Experiment 1

Dynamic response of transfer functions on MATLAB platform.

Background:

The most fundamental and time tested approach to design and analysis in the broad technology discipline of *systems and control*, happens to be in terms of *system output dynamics over time* in response to *standard inputs*.

In case of strictly linear systems, such studies can be conveniently conducted in terms of *transfer functions* or *transfer matrix* (depending on whether the system is SISO or MIMO, respectively), either in *analog* or *digital domain*.

Further, by theoretical background we know that several useful design and analytical *performance measures* have evolved from dynamic response concepts, such as ***peak overshoot***, ***peak time***, ***delay time***, ***settling time***, etc.

Objective:

The project requires analysis and discussion of dynamic response of a given linear analog system in terms of different performance measures.

Tutorial: (to be covered in not more than an hour)

In the MATLAB platform, go through the procedural steps as described for:

- *Control system modeling with model objects:*
  https://www.mathworks.com/help/control/ug/control-system-modeling-with-model-objects.html

- *Connecting models:*
  https://www.mathworks.com/help/control/examples/connecting-models.html

- *Creating discrete-time models:*
  https://www.mathworks.com/help/control/examples/creating-discrete-time-models.html

Elements of the software for familiarisation:

i. ***Models:*** Continuous-time zero/pole/gain model; sample time; discrete-time transfer function.

ii. ***Functions:*** append, connect, feedback, frd, grid, isdt, parallel, pid, series, ss, step, stepplot, sumblk, tf, zpk.

iii. ***Precedence rule:*** frd > ss > zpk > tf > pid.

Project: (to be covered in about two lab hours or with additional study hours, if required.)

The second order analog OLTF (which has no zeros) of an oven temperature system is provided, for which a given PD controller is to be considered in (*a*) cascade, and (*b*) feedback.

$$\text{OLTF:} \quad G_{OL}(s) = \frac{K}{s^2 + 3s + 10}$$

$$\text{PD control:} \quad G_c = 80(s + 5)$$

Note that in either configuration of the controller, the CL root loci are identical. However, their step response is always different for the two cases of (*a*) and (*b*) !

For observations and discussions:

Complete a comparison table using the step responses of (*a*) and (*b*) including

- **the percentage overshoot,**
- **the time to first peak,**
- **the settling time, and**
- **the steady-state error.**

Comment on the results, and explain the reason for the differences in the response.

If the ***OL gain of the oven temperature OLTF is prone to variation***, investigate the effect of this on the four quantities listed above.

You are expected to draw as detailed conclusions as possible, but all *in terms of the step response*.