

Lab # 01



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CSE-310L Control Systems Lab

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“On my honor, as a student of the University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work”

Submitted to:

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Lab Objectives:

- **Input/Output Relationship:** Understanding how each function manipulates system representations, either in the form of polynomials, transfer functions, or signals.
- **Stability and Response:** Observing how roots, poles, and zeros affect system stability and transient response.
- **System Design:** Learning how to connect systems in series, parallel, and feedback configurations to modify overall system behavior.

1. Root Function (**roots**)

- **Purpose:** Finds the roots of a polynomial equation.
- **Usage:** $r = \text{roots}(p)$
- **Explanation:** Given a vector p representing the coefficients of a polynomial, this function calculates the roots (solutions where the polynomial equals zero). It is useful in control systems for finding poles and zeros of transfer functions.

2. Poly Function (**poly**)

- **Purpose:** Generates a polynomial from its roots.
- **Usage:** $p = \text{poly}(r)$
- **Explanation:** This is the inverse of the roots function. Given a vector r of roots, it returns the coefficients of the polynomial. In control systems, this is used to create characteristic equations from known poles/zeros.

3. Polyval Function (**polyval**)

- **Purpose:** Evaluates a polynomial at specific values.
- **Usage:** $y = \text{polyval}(p, x)$
- **Explanation:** This function takes a polynomial p (as a vector of coefficients) and a set of input values x and returns the corresponding outputs y . It helps in plotting polynomial equations or evaluating system responses.

4. TF Function (**tf**)

- **Purpose:** Creates a transfer function model.
- **Usage:** `sys = tf(num, den)`
- **Explanation:** The transfer function (`tf`) is a mathematical representation of a system. `num` and `den` represent the numerator and denominator of the transfer function, respectively. This function is fundamental in analyzing the behavior of linear time-invariant (LTI) systems.

5. Impulse Function (**impz**)

- **Purpose:** Computes and plots the impulse response of a system.
- **Usage:** `impz(sys)`
- **Explanation:** The impulse function simulates the system's output when an impulse input (a sudden spike of infinite magnitude for an infinitesimally short time) is applied. This is useful in characterizing system dynamics.

6. Conv Function (**conv**)

- **Purpose:** Convolves two signals or polynomials.
- **Usage:** `c = conv(a, b)`
- **Explanation:** Convolution combines two sequences or polynomials to produce a third one. In the context of control systems, it's used to multiply polynomials, which corresponds to cascading transfer functions in the time domain.

7. PZmap Function (**pzmap**)

- **Purpose:** Plots the poles and zeros of a system.
- **Usage:** `pzmap(sys)`
- **Explanation:** This function plots the locations of poles and zeros in the complex plane. It's essential for understanding system stability and transient behavior.

8. Step Function (**step**)

- **Purpose:** Computes and plots the step response of a system.
- **Usage:** `step(sys)`

- **Explanation:** The step function simulates the system's response to a unit step input, which is useful for understanding the time-domain characteristics like rise time, settling time, and steady-state error.

9. Series Function (**series**)

- **Purpose:** Connects two transfer functions in series.
- **Usage:** `sys = series(sys1, sys2)`
- **Explanation:** This function connects two systems such that the output of the first system is the input to the second. The resulting system is the product of the two transfer functions.

10. Parallel Function (**parallel**)

- **Purpose:** Connects two transfer functions in parallel.
- **Usage:** `sys = parallel(sys1, sys2)`
- **Explanation:** This function connects two systems such that both receive the same input, and their outputs are summed. This corresponds to adding two transfer functions.

11. Feedback Function (**feedback**)

- **Purpose:** Creates a feedback loop between two systems.
- **Usage:** `sys = feedback(sys1, sys2)`
- **Explanation:** This function computes the closed-loop transfer function of a system with negative feedback. It's critical in control system design to achieve desired stability and performance.