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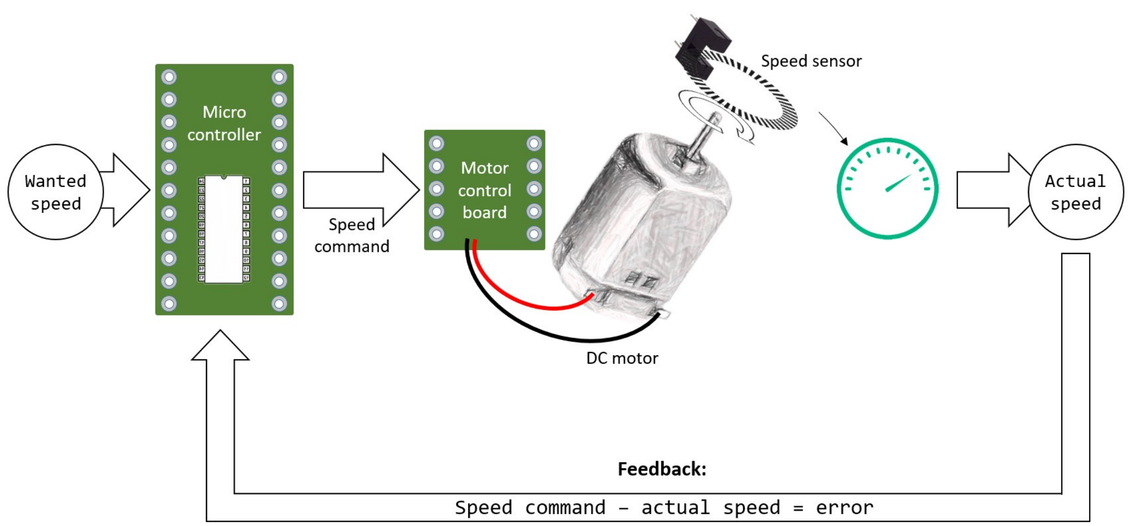
AIM

To implement Closed Loop Speed Control of DC motor using PID controller on a simulation using SIMULINK software.

SOFTWARES USED

1) **MATLAB** (an abbreviation of "matrix laboratory") is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

2) **Simulink** is a MATLAB-based graphical programming environment for modeling, simulating and analyzing multi domain dynamical systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it. Simulink is widely used in automatic control and digital signal processing for multidomain simulation and model-based design.



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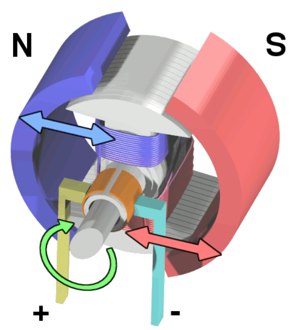
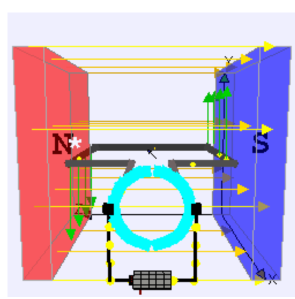
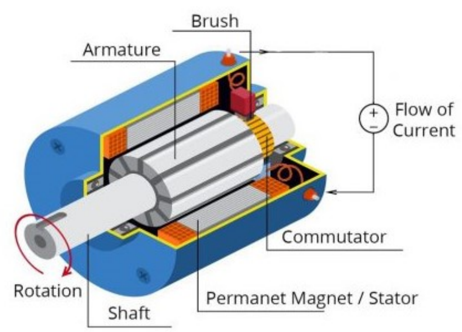
THEORY

SPEED CONTROL OF DC MOTORS

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.







The reason to control the speed of the engine is to conquer the issue in the industry like to maintain a strategic distance from machine harms and to stay away from the moderate ascent time and high overshoot. This is on account of when the beginning voltage is high, it isn’t reasonable for a machine as it can make machine harms. In this way, a controller like PID is created to beat this issue.

The PID controllers always have been broadly utilized for control of speed in the dc motor. In all strategies the speed is controlled by monitoring the armature voltage, armature present, terminal voltage and by control-ling the field current of the dc machine.

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Numerous experimental techniques are utilized for tuning of the PID parameters like inherited calculation, GSA calculation, ICA calculation, fluffy tuning, microcontroller tuning and so forth the yield for the speed control is obtained through the expansion of the rotor shaft. Speed regulator of the dc engine was having an issue with different information sources and controlling factors for speed. Some of the other methods which can be used to control DC motor speed are:

1) Flux control method
2) Variable resistance in series with motor Voltage control method
3) Using IR sensor and Arduino
4) Using PWM Hysteresis Using Fuzzy logout of these, this paper will focus on three techniques and compare their results. They include IR sensor and Arduino method (hardware), PID controller and PWM Hysteresis (software).

PID CONTROLLER

A proportional integral subsidiary controller (PID controller) is generally utilized as a part of mechanical control frameworks. It is a bland control circle criticism instrument and utilized as an input controller. PID working standard is that it figures blunder esteem from the handled estimated esteem and the coveted reference point. Crafted by the controller is to limit the blunder by changing the contributions of the framework.

In the event that the framework isn‟t plainly known at that point, applying a PID controller gives the best results in the event that it is tuned legitimately by keeping parameters of the framework as per the idea of the framework. The PID estimation relies on three parameters which is known as the corresponding, the indispensable and subordinate part which is called P, I and D part.

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P decides the response to current blunder, I decide response to the aggregate of as of late showed up blunders, D determines response as indicated by the rate of blunder evolving. The aggregate of each of the three sections contribute the control instrument, for example, speed control of an engine in which P esteem relies on current mistake, I on the gathering of past mistakes and D anticipate future blunder in light of the current rate of progress.

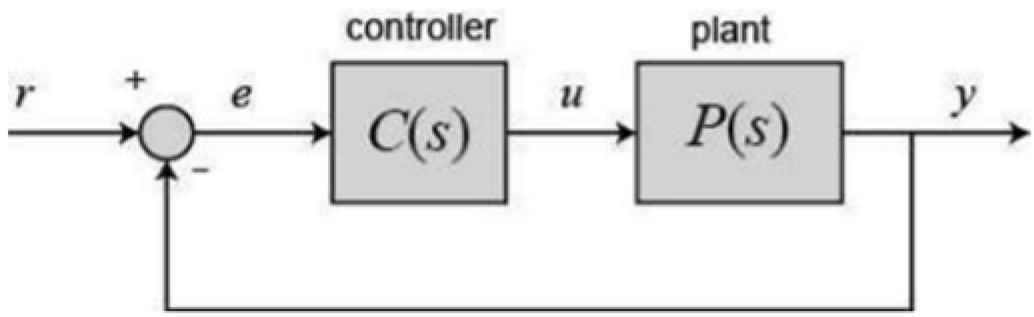

Fig. 1:- The feedback system of PID controller.

As subsidiary activity is touchy to commotion so generally the controllers are PI controllers instead of PID as it is unrealistic a framework without aggravations. Vital part makes a difference in the framework to reach onto its objective esteem while P part increment overshoots. The P expression takes the yield corresponding to blunder esteem. Its reaction can be balanced by increasing the blunder by a consistent Kp which is called relative pick up. In the event that relative pick up is extensive then it makes a high overshoot which temperamental the framework, while a little yield change influences a little control to activity. The error constants that the PID helps in rectifying are named as Kp, Kp and Kd.

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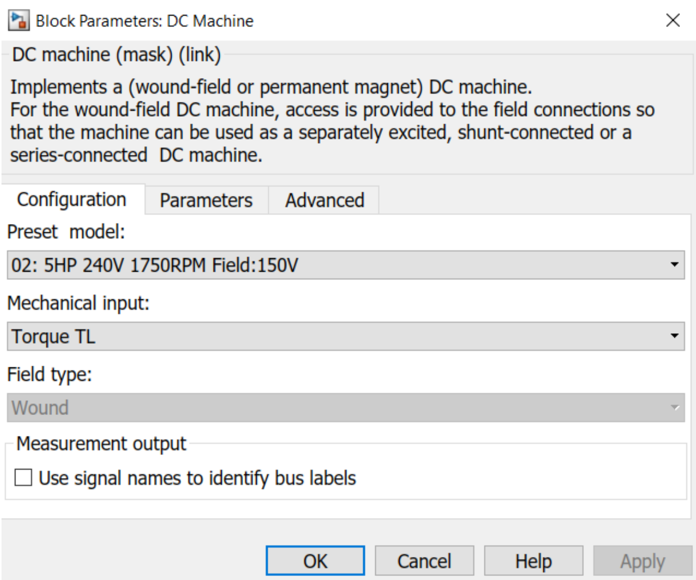
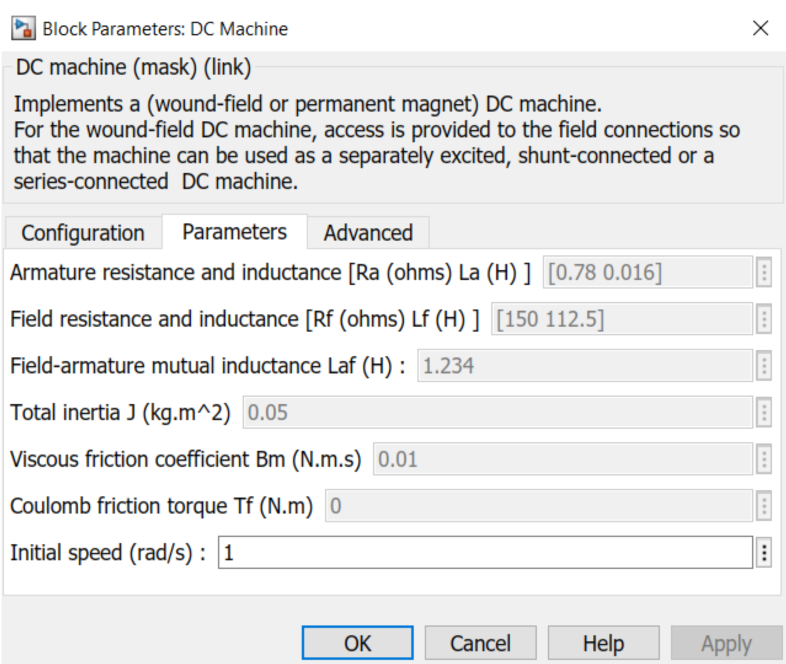
OBSERVATIONS

Instead of using the Ziegler–Nichols method or any other mathematical technique, we will tune the PID controller using the inbuilt auto-tuning on Simulink. For this we must first, construct a speed control model using the inbuilt PID controller.

The selected DC motor parameters are: -





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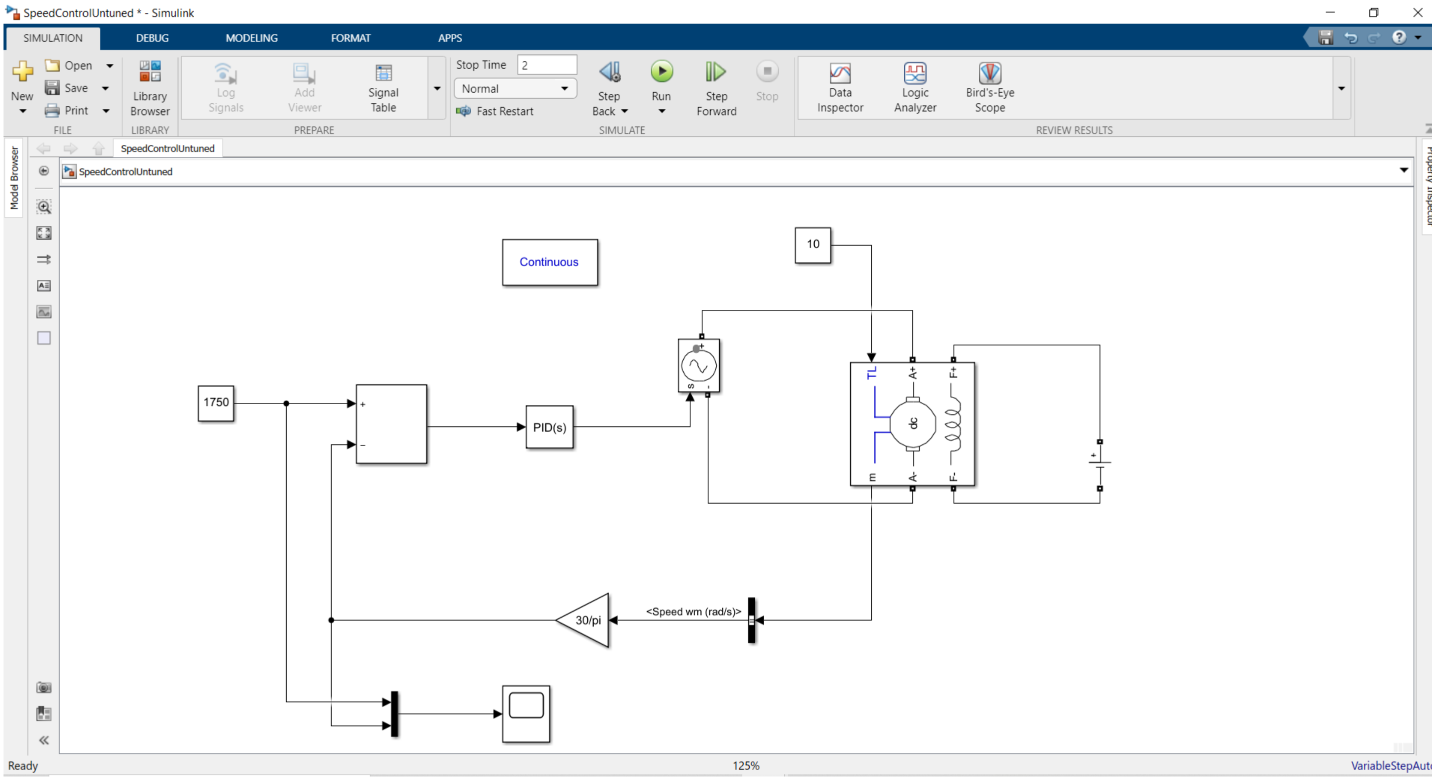
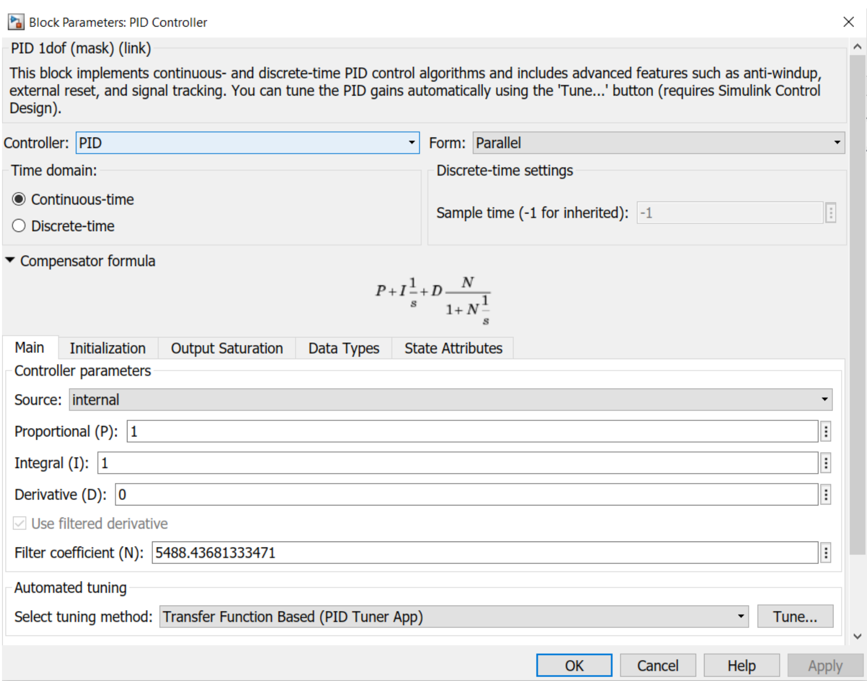
Now we build the Simulink Model using the inbuilt PID controller.



The value of PID controller parameters before tuning are



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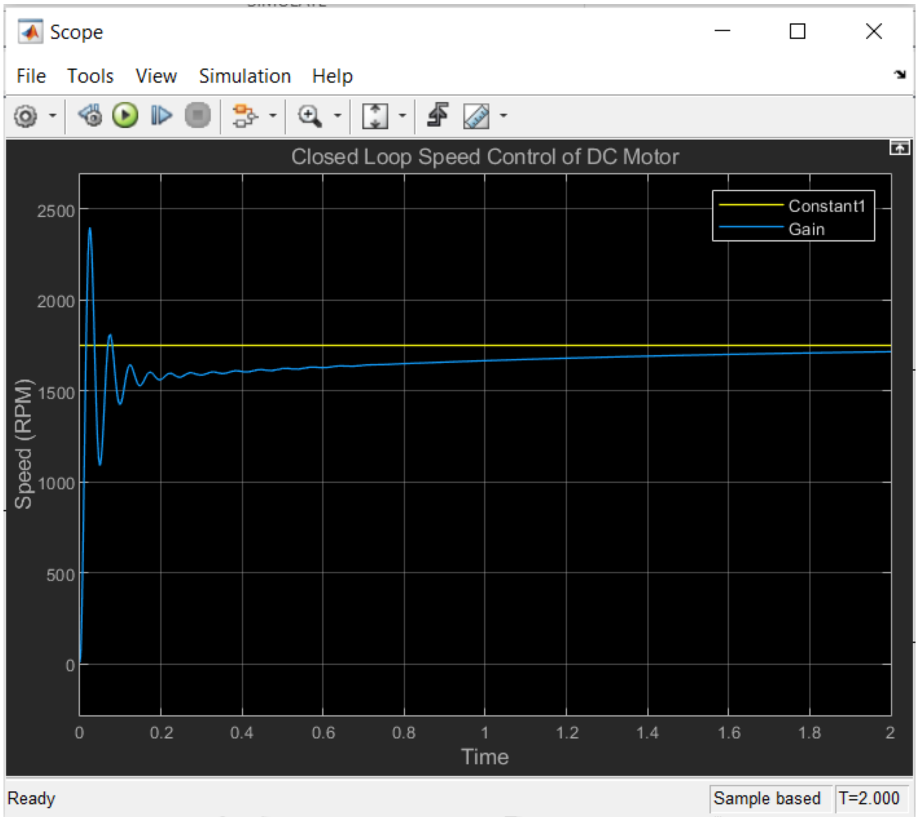
The simulation results are



As we can see, even after T=2.00s, the Reference Speed (1750 RPM) has still not been attained, hence, we will use the transfer function block based tuning method.

Controller Parameters

	Tuned	Block
P	0.2146	1
I	5.2665	1
D	0.0021659	0
N	5488.4368	5488.4368

Performance and Robustness

	Tuned	Block
Rise time	0.034 seconds	0.0116 seconds
Settling time	0.153 seconds	1.69 seconds
Overshoot	5.41 %	37.1 %
Peak	1.05	1.37
Gain margin	Inf dB @ Inf rad/s	Inf dB @ Inf rad/s
Phase margin	64.5 deg @ 48 rad/s	26.1 deg @ 109 rad/s
Closed-loop stability	Stable	Stable

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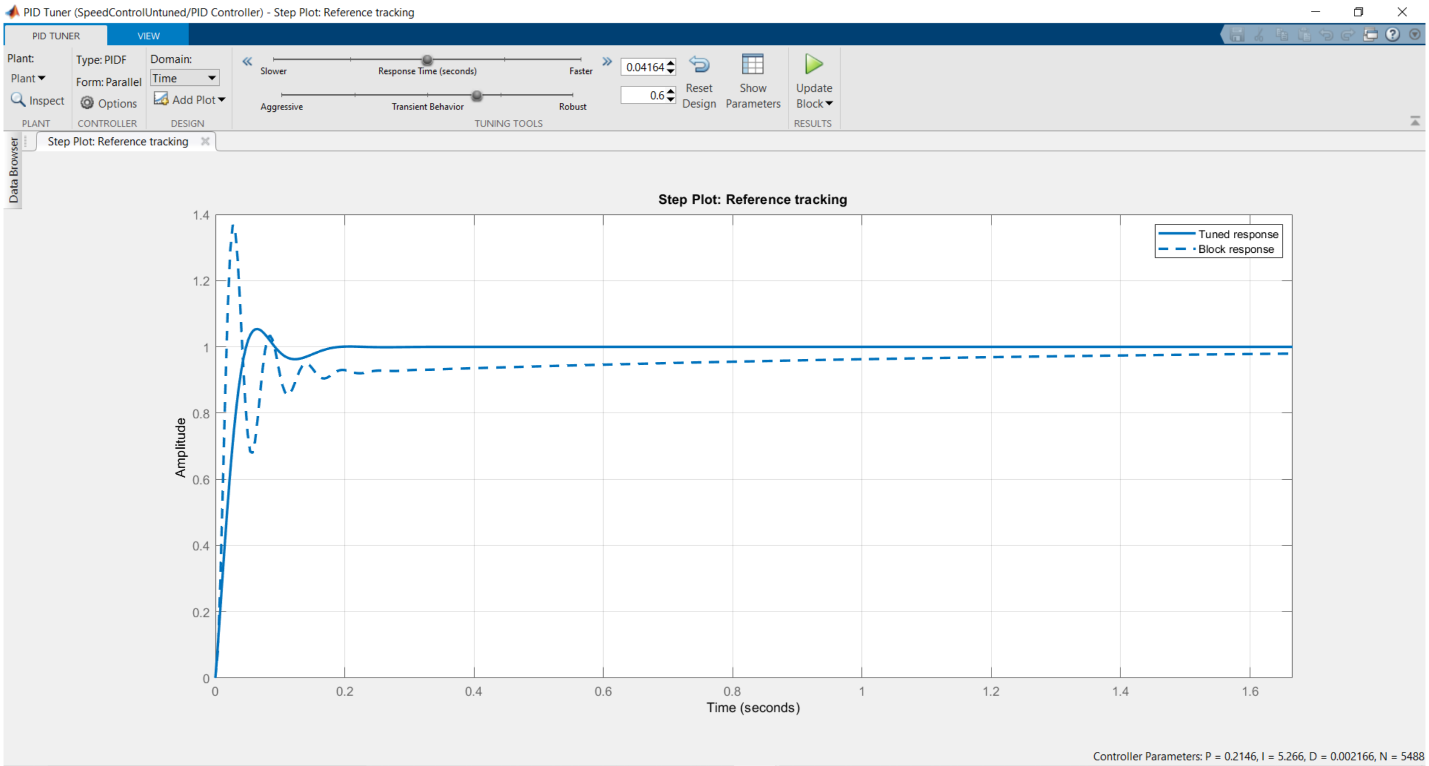

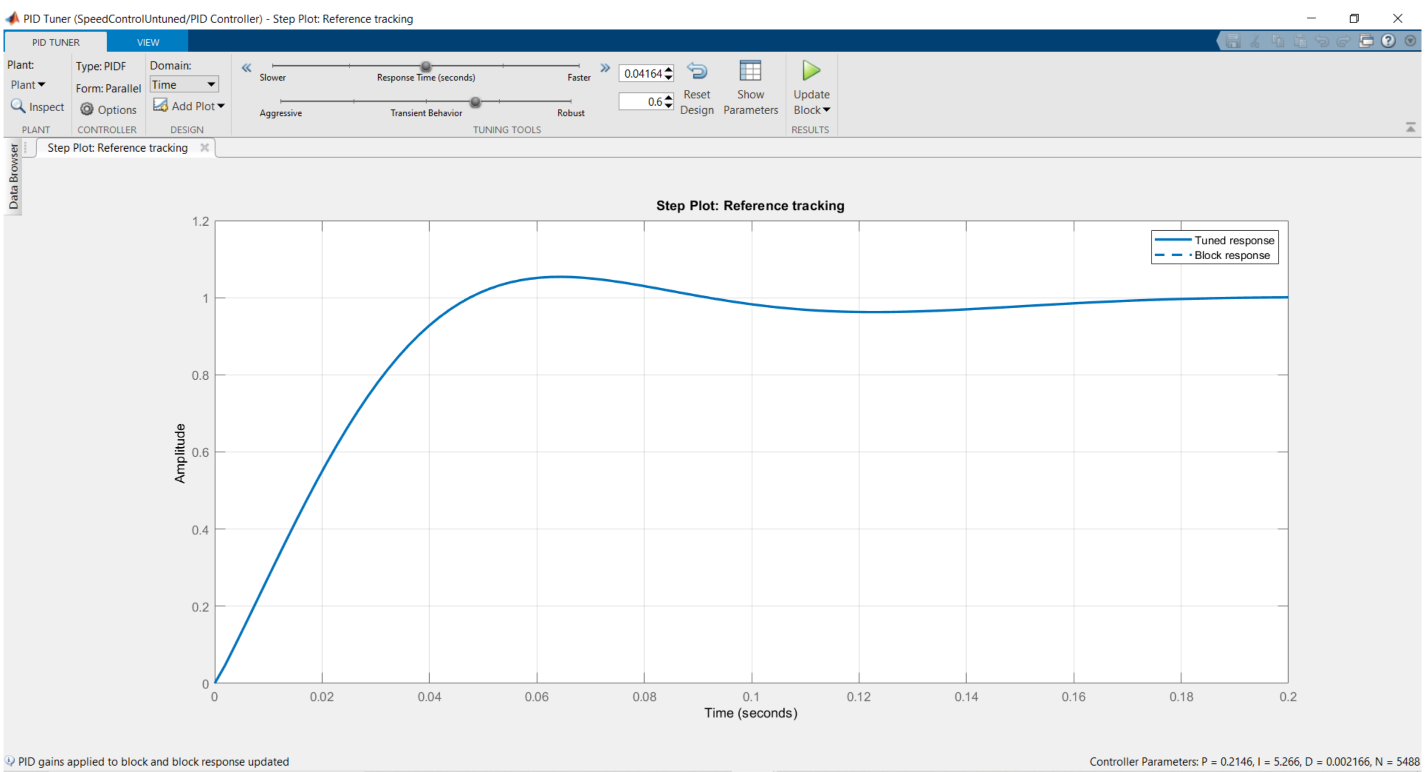

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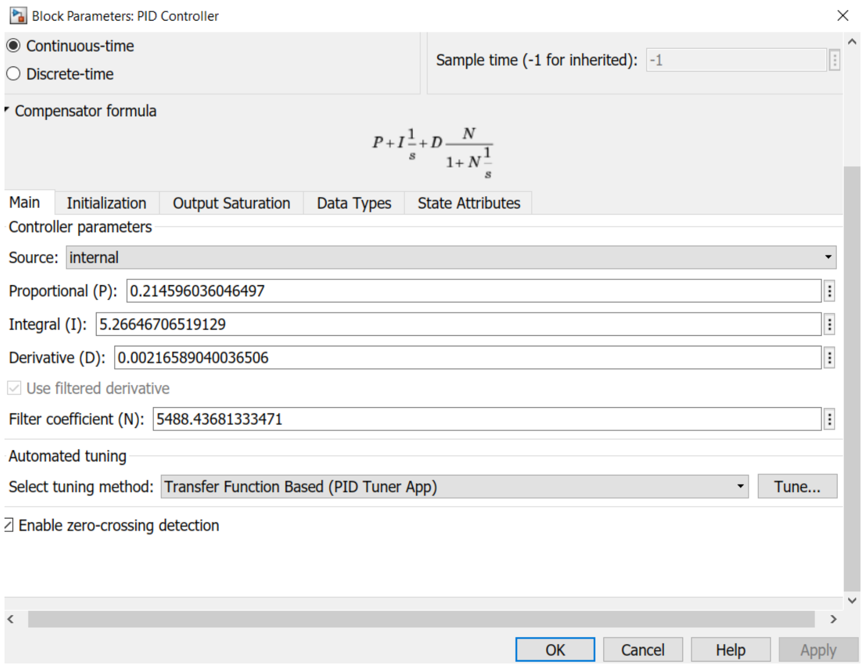
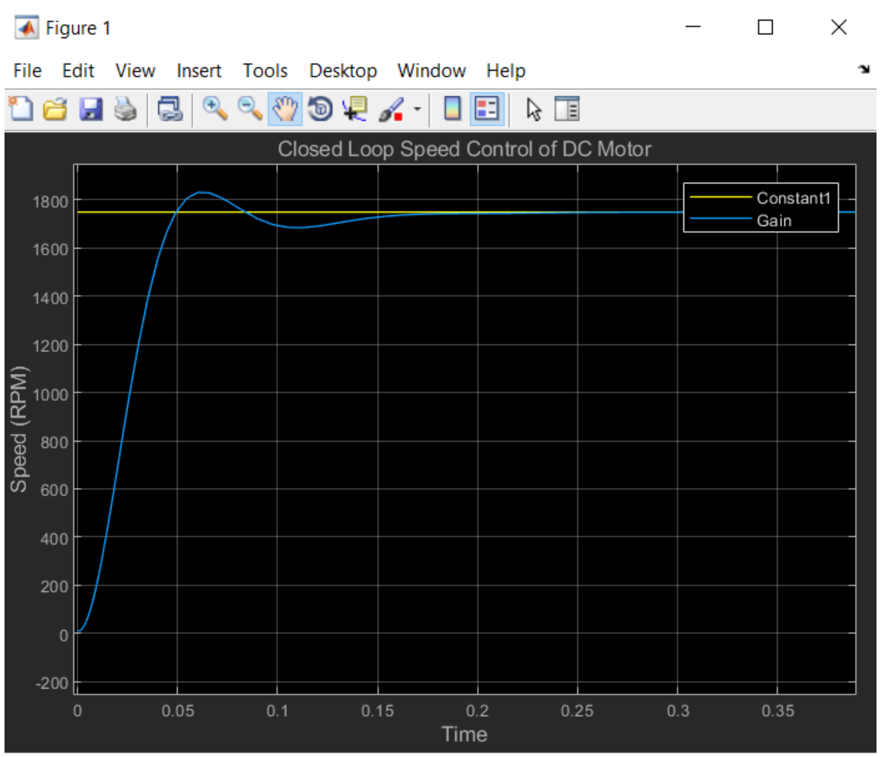
The updated values of PID controller parameters are



Now, upon re-running the simulation, we can see that the results are much better as we get convergence at T=0.2s



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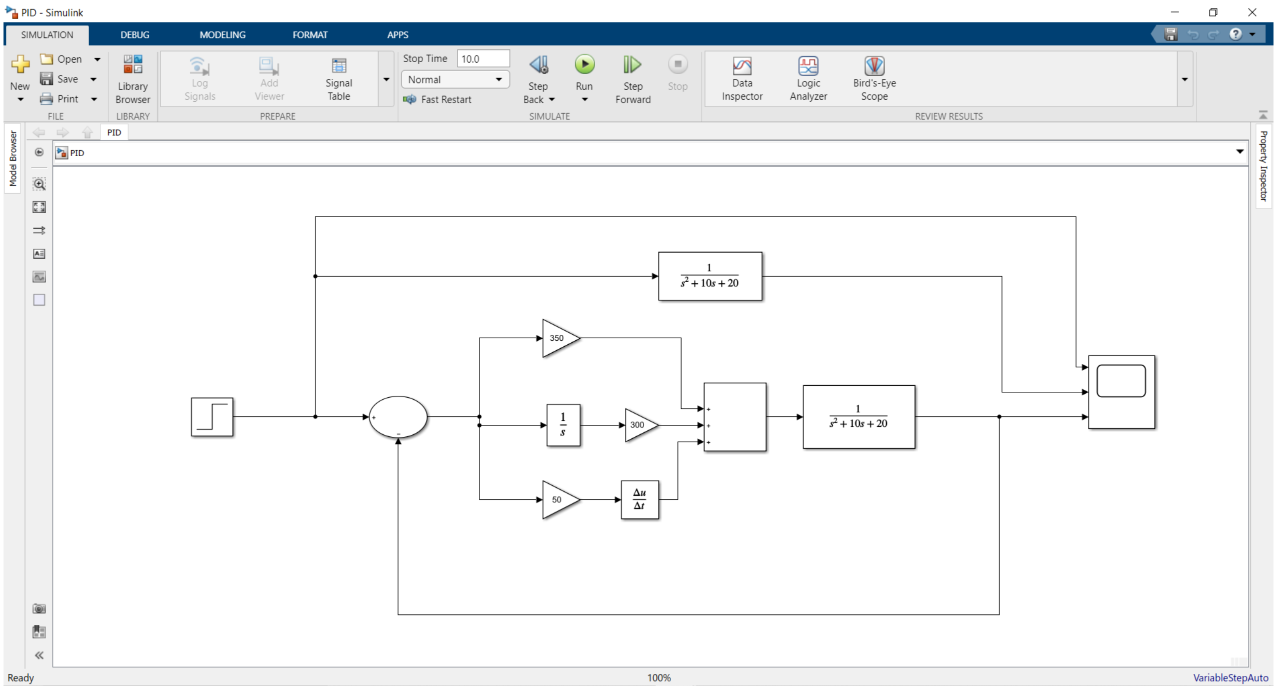
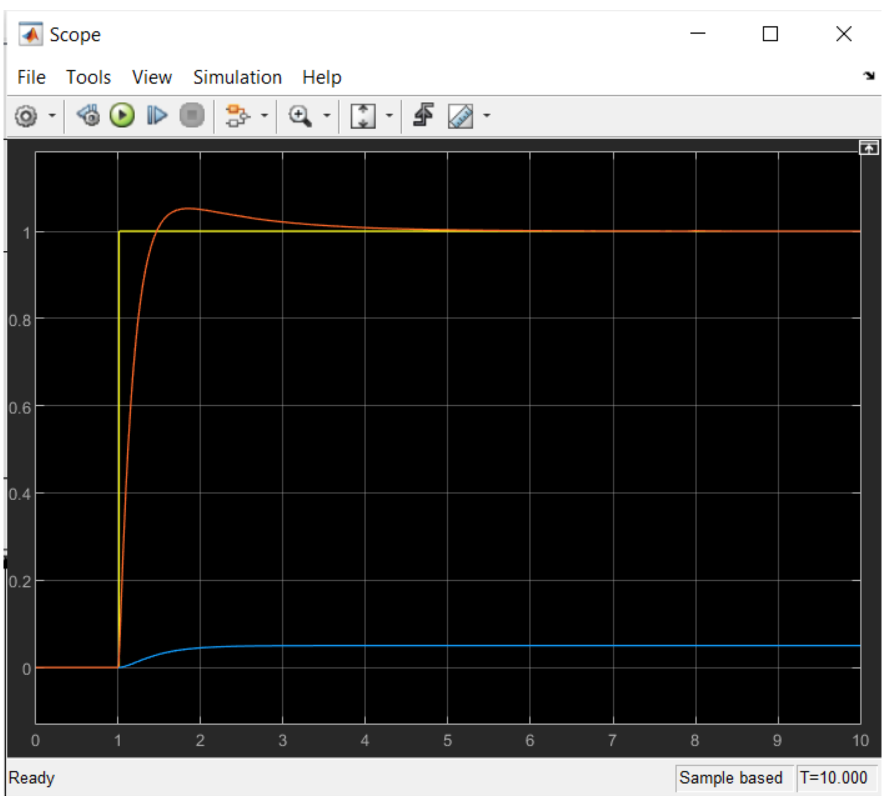
We can also construct our own PID controller model and test it on a basic transfer function





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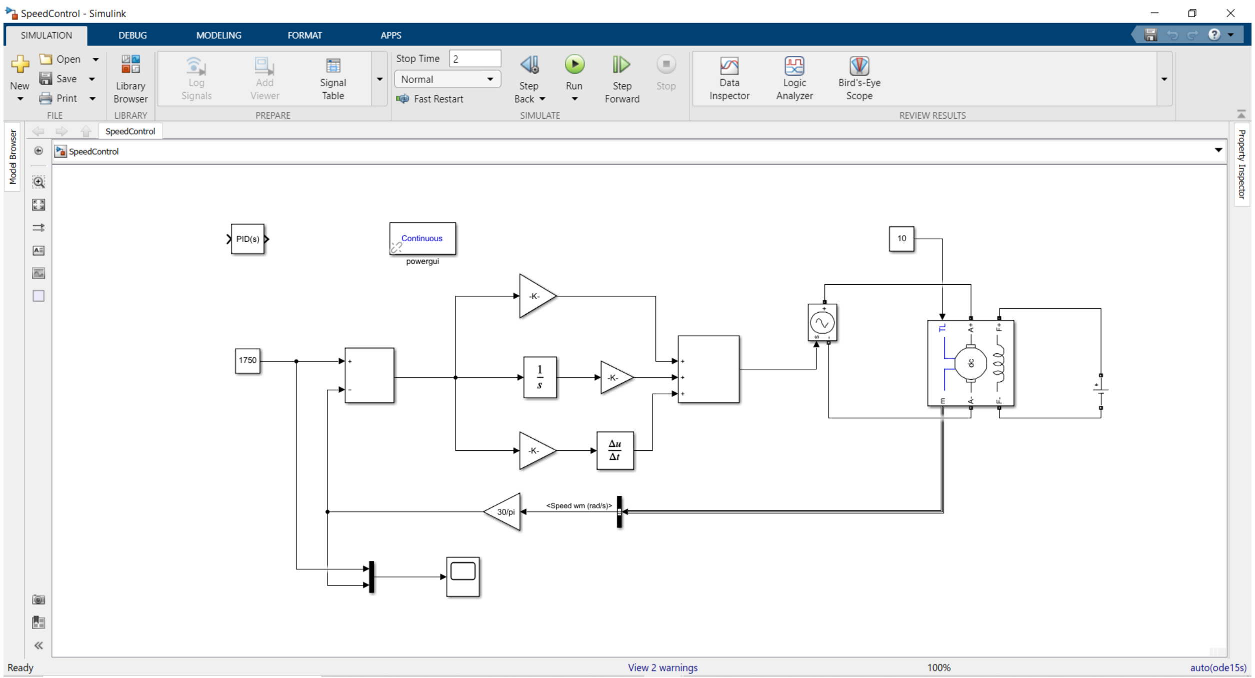
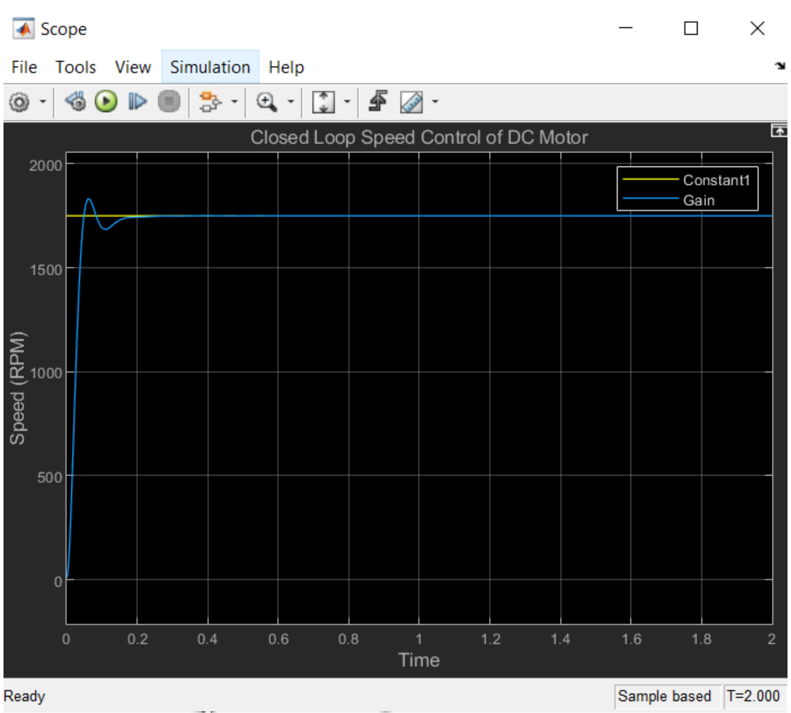
Now, we may replace the inbuilt PID controller with the model we have constructed and change the value of the constants to those after tuning.



It gives us the exact same output



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RESULT

We were successfully able to simulate the implementation of Speed Control of a DC Motor using the tuned parameters of our own PID Controller model on Simulink software.

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