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Multiprocess Control using PLC

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Abstract: In this project, the pressure and flow control are given by placing a digital flow meter between pipelines in addition to connecting a pressure transmitter to the tank's top. Pressure flow will be converted into an analogue signal via the pressure transmitter. With the aid of a pneumatic control valve that is activated by the I/P converter, the pressure and flow can be adjusted and monitored by the PLC in accordance with the setpoint. PLC is used throughout the system to communicate with the automation system.
Keywords: PID, Flow, Pressure, Pressure Transmitter, and Flow Transmitter

I. INTRODUCTION

The proportional, integral, and derivative (PID) controller was widely utilised in industries to meet high control performance criteria and advanced control engineering approaches. Programmable logic controllers (PLCs) are frequently used in industrial settings to simplify controlling in systems for manufacturing, process control, etc. Ladder logic is the most commonly used language out of the several ones discussed for PLC programming. The PID controller, which was based on a microcontroller, was used in the past by the industries employing automation to manage the process temperature, flow, level, pressure, and density. Following that, PLCs were employed to improve automation in the processes of regulating industries, but as time has gone on, PLCs are now also capable of performing PID control operations. The Rockwell software.

II. PROBLEM STATEMENT

Relay-based systems, digitalized systems, and other traditional techniques are employed to control the system. One of the numerous problems of logical computers is that their control panels can be so large that they fill a whole room or wall. A sophisticated system was created by the enormous interconnection of wires that made up the panels. Continuous maintenance was necessary since the lifespan of the electromechanical relays installed in the control panel was constrained. Personnel should inspect all large and enormous panels to determine which relay in the control panel, which has to be replaced, caused the prolonged downtime. When thinking about the maintenance of such complicated panels, qualified workers are needed to spot any mistakes. We can only operate with traditional process control approaches.

III. RESEARCH METHODOLOGY

Process control that is extremely complicated, such that employed in the process industries, may call for algorithms and performance that goes beyond what is possible with high performance. Customised solutions might be needed for controllers with extremely high speeds or precision. Then, in this project, we wish to eliminate the flaws in the traditional approaches that were applied in industry to control several operations. The PLC implements the PID controller, and the PLC software’s ladder diagram is used to create the algorithms. The system’s advantage is that all parameters are set or can be seen in the ladder logic programme on a PC, thus it doesn’t need an external device to monitor and control activities. We are able to monitor and manage multiple industrial processes in real time with the suggested solution.

IV. PID CONTROL MODEL

On-off, proportional, and PID controllers are the three fundamental types. This kind of controller is capable of giving derivative, integral, and proportional control. These changes can be stated as integrals and derivatives in time-based units, as well as by their reciprocals. Using trial and error, the proportional, integral, and derivative terms can each be “tuned” to a specific system. In this, a PID controller compares the measure value to a reference set point value. The error is determined anew for a desired value for manipulatable input by feedback procedure. The feedback and fluctuating rate of the error signal can be used by the PID controller to set process outputs that are accurate and steady.

$$U(t) = Kp\, e(t) + KpKi \int_0 e(t)dt + KpKd\, de(t)/dt$$

In which U(t) is the control signal, Kp is the proportional gain, and Ki is the integral gain. Derivative gain, Kd. The error term will be e(t), the sum of all previous errors throughout time will be e(t)dt, and the rate of change of the error term will be de(t)/dt.

E (t) equals to r(t) – y(t).

Where: y (t): Measured value, r (t): Set point (SP)

V. PROGRAMMABLE LOGIC CONTROLLER

A PLC is a type of digital computer that may automate industrial processes. A PLC is a microprocessor-based system that receives analogue or digital inputs from the field, performs logical calculations in accordance with the user's logic programme, and then produces analogue or digital data that can be used for process control or monitoring. PLCs can be utilised in a wide range of machines and sectors. PLC systems are essential for facilitating human activity. It is a kind of control system that, when used, modifies a system's behaviour. Draw the ladder of a keyboard onto a display screen to programme, operate, and control a PLC. In essence, it is used to regulate a process sensors and relays. This method is based on.

VI. PROCESS DESCRIPTION

The entire system's equipment and parts are installed in a typical cubical metal frame structure that cycles through the execution of the connecting pipeline. Here are the components of the system:

1) Allen Bradley MicroLogix 1200 PLC trainer
2) Water storage
3) Pressure vessel
4) Pressure transmitter
5) Flow transmitter
6) Pneumatic Control valve
7) I/P converter
8) SMPS
9) Compressor
10) Rotameter
11) Pump

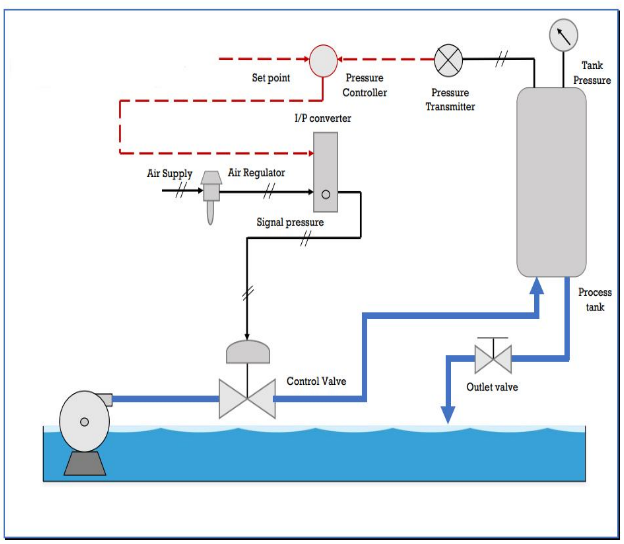

Figure 6.1: Pressure control schematic diagram

The liquid flow that needs to be controlled travels from the pump through a flow transmitter and control valve before entering the tank via a rotameter. The flow transmitter sends the PLC the standard 4 to 20 ma analogue input signal representing the liquid flow rate, and the PLC sends the output signal (4 to 20 ma) in accordance with the set point to the I/P converter, which converts the current into pressure and opens the valve. The Flow Control Loop operates in this manner.

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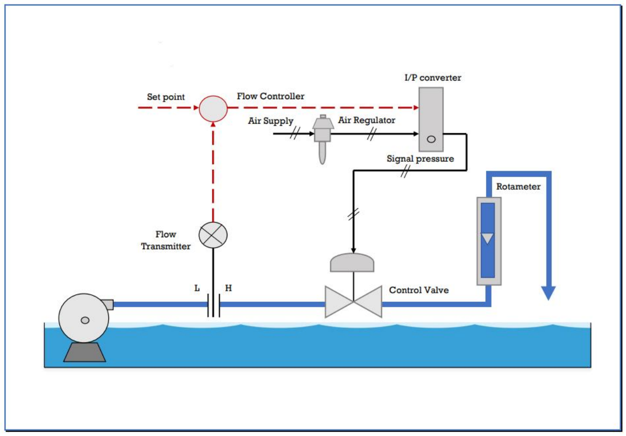
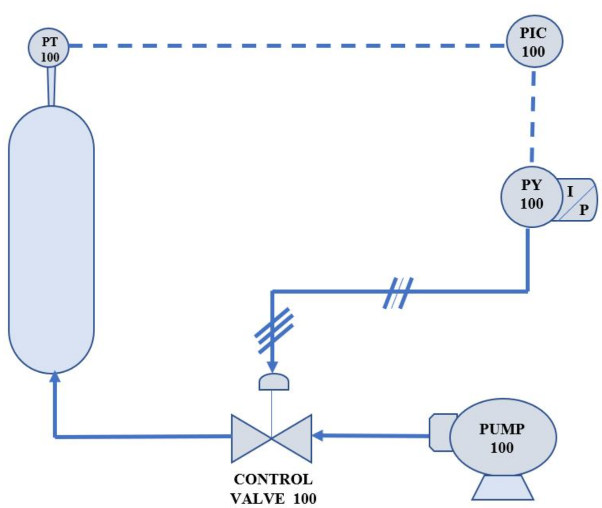


Figure 6.2 flow-control schematic diagram

Liquid flows from the pump through the control valve and into the pressure tank. The PLC receives output signals (4 to 20 ma) in accordance with the set point from the PLC, and the I/P converter uses these signals to convert current into pressure and open the valve. The pressure transmitter provides the PLC with the current pressure of liquid, which is the standard 4 to 20 ma analogue input signal. The pressure Control Loop operates in this manner.

VII. PRESSURE CONTROL SYSTEM

The pressure tank is equipped with a pressure transmitter, which measures tank pressure. This is connected to by a probe that sends the signal. The tank's effective pressure is scaled from 0 to 100%. The pressure transmitter's output signal range for this ahead is 4–20 mA. The pressure transmitter (PT) transmits an electrical signal in accordance with the pressure in the tank. For instance, if the tank's pressure is 50%, a 12 mA signal is sent. The measurement variable (MV) or process variable (PV) value is read by the controller, who then compares it to the setpoint (SP) value. The controller receives the error, which is the difference between these two numbers. The PLC's output signal range is 4–20 mA; after that, the output signal is routed to an I/P converter, which transforms the current into pressure. The I/P converter applies pressure to the pneumatic control valve (PCV), which regulates the pressure in the tank, in accordance with the PLC's output signal. The PCV is an air-operated valve that opens in response to applied pressure. If the tank's pressure is low, the PCV will further open to boost the pressure and increase the flow of the liquid. The PCV will further close to further reduce the pressure of the liquid in the pressure tank, hence reducing the flow of the liquid, if the pressure in the tank is high. The 'PRESSURE CONTROL SYSTEM' functions in this way.



7.1 Pressure control system P & I diagram

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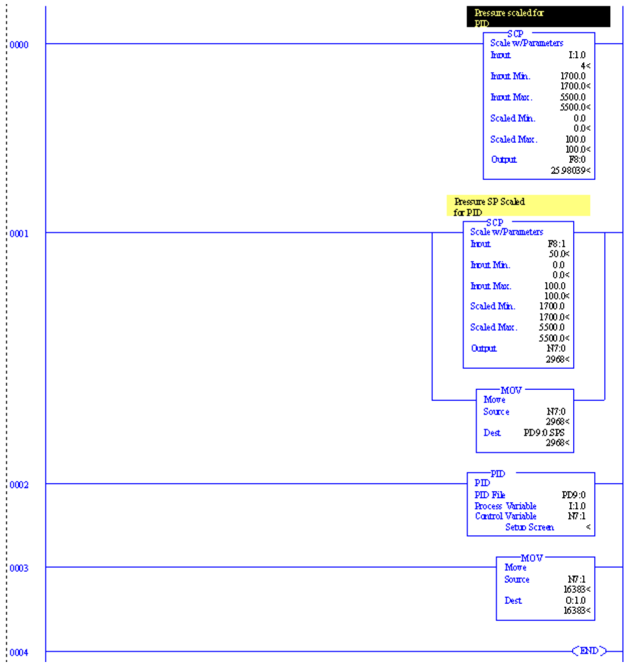
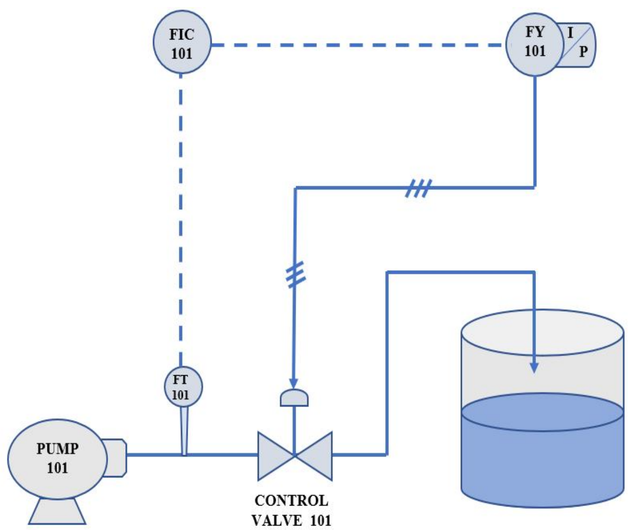
A. Programming for Pressure Control



VIII. FLOW CONTROL SYSTEM



8.1 Flow control system P & I diagram

Between the pipe, the flow transmitter is installed. The flow transmitter, which detects the liquid's flow rate. This is connected to by a probe that sends the signal. The liquid's effective flow rate is scaled from 0 to 100%. The flow transmitter's output signal range for this ahead is 4–20 mA. The flow transmitter (FT) transmits an electrical signal in accordance with the liquid's flow rate. Example: A 12 mA signal is transmitted if the liquid flow rate is 50%. The measurement variable (MV) or process variable (PV) value is read by the controller, who then compares it to the setpoint (SP) value. The error is the difference between these two values to the controller is fed. The 4 to 20 mA output signal range of the PLC is then sent to the I/P converter, which transforms the current into pressure. The I/P converter provides pressure to the pneumatic control valve (PCV), which regulates the liquid flow rate, in accordance with the PLC's output signal. The PCV is an air-operated valve that opens in response to applied pressure. If the liquid flow rate is low, the PCV will further open to enhance the flow rate, increasing the liquid flow. If the liquid flow rate is high, the PCV will further close to reduce the liquid flow rate, therefore decreasing the liquid's stream. The 'FLOW CONTROL SYSTEM' functions in this fashion.

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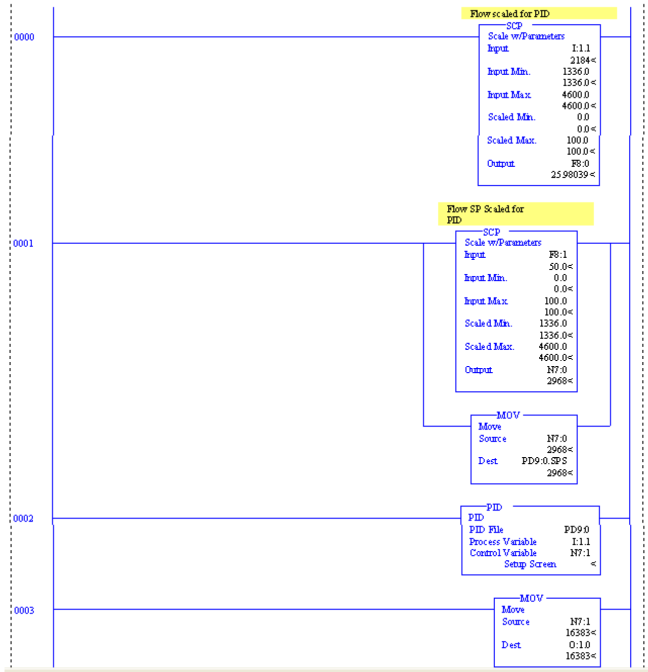
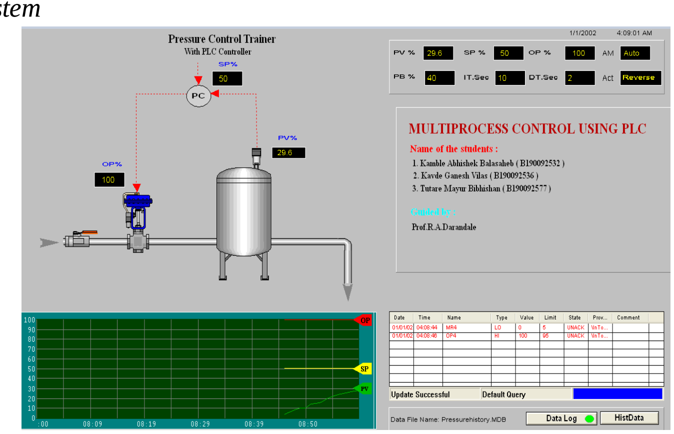
A. Programming For Flow Control



IX. RESULT AND DISCUSSION

The design and implementation of the "Design of a Multiprocess Control System Using PLC" have been successful. Utilising the PID algorithm, the PLC serves as a pressure and flow control system. Through the PLC, the entire flow and pressure control system was monitored and managed in real time. The PLC is connected to a SCADA system, and it has been shown that efficiency has increased. Less time is needed to monitor and control processes, data is processed more quickly and accurately, and communication and operation are both seamless. With this proposed system, it has been noticed that multiprocess monitoring and control operate effectively, and disturbance rejection is also improved. The performance meets expectations.

A. SCADA Pressure Control System

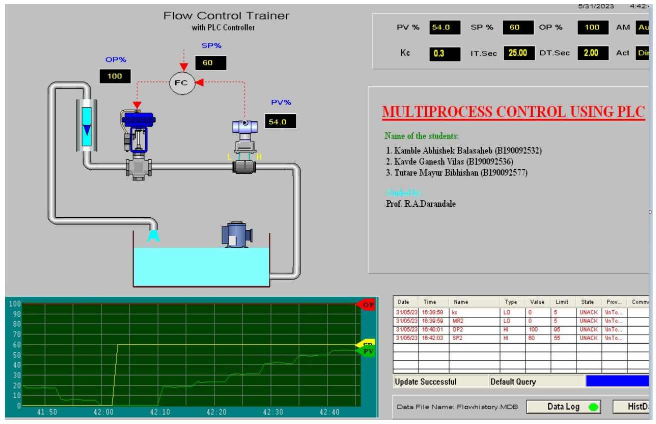


9.1 SCADA pressure control system

SR.NO	Tag Name	Type	Access Name	Item Name (Address)	Process
1.	PV4	I/O Real	PLC	F8:0	Pressure
2.	SP4	I/O Real	PLC	F8:1	Pressure
3.	OP4	I/O Real	PLC	N7:1	Pressure
4.	PB4	I/O Real	PLC	PD9:0.KC	Pressure
5.	IT4	I/O Real	PLC	PD9:0.Ti	Pressure
6.	DT4	I/O Real	PLC	PD9:0.TD	Pressure

Table 9.1: Dictionary of Tag Names

B. SCADA Flow Control System



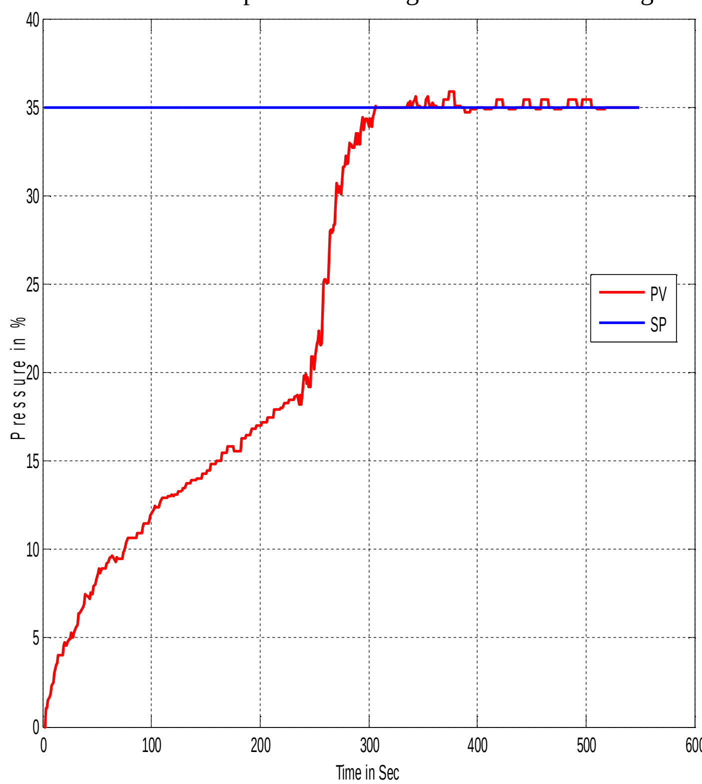
9.2 SCADA flow control system

SR.NO	Tag Name	Type	Access Name	Item Name (Address)	Process
1.	PV2	I/O Real	PLC	F8:0	Flow
2.	SP2	I/O Real	PLC	F8:1	Flow
3.	OP2	I/O Real	PLC	N7:1	Flow
4.	PB2	I/O Real	PLC	PD9:0.KC	Flow
5.	IT2	I/O Real	PLC	PD9:0.Ti	Flow
6.	D24	I/O Real	PLC	PD9:0.TD	Flow

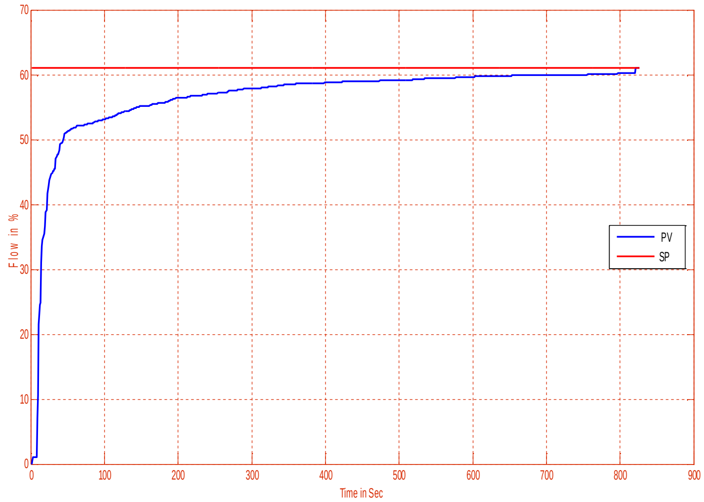
Table 9.2 : Dictionary of Tag Names

X. REAL TIME EXPERIMENT RESULTS

In SCADA, two separate systems are used to demonstrate the PID controlling PLC's effective control. The following graphic illustrates the real-time outcomes of the pressure and flow control process utilizing PID controller tuning and the adjust and observe method.



10.1 Real time response of pressure control system



10.2 Real time response of pressure control system

XI. CONCLUSION

Pressure and flow in many processes have been tracked in real time and managed by PLC in this project. According to the results of the pressure and flow control system, the suggested approach is more efficient than other ways in terms of longevity, speed of parameter control, and error. It is quite challenging to work for precision with other controllers, but in this work employing PLC, the PID implementation boosts the process system's accuracy.

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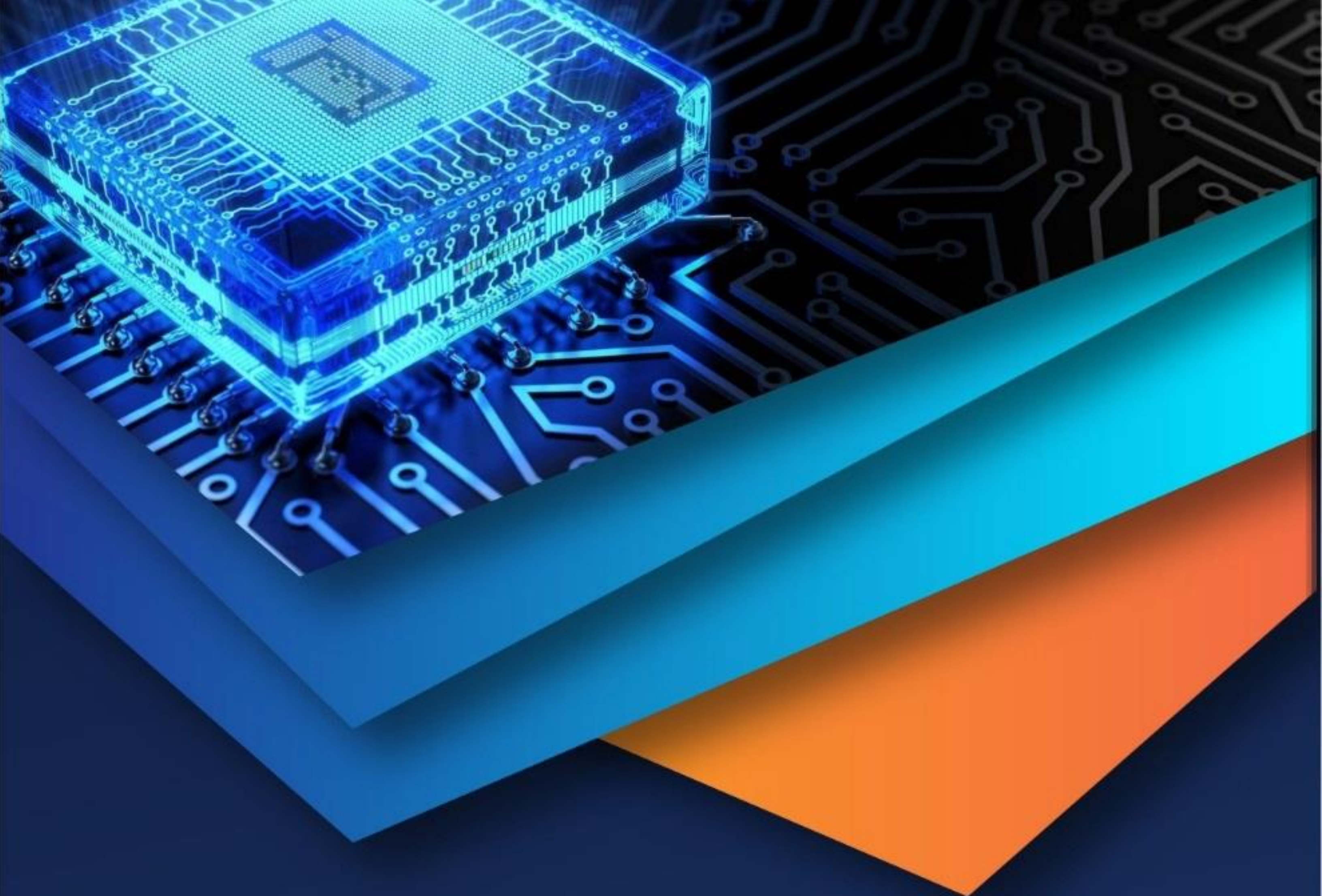

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