DISCUSSION WEEK 5

4.16 A compensated motor position control system is shown in Fig. 4.31. Assume that the sensor dynamics are $H(s) = 1$.

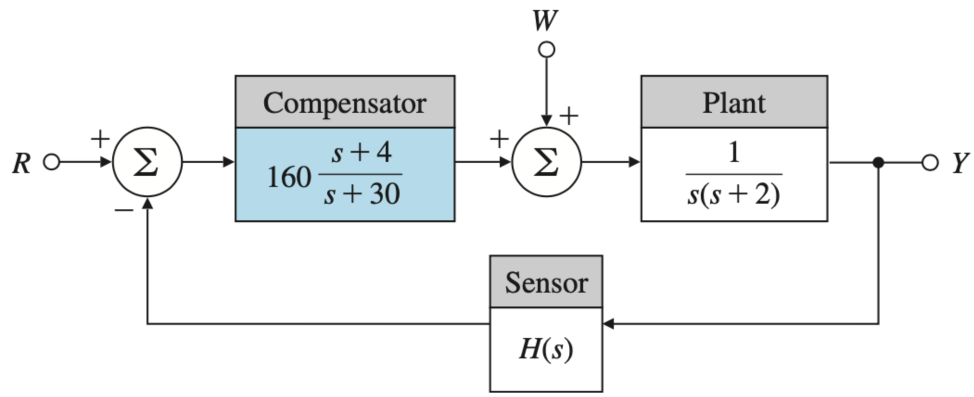


Figure 4.31
Control system for Problem 4.16

(a) Can the system track a step reference input r with zero steady-state error? If yes, give the value of the velocity constant.

(b) Can the system reject a step disturbance w with zero steady-state error? If yes, give the value of the velocity constant.

4.27 Consider the automobile speed control system depicted in Fig. 4.40.

(a) Find the transfer functions from $W(s)$ and from $R(s)$ to $Y(s)$.

(b) Assume that the desired speed is a constant reference r, so that $R(s) = \frac{r_o}{s}$. Assume that the road is level, so $w(t) = 0$. Compute values of the gains k_P, H_r, and H_y to guarantee that

$$\lim_{t\to\infty} y(t) = r_o.$$

Include both the open-loop (assuming $H_y = 0$) and feedback cases ($H_y \neq 0$) in your discussion.

(c) Repeat part (b) assuming that a constant grade disturbance $W(s) = \frac{w_o}{s}$ is present *in addition to* the reference input. In particular, find the variation in speed due to the grade change for both the feed forward and feedback cases. Use your results to explain (1) why feedback control is necessary and (2) how the gain k_P should be chosen to reduce steady-state error.

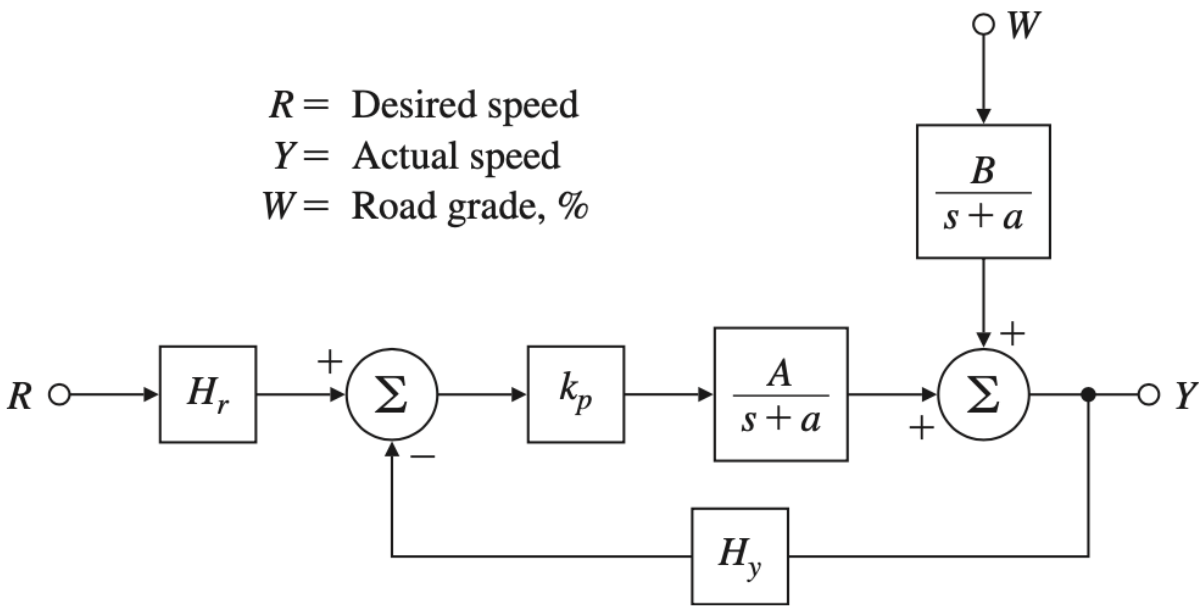


Figure 4.40
Automobile
speed-control system

4.32 The DC motor speed control shown in Fig. 4.44 is described by the differential equation

$$\dot{y} + 60y = 600v_a - 1500w,$$

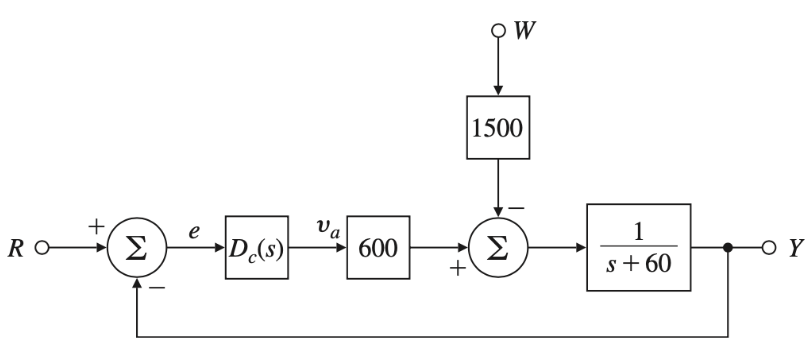
where y is the motor speed, v_a is the armature voltage, and w is the load torque. Assume the armature voltage is computed using the PI control law

$$v_a = -\left(k_P e + k_I \int_0^t e\,dt\right),$$

where $e = r - y$.

(a) Compute the transfer function from W to Y as a function of k_P and k_I.

(b) Compute values for k_P and k_I so that the characteristic equation of the closed-loop system will have roots at $-60 \pm 60j$.



4.33 For the system in Fig. 4.44, compute the following steady-state errors:

(a) to a unit-step reference input;

(b) to a unit-ramp reference input;

(c) to a unit-step disturbance input;

(d) for a unit-ramp disturbance input.

(e) Verify your answers to (a) and (d) using Matlab. Note that a ramp response can be generated as a step response of a system modified by an added integrator at the reference input.