# EET 3732 – CONTROL SYSTEMS

## MATLAB Project # 1

**Objective:**

Write a script to plot time-domain response of overdamped and underdamped control systems based on user given output functions *Y(s)*.

Programming Steps:

1. Write down your name, date, course name, and project number at the beginning of your script as comments.
2. Explain the objective of your program as comments.
3. Ask user to enter coefficients of the numerator of the output function as a vector.
4. Ask user to enter coefficients of the denominator of the output function as a vector.
5. Use *residue* function to calculate the partial fractions corresponding to the output function.
6. Find the smallest non-zero real part of the root of denominator (characteristic equation) [smallest non-zero absolute value of the real part of *P* vector from residue function]. This will be the *dominant root* of the response and will define the shape of the response, i.e. how long it is going to take for the transient response to decay.
7. Calculate the time constant $\tau = 1/\text{dominant root}$
8. Calculate the time domain response corresponding to each of the partial fraction term up to $10\tau$. Keep your interval to be $\tau/100$. Note that time domain response for each of the partial fraction term for overdamped and underdamped systems can be given by $R(k)e^{P(k)t}$ , where *R(k)* is the *k*-th numerator of the partial fraction term and *P(k)* is the corresponding *k*-th root of the denominator.
9. Add up all of the individual responses from each of the partial fraction term to get the total response *y(t)*.
10. Plot *y(t)* vs. *t*
11. From your program, calculate the peak time, peak value, and percent overshoot for the output

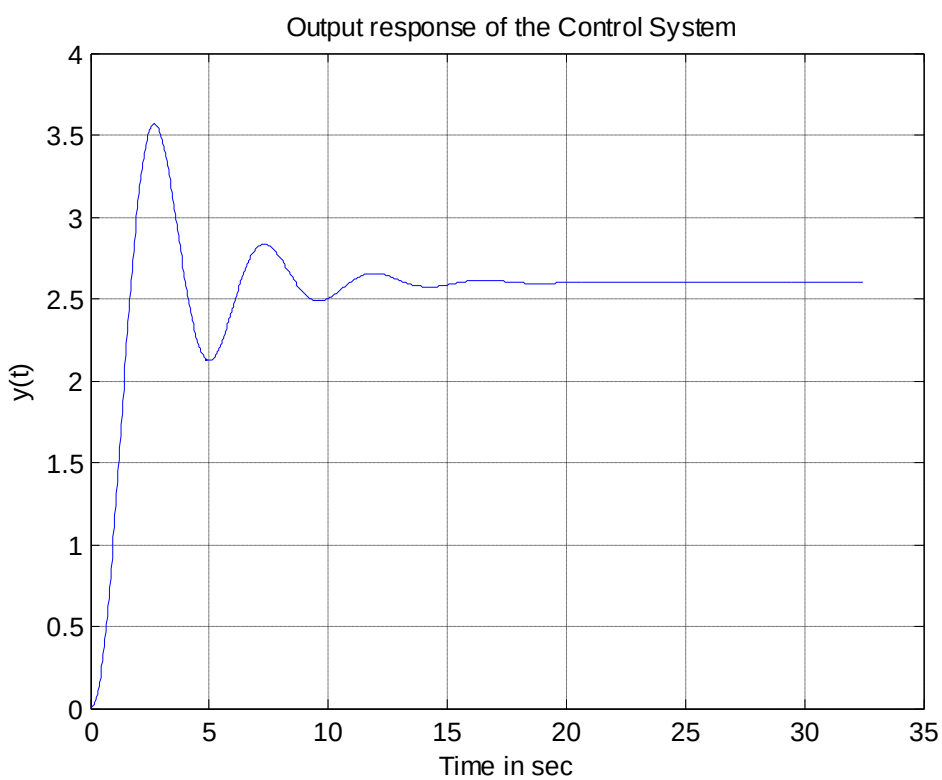
Note: Do not use any built-in function to calculate the time domain response directly from the coefficients of the output function.

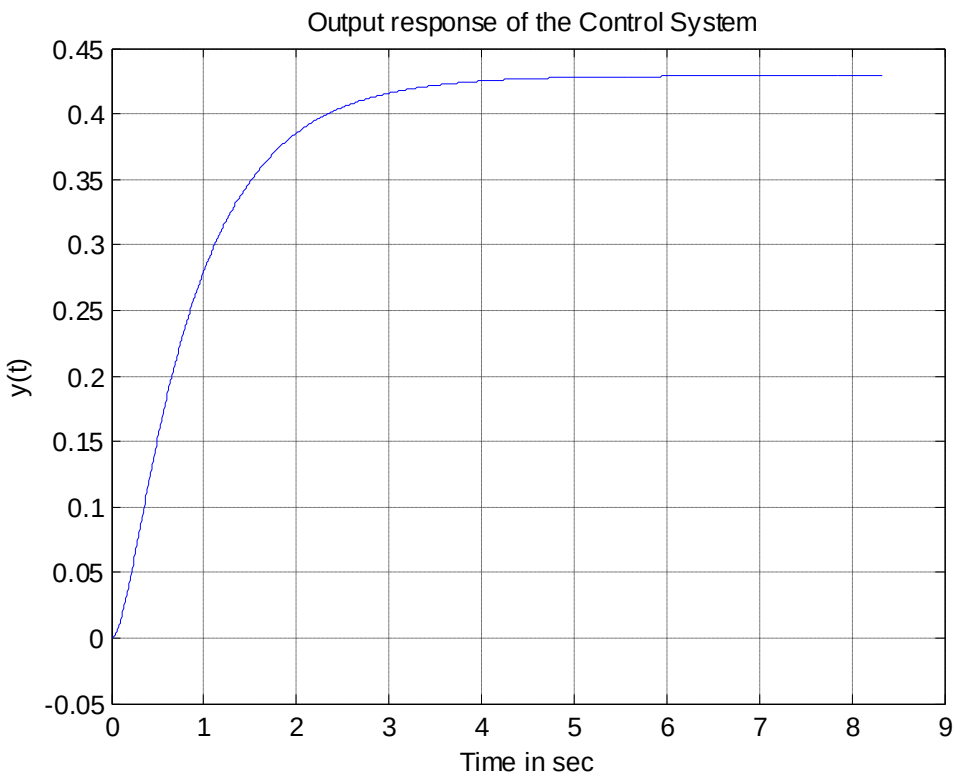
## Sample Outputs

*Sample # 1: Underdamped System*

```
Enter the numerator coefficients of the Output as a row vector: [5 26]
Enter the denominator coefficients of the Output as a row vector: [3 7 9 10 0]

The value of the time constant from dominant root is 3.244 sec
Peak value is 3.567
Time corresponding to the peak value is 2.693 sec
Percent overshoot value is 37.184%
>>
```



*Sample # 2: Overdamped System*

```
Enter the numerator coefficients of the Output as a row vector: [3.5 9.8]
Enter the denominator coefficients of the Output as a row vector: [1 10.2 29.84 22.848 0]

The value of the time constant from dominant root is 0.833 sec
Peak value is 0.429
Time corresponding to the peak value is 8.333 sec
Percent overshoot value is 0.000%
>>
```