Experiment 4

Controller design on MATLAB platform using discrete root loci.

Background:

Recall that by the nature of *magnitude* and *phase angle relations* that apply to CL characteristic equations, the *CL poles follow similar trends with gain variations* regardless of the domain being *analog or digital*. There interpretation in the two domains differ, essentially because the *constant* ω_{an} and *constant-*ζ lines differ between them.

Precisely due to this reason, the functions relevant to the present experiment are mostly the same as those for Expt. 2; the only difference being between the use of zgrid and sgrid, that allows the difference in interpretations.

Objective:

This project therefore requires design of a cascade feedback controller for a given digital transfer function, according to desired specifications.

A sensitivity analysis for variation of key parameters is further required.

(The key to the experiment is obviously: *correct interpretation of the plots* , which is considerably more involved in the present case !)

Tutorial:

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

- *Root locus design:* https://www.mathworks.com/help/control/ug/root-locus-design.html

Elements of the software for familiarisation:

i. ***App:*** controlSystemDesigner('rlocus',*)

ii. ***Functions/keywords:*** rlocus; rlocusplot; getoptions;setoptions; zgrid; plotoptions; tf; zpk.

Project:

The OLTF of a digital system under study has three marginally stable poles, that is, certain *frequencies at which sustained oscillations* are expected.

$$G_{OL}(z) = \frac{z^2 + 1.5z - 1}{(z-1)^3}$$

Investigate how the frequencies of sustained oscillations may be changed in CL, by modifying *the location of OL zeros*.

A proporional gain within the range $-\infty < K < \infty$ may be assumed for closing the loop.

For observations and discussions:

Obviously we need to study the problem with reference to the default values of OL zeros, which may be located within or outside the unit circle !

Keep a check on the gain by which you close the OLTF to realise the CLTF, though our focus is only on the sustained oscillation frequencies.

Needless to say, all your discussions and conclusions should be in terms of normalised frequencies, since the sampling time is not provided.