Ahsanullah University of Science and Technology

Department of Electrical and Electronic Engineering

4^{th} Year 1^{st} Semester

OPEN ENDED LAB REPORT

Course No. : **EEE-4106**

Course Title : **Control System-I Lab**

Section : **D1**

Group : **G1**

Submitted By,

SL No.	Student Name	Student ID
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Submitted To,

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Assistant Professor

Department of Electrical and Electronic Engineering

Ahsanullah University of Science and Technology

Experiment Name : Complete Control architecture as a physical electrical system on Veroboard.

Objective : The main objectives of this project-

- To tune a system if the system is fixed.
- To optimize the system performance according to design criteria.

Practical Application :

- Temperature Control in HVAC Systems: In heating, ventilation, and air conditioning (HVAC) systems, feedback control is used to maintain a desired temperature within a building. Sensors measure the current temperature, which is compared to the desired setpoint. The feedback loop then adjusts the heating or cooling output accordingly to maintain the temperature within an acceptable range.

- Robotics: Feedback control is crucial in robotics for precise motion control. Sensors such as encoders measure the actual position of robotic joints or end effectors, which is compared to the desired position. Feedback control algorithms then adjust the actuator outputs to minimize the difference, enabling accurate and controlled movement.

- Automotive Cruise Control: Feedback systems are employed in automotive cruise control systems to maintain a constant vehicle speed set by the driver. Speed sensors measure the actual vehicle speed, which is compared to the desired setpoint. The feedback loop then adjusts the throttle or braking input to maintain the desired speed, providing convenience and fuel efficiency.

- Industrial Automation: Feedback control plays a crucial role in various industrial automation processes such as manufacturing, chemical processing, and power generation. It ensures precise control of parameters such as pressure, flow rate, and temperature, leading to consistent product quality, improved efficiency, and enhanced safety.

- Flight Control Systems: In aircraft, feedback control is utilized in flight control systems to stabilize the aircraft and control its orientation (pitch, roll, and yaw). Sensors measure the aircraft's attitude and motion, which is compared to the desired trajectory. Feedback control algorithms then adjust the control surfaces (elevators, ailerons, and rudder) to maintain stable flight and maneuver the aircraft as required.

- Medical Devices: Feedback control is applied in various medical devices such as infusion pumps, ventilators, and insulin pumps. These systems continuously monitor patient parameters such as blood pressure, oxygen saturation, or glucose levels and adjust the delivery of medication or therapy accordingly to maintain optimal physiological conditions.

- Power Grid Control: In power systems, feedback control is used for voltage regulation, frequency control, and power factor correction. Sensors measure electrical parameters, and feedback control algorithms adjust generator outputs or switch capacitor banks to maintain grid stability and efficiency.

Solution :

ID : 20200105196
➢ Second Last digit of student ID = 9 **X = 9/2 = 4.5 = 5** ➢ Last digit of student ID = 6 **Y = 6/2 = 3**

Required Damping ratio for X0% or 50% Overshoot, $\zeta = \sqrt{\frac{1}{1+[\frac{\pi}{\ln(overshoot)}]^2}}$

$$= \sqrt{\frac{1}{1+[\frac{\pi}{\ln(0.5)}]^2}}$$

$$= 0.215$$

Settling time for the uncompensated system for the given plant,

$$Ts = 3\text{s}$$

Natural Frequency for the system $\omega n = 4.651\ rad/s$

From SiSO Tool the plant for the given system criteria,

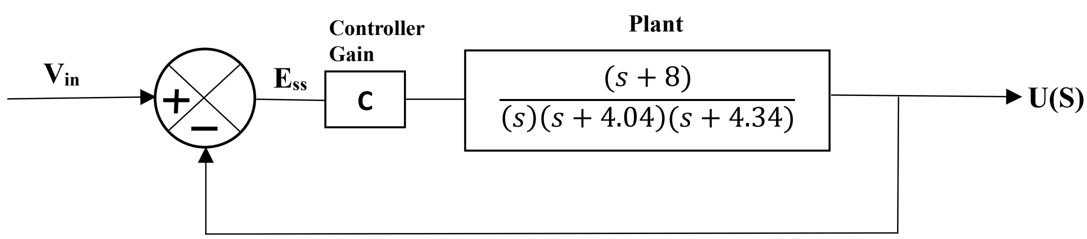


Figure : Block diagram for the given system.

C=22.368

Compensator Editor Data for Uncompensated System				
Type	Location	Damping	Frequency	Gain Controller(C)
Integrator	0	-1	0	22.368
Real Pole	-4.04	1	4.04	
Real Zero	-8	1	8	
Real Pole	-4.34	1	4.34	

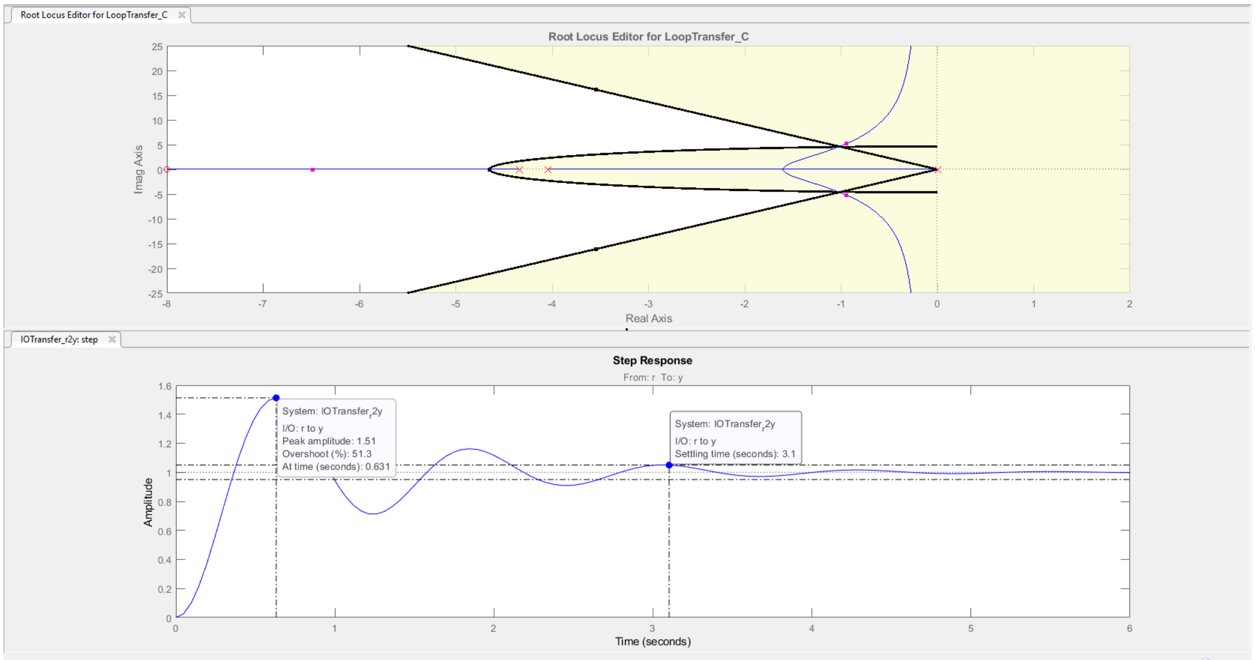


Figure : Root Locus Editor for Loop Transfer _C and Step Response for the given uncompensated system.

Basic Parameters for Uncompensated System			
Overshoot=50%	Damping Ratio , $\zeta = 0.215$	Settling Time Ts= 3s	Controller Gain,K=22.368

Physical Circuit Diagram for Uncompensated System (Designed on Easy EDA)

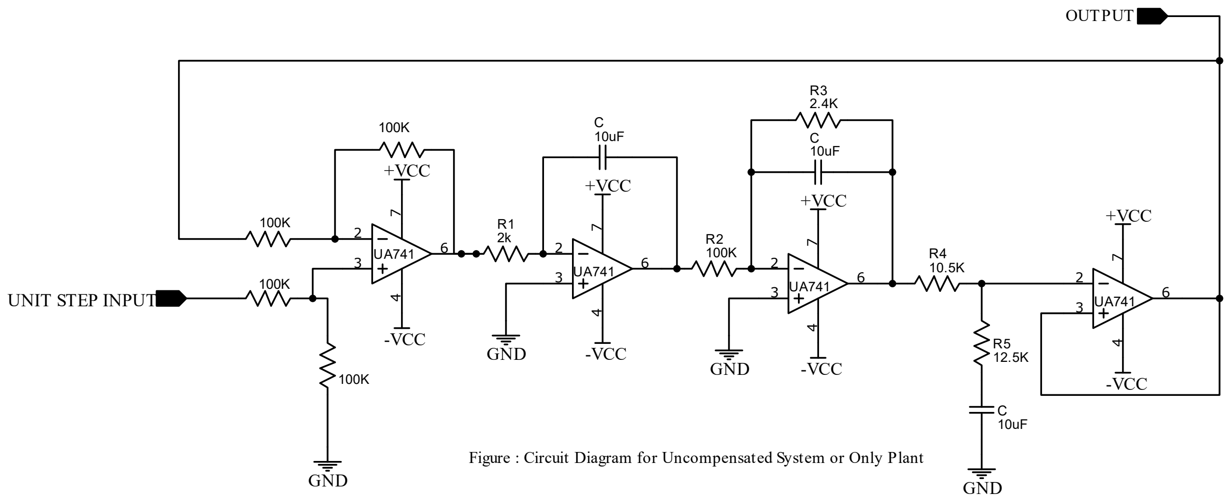


Figure : Physical Circuit diagram for given uncompensated system.

Design Parameters					
R1	R2	R3	R4	R5	C
2043.1096 ohm	100K	24752.475 ohm	10541.474 ohm	12.5K	10uF

Simulink Simulation :

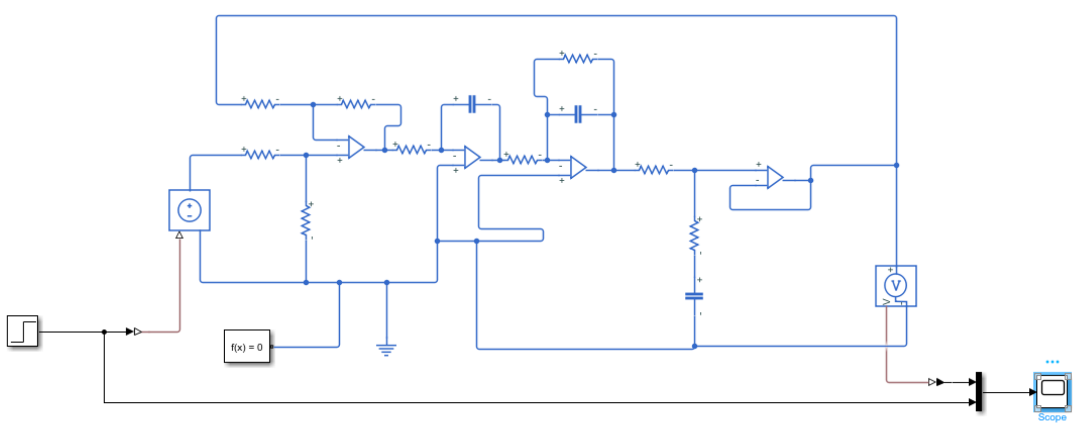
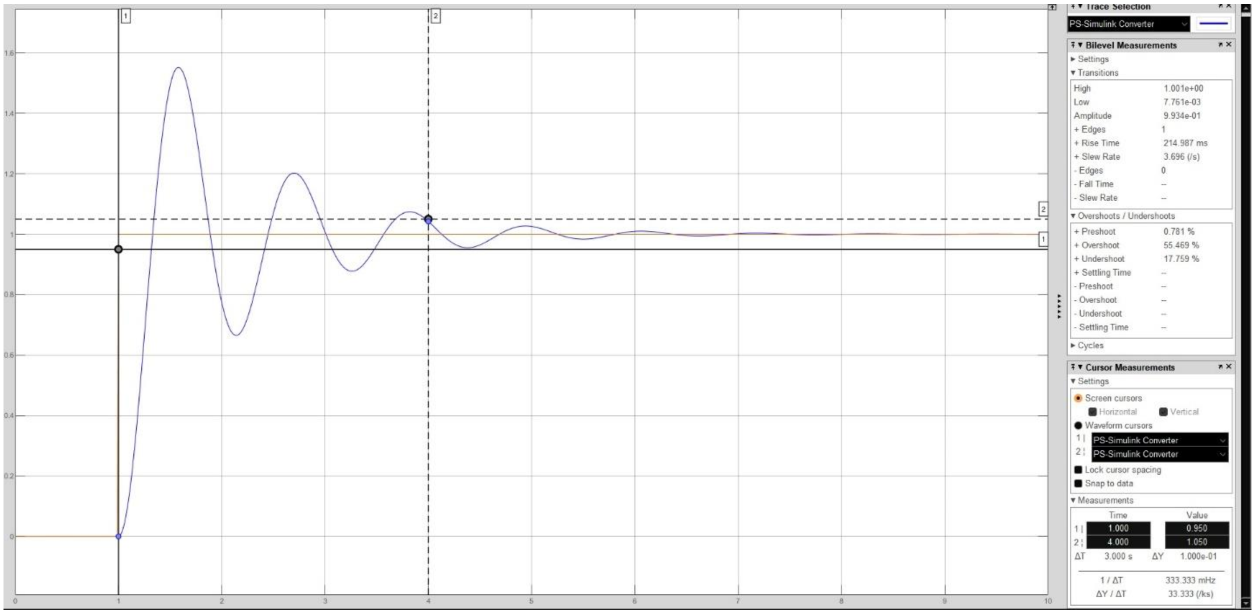


Figure : Physical Circuit diagram for given uncompensated system.

Output :



Simulated Result	
Settling Time Ts= 3s	Overshoot = 55.469%

New Design criteria Assumption

New OS = 30.7 %

Settling Time = 0.548 s

Compensator Editor Data for Compensated System				
Type	Location	Damping	Frequency	Gain Controller(C)
Integrator	0	-1	0	
Real Pole	-4.04	1	4.04	
Real Zero	-8	1	8	
Real Pole	-4.34	1	4.34	223.68
Real Pole	-10	1	10	
Real Zero	-1	1	1	
Integrator	0	-1	0	

Here, $K_{old} = 22.368$ and $K_{new} = 223.68$

Gain Factor = 223.68/22.368 = 10

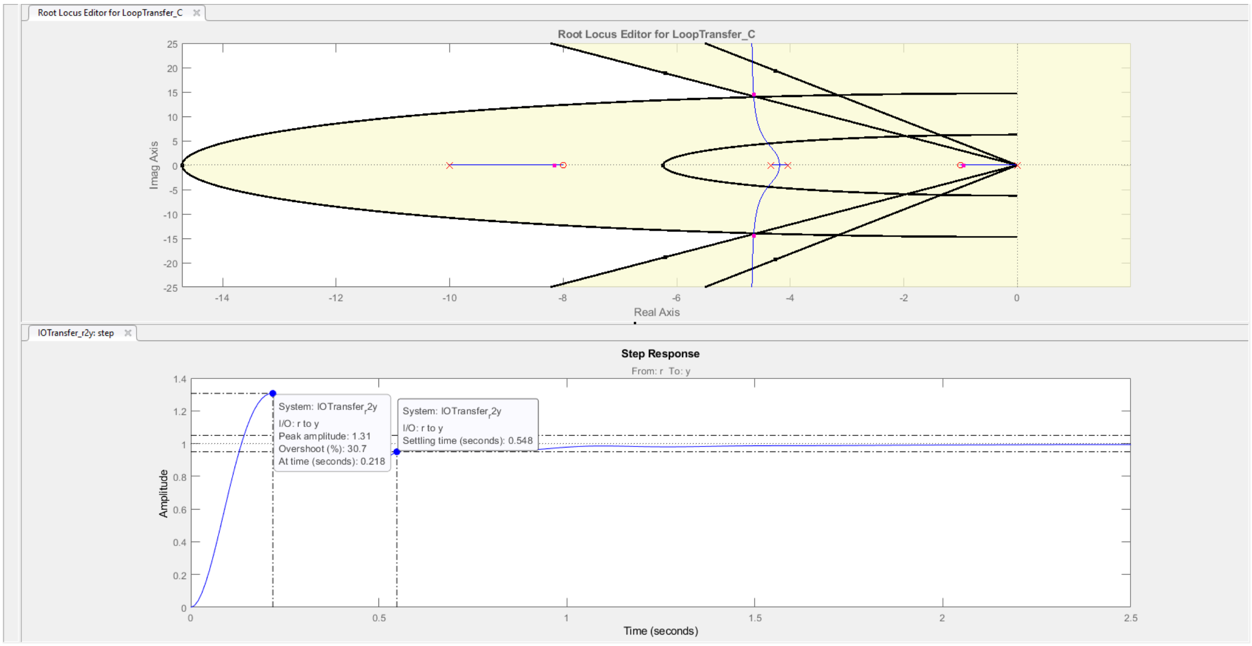


Figure : Root Locus Editor for Loop Transfer _C and Step Response for the compensated system.

Basic Parameters for Compensated System			
Overshoot=30.7%	Damping Ratio , $\zeta = 0.3126$	Settling TimeTs = 0.548s	Gain Factor = 10

Block Diagram for new Compensated System :

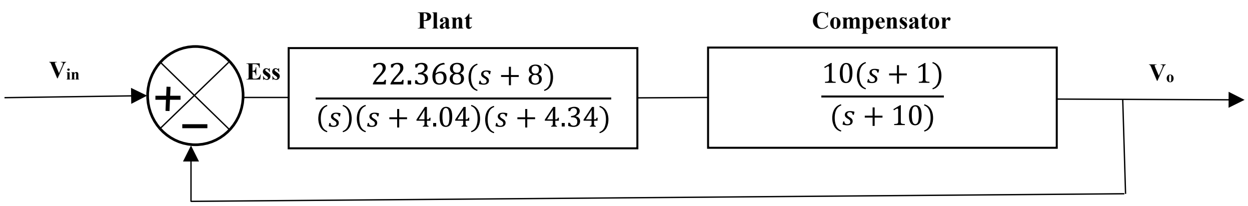


Figure : Block diagram for Compensated PID controller system.

Physical Circuit Diagram for Compensated System (Designed on Easy EDA)

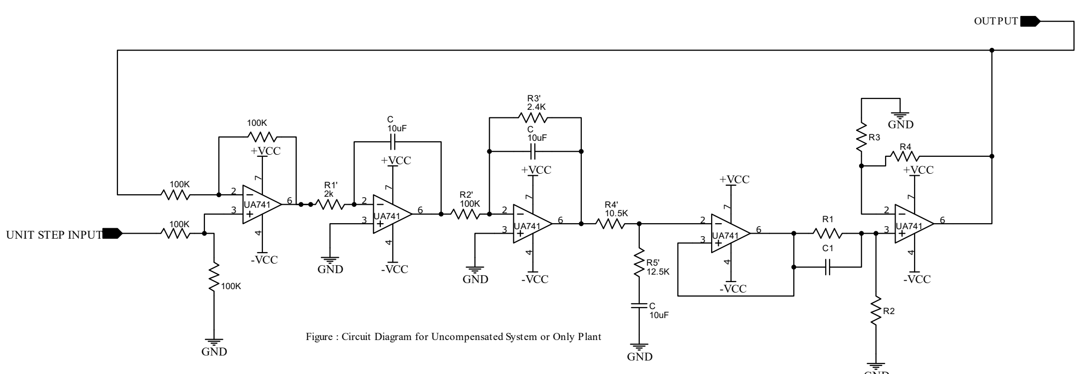


Figure : Physical Circuit diagram for Compensated system.

Simulink Simulation :

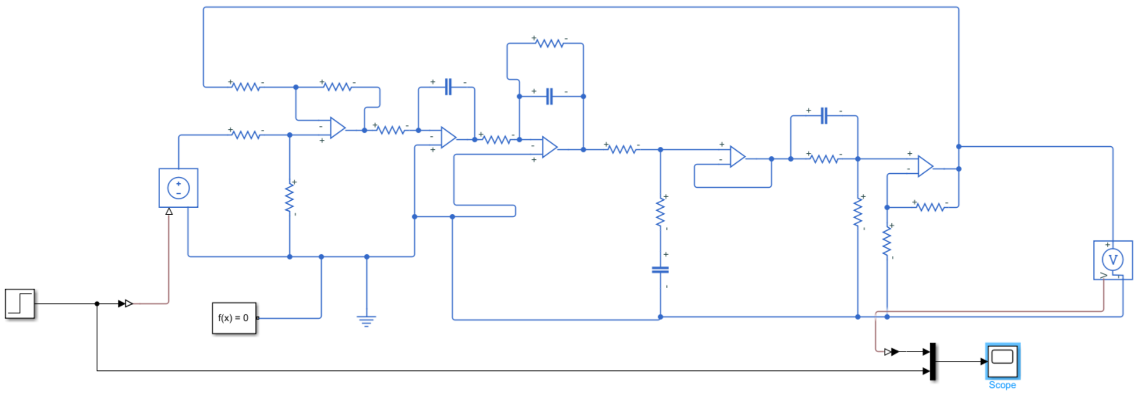
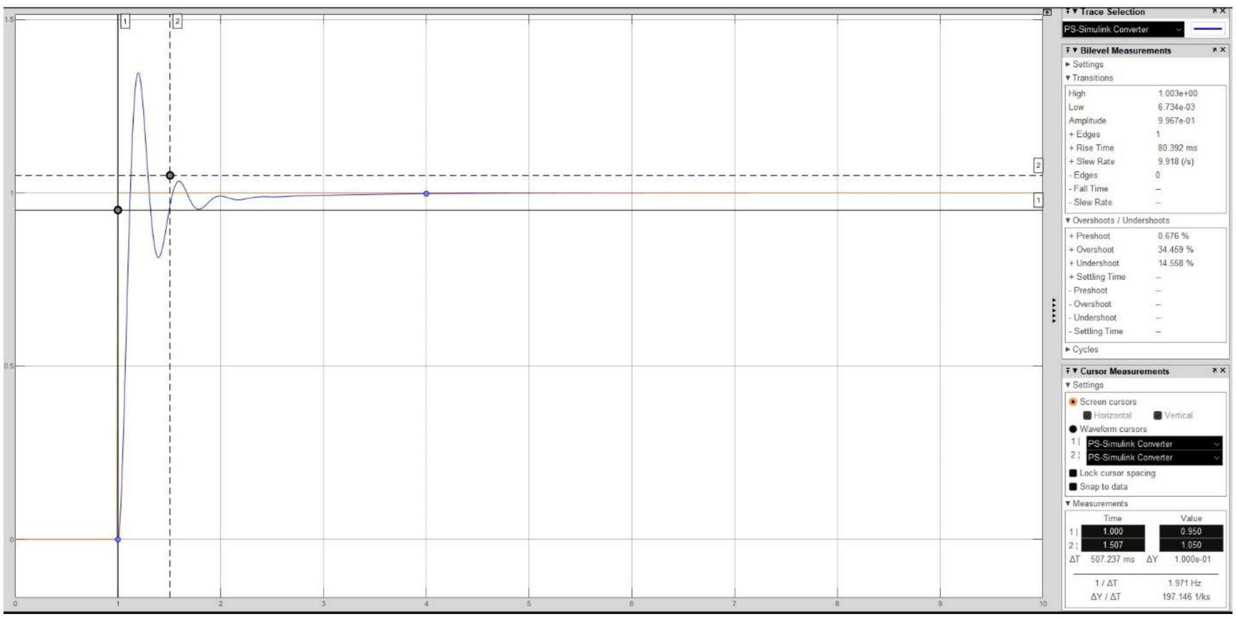


Figure : Physical Circuit diagram for given compensated system.

Output :



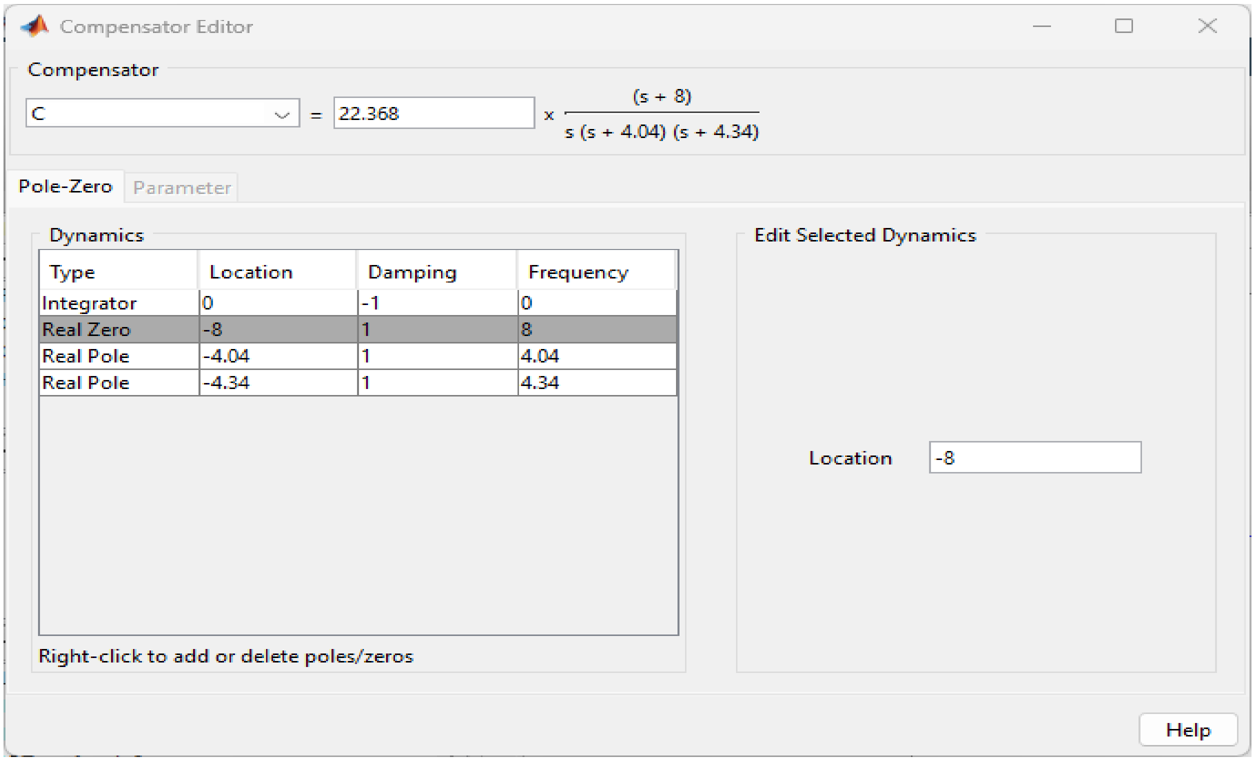
Design Parameters				
R1	R2	R3	R4	C
100K	11111.11K	1K	9K	10uF

Simulated Result	
Settling Time Ts= 0.507	Overshoot = 34.459%

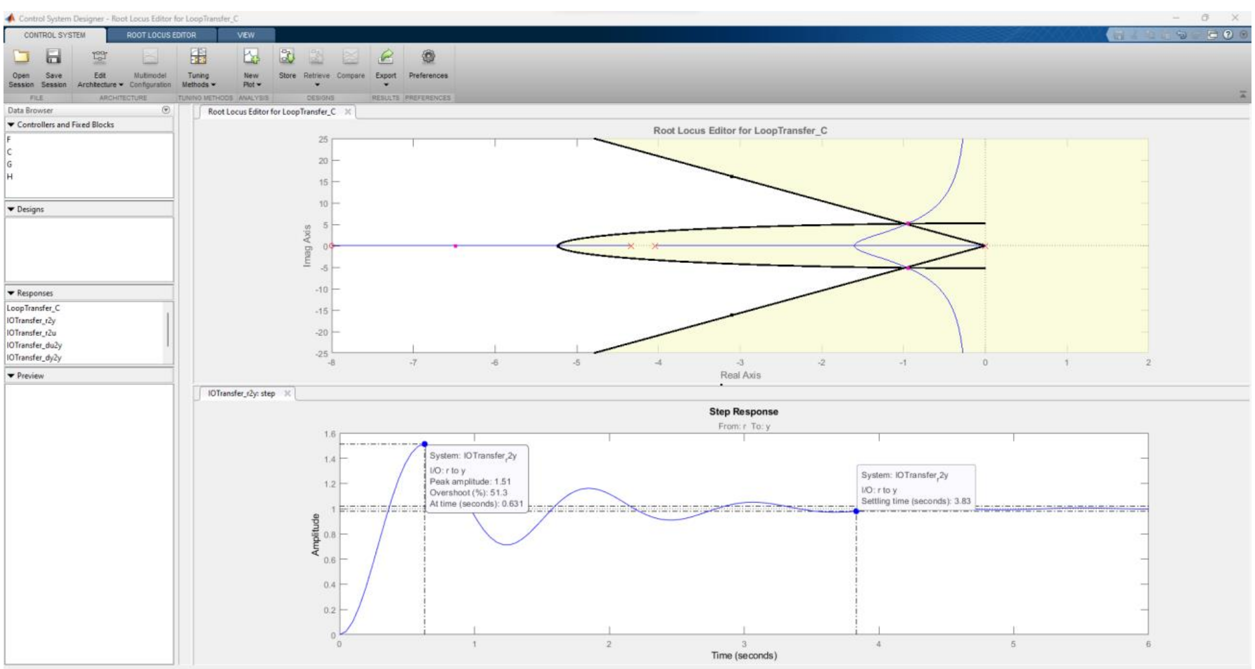
Discussion : Feedback systems in control engineering continuously compare a system's output with a desired reference signal, using the difference to adjust the system's input. They are crucial for maintaining desired performance levels in dynamic systems amidst uncertainty and disturbances. From household thermostats to industrial processes and robotics, feedback systems regulate variables like temperature, pressure, and motion. While offering benefits such as consistency and efficiency, designing effective feedback systems requires addressing stability, robustness, and performance challenges. In summary, feedback systems are essential for precise control across various domains, ensuring optimal system behavior and adaptation to changing conditions.

SISOTOOL OUTPUT

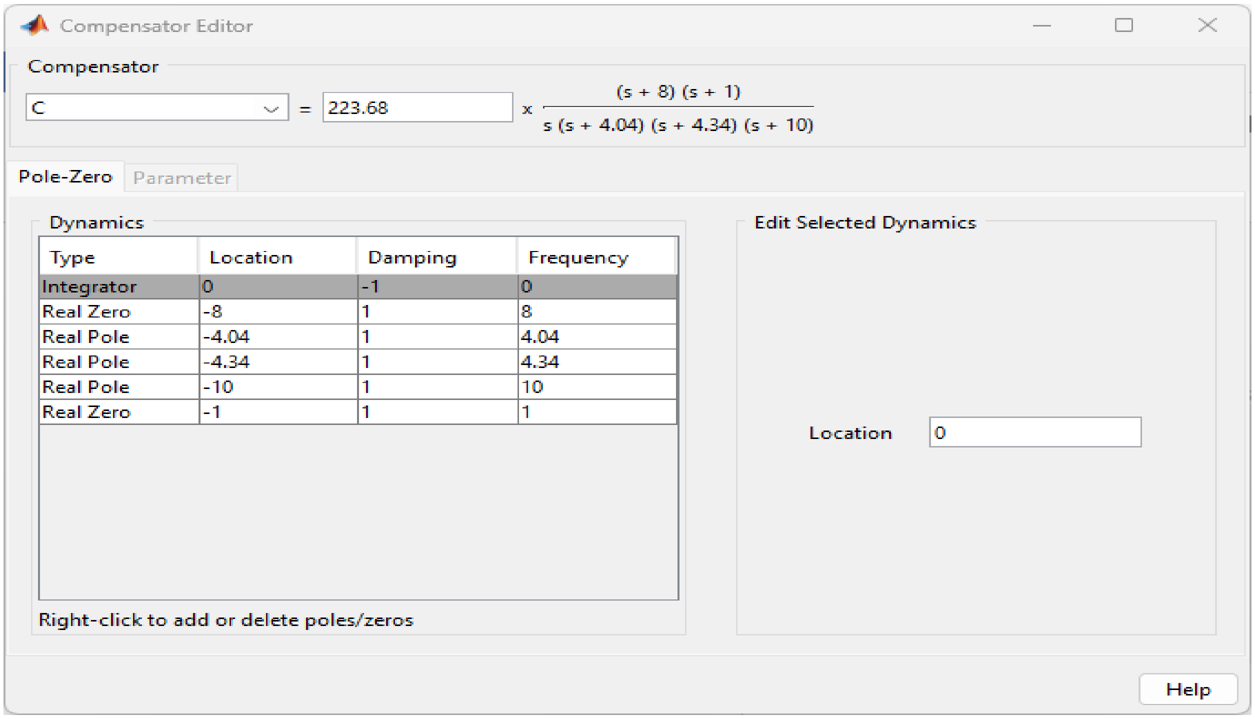
Plant Design



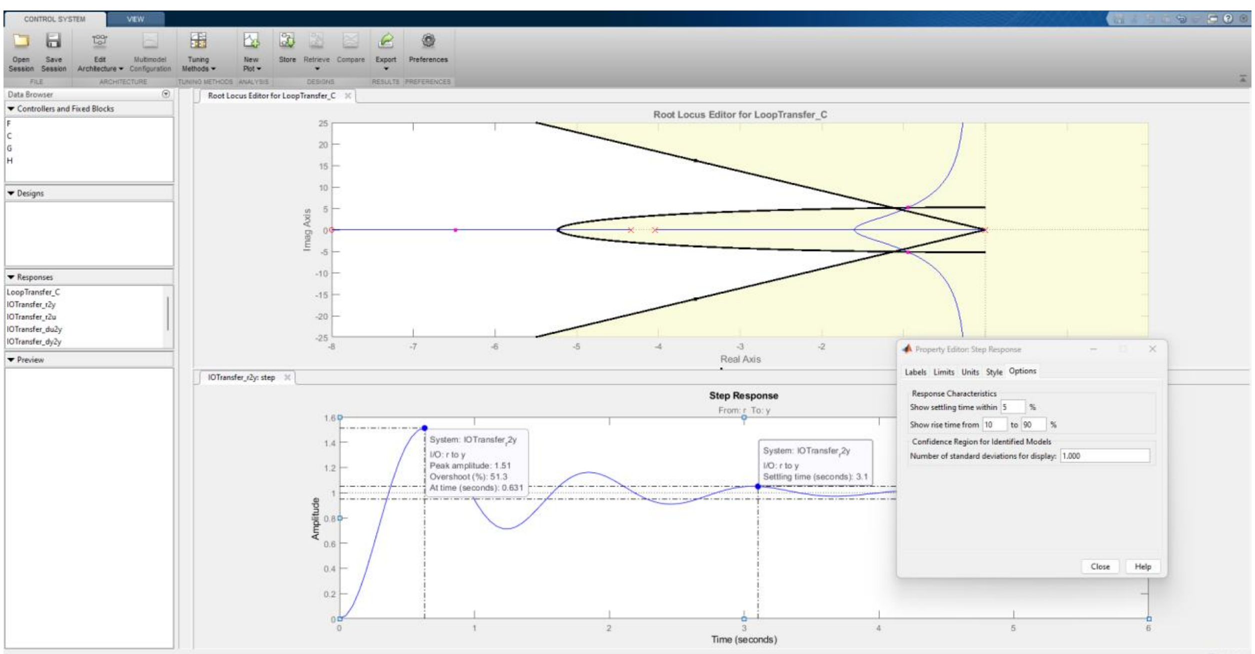
SISOTOOL output-



Compensator-



SISOTOOL Output-



SIMULINK OUTPUT

Plant-

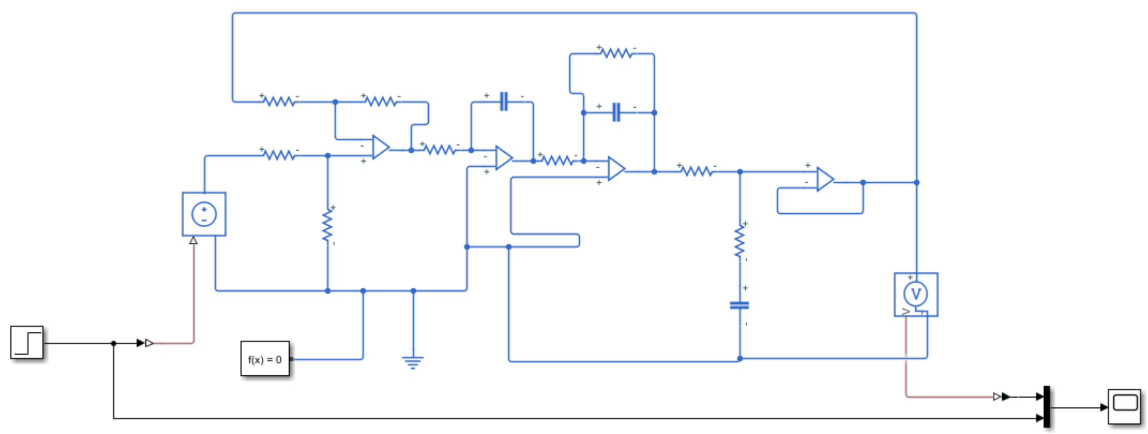


Figure : Circuit diagram for plant

Simulated Circuit Output-

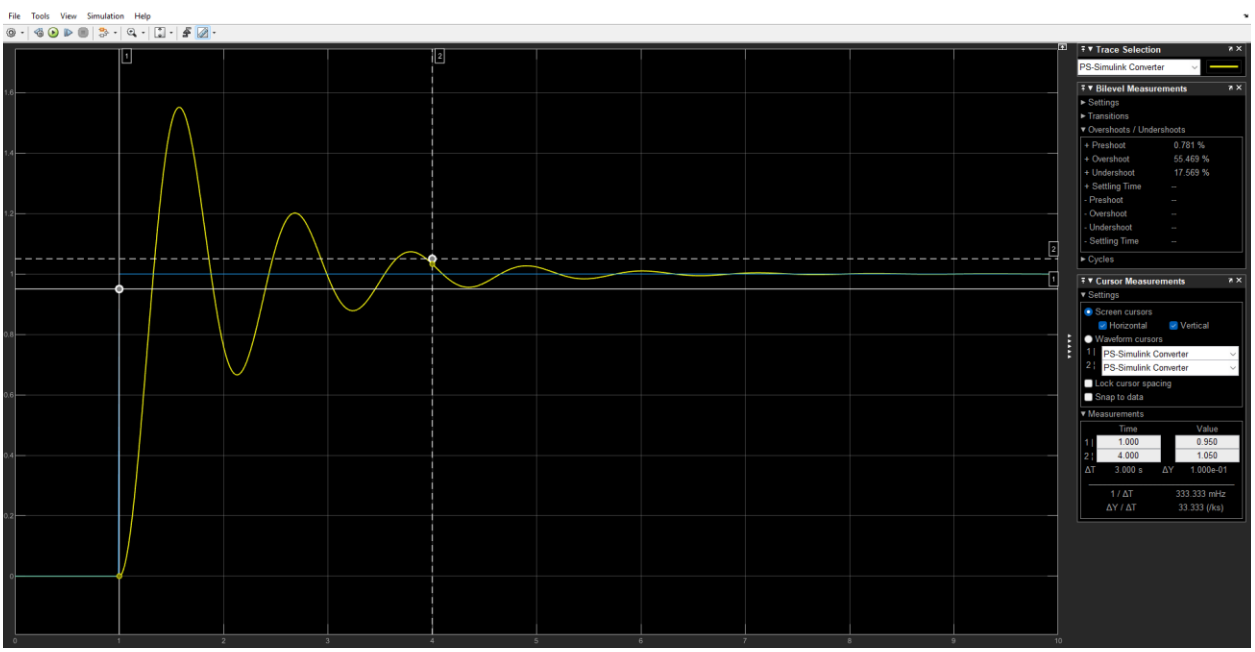


Figure : Simulation output without compensator.

Compensator-

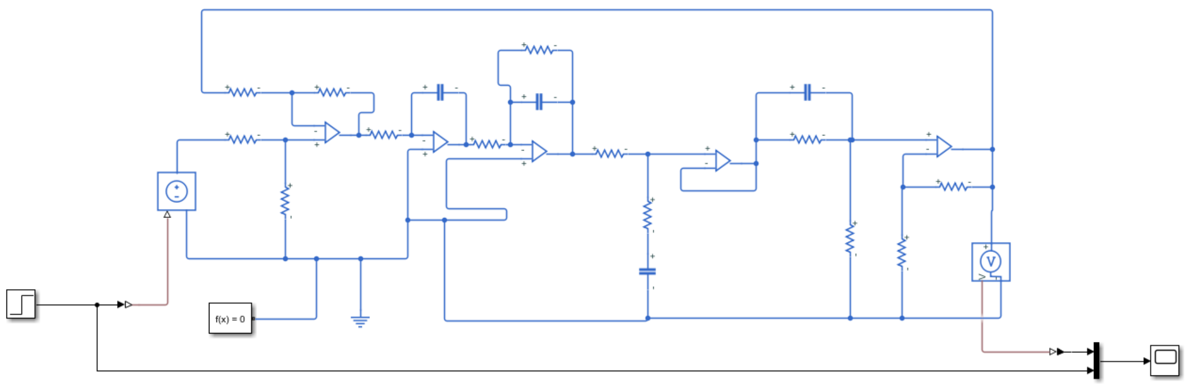


Figure : Circuit diagram for Compensated system

Simulated Circuit Output-

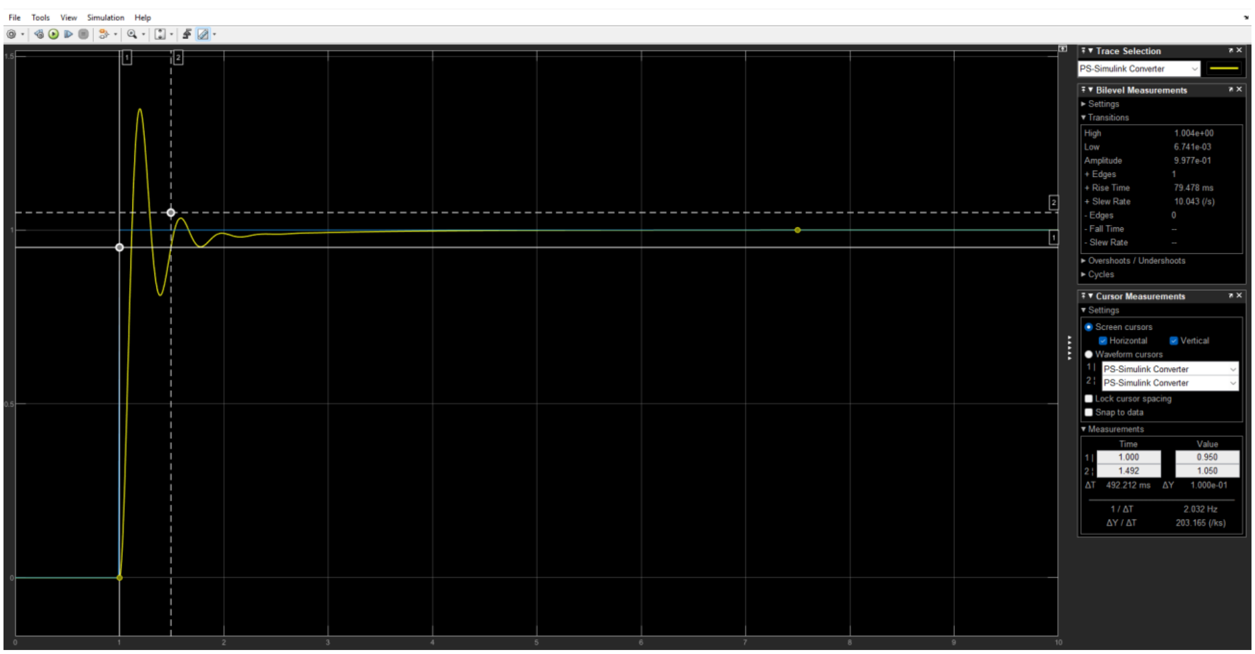


Figure : Simulation output of Compensated system.