01.2 intro.block Feedback control system block diagrams

1 As we have already seen, a useful tool for designing control systems is the block diagram. The plant and the controller are represented as blocks. Usually a transfer function (or transfer function matrix) can describe the function of each block. A typical block diagram is shown in Fig. def.1.

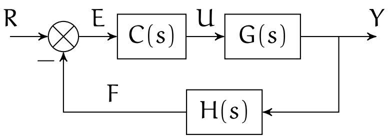

Figure block.1: a block diagram for a controller $C(s)$.

2 In this configuration, a command function $R(s)$ is provided to the control system. The feedback $H(s)Y(s)$ is subtracted from $R(s)$ to give the error $E(s)$. This is fed to the controller $C(s)$. The output of the controller is the control effort $U(s)$, which is the input of the plant $G(s)$. The output $Y(s)$, after being fed back as $H(s)Y(s)$, is what the control system is attempting to make equal to the command $R(s)$, therefore, ideally $E(s) = 0$.

3 Block diagrams express *algebraic* relationships. (The blocks do not dynamically "load" each other.) In the case of Fig. def.2, the relationships are

$$E(s) = R(s) - F(s) \tag{1a}$$

$$U(s) = C(s)E(s) \tag{1b}$$

$$Y(s) = G(s)U(s) \tag{1c}$$

$$F(s) = H(s)Y(s). \tag{1d}$$

The **closed-loop tranfer function** is defined as $Y(s)/R(s)$. This important transfer function shows how the system should respond to commands, of key importance for most performance criteria.

Figure block.2: a block diagram with the corresponding closed-loop transfer function block, derived in Example 01.2 intro.block-1.

Example 01.2 intro.block-1 re: Closed-loop transfer function

Given the feedback block diagram of Fig. def.1 (left), solve for the closed loop transfer function $Y(s)/R(s)$.