Modelling and control summaries

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USE OF MATLAB 3 – closed-loop transfer functions

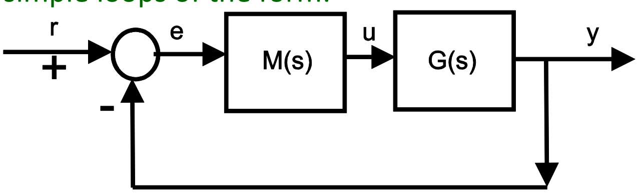
OVERVIEW: These notes gives a very narrow view of MATLAB and how to do a limited number of things. In general students need to become effective independent learners of MATLAB.

WHY USE MATLAB?

Closed-loop transfer functions can be tedious to compute on pen and paper and moreover, there are times when it is required to embed the building of transfer functions into scripts and other files you may need later.

$$y = \frac{GM}{1+GM} r = G_c r$$
$$u = \frac{M}{1+GM} r = G_{cu} r$$
$$e = \frac{1}{1+GM} r = G_{ce} r$$

While MATLAB does allow complex loops with multi-inputs and outputs, here we consider only simple loops of the form:



Students should be confident with the corresponding analysis.

This note looks at how MATLAB can be used to compute G_c, G_{cu}, G_{ce} for which the formulae are well known.

Forward path

For the loop above, the forward path (FP) constitutes the blocks between the loop input r and the signal in question: For e the FP is 1, for u the FP is M and for y the FP is GM.

Remainder path

For the loop above, the remainder path (RP) constitutes the blocks in the loop not within the FP: For e the RP is GM, for u the RP is G and for y the RP is 1.

Note that the product of the FP*RP gives all the blocks in the loop (here GM).

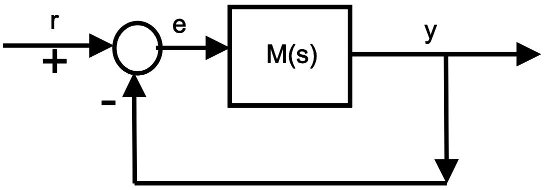
CLOSED-LOOP TRANSFER FUNCTION WITH MATLAB

The basic command is feedback and this has the following notation:

Gc = feedback(FP,RP)

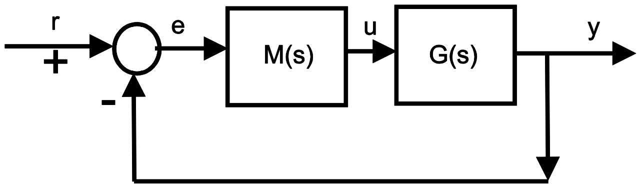
This will be illustrated with a number of examples.

EXAMPLE 1



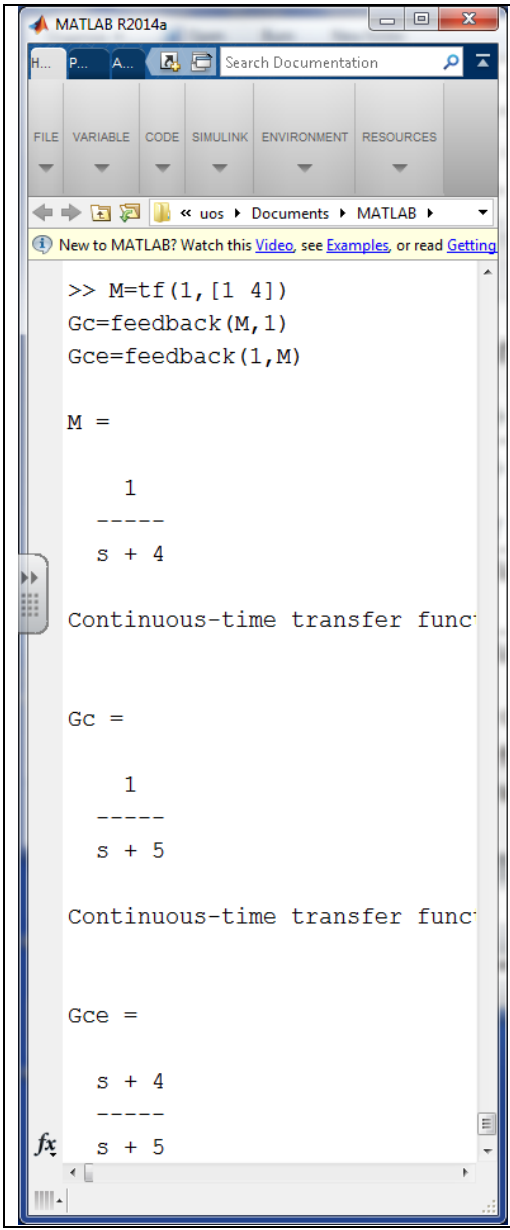
$$M = \frac{1}{s+4}$$

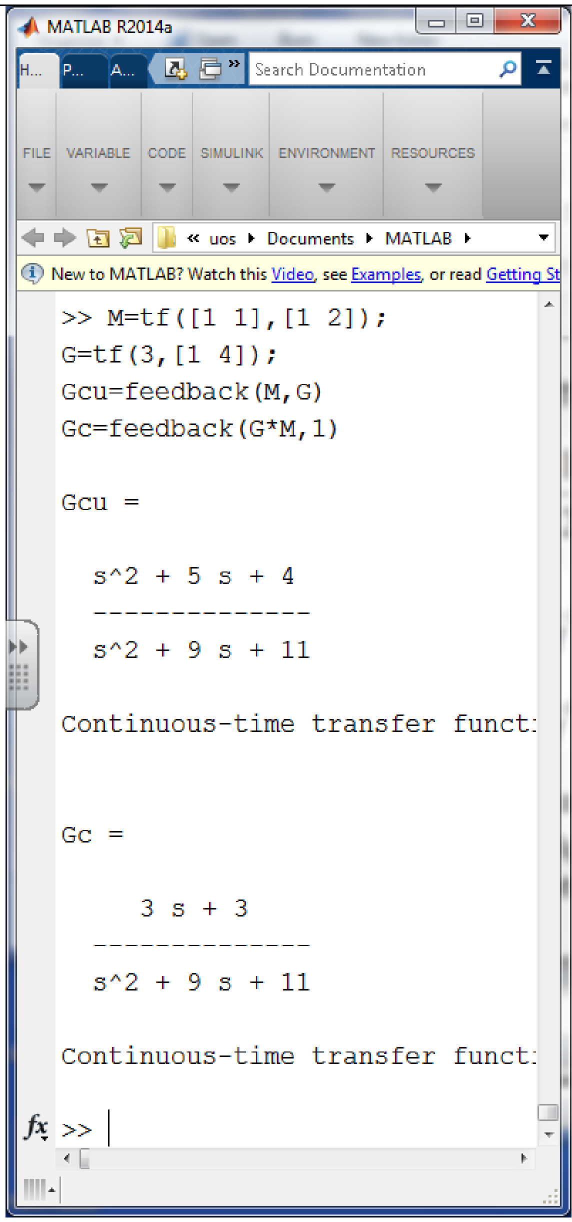
EXAMPLE 2



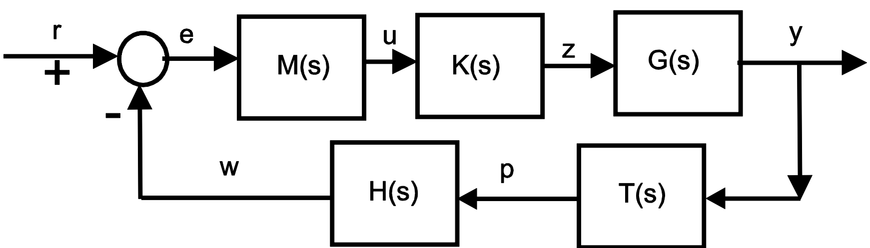
$$M = \frac{s+1}{s+2}; \quad G = \frac{3}{s+4}$$

NOTE: Work out G_c, G_{cu}, G_{ce} by hand to check and confirm the results given over the page.





More complex examples can be done as long as one is clear on the definition of forward path and remainder path. For this example let us assume that we want the closed-loop transfer function between r and z in which case: FP is given by M*K and RP is given by G*T*H.



Once the transfer functions are entered into MATLAB, the corresponding command would be:	**Gcz=feedback(M*K,G*T*H)**

REMARK: Once a closed-loop transfer function is computed within MATLAB, standard analysis tools such as pzmap, step.m and so on can be automated thus saving a lot of tedious work on pen and paper.