AS-74. 3125 Optimal, Adaptive and Robust Control
Exam 26. 8. 2011

The questions are available only in English. You can answer in Finnish, Swedish or English. The final grade is given when both the examination and the homework problems have been evaluated.

5 problems.

1. Consider the first order process

$$\frac{dy}{dt} = -ay + bu \quad \text{(parameters } a \text{ and } b \text{ are unknown constants)}$$

and the reference model

$$\frac{dy_m}{dt} = -a_m y_m + b_m r \quad (a_m \text{ and } b_m \text{ are constants set by the designer})$$

Design an adaptive feedback control law to the system, when the parameter adjustment is designed by the Lyapunov method. Present a "Simulink-like" figure presenting the closed-loop system.

2. Find an extremal for the functional

$$J(x) = \int_0^{\pi/2} \left[\dot{x}^2(t) - x^2(t)\right] dt$$

which satisfies the boundary conditions $x(0) = 0$ and $x(\pi/2) = 1$

3. Consider the system

$$\dot{x}(t) = -x(t) + u(t)$$

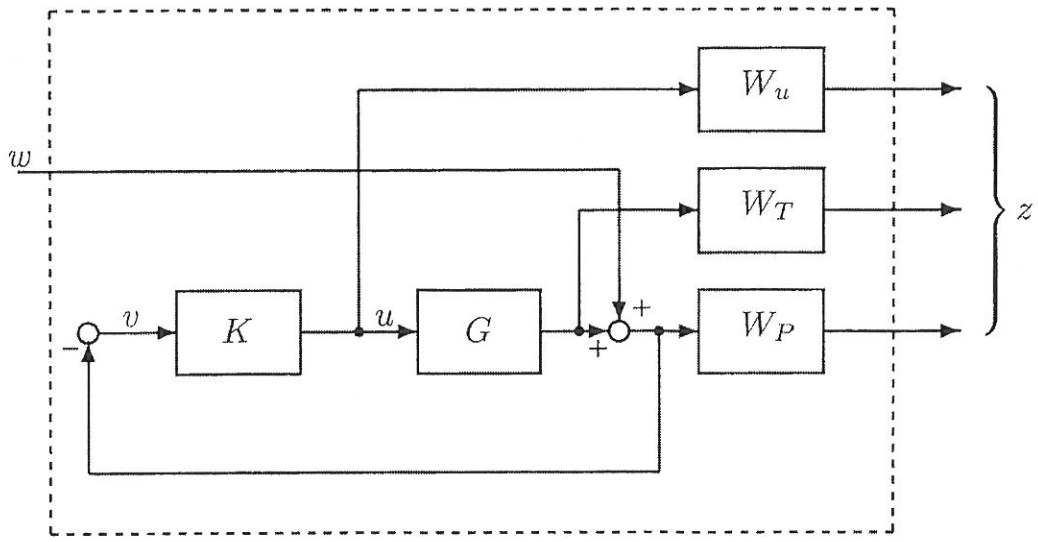
and the criterion

$$J = \int_0^1 \frac{1}{2}\left[3x^2(t) + u^2(t)\right] dt$$

a. The system is to be transferred from an arbitrary initial state to the origin such that the above criterion is minimized. Determine the optimal control law.
b. Same as in part **a**, but now $x(1)$ is free.

Note: The practical calculations can be troublesome here. If you do not wish to perform them to the end, make it anyway sure that your solutions have all information, from which the solution could be obtained by solving the equations.

4. Consider the following control configuration



where G is the process, K the controller, Wu, W_T and W_P are weights.

a. Present the system in the general control configuration (calculate P).
b. Close the loop, i.e. calculate N from $z = Nw$.

5. Explain shortly the following concepts

a. RLS
b. MIT Rule
c. The brachistochrone problem
d. Kalman-Yakubovich lemma
e. MΔ structure in robust control
f. DK-iteration