Exercise Sheet 5: Youla Parametrization

Problem 11:
We consider a plant with the transfer function

\[ G(s) = \frac{3001 (1 + s109/3001)}{s^3 + 3s^2 + 3s + 1} \]

a. Is this plant suitable for a Youla parameterization design?

b. Perform a Youla parametrization design for \( G(s) \) such that the complementary sensitivity \( T(s) \) has the form \( T(s) = \frac{1}{1 + 10s} \) for an appropriate value of \( r \).

c. Realize the block diagram of the feedback loop with \( G(s) \) and \( C(s) \) in Simulink and perform a reference step response of \( r = \sigma(t) \) and a disturbance step response of \( F_Z = 0.05\sigma(t) \).

Hint: Use the Simulink block of the plant on the course webpage.

d. Discuss the advantages of the controller design procedure. What is the disadvantage of the Youla parametrization design and how does it show in the experiment?

Problem 12:
Show the following statements for the Youla Parametrization.

a. If \( Q \) has non-negative relative degree, then also \( C \) has non-negative relative degree

b. Assume that the relative degree of \( G \) is \( r \). Then, the relative degree of \( C \) is only non-negative if the relative degree of \( T \) is larger or equal than \( r \)