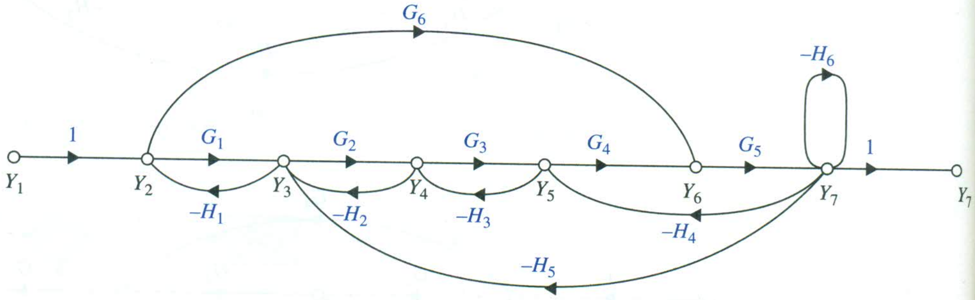
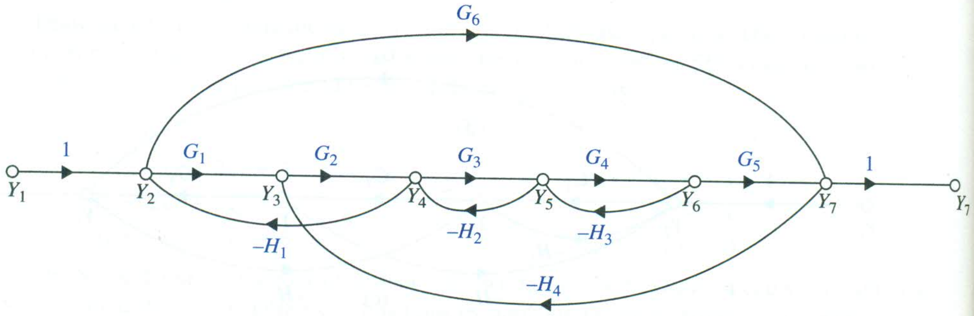
• Transfer functions of SFG

3-8. Find the transfer functions Y_7/Y_1 and Y_2/Y_1 of the SFGs shown in Fig. 3P-8.



(a)



(b)

Figure 3P-8

• Application of SFG

3-9. Signal-flow graphs may be used to solve a variety of electric network problems. Shown in Fig. 3P-9 is the equivalent circuit of an electronic circuit. The voltage source $e_d(t)$ represents a

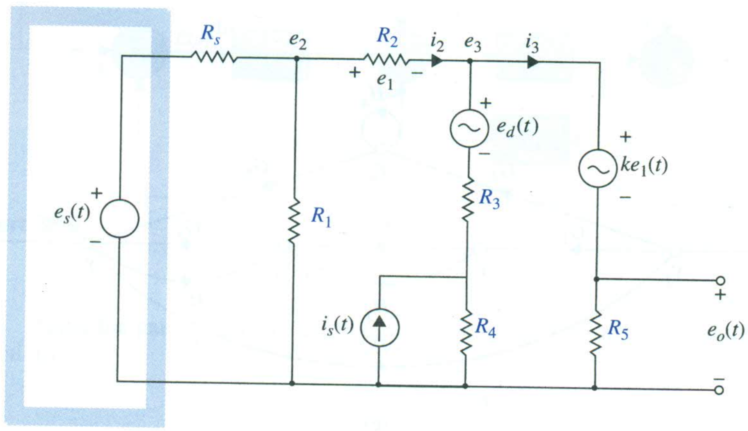


Figure 3P-9

disturbance voltage. The objective is to find the value of the constant k so that the output voltage $e_o(t)$ is not affected by $e_d(t)$. To solve the problem, it is best to first write a set of cause-and-effect equations for the network. This involves a combination of node and loop equations. Then construct an SFG using these equations. Find the gain e_o/e_d with all other inputs set to zero. For e_d not to affect e_o, set e_o/e_d to zero.

• SFG

3-10. Show that the two systems shown in Figs. 3P-10(a) and (b) are equivalent.

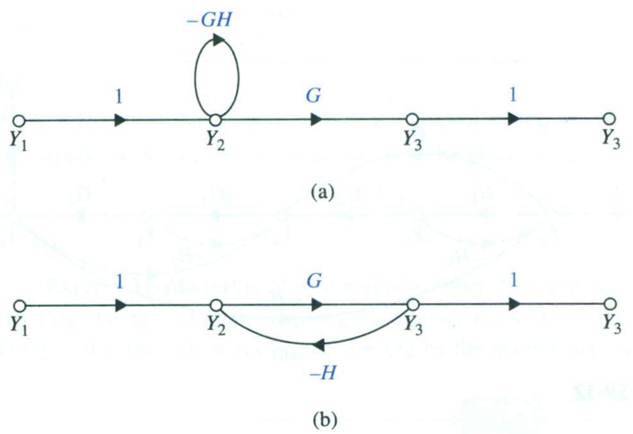


Figure 3P-10

• SFG

3-11. Show that the two systems shown in Figs. 3P-11(a) and (b) are not equivalent.

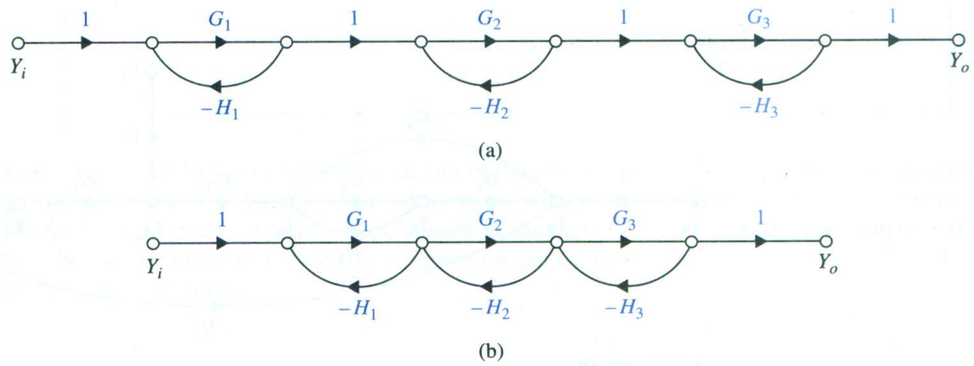


Figure 3P-11

• Transfer functions of SFG

3-12. Find the following transfer functions for the SFG shown in Fig. 3P-12.

$$\left.\frac{Y_6}{Y_1}\right|_{Y_7=0} \qquad \left.\frac{Y_6}{Y_7}\right|_{Y_1=0}$$

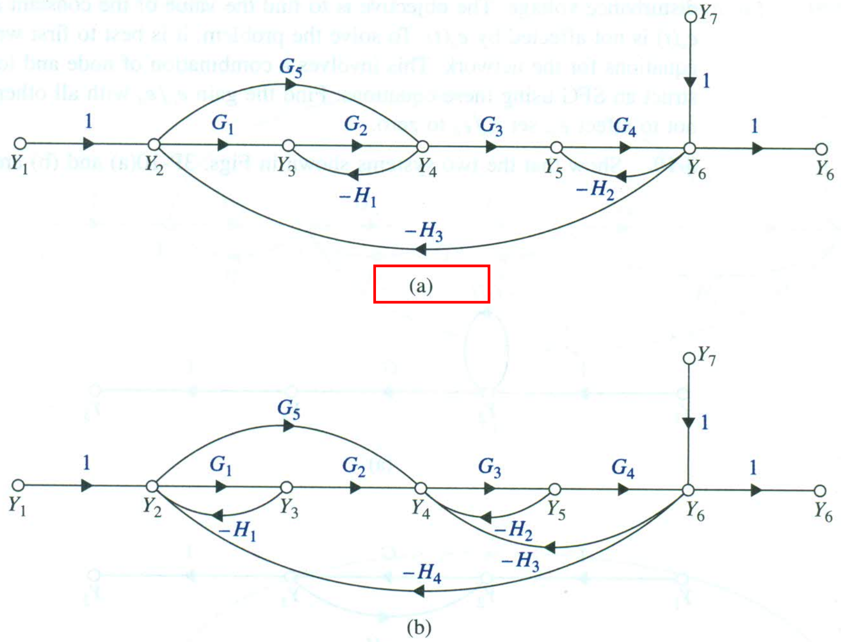


Figure 3P-12

• Transfer functions of SFG

3-13. Find the following transfer functions for the SFG shown in Fig. 3P-13. Comment on why the results for parts (c) and (d) are not the same.

(a) $\left.\dfrac{Y_7}{Y_1}\right|_{Y_8=0}$ **(b)** $\left.\dfrac{Y_7}{Y_8}\right|_{Y_1=0}$ **(c)** $\left.\dfrac{Y_7}{Y_4}\right|_{Y_8=0}$ **(d)** $\left.\dfrac{Y_7}{Y_4}\right|_{Y_1=0}$

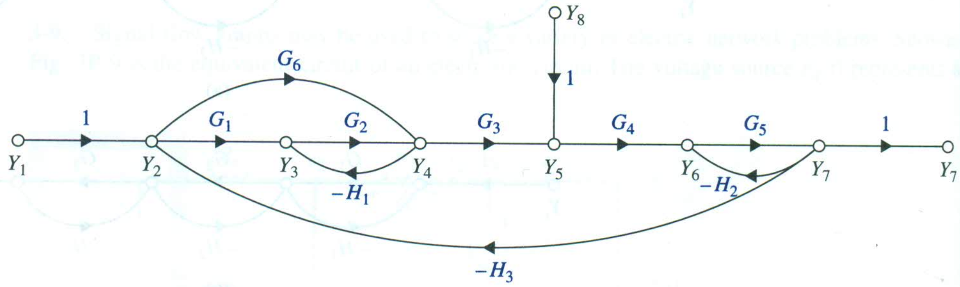


Figure 3P-13

• Transfer functions of block diagrams

3-14. The block diagram of a feedback control system is shown in Fig. 3P-14. Find the following transfer functions:

(a) $\left.\dfrac{Y(s)}{R(s)}\right|_{N=0}$ **(b)** $\left.\dfrac{Y(s)}{E(s)}\right|_{N=0}$ **(c)** $\left.\dfrac{Y(s)}{N(s)}\right|_{R=0}$

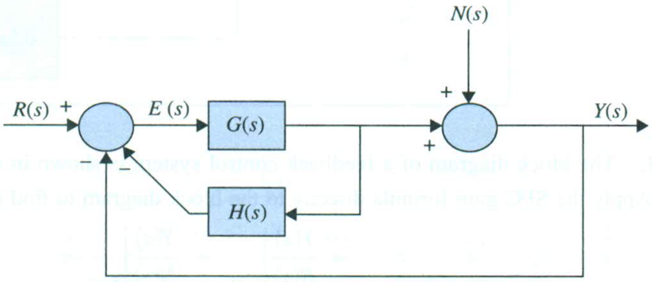
(d) Find the output $Y(s)$ when $R(s)$ and $N(s)$ are applied simultaneously.

• Transfer function of dc-motor control system

3-17. Figure 3P-17 shows the block diagram of a dc-motor control system. The signal $N(s)$ denotes the frictional torque at the motor shaft.

(a) Find the transfer function $H(s)$ so that the output $Y(s)$ is not affected by the disturbance torque $N(s)$.

(b) With $H(s)$ as determined in part (a), find the value of K so that the steady-state value of $e(t)$ is equal to 0.1 when the input is a unit-ramp function, $r(t) = tu_s(t)$, $R(s) = 1/s^2$, and $N(s) = 0$. Apply the final-value theorem.



$$G(s) = \frac{K(s+3)}{s(s+1)(s+2)}$$

Figure 3P-17

• Transfer function of position-control system

$\boxed{\textbf{3-18.}}$ The block diagram of the position-control system of the electronic word processor is shown in Fig. 3P-18.

(a) Find the loop transfer function $\Theta_o(s)/\Theta_e(s)$ (the outer feedback path is open).

(b) Find the closed-loop transfer function $\Theta_o(s)/\Theta_r(s)$.

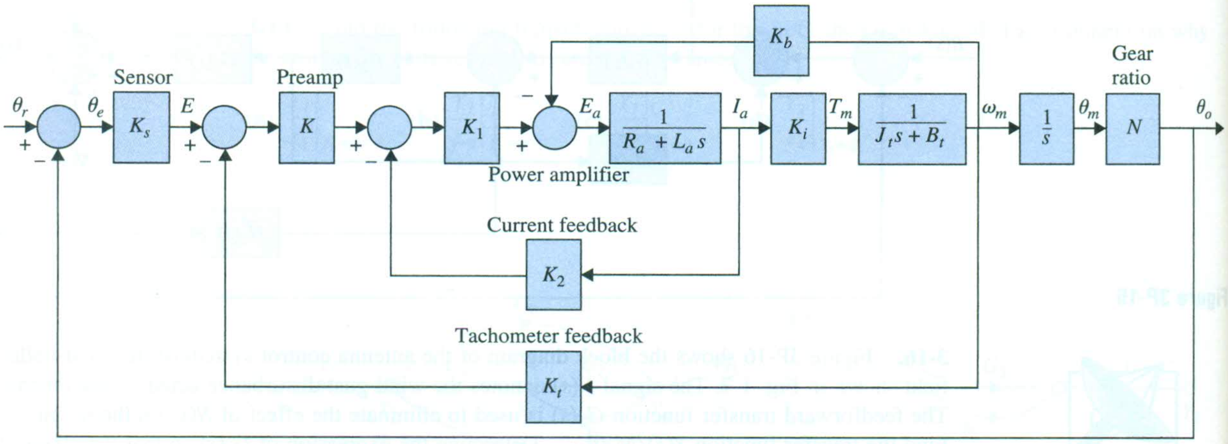


Figure 3P-18

• Turboprop engine

3-19. The coupling between the signals of the turboprop engine shown in Fig. 2-2 is shown in Fig. 3P-19. The signals are defined as

$R_1(s)$ = fuel rate	$R_2(s)$ = propeller blade angle
$Y_1(s)$ = engine speed	$Y_2(s)$ = turbine inlet temperature

(a) Draw an equivalent SFG for the system.

(b) Find the Δ of the system using the SFG gain formula.

(c) Find the following transfer functions:

$$\left.\frac{Y_1(s)}{R_1(s)}\right|_{R_2=0} \qquad \left.\frac{Y_1(s)}{R_2(s)}\right|_{R_1=0} \qquad \left.\frac{Y_2(s)}{R_1(s)}\right|_{R_2=0} \qquad \left.\frac{Y_2(s)}{R_2(s)}\right|_{R_1=0}$$