Ahsanullah University of Science and Technology

Department: Electrical & Electronic Engineering

Open Ended Project Report

Course No : EEE 4106
Course Name : Control System-I Lab

Project Name : PI Controller

Group : 05
Section : C2
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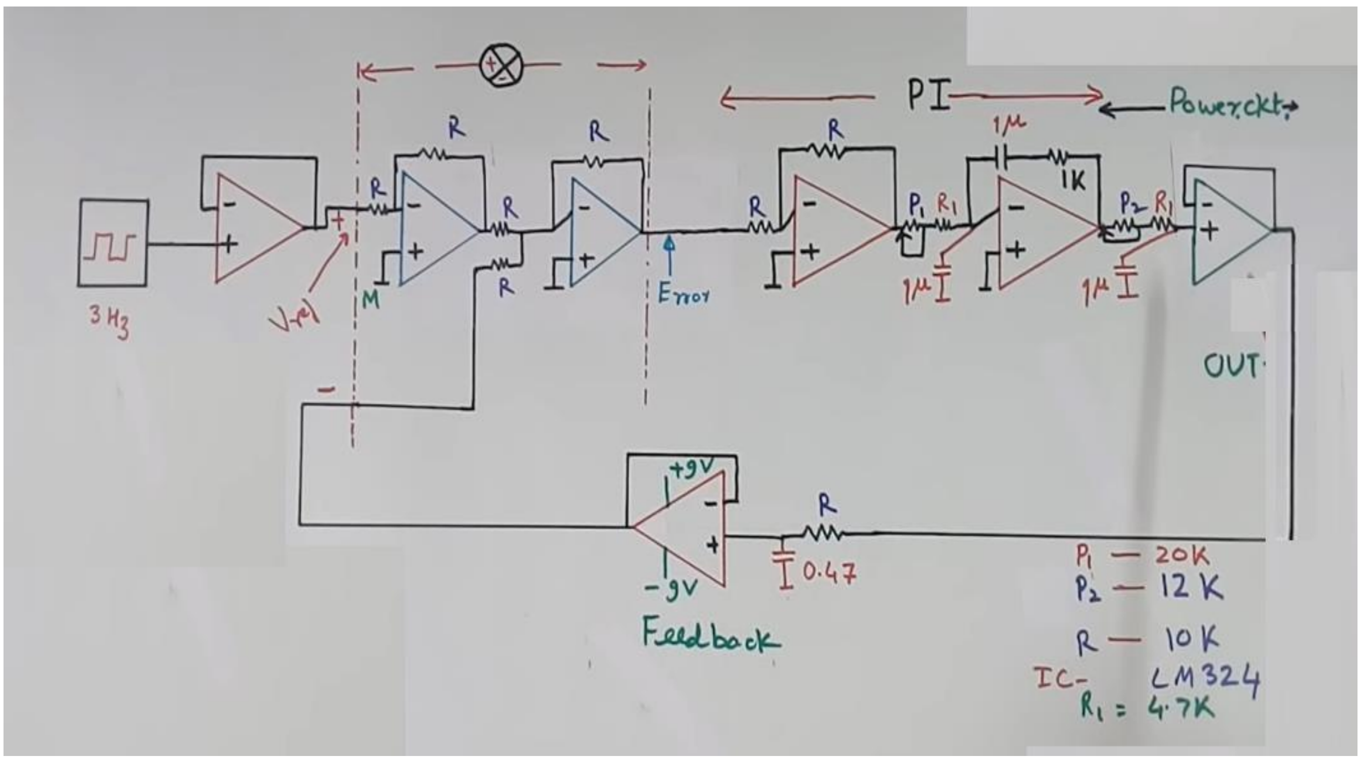
Objective: The goal of a proportional-integral (PI) control system is to manage a process variable by using both immediate proportional and accumulated integral actions. This achieves precise set-point tracking, minimizes steady-state error, and maintains stability in control processes.

Equipment:

1. Op-amp IC 324
2. Resistor
3. Wire
4. Breadboad

Circuit:



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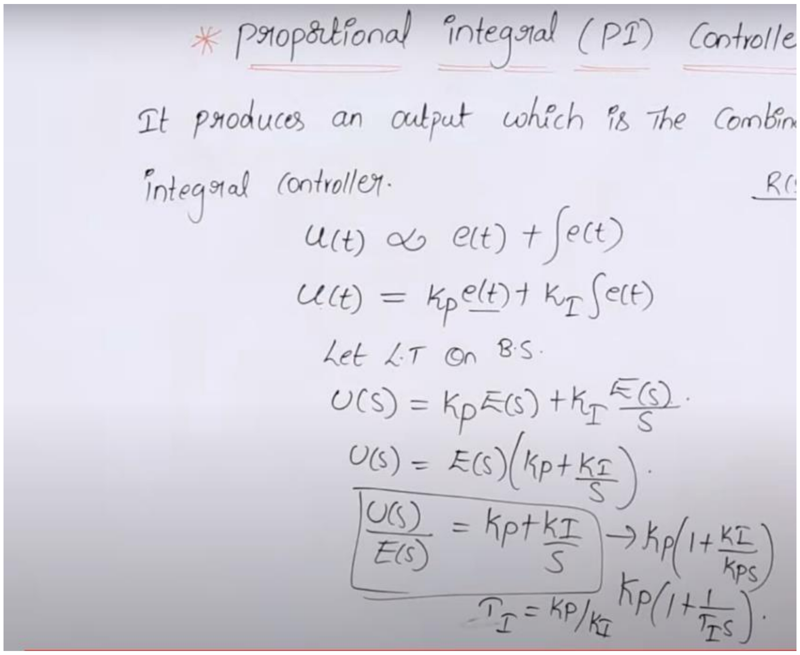

Real-life examples:

A PI Controller is a feedback control loop that calculates an error signal by taking the difference between the output of a system. This helps in the situation where proportional control is necessary to speed up the settling and integral control to reduce the error that is constant over time. A PI controller helps reduce both the rise time and the steady state errors ofthe system. To be helpful whenever you need to change the magnitude and lag thephase together.

Temperature Control in Ovens: Consider an industrial oven used for baking or curing processes. A PI controller can be used to maintain a specific temperature by adjusting the heating element's power output.

Automotive Cruise Control: In modern vehicles, cruise control systems use PI controllers to maintain a constant speed set by the driver.

Liquid Level Control in Tanks: In industrial processes involving tanks and liquid storage, a PI controller can be used to maintain a constant liquid level. The controller adjusts inlet and outlet valves to ensure that the liquid level stays at the desired setpoint, accounting for disturbances such as inflow and outflow variations.

Robotics and Motor Control: PI controllers are commonly used in robotics and motor control applications. For instance, a PI controller can be used to control the position or velocity of a robot arm or a motor-driven system.

Heating, Ventilation, and Air Conditioning (HVAC) Systems: PI controllers are essential in maintaining the desired temperature or humidity levels in HVAC systems.

pH Control in Chemical Processes: In chemical processes that require precise control of pH levels, a PI controller can be employed to maintain the pH at a specific value. The controller adjusts the dosing of acid or base based on the difference between the desired pH and the measured pH.

Pressure Control in Pneumatic Systems: In pneumatic systems, a PI controller can be used to regulate pressure. For example, in a compressed air system, the controller adjusts the pressure of the air supply to meet a desired setpoint, taking into account variations in demand and system behavior.

Advantages:

- Simple Design and Implementation
- Stability
- Reduced Oscillations
- Smooth Transitions
- Adaptability to Varying Loads

Disadvantages:

- Limited Performance for Complex Systems
- Tuning Complexity
- Integral Windup
- Trade-off Between Responsiveness and Stability
- Lack of Predictive Control

Discussion: Due to its capability to efficiently control process variables, the proportional-integral (PI) control system is a commonly utilized strategy in control engineering. This method gives a balanced approach to control by combining proportional and integral control actions. The proportional component ensures an immediate first adjustment by quickly responding to differences between the planned set-point and the actual process variable. On the other hand, the integral component resolves mistakes that have accumulated over time and helps eradicate any lingering steady-state error, improving the accuracy of the system. The PI control system's capacity to balance stability and fast responsiveness is one of its main advantages. The integral action addresses long-term disparities, keeping the system from settling at a non-optimal position, while the proportional action effectively manages rapid changes. The PI control system may be adapted to a number of applications, from temperature and pressure control to motor speed regulation, thanks to its dual-action design. The proper adjustment of proportional and integral constants, however, as well as a thorough comprehension of the dynamics of the process, are necessary when tuning a PI control system. too cautious tuning can provide slow responses, while too aggressive tuning might cause oscillations. For the best performance, the ideal balance must be found. In conclusion, the proportional-integral control system offers a robust solution for process control, addressing both rapid corrections and long-term accuracy. Its effectiveness in achieving stability and precise control makes it a fundamental tool in various industrial and engineering applications, albeit with the caveat that careful tuning is necessary for optimal results.