Project Report on

## “PID-Controller Demonstration for Different Applications”

*SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF*

**BACHELOR OF TECHNOLOGY IN CSE OF**

**VISHWAKARMA INSTITUTE OF TECHNOLOGY**

## Savitribai Phule Pune University

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*UNDER THE GUIDANCE OF*

### “Prof. PRAJAKTA DANDAVATE”



**DEPARTMENT OF “DESH”**

BANSILAL RAMNATH AGARWAL CHARITABLE TRUST’S

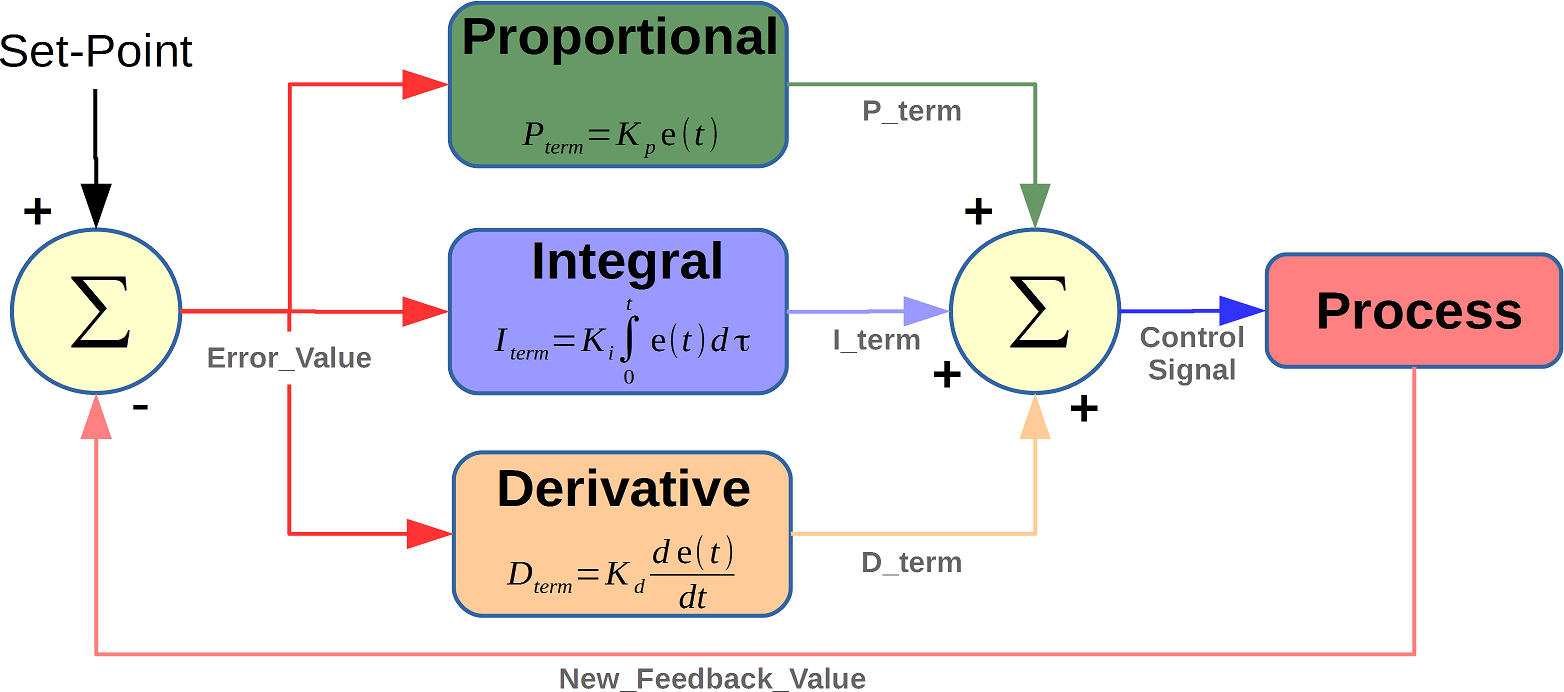
VISHWAKARMA INSTITUTE OF TECHNOLOGY

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

2023 - 2024

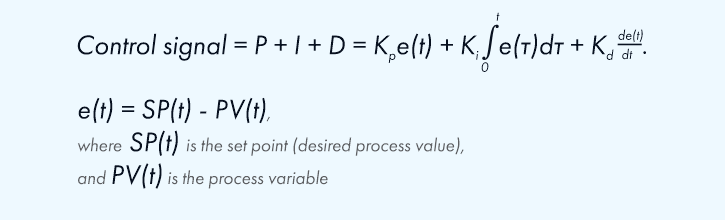
# Introduction

A PID (Proportional – Integral – Derivative) controller is an instrument used by control engineers to regulate temperature, flow, pressure, speed, and other process variables in industrial control systems. PID controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller. The working principle behind a PID controller is that the proportional (“P”), integral (“I”), and derivative (“D”) terms must be individually adjusted or ‘tuned’. Based on the difference between these values a correction factor is calculated and applied to the input. For example, if an oven is cooler than required, the heat will be increased.



A PID controller calculates the control signal based on three control terms: **proportional**, **integral**, and

**derivative**.



Where Kp=Proportional Gain Ki=Integral Gain Kd=Derivative Gain

There are various types of PID controllers. Such as the follows:

* P Controllers (only considers instantaneous errors and produces control signal)
* PI Controllers (consider Proportional and Integral gains. Calculates the history of error, removes steady state error)
* PID Controllers (removes overshoots, oscillations and compensates the sharp fluctuations in PI controller, takes account of possible future errors)

This demonstrates a PID controller which can work on different applications and a visual representation of the tuning process of our PID controller through a graph.

# Codes of main modules used in project Module No.1

**Explanation Code**

**#include <stdio.h> #include <unistd.h>**

**double Kp=2; double Ki=0.1; double Kd=0.3; double tempKd=0.3;**

**#define dt 0.1 // Time step double setpoint = 1.0;**

**// Function**

**double computePID(double setpoint, double current\_position, double \*prev\_error, double \*integral)**

**{**

**double error = setpoint - current\_position; double derivative = (error - \*prev\_error) / dt;**

**\*integral += error \* dt;**

**// PID eq**

**double output = Kp \* error + Ki \* (\*integral) + Kd \* derivative;**

**\*prev\_error = error;**

**return output;**

**}**

**// system dynamics**

**void simulateSystem(double &position, double &velocity, double c\_output)**

**{**

**velocity += c\_output \* dt; position += velocity \* dt;**

**}**

**// graph**

**void displayGraph(double position)**

**{**

**printf("\n"); if(position<setpoint)**

**{**

**printf("\t\t\t\t\t|"); int factor = 20;**

**int scaledPosition = (int)((position + 1.0) \* 0.5 \* factor);**

**for (int i = factor;; i--)**

**{**

**if ((i-1) != scaledPosition) printf(" ");**

**else**

**{**

**printf("#"); break;**

**}**

**}**

**printf("\n");**

**}**

**if(position>setpoint)**

**{**

**int j;**

**int factor = 20;**

**int scaledPosition = (int)(((position)) \* 0.5 \* factor ); for (j=0; j<(49-scaledPosition); j++)**

**{**

**printf(" ");**

**}**

**if(j!=0)**

**{**

**printf("#");**

**}**

**else**

**{**

**printf("\t\t\t\t\t|"); printf("\n"); return;**

**}**

**/\*for ( i= graphHeight; i > 2; --i) { //wrong code**

**if (i == scaledPosition){ printf("\*");**

**}**

**else**

**printf(" ");**

**}\*/**

**for(int j=10; j<(scaledPosition); j++)**

**{**

**printf(" ");**

**}**

**printf("|");**

**printf("\n");**

**}**

**}**

**int main()**

**{**

**printf("\033[?7l"); //escape sequence to avoid text wrapping on the left side of the terminal double am;**

**printf("Enter the amount of time you want to reach the set point:"); scanf("%lf",&am);**

**Kd=(tempKd\*51.3)/am; // we got 51.3 through experimentation**

**double ball\_position = 5.0; double ball\_velocity = 0.5; double prev\_error = 0.0; double integral = 0.0;**

**// Simulation loop**

**for (int i = 0; i <= (10\*am)+50; i++)**

**{**

**double control\_output = computePID(setpoint, ball\_position, &prev\_error, &integral); simulateSystem(ball\_position, ball\_velocity, control\_output);**

**printf("Time: %.2f, Position: %.2f, Control Output: %.2f\n", i \* dt, ball\_position, control\_output);**

**/\* if((dump==1)&&((am-(i \* dt))<=2.00)){ Kp-=1;**

**dump++;**

**}\*/ usleep(10000);**

**}**

**printf("\nThe AutoTuned Values of Kp,Ki,Kd are %.2f,%.2f,%.2f",Kp,Ki,Kd);**

**printf("\n\nEnter the Kp,Ki,Kd values for displaying the graph :"); scanf("%lf",&Kp);**

**scanf("%lf",&Ki);**

**scanf("%lf",&Kd);**

**ball\_position = 5.0;**

**ball\_velocity = 0.5;**

**prev\_error = 0.0;**

**integral = 0.0;**

**for (int i = 0,dump=1; i < 1000; i++)**

**{**

**double control\_output = computePID(setpoint, ball\_position, &prev\_error, &integral);**

**simulateSystem(ball\_position, ball\_velocity, control\_output);**

**// Display graph displayGraph(ball\_position);**

**/\* if((dump==1)&&((am-(i \* dt))<=2.00)){ Kp-=1;**

**dump++;**

**}\*/**

**//printf("Time: %.2f, Position: %.2f, Control Output: %.2f\n", i \* dt, ball\_position, control\_output);**

**usleep(10000);**

**}**

**return 0;**

**}**

**Explanation:**

* PID Controller Parameters:

Kp, Ki, and Kd are the proportional, integral, and derivative gains, respectively.

tempKd is a temporary variable for initializing Kd. dt is the time step used in the simulation.

* Function Definitions: computePID function:

Takes the setpoint, current position, previous error, and integral as input. Computes the PID control output based on the PID equation.

Updates the previous error and returns the control output.

* simulateSystem function:

Simulates the system dynamics based on the control output. Updates the position and velocity of the system. displayGraph function:

Displays a graphical representation of the system's position using ASCII characters.

The graph is printed on the console, and the '#' character represents the current position.

* Main Function: Initialization:

Initializes the PID controller parameters, system initial conditions, and other variables.

Asks the user to input the desired time to reach the setpoint (am) and adjusts Kd accordingly.

* Simulation Loop:

Runs a simulation loop to compute the PID control output and simulate the system's response over time.

Prints the time, position, and control output at each iteration. Uses usleep to introduce a delay for better visualization.

* Auto-Tuning:

Prints the auto-tuned values of Kp, Ki, and Kd after the initial simulation. User Input for Graph Display:

Asks the user to input new values for Kp, Ki, and Kd for a second simulation and graph display.

* Graph Display Loop:

Runs a loop to compute the PID control output, simulate the system, and display the graph.

Uses the displayGraph function to visually represent the system's position.

# Screenshots of results Screenshot no.1 explanation

Time: 0.00, Position: 4.76, Control Output: -28.56

Time: 0.10, Position: 4.46, Control Output: -6.40

Time: 0.20, Position: 4.11, Control Output: -5.51

Time: 0.30, Position: 3.71, Control Output: -4.54

Time: 0.40, Position: 3.27, Control Output: -3.54

Time: 0.50, Position: 2.81, Control Output: -2.51

Time: 0.60, Position: 2.34, Control Output: -1.48

Time: 0.70, Position: 1.86, Control Output: -0.46

Time: 0.80, Position: 1.38, Control Output: 0.51

Time: 0.90, Position: 0.92, Control Output: 1.43

Time: 1.00, Position: 0.49, Control Output: 2.28

Time: 1.10, Position: 0.08, Control Output: 3.04

Time: 1.20, Position: -0.29, Control Output: 3.71

Time: 1.30, Position: -0.62, Control Output: 4.27

Time: 1.40, Position: -0.90, Control Output: 4.73

Time: 1.50, Position: -1.13, Control Output: 5.06

Time: 1.60, Position: -1.31, Control Output: 5.28

Time: 1.70, Position: -1.43, Control Output: 5.39

Time: 1.80, Position: -1.50, Control Output: 5.38

Time: 1.90, Position: -1.51, Control Output: 5.27

Time: 2.00, Position: -1.48, Control Output: 5.06

Time: 2.10, Position: -1.40, Control Output: 4.75

Time: 2.20, Position: -1.27, Control Output: 4.37

Time: 2.30, Position: -1.11, Control Output: 3.92

Time: 2.40, Position: -0.91, Control Output: 3.41

Time: 2.50, Position: -0.68, Control Output: 2.86

Time: 2.60, Position: -0.43, Control Output: 2.27

Time: 2.70, Position: -0.17, Control Output: 1.67

Time: 2.80, Position: 0.11, Control Output: 1.06

Time: 2.90, Position: 0.39, Control Output: 0.46

Time: 3.00, Position: 0.67, Control Output: -0.12

Time: 3.10, Position: 0.95, Control Output: -0.67

Time: 3.20, Position: 1.21, Control Output: -1.18

Time: 3.30, Position: 1.46, Control Output: -1.65

Time: 3.40, Position: 1.68, Control Output: -2.06

Time: 3.50, Position: 1.88, Control Output: -2.41

Time: 3.60, Position: 2.06, Control Output: -2.70

Time: 3.70, Position: 2.20, Control Output: -2.92

Time: 3.80, Position: 2.31, Control Output: -3.07

Time: 3.90, Position: 2.40, Control Output: -3.15

Time: 4.00, Position: 2.45, Control Output: -3.17

Time: 4.10, Position: 2.47, Control Output: -3.13

Time: 4.20, Position: 2.46, Control Output: -3.02

Time: 4.30, Position: 2.42, Control Output: -2.86

Time: 4.40, Position: 2.35, Control Output: -2.65

Time: 4.50, Position: 2.26, Control Output: -2.39

Time: 4.60, Position: 2.15, Control Output: -2.10

Time: 4.70, Position: 2.02, Control Output: -1.79

Time: 4.80, Position: 1.88, Control Output: -1.45

Time: 4.90, Position: 1.73, Control Output: -1.10

Time: 5.00, Position: 1.56, Control Output: -0.74

Time: 5.10, Position: 1.40, Control Output: -0.38

Time: 5.20, Position: 1.23, Control Output: -0.04

Time: 5.30, Position: 1.07, Control Output: 0.29

Time: 5.40, Position: 0.91, Control Output: 0.60

Time: 5.50, Position: 0.77, Control Output: 0.89

Time: 5.60, Position: 0.63, Control Output: 1.14

Time: 5.70, Position: 0.51, Control Output: 1.36

Time: 5.80, Position: 0.40, Control Output: 1.54

Time: 5.90, Position: 0.31, Control Output: 1.68

Time: 6.00, Position: 0.24, Control Output: 1.78

Time: 6.10, Position: 0.18, Control Output: 1.84

Time: 6.20, Position: 0.15, Control Output: 1.87

Time: 6.30, Position: 0.13, Control Output: 1.85

Time: 6.40, Position: 0.13, Control Output: 1.80

Time: 6.50, Position: 0.15, Control Output: 1.71

Time: 6.60, Position: 0.18, Control Output: 1.60

Time: 6.70, Position: 0.23, Control Output: 1.46

Time: 6.80, Position: 0.29, Control Output: 1.29

Time: 6.90, Position: 0.36, Control Output: 1.11

Time: 7.00, Position: 0.45, Control Output: 0.92

Time: 7.10, Position: 0.53, Control Output: 0.71

Time: 7.20, Position: 0.63, Control Output: 0.50

Time: 7.30, Position: 0.73, Control Output: 0.29

Time: 7.40, Position: 0.82, Control Output: 0.09

Time: 7.50, Position: 0.92, Control Output: -0.11

Time: 7.60, Position: 1.01, Control Output: -0.30

Time: 7.70, Position: 1.10, Control Output: -0.47

Time: 7.80, Position: 1.18, Control Output: -0.62

Time: 7.90, Position: 1.26, Control Output: -0.76

Time: 8.00, Position: 1.32, Control Output: -0.87

Time: 8.10, Position: 1.38, Control Output: -0.96

Time: 8.20, Position: 1.43, Control Output: -1.03

Time: 8.30, Position: 1.46, Control Output: -1.07

Time: 8.40, Position: 1.49, Control Output: -1.09

Time: 8.50, Position: 1.50, Control Output: -1.09

Time: 8.60, Position: 1.50, Control Output: -1.07

Time: 8.70, Position: 1.50, Control Output: -1.02

Time: 8.80, Position: 1.48, Control Output: -0.96

Time: 8.90, Position: 1.45, Control Output: -0.88

Time: 9.00, Position: 1.42, Control Output: -0.79

Time: 9.10, Position: 1.38, Control Output: -0.69

Time: 9.20, Position: 1.33, Control Output: -0.58

Time: 9.30, Position: 1.28, Control Output: -0.46

Time: 9.40, Position: 1.23, Control Output: -0.33

Time: 9.50, Position: 1.17, Control Output: -0.21

Time: 9.60, Position: 1.11, Control Output: -0.09

Time: 9.70, Position: 1.06, Control Output: 0.03

Time: 9.80, Position: 1.00, Control Output: 0.14

Time: 9.90, Position: 0.95, Control Output: 0.24

Time: 10.00, Position: 0.90, Control Output: 0.34

Time: 10.10, Position: 0.85, Control Output: 0.42

Time: 10.20, Position: 0.81, Control Output: 0.49

Time: 10.30, Position: 0.78, Control Output: 0.55

Time: 10.40, Position: 0.75, Control Output: 0.59

Time: 10.50, Position: 0.73, Control Output: 0.62

Time: 10.60, Position: 0.71, Control Output: 0.64

Time: 10.70, Position: 0.70, Control Output: 0.64

Time: 10.80, Position: 0.70, Control Output: 0.63

Time: 10.90, Position: 0.70, Control Output: 0.61

Time: 11.00, Position: 0.71, Control Output: 0.58

Time: 11.10, Position: 0.72, Control Output: 0.54

Time: 11.20, Position: 0.74, Control Output: 0.48

Time: 11.30, Position: 0.76, Control Output: 0.42

Time: 11.40, Position: 0.79, Control Output: 0.36

Time: 11.50, Position: 0.82, Control Output: 0.29

Time: 11.60, Position: 0.85, Control Output: 0.22

Time: 11.70, Position: 0.88, Control Output: 0.15

Time: 11.80, Position: 0.91, Control Output: 0.08

Time: 11.90, Position: 0.95, Control Output: 0.00

Time: 12.00, Position: 0.98, Control Output: -0.06

Time: 12.10, Position: 1.01, Control Output: -0.12

Time: 12.20, Position: 1.04, Control Output: -0.18

Time: 12.30, Position: 1.07, Control Output: -0.23

Time: 12.40, Position: 1.10, Control Output: -0.28

Time: 12.50, Position: 1.12, Control Output: -0.31

Time: 12.60, Position: 1.14, Control Output: -0.34

Time: 12.70, Position: 1.15, Control Output: -0.36

Time: 12.80, Position: 1.16, Control Output: -0.37

Time: 12.90, Position: 1.17, Control Output: -0.38

Time: 13.00, Position: 1.17, Control Output: -0.38

Time: 13.10, Position: 1.17, Control Output: -0.36

Time: 13.20, Position: 1.17, Control Output: -0.35

Time: 13.30, Position: 1.16, Control Output: -0.32

Time: 13.40, Position: 1.15, Control Output: -0.29

Time: 13.50, Position: 1.14, Control Output: -0.26

Time: 13.60, Position: 1.12, Control Output: -0.22

Time: 13.70, Position: 1.11, Control Output: -0.18

Time: 13.80, Position: 1.09, Control Output: -0.14

Time: 13.90, Position: 1.07, Control Output: -0.10

Time: 14.00, Position: 1.05, Control Output: -0.06

Time: 14.10, Position: 1.03, Control Output: -0.02

Time: 14.20, Position: 1.01, Control Output: 0.02

Time: 14.30, Position: 0.99, Control Output: 0.06

Time: 14.40, Position: 0.97, Control Output: 0.10

Time: 14.50, Position: 0.96, Control Output: 0.13

Time: 14.60, Position: 0.94, Control Output: 0.15

Time: 14.70, Position: 0.93, Control Output: 0.18

Time: 14.80, Position: 0.92, Control Output: 0.20

Time: 14.90, Position: 0.91, Control Output: 0.21

Time: 15.00, Position: 0.90, Control Output: 0.22

Time: 15.10, Position: 0.90, Control Output: 0.22

Time: 15.20, Position: 0.89, Control Output: 0.22

Time: 15.30, Position: 0.89, Control Output: 0.22

Time: 15.40, Position: 0.89, Control Output: 0.21

Time: 15.50, Position: 0.90, Control Output: 0.19

Time: 15.60, Position: 0.90, Control Output: 0.18

Time: 15.70, Position: 0.91, Control Output: 0.16

Time: 15.80, Position: 0.92, Control Output: 0.14

Time: 15.90, Position: 0.93, Control Output: 0.12

Time: 16.00, Position: 0.94, Control Output: 0.09

Time: 16.10, Position: 0.95, Control Output: 0.07

Time: 16.20, Position: 0.96, Control Output: 0.04

Time: 16.30, Position: 0.97, Control Output: 0.02

Time: 16.40, Position: 0.98, Control Output: -0.01

Time: 16.50, Position: 1.00, Control Output: -0.03

Time: 16.60, Position: 1.01, Control Output: -0.05

Time: 16.70, Position: 1.02, Control Output: -0.07

Time: 16.80, Position: 1.03, Control Output: -0.09

Time: 16.90, Position: 1.03, Control Output: -0.10

Time: 17.00, Position: 1.04, Control Output: -0.11

Time: 17.10, Position: 1.05, Control Output: -0.12

Time: 17.20, Position: 1.05, Control Output: -0.13

Time: 17.30, Position: 1.05, Control Output: -0.13

Time: 17.40, Position: 1.06, Control Output: -0.13

Time: 17.50, Position: 1.06, Control Output: -0.13

Time: 17.60, Position: 1.06, Control Output: -0.12

Time: 17.70, Position: 1.06, Control Output: -0.12

Time: 17.80, Position: 1.05, Control Output: -0.11

Time: 17.90, Position: 1.05, Control Output: -0.10

Time: 18.00, Position: 1.04, Control Output: -0.09

Time: 18.10, Position: 1.04, Control Output: -0.07

Time: 18.20, Position: 1.03, Control Output: -0.06

Time: 18.30, Position: 1.03, Control Output: -0.04

Time: 18.40, Position: 1.02, Control Output: -0.03

Time: 18.50, Position: 1.01, Control Output: -0.01

Time: 18.60, Position: 1.01, Control Output: -0.00

Time: 18.70, Position: 1.00, Control Output: 0.01

Time: 18.80, Position: 0.99, Control Output: 0.03

Time: 18.90, Position: 0.99, Control Output: 0.04

Time: 19.00, Position: 0.98, Control Output: 0.05

Time: 19.10, Position: 0.98, Control Output: 0.06

Time: 19.20, Position: 0.97, Control Output: 0.06

Time: 19.30, Position: 0.97, Control Output: 0.07

Time: 19.40, Position: 0.97, Control Output: 0.07

Time: 19.50, Position: 0.96, Control Output: 0.08

Time: 19.60, Position: 0.96, Control Output: 0.08

Time: 19.70, Position: 0.96, Control Output: 0.08

Time: 19.80, Position: 0.96, Control Output: 0.07

Time: 19.90, Position: 0.96, Control Output: 0.07

Time: 20.00, Position: 0.96, Control Output: 0.07

Time: 20.10, Position: 0.97, Control Output: 0.06

Time: 20.20, Position: 0.97, Control Output: 0.05

Time: 20.30, Position: 0.97, Control Output: 0.05

Time: 20.40, Position: 0.97, Control Output: 0.04

Time: 20.50, Position: 0.98, Control Output: 0.03

Time: 20.60, Position: 0.98, Control Output: 0.02

Time: 20.70, Position: 0.99, Control Output: 0.01

Time: 20.80, Position: 0.99, Control Output: 0.00

Time: 20.90, Position: 0.99, Control Output: -0.01

Time: 21.00, Position: 1.00, Control Output: -0.01

Time: 21.10, Position: 1.00, Control Output: -0.02

Time: 21.20, Position: 1.01, Control Output: -0.03

Time: 21.30, Position: 1.01, Control Output: -0.03

Time: 21.40, Position: 1.01, Control Output: -0.04

Time: 21.50, Position: 1.01, Control Output: -0.04

Time: 21.60, Position: 1.02, Control Output: -0.04

Time: 21.70, Position: 1.02, Control Output: -0.04

Time: 21.80, Position: 1.02, Control Output: -0.05

Time: 21.90, Position: 1.02, Control Output: -0.05

Time: 22.00, Position: 1.02, Control Output: -0.04

Time: 22.10, Position: 1.02, Control Output: -0.04

Time: 22.20, Position: 1.02, Control Output: -0.04

Time: 22.30, Position: 1.02, Control Output: -0.04

Time: 22.40, Position: 1.01, Control Output: -0.03

Time: 22.50, Position: 1.01, Control Output: -0.03

Time: 22.60, Position: 1.01, Control Output: -0.02

Time: 22.70, Position: 1.01, Control Output: -0.02

Time: 22.80, Position: 1.01, Control Output: -0.01

Time: 22.90, Position: 1.00, Control Output: -0.01

Time: 23.00, Position: 1.00, Control Output: -0.00

Time: 23.10, Position: 1.00, Control Output: 0.00

Time: 23.20, Position: 1.00, Control Output: 0.01

Time: 23.30, Position: 1.00, Control Output: 0.01

Time: 23.40, Position: 0.99, Control Output: 0.01

Time: 23.50, Position: 0.99, Control Output: 0.02

Time: 23.60, Position: 0.99, Control Output: 0.02

Time: 23.70, Position: 0.99, Control Output: 0.02

Time: 23.80, Position: 0.99, Control Output: 0.02

Time: 23.90, Position: 0.99, Control Output: 0.03

Time: 24.00, Position: 0.99, Control Output: 0.03

Time: 24.10, Position: 0.99, Control Output: 0.03

Time: 24.20, Position: 0.99, Control Output: 0.03

Time: 24.30, Position: 0.99, Control Output: 0.03

Time: 24.40, Position: 0.99, Control Output: 0.02

Time: 24.50, Position: 0.99, Control Output: 0.02

Time: 24.60, Position: 0.99, Control Output: 0.02

Time: 24.70, Position: 0.99, Control Output: 0.02

Time: 24.80, Position: 0.99, Control Output: 0.01

Time: 24.90, Position: 0.99, Control Output: 0.01

Time: 25.00, Position: 0.99, Control Output: 0.01

Time: 25.10, Position: 0.99, Control Output: 0.01

Time: 25.20, Position: 0.99, Control Output: 0.00

Time: 25.30, Position: 1.00, Control Output: -0.00

Time: 25.40, Position: 1.00, Control Output: -0.00

Time: 25.50, Position: 1.00, Control Output: -0.01

Time: 25.60, Position: 1.00, Control Output: -0.01

Time: 25.70, Position: 1.00, Control Output: -0.01

Time: 25.80, Position: 1.00, Control Output: -0.01

Time: 25.90, Position: 1.00, Control Output: -0.01

Time: 26.00, Position: 1.00, Control Output: -0.01

Time: 26.10, Position: 1.00, Control Output: -0.01

Time: 26.20, Position: 1.00, Control Output: -0.02

Time: 26.30, Position: 1.01, Control Output: -0.02

Time: 26.40, Position: 1.01, Control Output: -0.02

Time: 26.50, Position: 1.01, Control Output: -0.01

Time: 26.60, Position: 1.01, Control Output: -0.01

Time: 26.70, Position: 1.00, Control Output: -0.01

Time: 26.80, Position: 1.00, Control Output: -0.01

Time: 26.90, Position: 1.00, Control Output: -0.01

Time: 27.00, Position: 1.00, Control Output: -0.01

Time: 27.10, Position: 1.00, Control Output: -0.01

Time: 27.20, Position: 1.00, Control Output: -0.01

Time: 27.30, Position: 1.00, Control Output: -0.00

Time: 27.40, Position: 1.00, Control Output: -0.00

Time: 27.50, Position: 1.00, Control Output: -0.00

Time: 27.60, Position: 1.00, Control Output: 0.00

Time: 27.70, Position: 1.00, Control Output: 0.00

Time: 27.80, Position: 1.00, Control Output: 0.00

Time: 27.90, Position: 1.00, Control Output: 0.01

Time: 28.00, Position: 1.00, Control Output: 0.01

Time: 28.10, Position: 1.00, Control Output: 0.01

Time: 28.20, Position: 0.99, Control Output: 0.01

Time: 28.30, Position: 0.99, Control Output: 0.01

Time: 28.40, Position: 0.99, Control Output: 0.01

Time: 28.50, Position: 0.99, Control Output: 0.01

Time: 28.60, Position: 0.99, Control Output: 0.01

Time: 28.70, Position: 0.99, Control Output: 0.01

Time: 28.80, Position: 0.99, Control Output: 0.01

Time: 28.90, Position: 0.99, Control Output: 0.01

Time: 29.00, Position: 0.99, Control Output: 0.01

Time: 29.10, Position: 0.99, Control Output: 0.01

Time: 29.20, Position: 1.00, Control Output: 0.01

Time: 29.30, Position: 1.00, Control Output: 0.00

Time: 29.40, Position: 1.00, Control Output: 0.00

Time: 29.50, Position: 1.00, Control Output: 0.00

Time: 29.60, Position: 1.00, Control Output: 0.00

Time: 29.70, Position: 1.00, Control Output: 0.00

Time: 29.80, Position: 1.00, Control Output: -0.00

Time: 29.90, Position: 1.00, Control Output: -0.00

Time: 30.00, Position: 1.00, Control Output: -0.00

Time: 30.10, Position: 1.00, Control Output: -0.00

Time: 30.20, Position: 1.00, Control Output: -0.00

Time: 30.30, Position: 1.00, Control Output: -0.00

Time: 30.40, Position: 1.00, Control Output: -0.00

Time: 30.50, Position: 1.00, Control Output: -0.01

Time: 30.60, Position: 1.00, Control Output: -0.01

Time: 30.70, Position: 1.00, Control Output: -0.01

Time: 30.80, Position: 1.00, Control Output: -0.01

Time: 30.90, Position: 1.00, Control Output: -0.01

Time: 31.00, Position: 1.00, Control Output: -0.01

Time: 31.10, Position: 1.00, Control Output: -0.00

Time: 31.20, Position: 1.00, Control Output: -0.00

Time: 31.30, Position: 1.00, Control Output: -0.00

Time: 31.40, Position: 1.00, Control Output: -0.00

Time: 31.50, Position: 1.00, Control Output: -0.00

Time: 31.60, Position: 1.00, Control Output: -0.00

Time: 31.70, Position: 1.00, Control Output: -0.00

Time: 31.80, Position: 1.00, Control Output: -0.00

Time: 31.90, Position: 1.00, Control Output: -0.00

Time: 32.00, Position: 1.00, Control Output: 0.00

Time: 32.10, Position: 1.00, Control Output: 0.00

Time: 32.20, Position: 1.00, Control Output: 0.00

Time: 32.30, Position: 1.00, Control Output: 0.00

Time: 32.40, Position: 1.00, Control Output: 0.00

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Time: 32.80, Position: 1.00, Control Output: 0.00

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Time: 33.00, Position: 1.00, Control Output: 0.00

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Time: 33.40, Position: 1.00, Control Output: 0.00

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Time: 34.00, Position: 1.00, Control Output: 0.00

Time: 34.10, Position: 1.00, Control Output: 0.00

Time: 34.20, Position: 1.00, Control Output: 0.00

Time: 34.30, Position: 1.00, Control Output: -0.00

Time: 34.40, Position: 1.00, Control Output: -0.00

Time: 34.50, Position: 1.00, Control Output: -0.00

Time: 34.60, Position: 1.00, Control Output: -0.00

Time: 34.70, Position: 1.00, Control Output: -0.00

Time: 34.80, Position: 1.00, Control Output: -0.00

Time: 34.90, Position: 1.00, Control Output: -0.00

Time: 35.00, Position: 1.00, Control Output: -0.00 The AutoTuned Values of Kp,Ki,Kd are 2.00,0.10,0.51

**Enter the Kp,Ki,Kd values for displaying the graph :3 2 1**

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# Conclusion

As we can see from the output, that the program autotunes Kp, Ki, Kd based on the user- defined values, and as seen later from the graph that the control oscillates and eventually stabilizes it to a setpoint, which is also enumerated in the graphic representation. Hence, we have successfully demonstrated the ball balancing of the PID controller, but, autotuning is not limited to time-based tuning, we will also further implement the infamous Ziegler Nicholas method.

# Future Scope

We are also implementing a PID algorithm for our EDAI project which is Automated Guided Vehicle (AGV) following a specified path (black tape). We will be using this algorithm for stability, safety(in terms of impacts to the hardware), and provide smooth driving.

# References

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