Design and Implementation of the Controller for the selected systems

VA1 – project guide (sample)

1. Differential equation
2. Laplace transform -> transfer function $G_s(s)$
3. System analysis (time response overview, frequency response overview, stability, etc.)
4. Controller design (use 2-3 methods of design, comparison of methods)
5. Result: algorithm (script, function, etc) + (1-2) xA4 paper from each example

Software: MATLAB/Simulink, Python, C/C++

Example:

1. Differential equation

$$0.5y''' + 4y'' + 0.5y' + 2y = 6u' + 3u$$

2. Laplace transform -> transfer function $G_s(s)$

$$G_s(s) = \frac{L\{y(t)\}}{L\{u(t)\}} = \frac{Y(s)}{U(s)}$$

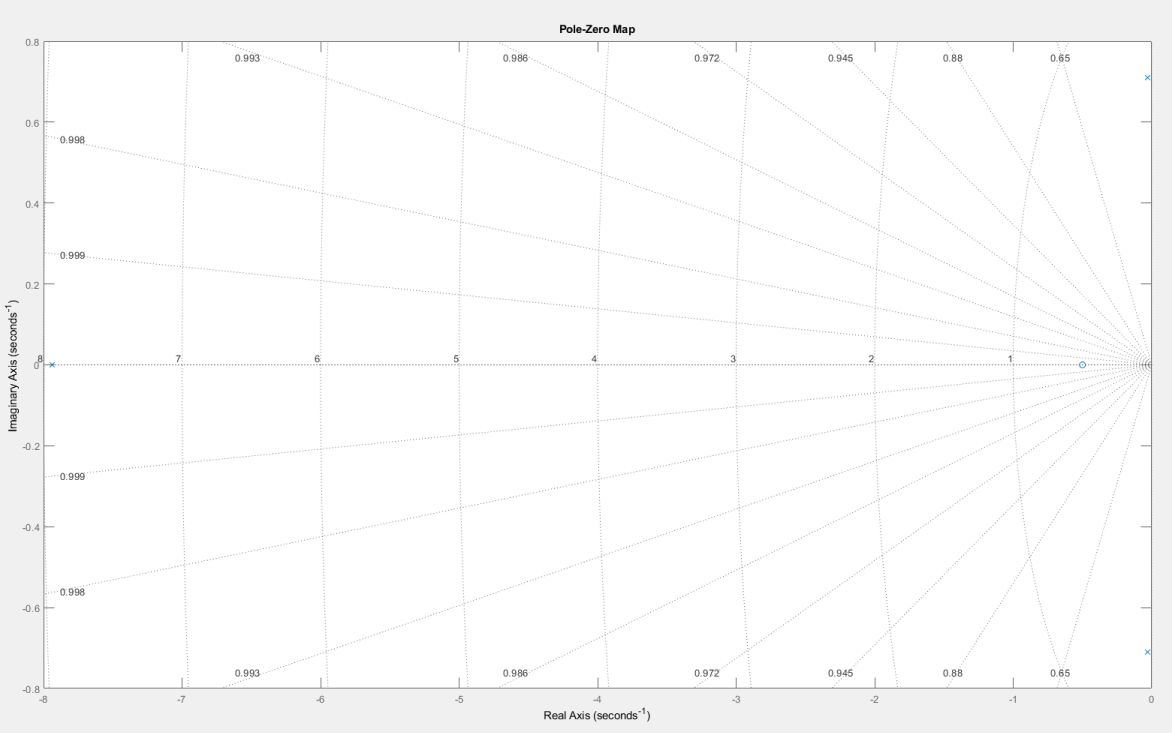
$$L\{0.5y'''(t) + 4y''(t) + 0.5y'(t) + 2y(t)\} = L\{6u'(t) + 3u(t)\}$$

$$0.5s^3Y(s) + 4s^2Y(s) + 0.5s^1Y(s) + 2s^0Y(s) = 6s^1U(s) + 3s^0U(s)$$

$$[0.5s^3 + 4s^2 + 0.5s^1 + 2s^0]Y(s) = [6s^1 + 3s^0]U(s)$$

$$G_s(s) = \frac{6s + 3}{0.5s^3 + 4s^2 + 0.5s + 2}$$

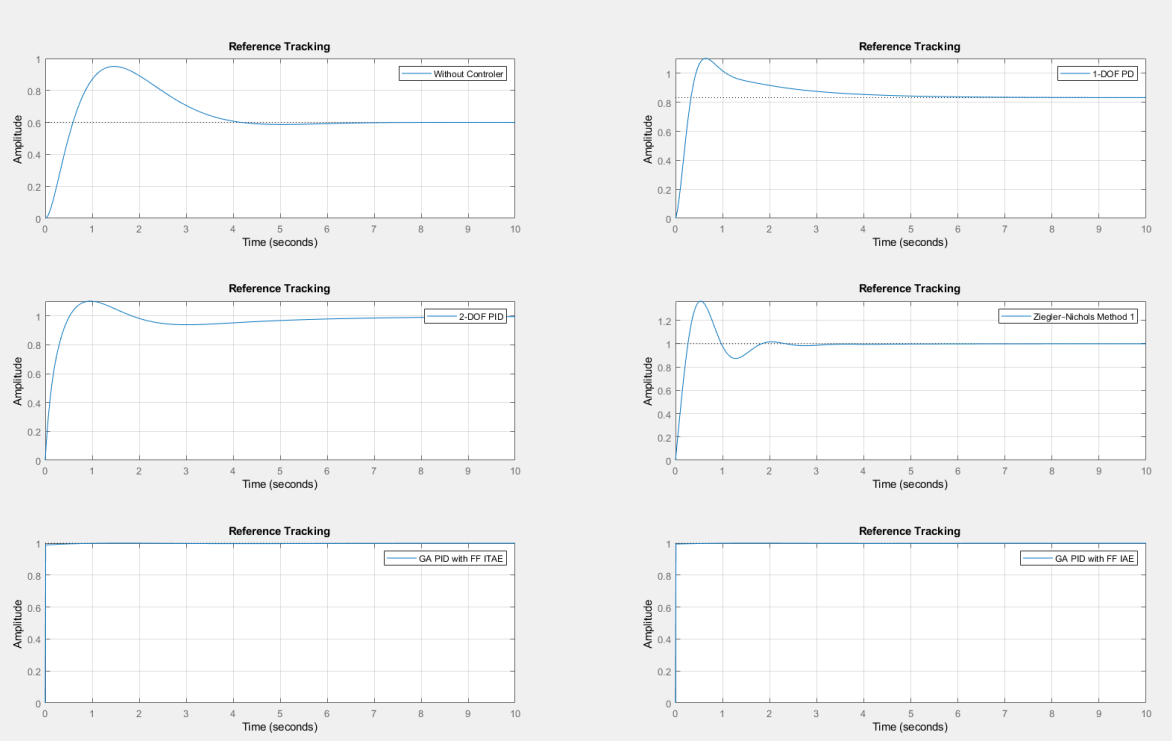
3. System analysis (time response overview, frequency response overview, stability, etc.)

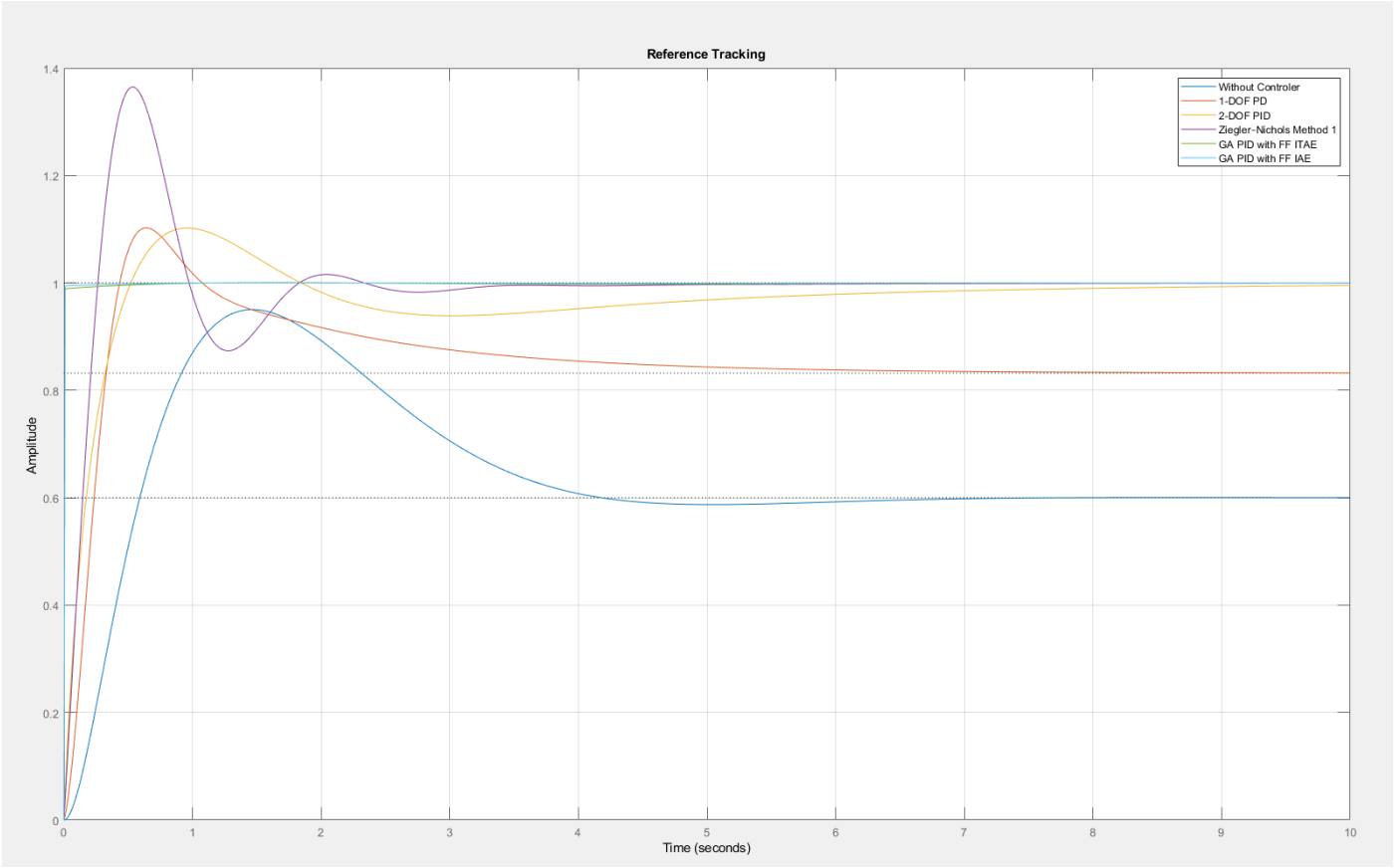



```
%% Stability
pzmap(G_s)

p_G_s = pole(G_s);
e     = 0;

for i = 1:length(p_G_s)
    if p_G_s(i) > 0
        disp('System is not stable!');
        e = 1;
    end
end

if e ~= 1
    disp('System is stable!');
end
```

```
Command Window
New to MATLAB? See resources for Getting Started.

System is stable!
```

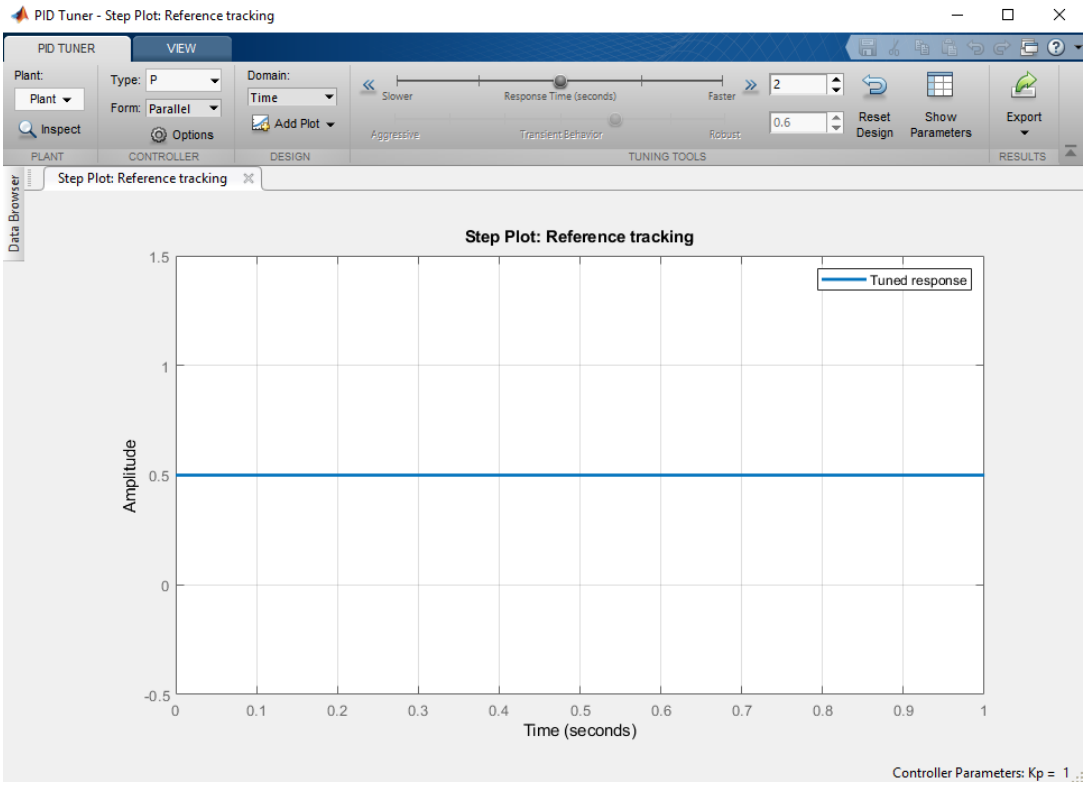
4. Controller design (use 2-3 methods of design, comparison of methods)



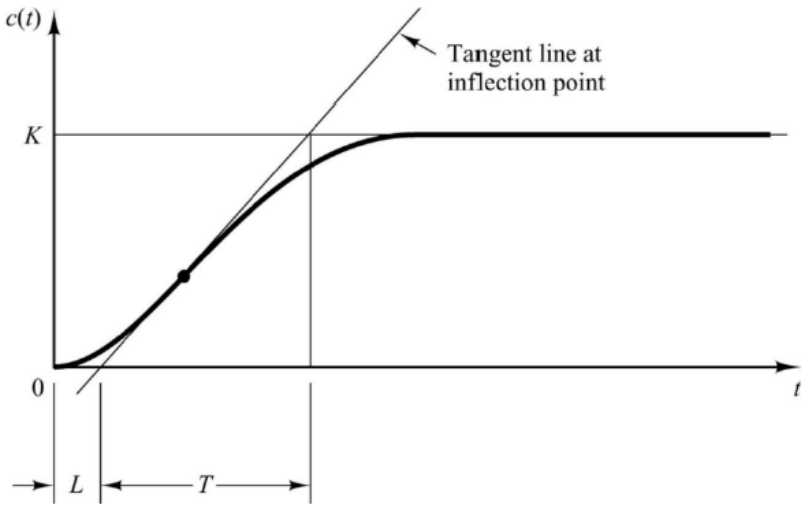


a. PID Tuner – PD Controller, 2-DOF PID

```
>> pidTuner % matlab toolbox
```



b. Ziegler-Nichols Method 1



c. Genetic algorithm (ITAE, IAE fitness function)