Problem

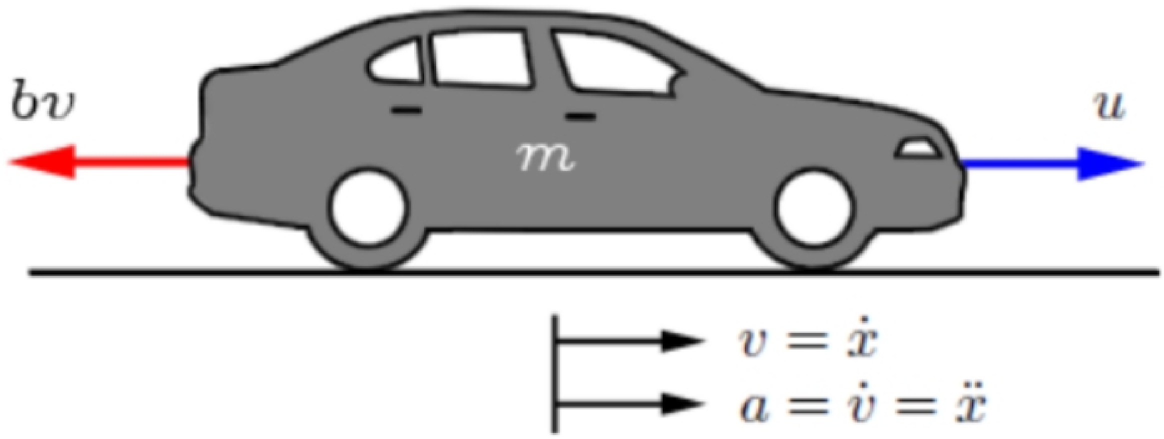


Figure 3:

2 Problem B

(m) vehicle mass **2000 kg**

(b) damping coefficient **50 N.s/m**

Our constants:

a = 1

b = 2

c = 2

S = 25

M = 2000

When an external force(u) is applied the car starts it accelerates from rest and runs at a speed of **25**m/s in the presence of resistive forces by the road(bv). From figure 3, along with the aforementioned information we get :

m’v+bv=u (b in this equation is damping coefficient ; b(damping) = **50**)…..(1)

We want it to reach the speed within **2s** and once it reach that speed that changes in the speed be less than **1%** of the desired speed. Once the the vehicle started, before it reaches the steady state running condition any possible overshoot in speed should be less than **2%**.

Design a PID controller for this purpose.

INTRODUCTION:

A proportional–integral–derivative controller (PID controller or three-term controller) is a control loop mechanism employing feedback that is widely used in industrial control systems and a variety of other applications requiring continuously modulated control. A PID controller continuously calculates an error value (e) as the difference between a desired setpoint (SP) and a measured process variable (PV) and applies a correction based on proportional, integral, and derivative terms (denoted P, I, and D respectively), hence the name.

Working:

The model of the cruise control system is relatively simple. If it is assumed that rolling resistance and air drag are proportional to the car's speed, then the problem is reduced to the simple mass and damper system shown below.

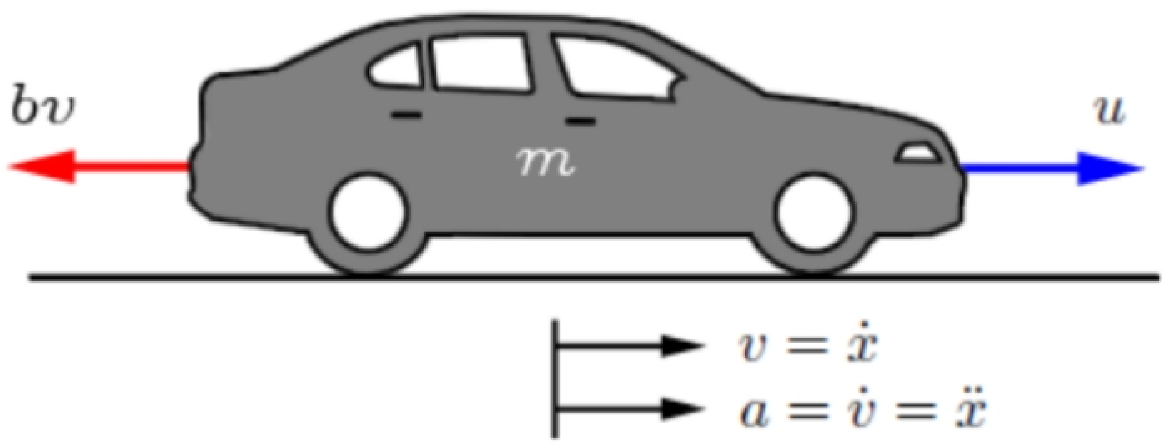


Figure 3:

Using Newton's 2nd law, the governing equation for this system becomes:

(1) mv’ + bv = u

IMPORTANT EQUATIONS :

$$u(t) = K_p e(t) + K_i \int e(t) + K_d \frac{\mathrm{d}e(t)}{\mathrm{d}t}$$

$$C(s) = K_p + \frac{K_i}{s} + K_d s = \frac{K_d s^2 + K_p s + K_i}{s}$$

The control signal (u) to the plant is equal to the proportional gain (K_p) times the magnitude of the error plus the integral gain (K_i) times the integral of the error plus the derivative gain (K_d) times the derivative of the error. This control signal (u) is fed to the plant and the new output (y) is obtained. The new output (y) is then fed back and compared to the reference to find the new error signal (e).The controller takes this new error signal and computes an update of the control input. This process continues while the controller is in effect.

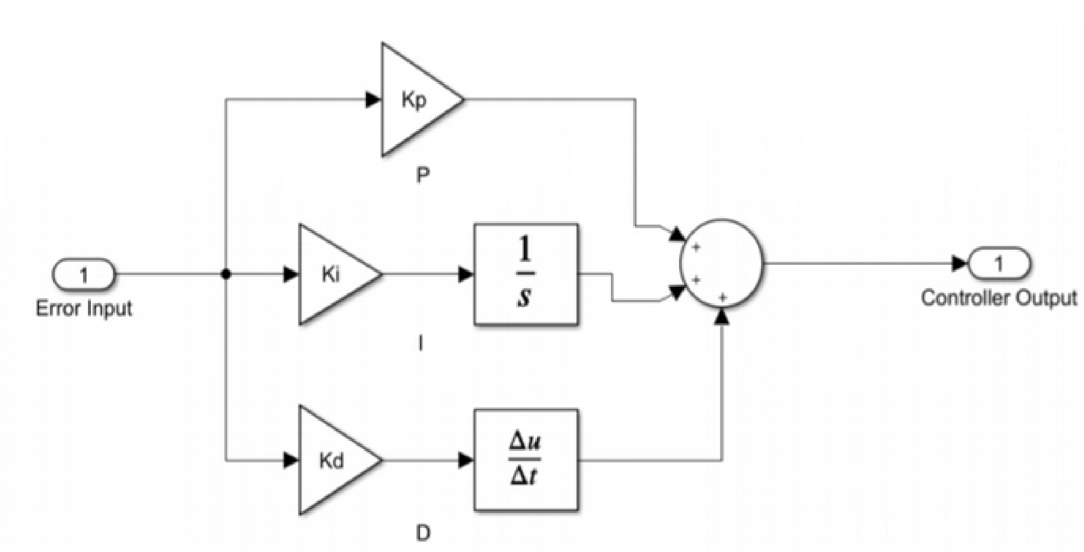
Transfer Function :

Taking the Laplace transform of the governing differential equation and assuming zero initial conditions, we find the transfer function of the cruise control system to be:

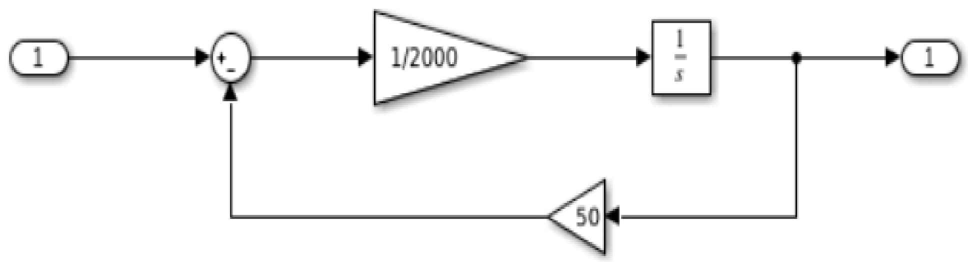
$$P(s) = \frac{V(s)}{U(s)} = \frac{1}{ms+b} \qquad [\frac{m/s}{N}]$$

PID CONTROLLER:

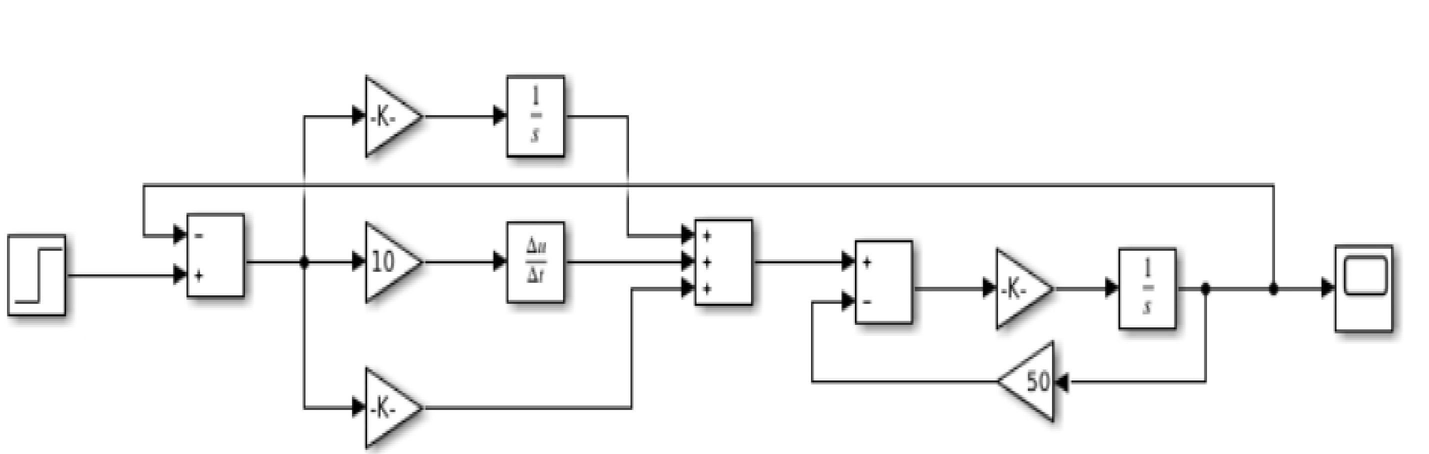
Using this model we approached a better model for our given project:



PLANT DESIGN :



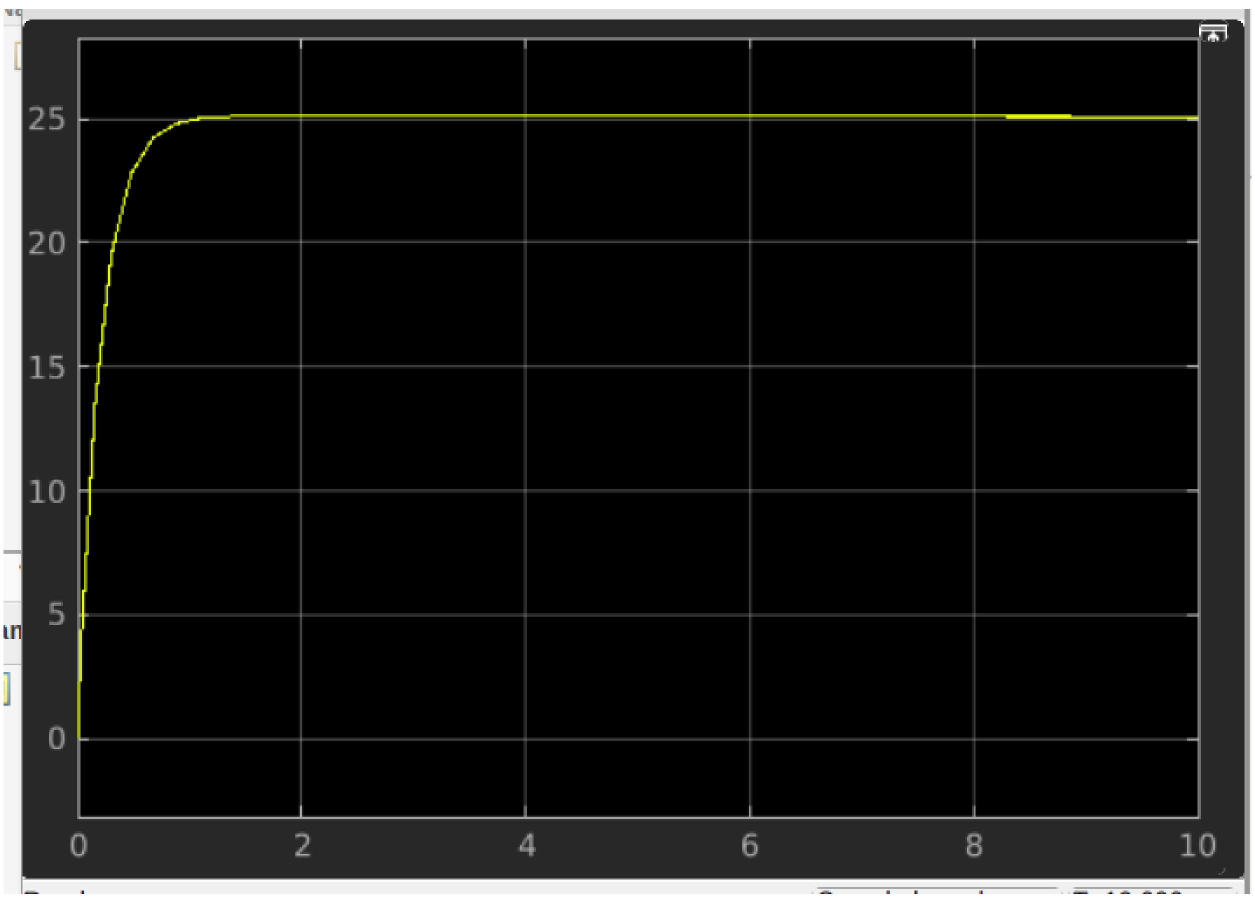
BLOCK DIAGRAM :



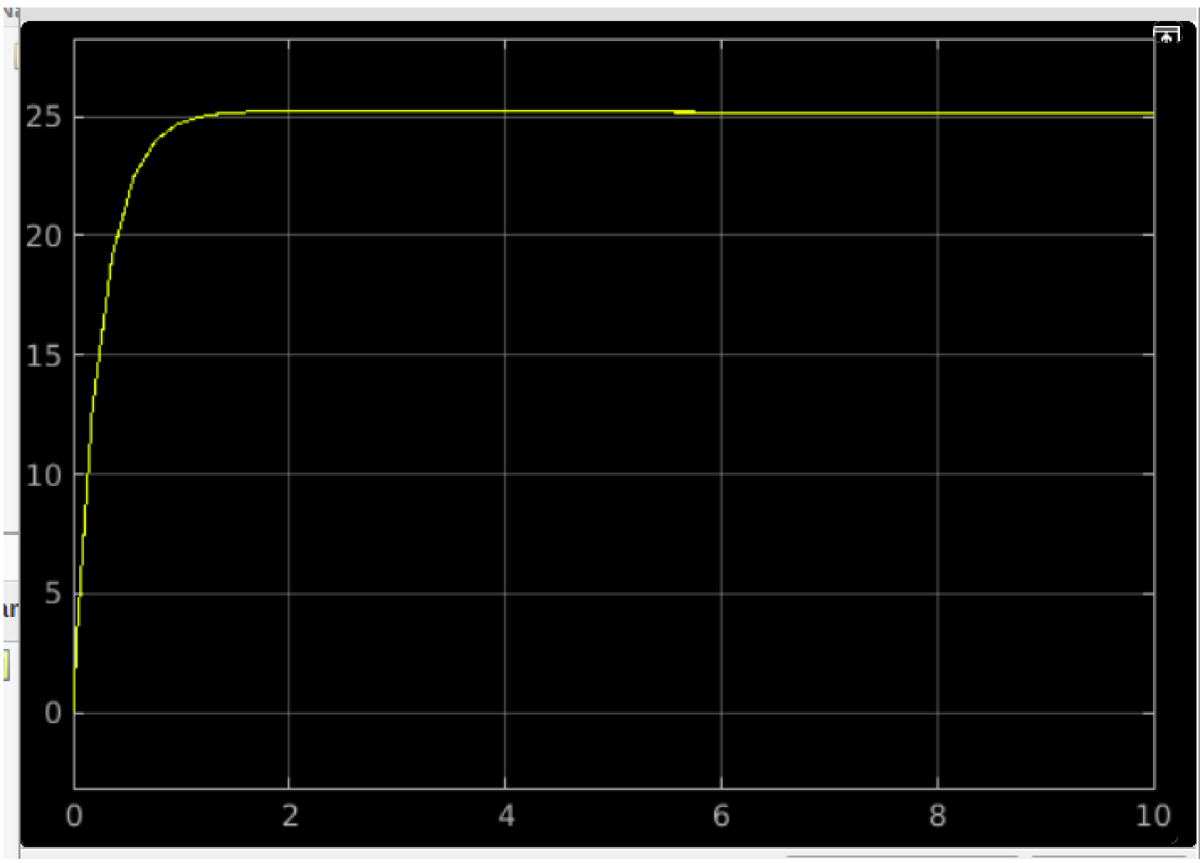
PID Gains of Step Response:

Following are the gains which we found after fine tuning(each figure attached below gains, we will also post it on moodle):

1. Kp = 8000
2. Kd = 10
3. Ki = 500



1. Kp = 8000
2. Kd = 1
3. Ki = 400



1. Kp = 7000
2. Kd = 1
3. Ki = 400