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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.1	**Attempt any five of the following.**		20
a)	**Define process automation. State its benefits.**		**04**

Ans.	**Process Automation:**
	
	 The technology that can control all the industrial processes without manual operation is called "Process Automation".
	
	 OR
	
	 Process Automation is the use of Automatic or robotic devices to complete given manufacturing task.
	
	 (Any other appropriate definition can also be considered)
	
	 Benefits:
	 Process automation provides following benefits-
	      a) Increased productivity,
	      b) Improved product quality and accuracy,
	      c) Reduced manpower,
	      d) Reduction in personal injury and accidents,
	      e) Reduction in the cost of product,
	      f) Increased safety,
	      g) Increased Profit.
		01 mark for Definition
		
		 any six ½ mark each total 3M	

b)	**Compare any two internationally recognized process automation systems in detail.(four points)**		**04**

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| Ans. | | | | Comparison (1 Mark for each point) | |

Sr.No.	Honeywell PAS	Yokogawa PAS
1	For mega plants especially oil and gas , Honeywell EPKS is a reliable solution	Yokogawa centum CS automation system is generally preferred for comparatively smaller plant.
2	In Honeywell EPKS automation system control modules can be independently loaded	Here independent module loading require reconfiguration of entire system.
3	Online download is possible for Honeywell EPKS	Online download is not available for Yokogawa centum CS system.
4	Security features of Honeywell PAS are most reliable.	Security features are moderately reliable
5	More user friendly GUI (HMI) programming.	GUI programming is little bit complex and required very experience person.
6	Honeywell EPKS system is more flexible	This is Less flexible.

(Comparison between Emerson's DeltaV DCS, Invensys DCS, ABB800xA, Allen Bradley Plant PAX can also be considered)

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c)	Compare proprietary and open network.(Any 4 points)				04

Ans.	Sr. No.	Criteria	Proprietary protocol	Open protocol		
	01	Concept	A closed protocol is one that is proprietary and not open to communication other products without an interface or gateway.	An open protocol allows vendors' equipment to interoperate without the need for a proprietary interface or gateway.	**4 marks for any 4 points**	
	02	Cost	High cost	Low cost		
	03	Service	Service is greatest advantage of this network	Service is not available for this network from vendors		
	04	Security	More secure	Less secure		
	05	Availability	Available through respective companies that own the right	Different vendors are available		
	06	Reliable	More reliable	Less reliable		
	07	Example	DCS data highway	Foundation field bus		

d)	Describe how interfacing of final control element and DCS is achieved			04

Ans.	**Diagram for interfacing of Final control element with DCS:**		
		02 mark for relevant Diagram	

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	Explanation:		
	Above figure shows the diagram for interfacing of final control element FY 301 and DCS controller FIC301via TS 40, JB 40, JB 30 and I/P converter FY 301A. In which the operator/engineer sitting in DCS work station, program DCS for required connectivity.	**02 mark for relevant Explanatio n**	
	The loop diagrams show the detailed arrangement of instrumentation components in a loop. They are used during design, construction, start up, and maintenance. All devices, pneumatic and electronic, that carry the same loop number are generally shown on the same loop diagram. This makes the loop diagram an ideal tool for troubleshooting. At a minimum, the loop diagram will show the interconnection of the devices, their locations, their power sources, and their control actions.		
e)	**With suitable example, explain importance of graphic displays in process automation.**		04
Ans.	**Diagram:** **Explanation:** Graphic display allows a picture to be drawn on the screen so that the operator can look at a portion of the process more realistically than by watching a row of bar graphs. Above fig shows the example of graphic display representing a	**02 mark for diagram**	

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	fractionating column. Process and control information is included in the picture, and it can be interactive, dynamically changing as real time information changes. A pipeline, for example, can become filled with the color when a valve is opened, the symbol of the valve can change color,and its condition can be identified by a label that indicates "ON" or "OFF". Graphics are valuable training tools and help the operator relate to plant conditions when a number of variables are changing at one time. **(Similar example of graphic display can also be considered)**	**02 mark for explanation**	
f)	**For Ethernet network compare bus topology with star topology.(any four points)**		**04**
Ans.	<table><tr><th>Sr.No.</th><th>Bus Topology</th><th>Star Topology</th></tr><tr><td>1</td><td>In Bus topology Devices are connected with each other by wire (Network protocol cable) in approximately strait manner.</td><td>In Star topology every device is connected to a host controller (Computer) by a separate wire(network protocol cable).</td></tr><tr><td>2</td><td>Less wiring is required as compared to Star topology</td><td>Increased wiring is required in star topology since every device is connected by separate wire.</td></tr><tr><td>3</td><td>If anyone device stops working then whole network get affected.</td><td>If anyone device stops working it does not affects the whole network.</td></tr><tr><td>4</td><td>Bus topology network can be widely spread along the large area of plant.</td><td>Star topology network is generally limited to smaller area of devices.</td></tr></table>	**Comparison (1Mark each point)**	

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	5	**Physical connection diagram:**	**Physical connection diagram:**		
g)		**Explain the role of SCADA in the automation.**			**04**
Ans.		**Role of SCADA in Automation:** SCADA is an acronym that stands for Supervisory Control and Data Acquisition. Generally SCADA is a system that acquires (or collects) data (or signal) from various field devices at a factory, plant or in the remote locations and then sends this data to a master computer which then manages and controls the data and entire system. SCADA technology is suitable to the processes that are spread over large area (in several miles) using SCADA, such system become relatively simple to control and monitor and it reduces the frequent visits of an operator to remote locations. General SCADA system performs following functions: a) Data Acquisition b) System control, c) System monitoring, d) System Management.	**04 marks for explanation**	
Q.2		**Attempt any Two of the following.**			**16**
a)		**(i) Explain in brief ERP.** **(ii) Explain concept of intelligent motor control.**			**08**
Ans.		**1. ERP:** Enterprise resource planning (ERP) is a business management software that a company can use to collect , store , manage and interpret data from many business activities, including:			

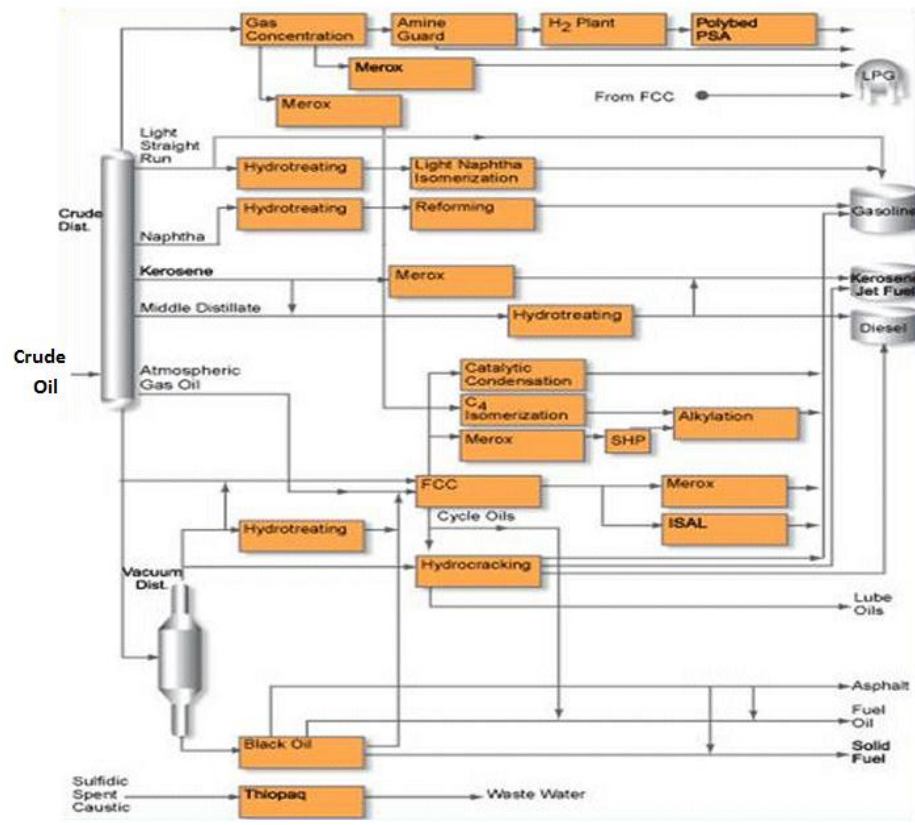|			
	a) Product planning, b) Manufacturing or service delivery, c) Marketing and sales, d) Inventory management, e) Shipping and payment. ERP provides an integrated view of core business processes, often in real time, using common database maintained by a database management system. ERP tracks business resources such as cash , raw material, production capacity and the status of business commitments. An ERP system covers the following common functional areas. In many ERP systems they are called as ERP Modules: a) Financial accounting, b) Management accounting, c) Human Resource, d) Manufacturing execution, e) Order Processing, f) Project Management, g) Customer relationship management. **2. Intelligent motor control:** An intelligent motor control (IMC) uses a microprocessor to control power electronic devices used for motor control. IMCs monitor the load on a motor an accordingly match motor torque to motor load. This is accomplished by reducing the voltage to the AC terminals and at the same time lowering the current and Kvar. This can provide a measure of energy efficiency improvement for motors that runs under light load for a large part of time , resulting in less heat , noise and vibrations generated by the motors. Need of Intelligent Motor control in Process plant: 1) For monitoring the quality of incoming power to maximize the life of motor. 2) To monitor Motor operation , 3) Load and power consideration of motor, 4) Operating efficiency	**04 mark for Explanation of ERP** **04 mark for Explanation of intelligent motor control**	
b)	a) **State the use of following in Plans.** (i) **MES** (ii) **Historian**		08

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| Ans. | • **MES (Manufacturing Execution system):**

Manufacturing execution system (MES) are computerized systems used in manufacturing. MES can provide the right information at the time and shows the manufacturing decision makers how the present conditions on the plant floor can be optimized to improve production output.

Following are the uses (Core functions) of manufacturing execution system (MES):

   a) Accept the work orders through automatic or manual entry.
   b) Planning, scheduling and loading of each operation workstations.
   c) Inventory tracking and management.
   d) Material movement within the process plant,
   e) Data collection from various location.
   f) Exception management.

(Similar uses of MES can also be considered)

• **Historian:**
Historian refers to a database software application that logs or historizes time based process data. Historian software is used to record trends and historical information about industrial processes for future reference.
It captures and stores plant management information about production status, performance monitoring, quality assurance, tracking and genealogy, and product delivery with enhance data.

Following are the uses(functions) of Historian in process automation:

   a) Data collection from real time external system,
   b) Storage and archiving of very large volumes of data,
   c) Basic data limit monitoring (alarms) and user prompt massages.
   d) Performing read and writes operation.
     (Similar uses of Historian can also be considered) | **04 mark for Explanation of MES**

04 mark for Explanation of Historian | |

c)	a) **What do mean by continuous process plants? Develop and Explain the architecture refinery plant in detail.**		08
Ans.	**Definition of continuous process plant:** Continuous process plant is plant which is designed to produce continuous outflow of material. Example- Production of electricity, Production of chemical etc. **Development of architecture for refinery Plant:** Crude oil is a multicomponent mixture consisting of more than 108 compounds. Petroleum refining refers to the separation as well as reactive processes to yield various valuable products. Therefore, a key issue in the petroleum refining is to deal with multicomponent feed stream and multicomponent product streams. **Architectural Overview of Refinery Plant:** Primary crude oil cuts in a typical refinery include gases, light/heavy naphtha, kerosene, light gas oil, heavy gas oil and residue. From these intermediate refinery product streams several final product streams such as fuel gas, liquefied petroleum gas (LPG), gasoline, jet fuel, kerosene, auto diesel, lubricants, bunker oil, asphalt and coke are obtained. The entire refinery technology involves careful manipulation of various feed properties using both chemical and physical changes. Conceptually, a process refinery can be viewed upon as a combination of both physical and chemical processes or unit operations and unit processes respectively. Typically, the dominant physical process in a refinery is the distillation process that enables the removal of lighter components from the heavier components. Other chemical processes such as alkylation and isomerisation are equally important in the refinery engineering as these processes enable the reactive transformation of various functional groups to desired functional groups in the product streams.	**01 mark for Definition** **03 marks for oil refinery architectural explanation**	

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	General Block diagram of oil refinery architecture :		
		04 marks for relevant block diagram of oil refinery architecture	
Q.3	**Attempt any Two of the following.**		**16**
a)	**a) Explain Following in detail.** **i) Control Net ii) Ethernet**		**08**
Ans.	**Control Net:** - Control net is an open industrial network protocol for industrial automation applications. - Control Net was earlier supported by controlnet International, but in 2008 support and management of controlnet is transferred to ODVA. - Control Net communication protocol is defined by Allen Bradley in 1996. - It has am Maximum data transmission rate of 5 mbps. - In control net protocol supports maximum of 99 devices (Nodes) to a single network. - It supports master slave (Producer/ consumer) communication method.	**04 mark For Control Net**	

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	- The maximum permissible line length depend on transmission rate is 250 meter-1000 meters. - It uses co axial cable or fiber optics cable as a physical media for communication. **Ethernet:** - Ethernet is based on local area networking technology. - It requires twisted pair cable or fiber optics cable for communication. - It is an open communication protocol that permits connectivity of all levels of Plants hierarchy. - It supports various transmission speed between 10 to 100 Mbps. - The bus can communicate over a maximum distance of 100m and can be expanded using routers and switches. - Fiber optics Ethernet is used for communication over larger distances with high speed.	**04 mark for Ethernet**	
b)	b) **Write FBD program to control speed of motor for following conditions: 8M** i) **When start button is pressed it turn on the motor** ii) **When speed of motor increases above 1200 rpm motor will turn off automatically.**		**08**
Ans.	**Step I: Preparing Ladder diagram :** 	**4 mark for step 1**	

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	When start button is pressed internal relay is activated and latched. Latched internal relay turns ON the motor. When speed of motor goes beyond 1200rpm speed sensor is activated and opens the contact which turns OFF the motor. **Step II: Converting Ladder diagram into FBD program** Start button and internal relay is 'OR'ed through OR block , which is then 'AND'ed with stop button .Third AND block controls the motor ON-OFF condition when speed of Motor goes above 1200rpm speed sensor status become logic zero. And makes the output of AND block zero, which turns OFF motor.	**04 mark for step2**	
c)	**Develop Modular program for petrochemical continuous process plant and explain.**		**08**
Ans.	**Petrochemicals** are derived from various chemical compounds, mainly from hydrocarbons. These hydrocarbons are derived from crude oil and natural gas. Among the various fractions produced by distillation of crude oil, petroleum gases, naphtha, kerosene and gas oil are the main feed stocks for **petrochemical industry**. Since the process industries are being largely "continuous" processes. The world of process automation of such process industries is governed or run by operational procedures. But what is a procedure exactly? Procedures are nothing more than a predetermined set of tasks that must be completed in a set order and in a consistent manner every time to achieved a desired goal or end result. Startup, shutdown, and grade change are probably the most common.	**2 mark for operational procedures**	

Whether you are doing a startup, shutdown, grade change, or are in the middle of a maintenance turnaround, your plant is governed by procedures and transitional states that can either run smoothly and provide you with superior plant performance, a safe and orderly start-up/shutdown or they can cost you in terms of unplanned shutdowns, incidents, lost product, and lost opportunities.

Of course, procedures vary in terms of complexity and duration, and requirements for plant procedures vary for each industry, but the common fact remains that plants cannot operate without them.

Petrochemical continuous process plant
Startup
Shutdown
Grade Changes
Switchover
Transition management

2 mark for major operational steps(any four)

1. Startup

Safe and efficient startup of **Petrochemical plant** is critical to its overall operation. Startup frequency can vary, from once every day to once every five years. If startups occur often, they can occur on different shifts, and the time and skill of the operator on duty can determine the efficiency of the startup. If startups occur at longer intervals, companies run the risk of not having experienced personnel available to run and oversee the startup. There have been cases where companies have had to bring operators out of retirement to restart a unit   after   a   shutdown.

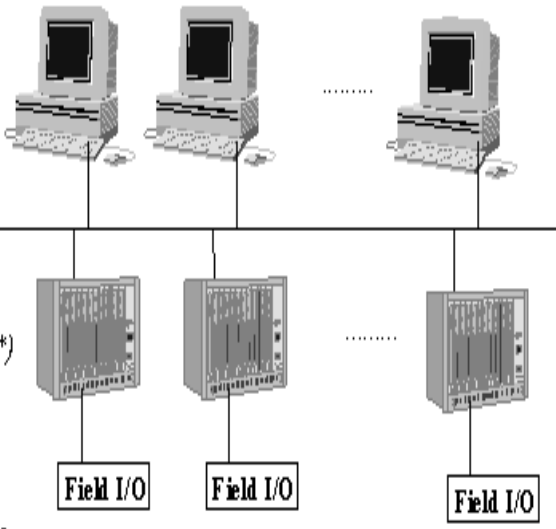**4 mark for major operational steps explanation**

2. Shutdown

Orderly and safe shutdown of **Petrochemical plant** is just as critical as a startup. One key item in the shutdown procedures is recognising that a shutdown might not be scheduled. System problems or severe weather such as approaching hurricanes can require a shutdown of

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	distillation operations at very short notice. As with startups, on-shift operating personnel might not have the most experience in shutting down a system. **3. & 4. Feedstock and product output transitions** Many chemical processing units regularly operate at more than one optimum steady state. Transitions inherently increase the risk of disruptions that can lead to incidents. With distillation operations consuming a large amount of the energy requirements in a refining or petrochemical application, efficient production is a key to meeting product specifications and producing the best possible yields of valuable products. Performing procedural operations in an inefficient or time-consuming manner will have a significant economic impact on the complete operation.		
Q.4	**Attempt any Two of the following.**		**16**
a)	**Draw and Explain Schematic of PC work station and servers in detail.**		**08**
Ans.	**Schematic diagram:** 	**04 mark for diagram**	

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	Explanation: **PC base workstation:** A workstation is a personal computer that is used for high end applications such as graphic design, video editing, CAD, 3-D design, or other CPU and RAM intensive programs. A workstation typically has a top of the line, fast processor, multiple hard drives, and a lot of RAM memory. A workstation may also have special audio, video, or processing cards for special editing work. A workstation is marketed by computer manufacturers to professional users, while the server is more of a utility device. **Server:** A server is an application or device that performs service for connected clients as part of client server architecture. It can also be a computer system that has been designated for running a specific server application. A server can also serve applications to users on an intranet.	**04 mark for explanation**	
b)	**With suitable diagram describe HOT standby architecture in detail.**		**08**
Ans.	**Diagram:** 	**04 mark for diagram**	

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	Explanation: During any critical application, it is very important that system should work reliably and should have continuous control of process, even though there is a failure of processor, or power supply due to ant reason. To achieve this, there must be standby processor or power supply with the system. This feature of system is called as "Redundancy". Redundancy means extra system components added or kept standby to avoid the chance of total system failure. Redundancy is of two types- 　　a) Hot standby 　　b) Cold standby Hot standby is a redundancy method in which one system runs simultaneously with an identical primary system. Upon failure of primary system, the Hot standby immediately takes over, replacing the primary system. However, Data is stilled mirrored in real time. Thus both the system has identical data. Hot standby is also known as Hot Spare. The general architecture of Hot standby redundancy is shown in above fig.	**04 mark for explanation**	
c)	**Write SFC (Sequential flow charts) program for Temperature control loop system for following conditions.** 　　**i)** **System is used for measurement and control in the range +275 C to + 300 C.** 　　**ii)** **If temperature goes below +275 C, Heater will be ON and FAN will be ON.** 　　**iii)** **If temperature goes above +300 C, Heater will be OFF and FAN will be ON.** 　　**iv)** **Use separate ON/OFF switches for overall system.**		**08**

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Ans.	**Step I: Preparing Ladder diagram:**		
		04 mark for step 1	

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	Step II: Preparing SFC program: 	**04 mark for step 2**	
Q.5	**Attempt any Two of the following.**		**16**
a)	**i) State any four Applications of Automation.** **ii) State Role of PLC and DCS in Automation.**		**08**

Ans.	**Application areas of Automation:**
	Practically, automation is applicable in every area of manufacturing industries. Some of the applications areas are given below. **However other similar applications can be considered.**
	
	1) Building Automation: automation required in building to –
	    i) Control of automatic lifts
	    ii) To control automatic fire equipment's like water sprinklers, smoke detector etc.
	    iii) To control automatic centralized air conditioning system.
		01 Mark each application any four application	

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2) Robotics :
  i)   To control the motion of the Robot or its arm (i.e. up-down or forward backward)
  ii)   To control direction of Robot.
  iii) To control the gripper of the robot to control to pick and place the objects.

3) Infrastructure:
  i)   Control of heavy vehicles which are required to construct roads, subways etc.
  ii)   Transport and installation of heavy concrete blocks for bridges, tunnels etc.

4) Aerospace:
  i)   To locate and control the position of aircraft. i. e. Air traffic control.
  ii)   Loading, Unloading, scanning of passenger goods.
  iii) To observe climatic condition and to make proper communication between air craft and control room.

5) Railways:
  i)   Control of signaling system to avoid accidents.
  ii)   Control the automatic track changing system.
  iii) Automatic opening and closing of railway doors.

6) Automobiles:
  i)   Assembling of various parts together automatically.
  ii)   Adjusting the color combination and painting the vehicle.
  iii) Transportation of assembled vehicles from one section to other section of manufacturing unit.

7) Telecom:
  i)   Proper communication between satellite and receiver.
  ii)   Wireless communication between two mobile telephone set.
  iii) Teleconferencing service.

8) Medical:
  i)   Medical surgery through robot.
  ii)   Scanning of internal parts of human body through automatic scanning methods like CT, MRI, PET scanning.

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9) Process industries:
 	
    i)   To control various parameters such as temp, liquid level, flow, pressure, humidity automatically.
    ii)   To control various batch processes.
    iii)   Transportation, assembling, packaging of various products.
 	
Role of PLC:
 	
PLC pays very important role in automation; in fact PLC is the tool that provides the control for automatic processes. In many automatic processes, PLC work as a central control system PLC based systems use software programming instead of hard wires to the control the input and output devices.
Programmable logic controller is a solid state electronic device designed in the early 1970s to replace electromechanical relays, mechanical timers, counters and sequencers.
Use of PLC offers the following advantages compared with electromechanical relays-
 	
    i)   Ease of programming and reprogramming
    ii)   Easy troubleshooting and diagnostics
    iii)   In built software timers, counters, relays etc.
    iv)   Quickly change over from one product to another
    v)   Provides quick status of inputs, outputs, timers, counters etc.
 	
Role of DCS:
 	
The distributed control system (DCS) is the dominant form of instrumentation used for industrial process control. A DCS is installed in two different work areas of process. In DCS the process operation is located in central control room from this location the operator can view information transmitted from the processing area and displayed on LCD screens and change control conditions from a keyboard and mouse.
 	
Use of DCS offers following benefits in process industries –
 	
    i)   Reduced installation cost
    ii)   Less wiring required.
	02 marks for role of PLC
	
	02 marks for role of DCS

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	iii) Panel space is reduced. iv) Allows inter controller communication. v) Real time Process control. vi) Provision of redundancy. vii) Optimum utilization of available manpower.			
b)	**i) Describe intelligent transmitter and Buses.** **ii) State features of Mod bus (any four points.)**			**08**

Ans.	**Intelligent Transmitter:**
	
	Intelligent transmitters are the transmitters used in modern industrial process plants for transmission of process parameters form field to central control room. They are much beyond SMART transmitters since they have many inbuilt features such as-
	
	    i) Remote and digital communication facility is inbuilt in Intelligent transmitters
	    ii) Intelligent transmitters can provide process data beyond process value.
	    iii) Self diagnostics and remote diagnostic is possible with intelligent transmitters.
	    iv) Remote calibration as well as configuration is possible.
	    v) They are capable of communicating different devices at the same time.
	    vi) Intelligent transmitters can be directly integrated with plants IT system.
	    vii) High speed and real time data transfer from field to control room is possible.
	    viii) Today's intelligent transmitters come with inbuilt security features.
	
	Communication Buses:
	
	In DCS communication is required to be established between widely spread field devices and central control system (DCS controller). This communication uses co axial, optical fiber or copper cables. But DCS system do not communicate with just simple electrical signal , In DCS data is encoded in protocol format which are available in two types
		02 marks for Intelligent Transmitter
		
		02 marks for Communication Buses	

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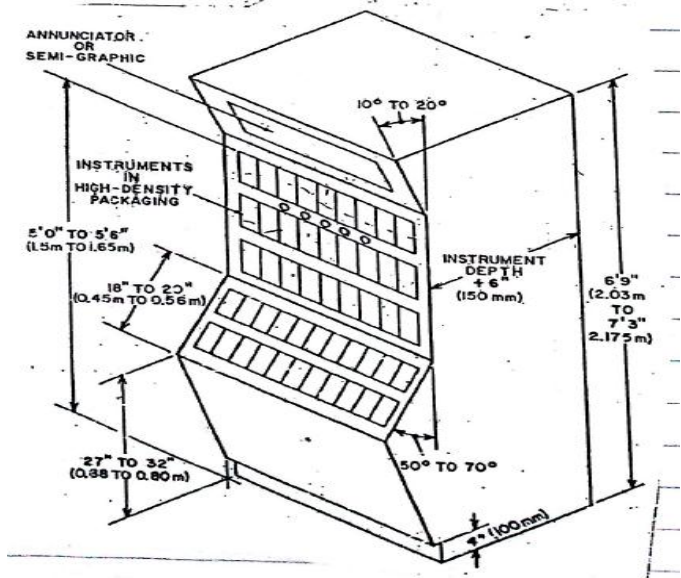|		

i)   Open Protocol buses:
      a) Modbus –RTU
      b) Modbus –ASCII
      c) Profibus
      d) Foundation field bus
      e) CAN Open
      f)   Controlnet
      g) Devicenet
ii)   Proprietary Buses:
      a) Allen Bradley –DF1 –Ethernet IP
      b) Siemens S7
 	
ii)Features of mod bus
 	
Modbus (Modicon Bus) is a serial communication protocol published by Modicon in 1979 for use with its programmable logic controllers (PLCs). It is simple and robust industrial communication protocol. The features of MODBUS are listed below:
 	
i)   Modbus is Open protocol and it is royalty free.
ii)   It allows communication between approximately 247 devices when connected to same network without repeaters.
iii)   It supports transmission speed between 9.6kbps to 19.2kbps
iv)   The bus can communicate over a maximum distance of 1300 meters and can be expanded using routers and switches.
v)   It supports master slave communication method.
vi)   Modbus uses double shielded twisted pair wire as physical media for communication.
vii) Can be connected in Linear , Star ,Tree or Daisy chain network topology.
viii) Modbus communication protocol is available in three types- Modbus ASCII, Modbus RTU and Modbus Ethernet.
 	
(Any other similar features can be considered)
	1 Mark each features total 4Mark	

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c)	**List different local operator station used in safe and hazardous area. Explain any one in detail.**		**08**

Ans.	**Local operator stations are divided into following three types:**
	
	1) Straight or flat face panel
	2) Break front panel or stand up console.
	3) Operators console.
	
	1) Straight or flat face operator panel:
	    Diagram:
	
	Explanation:
	
	    It is the least expensive, easy to construct and simple to design operator panel. The straight and vertical plane of the panel allows an orderly layout and tubing, electrical duct work and miscellaneous equipments. Instruments can be arranged so that all are accessible for maintenance and calibration.
	    The lower row of instruments should be used for recording and indicating instruments. The middle row is used for controlling instruments. And the upper row should be used for alarms.
		02 mark for listing types
		
		Explanation of any one type 3M diagram and 3M explanation	

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2) Break front Operator Panels:
Diagram:

Explanation:
Break front panel allows greater use of the front panel of the board, because the instruments located in the lower rows are swung upward to a convenient height as shown in fig.

The top portion of the Panel is swung down word to an angle normal to the line of sight allowing better visibility. The higher instrument density significantly reduces the space for maintenance and for mounting of auxiliary components in the back of the panel.

3) Operators Console:
Diagram:
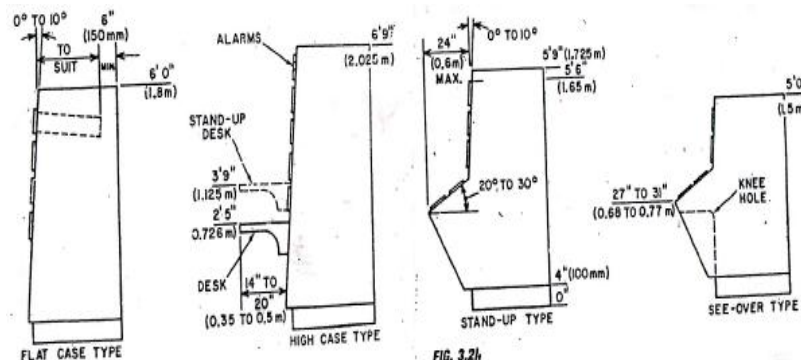
FIG. 3.2h
Variations of console shapes.

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	Explanation: Operator console is a panel containing a set of controls. It is defined as a panel or desk on which dials switches and other apparatus are mounted which are used in centrally controlling devices. Consoles are often used with high density instrumentation in control rooms that are limited in size. That one console per operator or one operator per console. Different shapes of operator consoles are shown in above figure.		
Q.6	**Attempt any Two of the following.**		**16**
a)	**Draw generalized block diagram of distributed control system (DCS). State function of each block.**		**08**

Ans.	**Block Diagram:**
	
	Explanation of each block
	    1) Engineering work station (EWS): functions of EWS are-
	         - Development of Project
	         - Configuration of Graphics.
	         - Configuration of Alarms, logic and trends for entire project.
		04 mark for relevant diagram	

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	- Providing security to process plant.
	- Documentation.
	- System maintenance.
	2) Operator workstation (OWS): functions of OWS are-
	    - It provide the operator interface including color graphics, faceplates, alarms, data logging and trends etc.
	    - From operator station, operator can view of process plant as well as can control the process.
	    - Diagnostics and troubleshooting of process problems.
	3) Historian:
	    It stores and retrieves historical data collected by the field control units such as PLC, SDS or any other intelligent device in the system.
	4) Controllers:
	    They are generally called as field control units (FCUs). They are generally PLC or similar types of controllers. A controller executes sequential and regulatory logic and directly scans I/Os.
	5) Networking and communication:
	    DCS supports redundant and non redundant fiber optics and Ethernet local network using the TCP/IP networking protocol for standardized, advanced applications.
		1 Mark each. any four blocks for 04 mark	

b)	**i) State any four remote input devices and four remote output devices used in hazardous area.** **ii) State their features**		**08**
Ans.	**Remote input devices:** 1) Low current Proximity sensors, 2) Pneumatic flapper nozzle, 3) RTDs, 4) Thermocouples, 5) Pyrometer sensors, 6) Push button switches, 7) Infrared sensors, 8) Potentiometers.	**Any four can be considered – ½ Mark each total 2Mark**	

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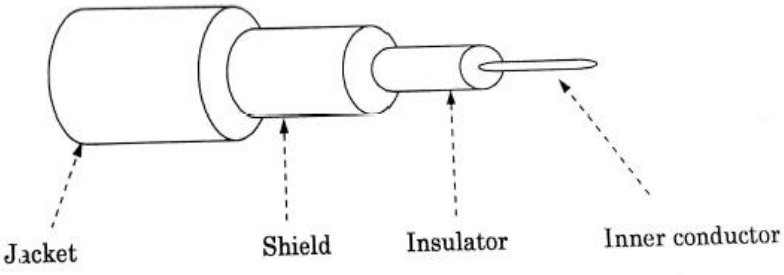|		

Remote Output Devices:
 	
  1) Pneumatic control Valve,
  2) Pneumatic pistons,
  3) Low voltage indicating lamps,
  4) TTL output devices,
  5) Motors,
  6) Variable frequency drives (VFDs)
  7) Pneumatic signal splitters,
  8) Light dimmers.
 	
(Input and output devices other than above list can also be considered)
 	
(ii) State their features.
 	
Features of Input and Output devices used in hazardous area are:
 	
1. Equipments are designed as per the class, group and zone of hazardous location. The equipment category indicates the level of protection offered by the equipment.
   • Category 1 equipment may be used in zone 0, zone 1 or zone 2 areas.
   • Category 2 equipment may be used in zone 1 or zone 2 areas.
   • Category 3 equipment may only be used in zone 2 areas
2. Devices used in hazardous area are labeled with the equipment protection level (EPL) .
3. Devices used in Hazardous Area are labeled with their temperature classification. The temperature classification on the electrical equipment label will be one of the following (in <u>degree Celsius</u>):
	Any four can be considered – ½ Mark each total 2Mark
	
	(1M each any four features total 4M)	

USA °C		International (IEC) °C	Germany °C Continuous - Short Time
T1 - 450	T3A - 180	T1 - 450	G1: 360 - 400
T2 - 300	T3B - 165	T2 - 300	G2: 240 - 270
T2A - 280	T3C - 160	T3 - 200	G3: 160 - 180
T2B - 260	T4 - 135	T4 - 135	G4: 110 - 125
T2C - 230	T4A - 120	T5 - 100	G5: 80 - 90
T2D - 215	T5 - 100	T6 - 85	
T3 - 200	T6 - 85		

4. To ensure safety in a given situation Devices used in hazardous area are placed into protection level categories according to manufacture method and suitability for different situations. Category 1 is the highest safety level and Category 3 the lowest.

(Similar features can also be considered)

| c) | (i) Draw and describe co axial network cabling.
(ii) State characteristics of
      1. **Copper network cabling**
      2. **Fiber optic cabling** | | 08 |

Ans.	**Diagram of Co axial cable:**		
		02 mark for diagram	

Jacket   Shield   Insulator   Inner conductor

Explanation:

It consists of Copper conductor covered by insulator made up of vinyl or polyethylene. Insulator is shielded and the insulating outer jacket isolates the shield from ground. This is Co-axial tube. Each co axial tube thus obtained is finally wrapped with two helically applied insulating paper tape. A co axial cable consists of 2, 4, 6 and 8 such co axial tube pairs together. The complete cable core is wrapped with two layers of paper tube and then lead sheath is applied. Fig above shows the cut section view of co axial cable. In which the inner conductor is made up of annealed copper. Insulator is made up of foamed polyethylene. An outer conductor of laminated aluminum tape . Jacket is made up of a Sheath of solid polyethylene or PVC.

02 mark for explanation

(ii) State characteristics of-

1) Copper network cabling

2) Fiber optic cabling.

any four ½ Mark each for 2Marks

1) **Characteristics of Copper network cabling :**
   a) Current carrying capacity is good.
   b) Copper cables are sufficiently flexible to withstand installation or the intended use and service without brittle and breaking.
   c) Copper cables generally provide very low resistance per unit length, so that the signal losses are low.
   d) Copper cables have impedance about 50 ohms to 70 ohms.
   e) Copper cable provides high tensile strength.

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	f) Copper cable has low thermal coefficient of expansion.
	g) Copper cable resists corrosion from moisture, humidity, industrial pollution, and other atmospheric influences.
	    (Similar characteristics can also be considered)
	2) **Characteristics Fiber optics cabling :**
	    a) The optical fiber is electrically non-conductive, so it does not act as an antenna to pick up electromagnetic signals, therefore less Immunity to electromagnetic interference.
	    b) Fiber optics cable provides Low attenuation loss over long distances.
	    c) Optical fibers do not conduct electricity, therefore preventing problems with ground loops .
	    d) Fiber optics cable provides wide bandwidth for signal transmission.
	    e) Optical fiber can be used to transmit power using a photovoltaic to convert the light into electricity.
	    f) Fiber optic cables provide superior quality transmissions in long distance communication.
	    (Similar characteristics can also be considered)
		Any four-½mark each for
		
		2Marks	