**IQRA National University, Peshawar**
**Department of Electrical Engineering**
**Spring 2020**
**Elective 5** (Power).
**Elective 4** (Electronics).
**Industrial Electronics**
*Terminal Examination*

**Name:** **FAWAD AHMAD**

**Reg.No:** **13204**

Instructor: Engr. Sanaullah Ahmad

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*Total Marks : 50*
*Attempt All Questions.*

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**Question No 1.** 10

A. Consider a lubricating oil tank in Industrial Plant having 2 sensors, one is put near to the bottom and one near to top, to fill the tank, motor A will pump oil to tank until the high level sensor turns on, at that point the motor A turns OFF. Motor A is turned ON when the level fall below the low level sensor. Explain the states of PLC operating cycle with help of neat ladder diagrams. **CLO-3**

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**Question No 2** 20

**A.** Write some benefits of Industrial Automation **CLO-2**
**B.** Briefly explain the components and functions of SCADA system **CLO-2**

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**Question No 3** 20

**A.** Differentiate between Hardwired control systems and PLC system **CLO-3**
**B.** What are the function of SCADA systems **CLO-2**

*.Good Luck.*

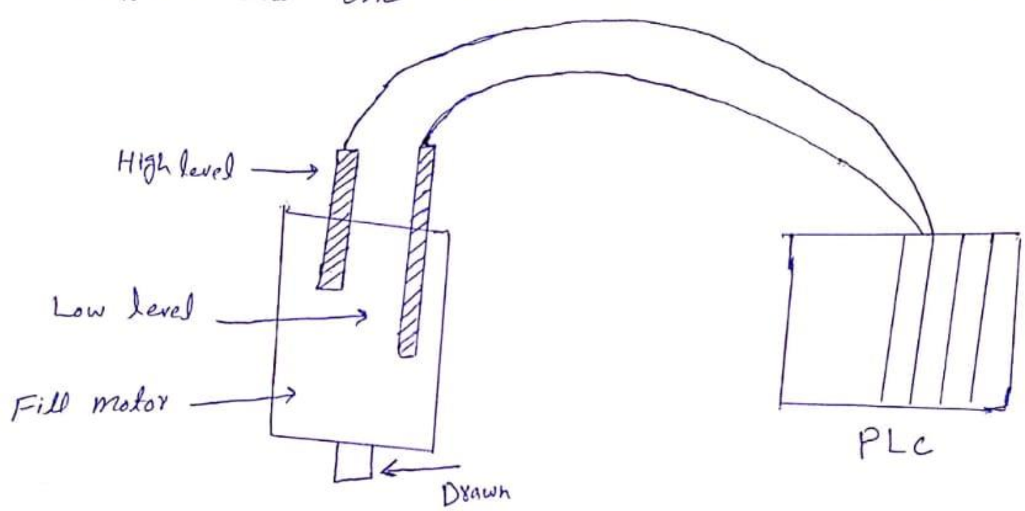
**Question: 1 (A)**:

Consider a lubricating oil tank in Industrial Plant having 2 sensors, one is put near to the bottom and one near to top, to fill the tank, motor A will pump oil to tank until the high level sensor turns on, at that point the motor A turns OFF. Motor A is turned ON when the level fall below the low level sensor. Explain the states of PLC operating cycle with help of neat ladder diagrams ?

**ANSWER**:

Answer :

Let us Consider the following application to Control lubricating oil being dispensed from a tank This is possible by two Sensors. one near the bottom and one near the Top as Shown below.




In this application we want to Fill motor to Pump lubricating oil into the tank until high level Sensor turns ON. At this point the motor is to be turned OFF. As the level falls below the low level Sensor. The Fill motor is again turned ON the Process is repeated.

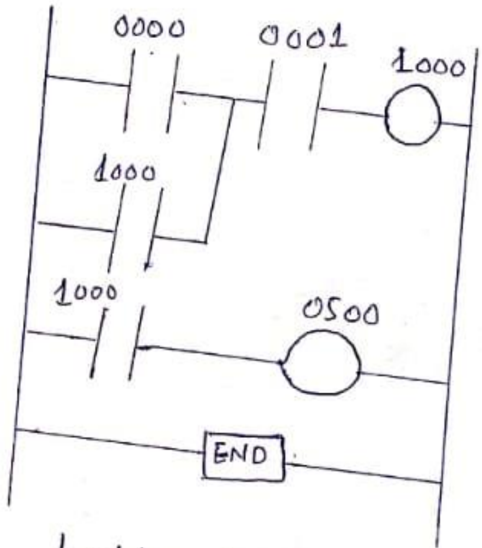
Here are three Input/Output devices are Needed two-inputs and one output (the Fill motor). Both of the input will be NC (Normally closed) fiber optic level Sensor when they are not immersed in liquid they will be ON but When immersed in liquid they will be OFF. Each input and output device is given an address. This will let the PLC know where they are Physicaly Connected. The addresses are Shown in Figur below.

| Input | Address |
|---|---|
| Low | 0000 |
| High | 0001 |

| Outputs | Address |
|---|---|
| motor | 0500 |

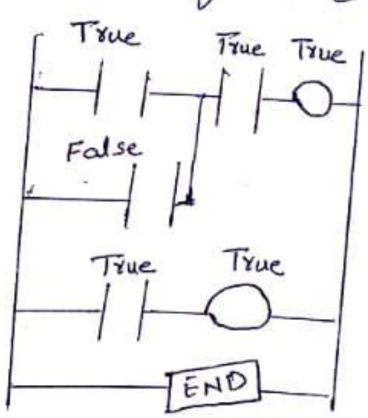
| Internal utility Relay |
|---|
| 1000 |

The Ladder Diagram for this application is Shown below Note that in this application an internal Relay is used. The Contact of these relays Can be used as many times are required. In this Case they are used twice to Simulate a relay with two sets of Contacts. These relays do not Physically exist in the Plc but rather they are bits in register that you Can use a Simulate relay.

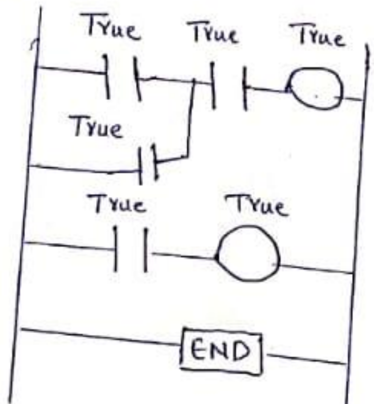



Ladder Diagram.

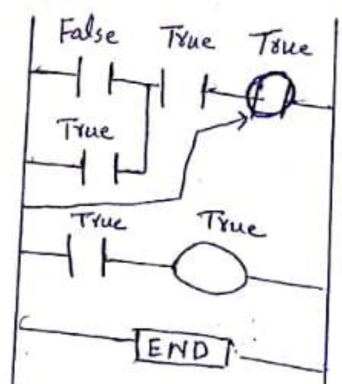
The Program Scan:



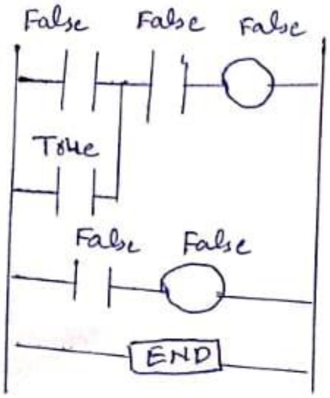

Initially the Tank is Empty. Therefor input 0000 is True and input 0001 is also True.




The internal relay is turned ON as the water level Rises.

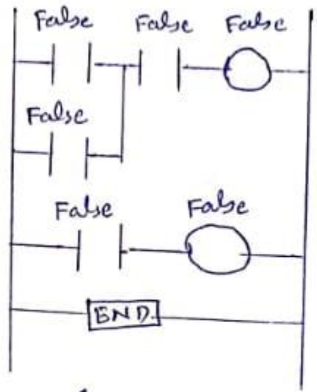



After Scan 2 the Oil level Rises Above the Low level Sensor and it becomes open (i-e FALSE)



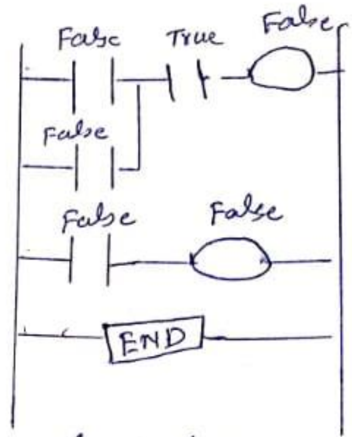

Scan 4

After Scan 4 the oil level rises Above the high level Sensor at it also become open (i-e False)




Scan 5

Since there is no more true logic path output 500 is longer energized (True) and therefor the motor turns off.




Scan 6

After Scan 6 the oil level falls below the high level Sensor and it will become true Again.

**QUESTION: 2 (A)**

Write some benefits of Industrial Automation ?

**ANSWER:**

## Benefits of An Industrial Automation System:

1. **Productivity**: These systems make automation possible for factories and industrial processes, allowing a **continuous mass production 24/7**. 24 hours a day, seven days a week, which improves productivity and reduces assembly times.

2. **Quality:** By means of adaptive control and monitoring in different stages and industrial processes, these systems are useful in **eliminating human error and thus improve the quality** and **homogeneity of the products** offered. The performance is not reduced after several hours of continuous work.

3. **Greater consistency**. Machines and computers work at a constant and continuous pace. Therefore, automated production processes have a **longer duration, stability and solidity** when managed with an automation system.

4. **Flexibility**. Implementing a new task in a traditional production chain involves hours or days of user training. On the other hand, with an automated system, reprogramming a robot or machine is a simple and fast process that provides **greater flexibility in the production process**.

5. **More precise information**. Automation of data collection **improves accuracy and reduces costs**. Such increased accuracy enables company managers to make better decisions.

6. **Safety.** It is **safer to use robots** on production lines with dangerous working conditions for humans. In the United States, the Occupational Safety and Health Act was passed in 1970 with the aim of improving job safety and protecting employees. Since its passage, it has promoted automation and robotics in the country's factories and the use of automation systems.

7. **Cost reduction**. Although the initial investment in industrial automation systems might be rather high, implementing this technology will translate into a **reduction of data analytics costs**. Furthermore, thanks to this automated data analysis, the risk of machine failure and service interruptions is reduced to a minimum.

8. **Improved working conditions**. Workers in a factory where an industrial automation system has been implemented work fewer hours and spend their time on high value-added tasks.

9. **Increased added value**. Automation systems free employees from having to perform tedious and routine functions. When the action of machines and computers frees employees from performing these functions, they can carry out **more v**alue-added tasks in other areas of the company that provide greater benefit.

10. **Improved human capacity**: The systems that companies implement to automate their services not only perform the tasks that a human being would do, but they are capable of performing functions that exceed the capabilities of a real person. They are **better in size, weight, speed and resistance**, among other characteristics.

**QUESTION: 2 (B)**

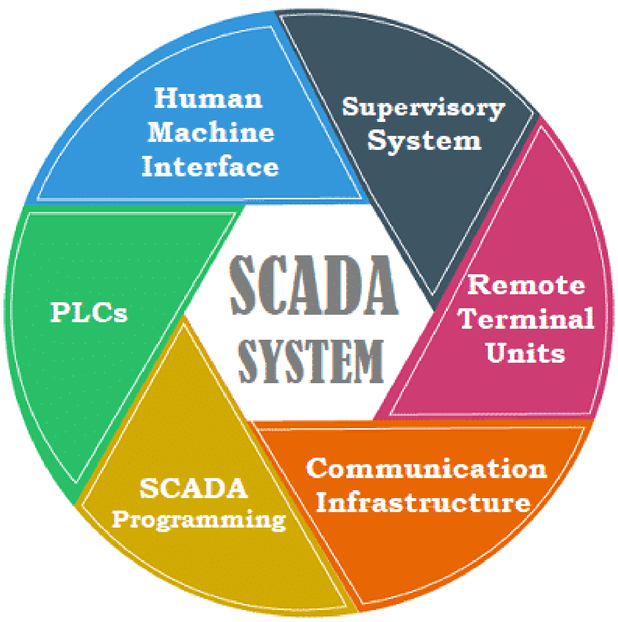
Briefly explain the components and functions of SCADA System?

**ANSWER:**

## Basic Components of SCADA System:

A basic SCADA system consists of following components:

1. Human Machine Interface
2. Supervisory System
3. Remote Terminal Units
4. Programmable Logic Controllers (PLCs)
5. Communication Infrastructure
6. SCADA Programming




1. **Human Machine Interface:**

It is an I/O device that allows a human operator to control the process data. This is achieved by linking SCADA's databases and software programs for providing management information like detailed schematics, scheduled maintenance, data diagnostics and logistic information. The operating personnel can also see the graphical representation of data.

2. **Supervisory System:**

This system acts as a communication server between the HMI software in control room workstations and its equipment like PLCs, RTUs, sensors etc.

Smaller Supervisory Control and Data Acquisition systems have only a single PC that serves as a supervisory or master system. Larger Supervisory Control and Data Acquisition systems have multiple servers, sites for disaster recovery and distributed software applications. The servers are configured as dual-redundant or hot-standby formation for continuously monitoring server failure.

3. **Remote Terminal Units:**

This system contains physical objects that are interfaced with Remote Terminal Units (RTUs). These electronic devices are controlled by microprocessors and are used for transmitting recorded data to the supervisory systems. They also receive data from the master system in order to control the connected objects.

4. **Programmable Logic Controllers:**

PLCs find their use in the Supervisory Control and Data Acquisition system through sensors. They are attached to the sensors in order to convert the sensor output signal into digital data.
They are preferred over RTUs because of their configuration, flexibility, affordability and versatility.

5. **Communication Infrastructure:**

Generally, a combination of direct wired connection and radio is used in Supervisory Control and Data Acquisition systems. However, SDH/ SONET can also be used for larger systems like railways and power stations.

Among the compact SCADA protocols, few recognized and standardized protocols deliver information only when the RTUs are polled by the supervisory station.

6. **SCADA Programming:**

SCADA programming in HMI or master station is used for creating diagrams and maps that provide vital information during process or event failure. Most of the commercial Supervisory Control and Data Acquisition systems use standardized interfaces in programming.

C language or derived programming language is generally used for such programming.

## Functions of SCADA

A SCADA system performs four functions:

- Data acquisition
- Networked data communication
- Data presentation
- Control

These functions are performed by four kinds of SCADA components :

1. **Sensors**: (either digital or analog) and control relays that directly interface with the managed system.

2. **Remote telemetry units (RTUs):** These are small computerized units deployed in the field at specific sites and locations. RTUs serve as local collection points for gathering reports from sensors and delivering commands to control relays.

3. **SCADA master units:** These are larger computer consoles that serve as the central processor for the SCADA system. Master units provide a human interface to the system and automatically regulate the managed system in response to sensor inputs.

4. **The communications network** : That connects the SCADA master unit to the RTUs in the field.

**QUESTION: 3 (A):**

Differentiate between Hardwired control systems and PLC system?

**ANSWER:**

## Hard-wired control systems:

In hard wired control systems, relays are used. For example: In Electrical-control, the wiring of control elements such as sensors, solenoids, counters etc. are through relays control. Such relay controlled systems are also called as hard-wired control system because any modification in control program involves rewiring of the circuit.

Therefore, hardwired controls are cumbersome and difficult to modify when production requirement changes regularly. Hard-wired control systems are difficult to maintain because any small problem in design could be a major problem in terms of tracing and rewiring.

Hard wired control systems consists of three division

**1. Input section –** Consists of push –buttons, switches and sensors. They transfer signals to the processing section

**2. Processing section** – Consists of relay coils and contacts. They determined the relationship between the inputs received and outputs required

**3. Output section –** Consists of solenoids, lamps, and contactor coils etc. The processed signals are transferred to this section.

## PLC Systems:

PLC systems offer number of advantages over hard wired electromechanical relay control systems. Unlike the electromechanical relays, PLCs are not hard-wired to perform specific functions. Thus, when system operation requirement change, a software program is readily changed instead of having to physically rewire relays.

In addition, PLCs are more reliable, faster in operation, smaller in size, and can be readily expanded.

PLC systems consists of three division

**1. Input section –** Consists of push –buttons, switches and sensors which are connected to specific input addresses in the program. They transfer address information to the processing section

**2. Processing section –** The microprocessor receives the input signals from input sections and executes the information (called instructions) in the software program and sends the processed signals to output section

**3. Output section –** Takes the signal from processing section and modify the signal from the processor to operate output devices connected to specific output addresses.

**QUESTION: 3 (B):**

What are the function of SCADA systems?

**ANSWER:**

## Functions of SCADA:

A SCADA system performs four functions:

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4. **The communications network** that connects the SCADA master unit to the RTUs in the field.

## Data Acquisition:

First, the systems you need to monitor are much more complex than just one machine with one output. So a real-life SCADA system needs to monitor hundreds or thousands of sensors. Some sensors measure inputs into the system (for example, water flowing into a reservoir), and some sensors measure outputs (like valve pressure as water is released from the reservoir). Some of those sensors measure simple events that can be detected by a straightforward on/off switch, called a discrete input (or digital input).

For example, in our simple model of the widget fabricator, the switch that turns on the light would be a discrete input. In real life, discrete inputs are used to measure simple states, like whether equipment is on or off, or tripwire alarms, like a power failure at a critical facility. Some sensors measure more complex situations where exact measurement is important.

These are analog sensors, which can detect continuous changes in a voltage or current input. Analog sensors are used to track fluid levels in tanks, voltage levels in batteries, temperature and other factors that can be measured in a continuous range of input. For most analog factors, there is a normal range defined by a bottom and top level.

For example, you may want the temperature in a server room to stay between 60 and 85 degrees Fahrenheit. If the temperature goes above or below this range, it will trigger a threshold alarm. In more advanced systems, there are four threshold alarms for analog sensors, defining Major Under, Minor Under, Minor Over and Major Over alarms.

## Data Communication:

In our simple model of the widget fabricator, the “network” is just the wire leading from the switch to the panel light. In real life, you want to be able to monitor multiple systems from a central location, so you need a communications network to transport all the data collected from your sensors.

Early SCADA networks communicated over radio, modem or dedicated serial lines. Today the trend is to put SCADA data on Ethernet and IP over SONET. For security reasons, SCADA data should be kept on closed LAN/WANs without exposing sensitive data to the open Internet. Real SCADA systems don’t communicate with just simple electrical signals, either.

SCADA data is encoded in protocol format. Older SCADA systems depended on closed proprietary protocols, but today the trend is to open, standard protocols and protocol mediation. Sensors and control relays are very simple electric devices that can’t generate or interpret protocol communication on their own. Therefore the remote telemetry unit (RTU) is needed to provide an interface between the sensors and the SCADA network. The RTU encodes sensor inputs into protocol format and forwards them to the SCADA master; in turn, the RTU receives control commands in protocol format from the master and transmits electrical signals to the appropriate control relays.

## Data Presentation:

The only display element in our model SCADA system is the light that comes on when the switch is activated. This obviously won’t do on a large scale — you can’t track a lightboard of a thousand separate lights, and you don’t want to pay someone simply to watch a lightboard, either.

A real SCADA system reports to human operators over a specialized computer that is variously called a master station, an HMI (Human-Machine Interface) or an HCI (Human-Computer Interface). The SCADA master station has several different functions. The master continuously monitors all sensors and alerts the operator when there is an “alarm” — that is, when a control factor is operating outside what is defined as its normal operation.

The master presents a comprehensive view of the entire managed system, and presents more detail in response to user requests. The master also performs data processing on information gathered from sensors — it maintains report logs and summarizes historical trends.An advanced SCADA master can add a great deal of intelligence and automation to your systems management, making your job much easier.

## Control:

Unfortunately, our miniature SCADA system monitoring the widget fabricator doesn’t include any control elements. So let’s add one. Let’s say the human operator also has a button on his control panel. When he presses the button, it activates a switch on the widget fabricator that brings more widget parts into the fabricator.

Now let’s add the full computerized control of a SCADA master unit that controls the entire factory. You now have a control system that responds to inputs elsewhere in the system. If the machines that make widget parts break down, you can slow down or stop the widget fabricator. If the part fabricators are running efficiently, you can speed up the widget fabricator. If you have a sufficiently sophisticated master unit, these controls can run completely automatically, without the need for human intervention.

Of course, you can still manually override the automatic controls from the master station. In real life, SCADA systems automatically regulate all kinds of industrial processes.

For example, if too much pressure is building up in a gas pipeline, the SCADA system can automatically open a release valve. Electricity production can be adjusted to meet demands on the power grid. Even these real-world examples are simplified; a full-scale SCADA system can adjust the managed system in response to multiple inputs.

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**END OF PAPER**