2.6 Transfer Function MATLAB Laboratory Experiment

Part 1. Consider the continuous-time system represented by its transfer function

$$G(s) = \frac{s+1}{s^2+5s+6}$$

Using MATLAB plot:

(a) The impulse response of the system. Use `impulse(num,den,t)` with `t=0:0.1:5`.
(b) The step response of the system. Use the function `step(num,den,t)` with `t=0:0.1:5`.
(c) The system output response due to the input $\sin(2t)$. Use the function `lsim(num,den,u,t)` with `t=0:0.2:20` and `u=sin(2*t)`.
(d) The system output response due to the input e^{-t}. Use the function `lsim(num,den,u,t)` with `t=0:0.1:5` and `u=exp(-t)`.

Part 2. A discrete-time system is described by the transfer function

$$G(z) = \frac{z-2}{z^2-2.5z+1}$$

Using MATLAB plot:

(a) The impulse response of the system. Use `dimpulse(num,den)` and `axis([0 10 0 1.5])`.
(b) The step response of the system. Use `dstep(num,den)` and `axis([0 10 0 3])`.
(c) The response due to the input $\sin(2k)$. Use `dlsim(num,den,u)` with `k=0:1:50` and `u=sin(2*k)`.
(d) The steady state response due to the input 2^{-k}. Use `dlsim(num,den,u)` with `u=2.^(-k)` and `axis([0 11 0 1.1])`. Note that "." after 2 in MATLAB indicates a pointwise operation.

Part 3. Consider a flexible beam system (Qiu and Davison, 1993) whose linearized model has the transfer function

$$G(s) = \frac{1.65s^4 - 0.331s^3 - 576s^2 + 90.6s + 19080}{s^6 + 0.996s^5 + 463s^4 + 97.8s^3 + 12131s^2 + 8.11s}$$

Use MATLAB in order to find:

(a) The system open-loop poles and zeros. Use the functions `roots(num)` and `roots(den)`.

(b) The system closed-loop transfer function assuming unity negative feedback. Use `[numc,denc]=cloop(num,den,-1)`.

(c) The closed-loop poles and zeros and compare them to the open-loop poles and zeros found in (a). Use `roots(numc)` and `roots(denc)`.

Part 4. The block diagram of a simple positioning control system using a field-controlled DC motor is shown in Figure 2.27.

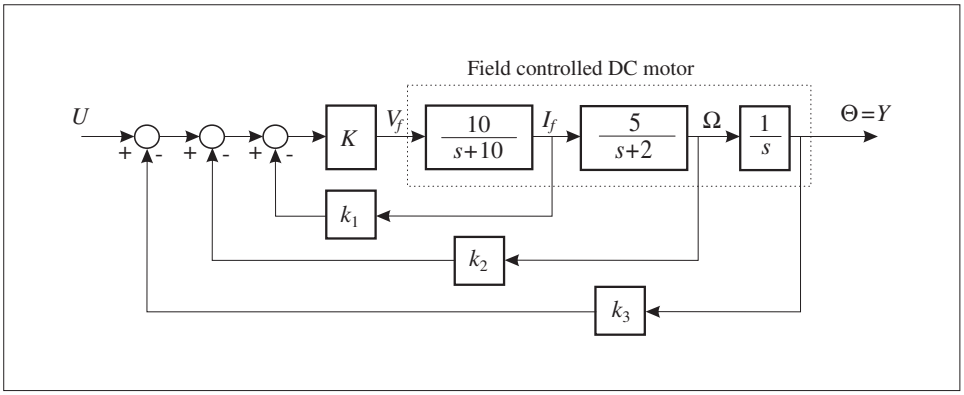

Figure 2.27: Position control system

(a) Using the rules of block diagram algebra reduce this system to the basic feedback system shown in Figure 2.2a, and find the system transfer function $Y(s)/U(s)$.

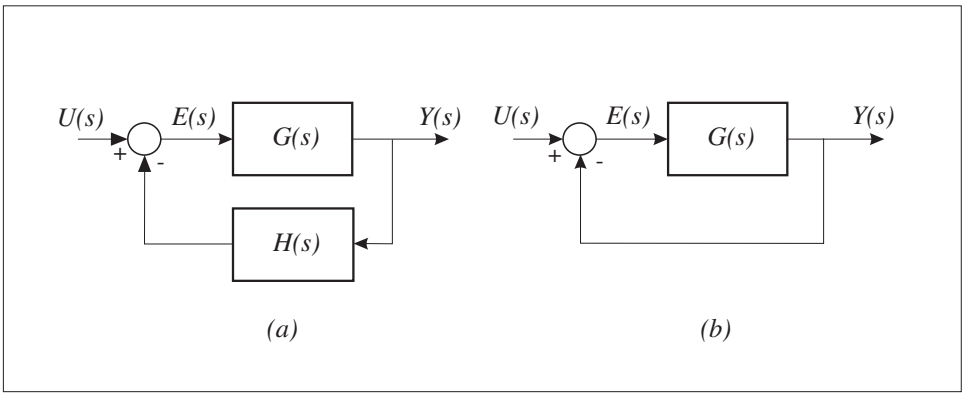

Figure 2.2: Simple feedback structures

(b) Find the transfer function of this system using Mason's gain formula.
(c) If $K = 2$, $k_1 = -0.05$, $k_2 = 0.16$, and $k_3 = 0.24$, write the MATLAB script to find the transfer function of this system (see Example 2.5).
(d) Using MATLAB functions, find the poles of the closed-loop system.
(e) For the given system poles find the partial fraction expansion using the MATLAB function `residue`. From the partial fraction expansion find analytically the system response to a unit step input. Check the obtained results using the MATLAB function `step`.
(f) Plot the unit step response of the system for the time interval of 10 seconds.