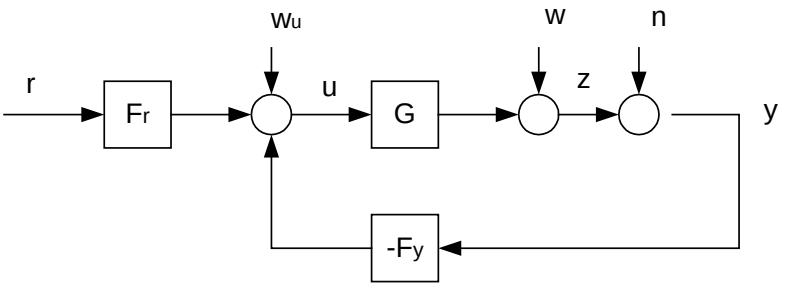
ELEC-E8116 Model-based control systems / exercises 4

Problem 1. Let A and B be such matrices that AB and BA are both defined. Prove the so-called "push-through"-rule

$$A(I + BA)^{-1} = (I + AB)^{-1} A$$

Problem 2. Consider the closed-loop system shown in the figure below



Suppose that the control, load and measurement disturbances are all zeros. Let there be modeling error in the process transfer function G such that the real process is defined as

$$G_0 = (I + \Delta_G)G$$

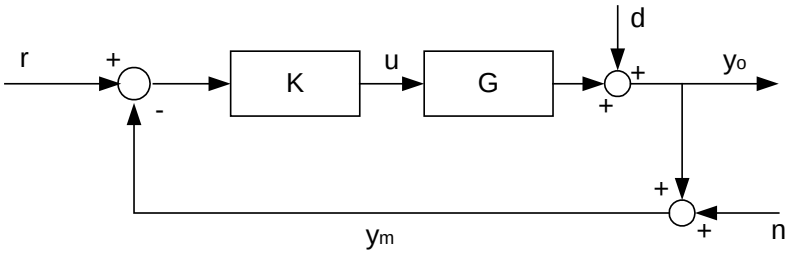
where Δ_G is the relative model error.

- **a.** Derive formulas for the real output z_0 and for the output predicted by the model, z.
- **b.** Derive the formulas

$$z_0 = (I + \Delta_z)z$$
$$\Delta_z = S_0 \Delta_G$$
$$S_0 = (I + G_0 F_y)^{-1}$$

What can be said about the sensitivity of the system?

Problem 3. Consider the closed-loop system shown in the figure below.



Write the equations describing the system and identify

- **a.** the closed loop transfer function
- **b.** the sensitivity function
- **c.** the complementary sensitivity function

- Write formulas for the output y_0, control u and error $e = r-y_0$.

- What are the requirements for the transfer functions in a-c in order that the system would perform well?