involving motion control, high-speed interlocking, control of motors and drives, he DCS does not have to be that quick. • Control Loops require deterministic Scan execution at speed 100-500ms • System redundancy is often required • Online configuration changes often required	**01 mark for each point (any four point)**

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	• Analog Control – Simple to Advanced PID upto Advanced Process Control-cascade, Split range, Ratio etc. **6. Degree of customization required** • In PLC Powerful Programming languages are typically available to facilitate the creation of custom code from scratch. DCS consists of Pre-engineered solutions consists of standards, templates & extensive libraries. • The highest priority of DCS is to deliver reliability & availability, which often results in a design which trades unlimited functionality for repeatability and dependability		
4 (a)	**Attempt any THREE of the following**		**12**
(i)	**Draw P and ID symbol for:** **1) Butterfly valve** **2) Boiler** **3) Electric signal** **4) Pneumatic signal**		**04**
Ans.	**1) Butterfly valve :** **2) Boiler:** **3) Electrical Signal:** - - - - - - - - - - - - - **4) Pneumatic Signal:** —//——//——	01 Mark-each symbol	
(ii)	**Draw and explain flow characteristics of control valve.**		**04**

Ans		01 Mark for diagram	
	Stem position as S/SMax		

1. Quick Opening:

This type of valve is used for full ON / OFF control operation. The valve characteristic shows that relatively small motion of valve stem results in maximum possible flow rate through the valve. It is used when maximum valve capacity must be obtained quickly.

2. Linear:

This type of valve characteristic has a flow rate that varies linearly with stem position. It represents ideal situation where valve alone determine the pressure drop.

Relationship is expressed as,

$Q/Q_{max} = S/S_{max}$

3. Equal Percentage:

In equal percentage valve equal increment of the stem travels give equal % change of the existing flow. This type of valves does not shut off flow completely when at one end of its travel.

Relationship is expressed as,

$R = Q_{max}/Q_{min}$

Where

R = Rangebility

Qmax = Maximum Flow rate

Qmin = Minimum Flow rate

$Q = Q_{min}(R)^{S/S_{max}}$

Where

01 mark for each characteristic

_____

	Q = Flow rate S = Stem Position Smax = Maximum Stem Position **Q/ Q$_{max}$ = S/ S$_{max}$**		
(iii)	**Compare continuous process and batch process(four points)**		**04**
Ans.		**01 Mark for each point**	

Batch Process	Continuous Process
1.In this material is fed to equipment at a time and then it is processed to obtain finished products.	1.In this material is fed continuously in equipment and is immediately processed and finished product is obtained continuously.
2.During process operation neither addition of material nor removal of finished product from unit occurs.	2.During process operation therate of process output is matched with input material.
3.Preferred in small scale production.	3.Preferred in large scale production.
4.Simple instruction and Control system is required.	4.More elaborated instruction And control system is required.
5.Load changes effects are less.	5.Load changes effects are more.

(Any other relevant point may also be considered)

(iv)	**State the role of instrumentation engineer in control project engineering.**		**04**
Ans.	**Role of Instrumentation engineer in Project engineering:**	**½ mark for each point(any eight points)**	

- designing and developing new control systems
- testing, maintaining and modifying existing systems
- analyzing data and presenting findings in written reports
- managing operations
- working collaboratively with design engineers, operation engineers, purchasers and other internal staff
- liaising with clients, suppliers, contractors and relevant authorities (e.g. the Nuclear Decommissioning Authority)
- project management within cost and time constrained environments
- understanding and ensuring compliance with relevant health and safety regulations and quality standards
- providing advice and consultancy support
- purchasing equipment

	• writing computer software and test procedures • Developing new business proposals.		
b)	**Attempt any ONE of the following**		**06**
(i)	**State the need of valve positioned in control valve. List the types of valve positioners.**		**06**
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 end 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. 8. Large varying fluid pressures. 9. It can modify valve characteristics. **Types of Valve Positioners**: 1) Electro-pneumatic Force balances positioner. 2) The motion-balance Positioner. 3) Force balance positioner 4) Digital to pneumatic valve positioner	**04 Marks for need** **02 marks for types**	
(ii)	**List the different communication methods in DCS. Explain any one in detail.**		**06**
Ans.	**Different communication methods of DCS are** 1) MODBUS 2) PROFIBUS 3) ControlNet 4) Ethernet **1) MODBUS :** ▪ MODBUS is a serial communications, application-layer protocol based on client/server or request/reply architecture for process control systems. It was published by Modicon (now Schneider Electric) in 1979. ▪ Modbus is used for Supervisory Control and Data Acquisition (SCADA) type network communication between devices. It is used to connect a supervisory computer with a remote terminal unit (RTU) in SCADA systems. ▪ The Modbus protocol follows a master and slave architecture where a master transmits a request to a slave	**02 Marks for List** **04 marks for explanation of any one method**	

and waits for the response. It provides up to 247 slaves for one master. Only the master initiates a transaction giving the master full control over the flow of information. For example a system that measures temperature and humidity and communicates the results to a computer.

- Here, transmission medium is not defined. The user can therefore choose between RS-232C, RS-422 or 20 mA current loops, all of which are suitable for the transmission rates which the protocol defines.
- Certain characteristics of the MODBUS protocol are fixed, such as frame format, frame sequences, handling of communications errors, and exception conditions and the functions performed. Other characteristics are user-selectable. These are transmission medium, transmission characteristics, and transmission mode (RTU or ASCII).

OR

2) **PROFIBUS:**
- The Process *Fieldbus,* PROFIBUS, is a German standard.
- PROFIBUS specifies Layers 1, 2, and 7 in accordance with the OSI model.
- It provides high-performance communications sys-tem for simple, inexpensive equipment.
- Its functionality and data transfer capabilities ensure transparency to higher network levels.
- Communication with simple field instrumentation with immediate response, master-slave access with central polling and broadcast messages
- PROFIBUS uses a hybrid access method combining a centralized master-slave system with decentralized token passing.
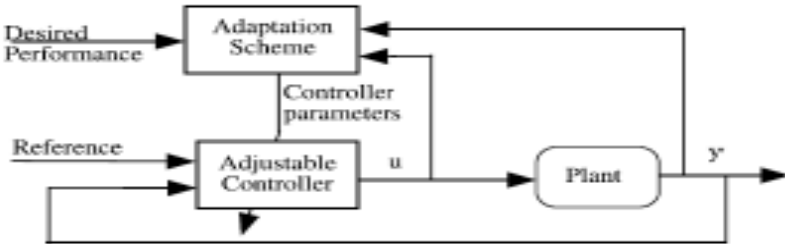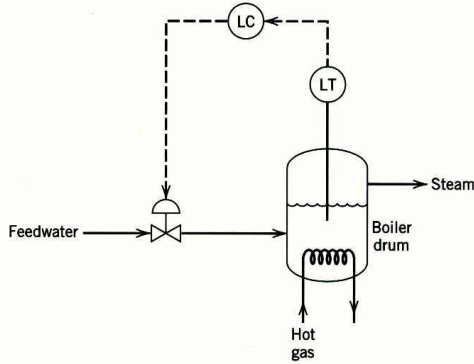
OR

3) **ControlNet :**
- ControlNet is an open industrial control network protocol for real-time industrial automation applications.
- ControlNet is a member of the CIP (Common Industrial Protocol) network family.
- ControlNet has good real-time capabilities providing high-speed deterministic transmission for time-critical I/O data and messaging data.
- ControlNet is highly deterministic (the ability to reliably predict when data will be delivered) and repeatable (ensures that transmit times are constant and unaffected by devices connecting to, or leaving, the network) and thus

	meets critical requirements for synchronized and coordinated real-time motion control applications. ▪ ControlNet was developed by Rockwell Automation and today, it is managed by the ControlNet International User organization. ▪ ControlNet products are certified by the ControlNet International user organization, guaranteeing worldwide compatibility ▪ It has the built-in support for fully redundant cables,and communication on ControlNet can be strictly scheduled and highly deterministic. These are its features. ▪ ControlNet is standardized in the European standard series EN 50170. It uses coax cables and a transmission speed of 5 Mbit/s. The Media Access method allows multiple controllers to control I/O on the same wire. **OR** **4) Ethernet:** ▪ Ethernet is the most widely-installed local area network (LAN) technology. ▪ It is specified in IEEE 802.3 standard. ▪ Ethernet was originally developed by Xerox from an earlier specification called Alohanet (for the Palo Alto Research Center Aloha network) and then developed further by Xerox, DEC, and Intel in 1976. ▪ An Ethernet LAN typically uses coaxial cable or special grades of twisted pair wires to connect the devices. ▪ Ethernet is also used in wireless LANs. ▪ The most commonly installed Ethernet systems are called 10BASE-T ▪ It provides transmission speeds up to 10 Mbps. ▪ It uses a Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol to handle simultaneous demands. ▪ Ethernet uses a bus or star topology.		
5	**Attempt any TWO of the following**		**16**
a)(i)	**Explain adaptive control scheme with the help of suitable diagram.**		**04**
Ans.	In Adaptive control, the parameters are automatically adjusted to meet the corresponding variation in the parameters of the process being controlled in order to get the desired response of the control loop. Unlike the conventional control system where the parameters are fixed and outputs are variable, in adaptive control system, the	**02 marks-Explanation**	

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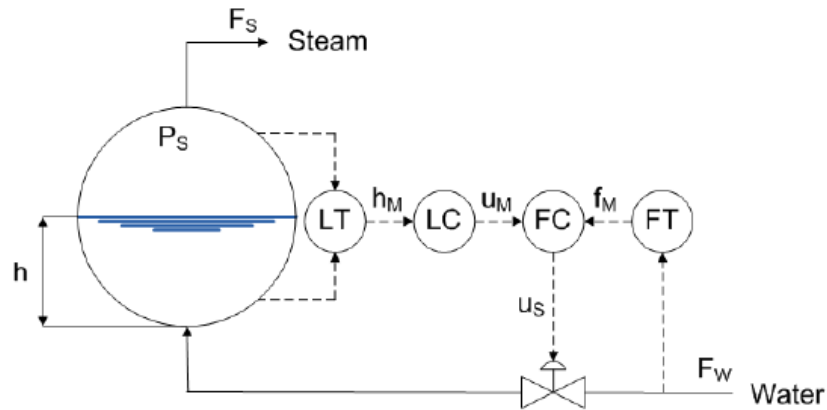|			
	parameters re adjusted. In the diagram shown below, a closed loop controller is shown whose parameters can be changed to change the response of the system. The output of the system is compared to the desired performance and based on this error, the controller parameters are adjusted. 	**02 marks-Diagram**	
(ii)	**Explain the selection criteria for a control valve**		**04**
Ans.	**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.	**01 mark each** **(Any four point)**	
b)	**Draw P and ID for one element, two element and three element boiler control. Prepare the list of IO and instrument index sheet for the same.**		**08**
Ans	One element boiler control: P&I Diagram:	**02 marks for each Diagram**	

Two-element boiler control:
P&I Diagram:

Three element boiler control:
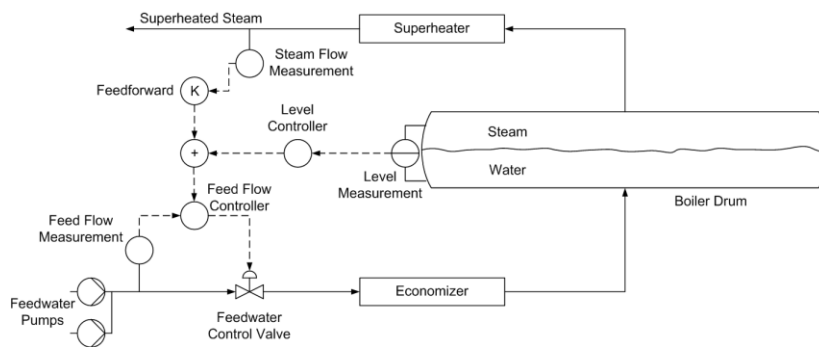
Instrument index sheet:
1) **Single Element**

Tag no	Type of instrument	Location
LT 100	Level transmitter	field
LC 100	Level controller	field

02 marks for instrument index sheet

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2) **Two Element**

Tag no	Type of instrument	Location
LT 101	Level transmitter	field
LC 101	Level controller	field
FT 102	Flow transmitter	field
FC 102	Flow controller	field

3) **Three Element**

Tag no	Type of instrument	Location
LT 103	Level transmitter	field
LC 103	Level controller	field
FT 104	Flow transmitter	field
FC 104	Flow controller	Field
FT 105	Flow transmitter	field
FC 105	Flow controller	Field

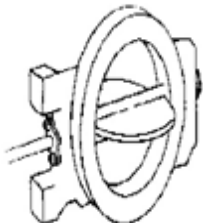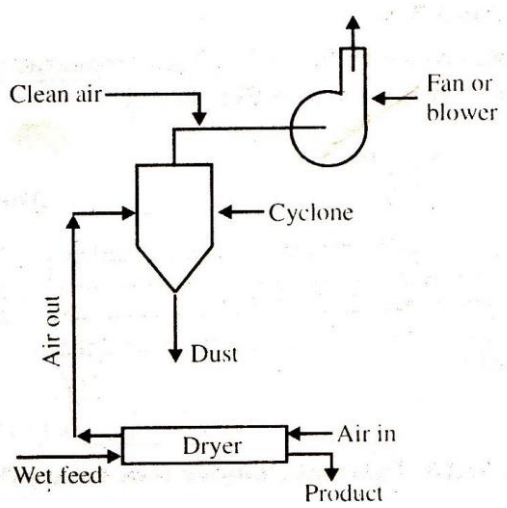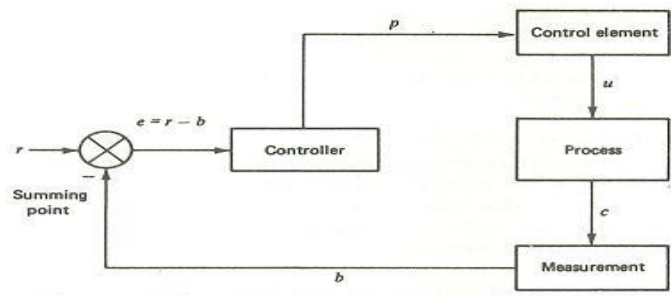| c)	**Draw the architecture of DCS .Explain the function of each block.**		08
Ans.	(Any other relevant diagram can be considered) **1. Input-output module:** All these modules are mounted in a single or multirack system connected on common communication highway. I/O module scan and digitize the process in simple logic. It provides the main interface between DCS and process being controlled. They convert the information provided by process instruments into digital form.	**02 marks - Diagram** **06 marks for explanation**	
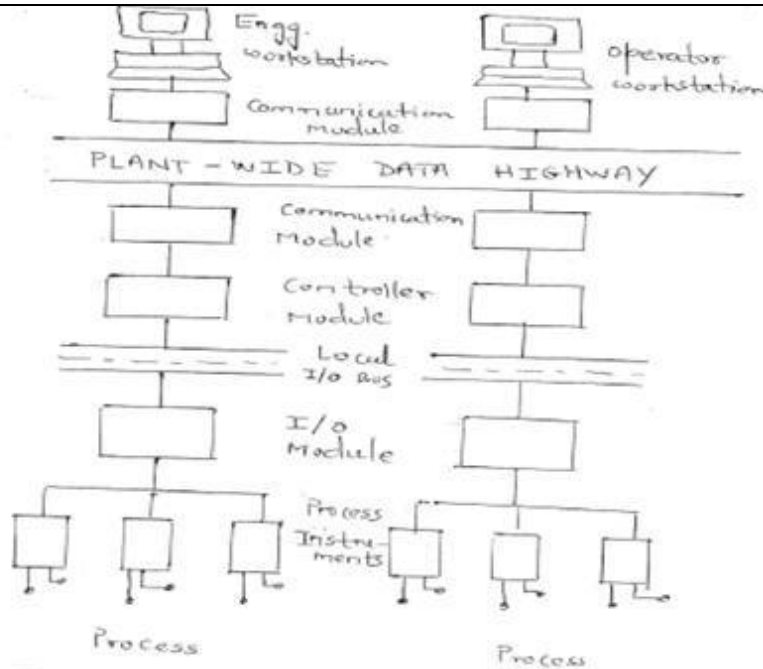
They also provide signal filtering.

2. Local i/o bus:
It provides bridge between I/O and controller module and is restricted in terms of geographical area and data loading. It operates at slower speed than the plant wide data highway communication.

3. Controller module:
It is the brain of the DCS. It updates field data from I/O module and performs control calculation and logic to make the process changes. It also consists of memory, registers and buses, CPU, ROM and RAM. Hence it is microprocessor based device.

4. Communication module:
It provides communication between data highway and other modules such as controller module and user interfaces. Communication module manages the flow of information between the data highway, controller module and user interface

5. Data highway:
The data highway is the communication device that allows distribution of the controlling function throughout a large plant area. It is the digital data link that connects the multifunction controllers with the central operator stations. Data highway is microprocessor based module through which the messages and files are transferred. The medium can be coaxial cable or the fiber glass cable.

6. User interface:
It provides the interface between user and process. It can either operator interface or engineer interface.

- Operator Station:- it performs:
1) From operator station, operator can view entire plant/process and can control the process.
2) Controlling the complete process (regulatory and supervisory control); allows configuration of all inputs
3) Alarm display setting.

- Engineer Station:- it performs following functions:
1) system design and generation of system loop diagram
2) documentation
3) programming system maintenance

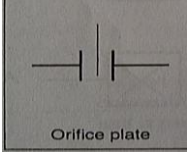| 6	Attempt any FOUR of the following		16
a)	**List different process display. State the function of any two displays.**		**04**
Ans	**Types of process displays:** 1.Group display, 2.Overview display, 3.Detail display, 4.Graphic display, 5. Trend display.	**02 marks for types.**	
	i) **Group display:** 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	**01 marks for each display (any two display)**	
b)	**Explain the construction and working of butterfly valve.**		**04**
Ans	• In this valve, the plug is in the form of a disc. The "butterfly" is the metal disc mounted on a rod. The disc is positioned in the center of the pipe.A rod connected to an actuator on the outside of the valve is passing through the disc. Rotating the actuator turns the disc either parallel or perpendicular to the flow. • The disc is always present within the flow, therefore a pressure drop is always induced in the flow, regardless of valve position.	**03 marks for Explanation**	

	• A butterfly valve is from a family of valves called quarter-turn valves. In operation, the valve is fully open or closed when the disc is rotated a quarter turn. When the valve is closed, the disc is turned so that it completely blocks off the passageway. When the valve is fully open, the disc is rotated a quarter turn for the passage of the fluid. • Butterfly valves are less costly and lighter in weight, therefore less support is required. It is used for isolating or regulating flow. **Diagram:** 	**01 mark for diagram**	
c)	**What is drying? Explain the operation of drum dryer with the help of neat diagram.**		04
Ans.	• Drying is the process of the removal of liquids, such as water or other solvents, by adding heat to vaporize them. The dryer is used to get dry solids by removing the liquid from a wet material **Drum Dryers:** • The drum dryer is made up of a large, rotating cylindrical tube, usually supported by concrete columns or steel beams. • The dryer slopes slightly so that the discharge end is lower than the material feed end in order to convey the material through the dryer under gravity. • Material to be dried enters the dryer, and as the dryer rotates, the material is lifted up by a series of internal fins lining the inner wall of the dryer. • When the material gets high enough to roll back off the fins, it falls back down to the bottom of the dryer, passing	**01 mark for definition** **02 marks for Explanation**	

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	through the hot gas stream as it falls. **(Any other relevant diagram can be considered)**	**01 mark for Diagram**	
d)	**Draw the block diagram of process control system and explain the role of each block.**		**04**
Ans.	**Functions:** 1) Controller: It is the brain of the control system that takes decision to maintain the process variable to its desired value. Mostly the summing point is also an integral part of the controller. The summing point outputs an error signal ($e = r - b$) to the controller, from the reference input(r) and set point (b). 2) Final control element: These are designed to take action for implementing the decision taken by the controller. Signal generated by the controller (p) is transmitted to the final control element situated in the field connected to the process/plant. 3) Measurement: for measuring process variable transducer is used which convert non electrical parameter into	**02 marks for Diagram** **02 marks for Explanation**	

	electrical parameter. 4) Process: In process different operations are carried out and measurement and controlling of process parameters are actually carried out with the help of transducer and controller.		
e)	**Draw P and ID symbol for:** **i) Pressure transmitter** **ii) Ball valve** **iii) Orifice meter** **iv) Solenoid valve**		**04**
Ans.	i) (PT) iii) Orifice plate ii) (ball valve symbol) iv) (solenoid valve symbol with S)	**01 mark for each symbol**	