1. For a system with the transfer function

$$H(s)=\frac{s+3}{s^3+9s^2+24s+20}$$

(a) Find the observable canonical form of the state equations.

(b) Please indicate if the system is stable with clear explanations.

2. For a system with the block diagram in Fig. 1,

(a) Find the output $Y(s)$

(b) Find $G_4(s)$ such that the output $Y(s)$ is totally independent of the noise $N(s)$

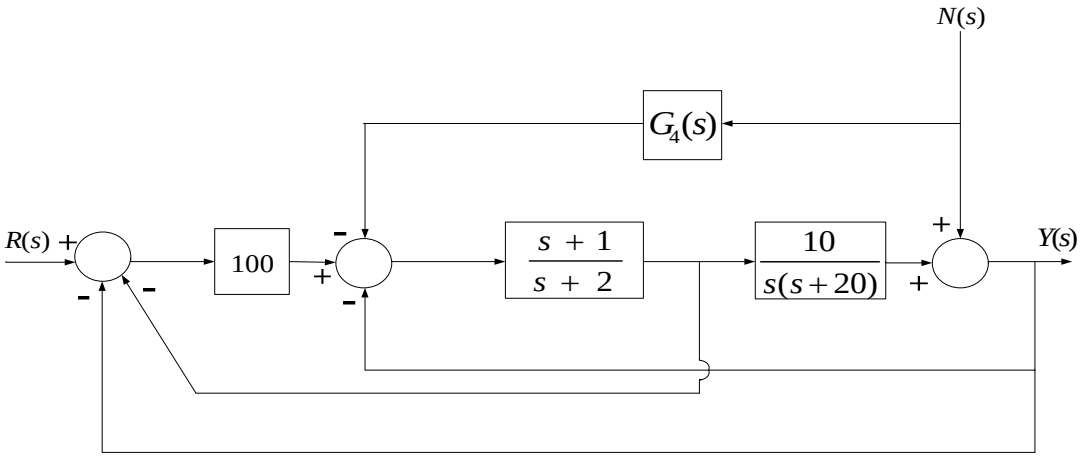

Fig. 1. Block Diagram

3. Consider the linear differential equation

$$\ddot{y}+10.91\dot{y}+100y=100u$$

with initial conditions $y(0)=\dot{y}(0)=0$. If u is a unit step input, find the output $y(t)$.

4. Consider a system with the loop transfer function

$$G(s)H(s)=\frac{K}{s(s+a)};\quad a>0$$

(a) Please roughly draw the root locus of this system.

(b) If one more pole at $-b$; $b>0$ is added, please roughly draw the root locus of this system and explain the effect of the pole adding.

(c) If one zero at $-b$; $b>0$ is added, please roughly draw the root locus of this system and explain the effect of the zero adding.

5. For the signal flow graph in Fig.2, please find the transfer functions (a) $\frac{Y_7}{Y_1}$ (b) $\frac{Y_7}{Y_4}|_{Y_8=0}$

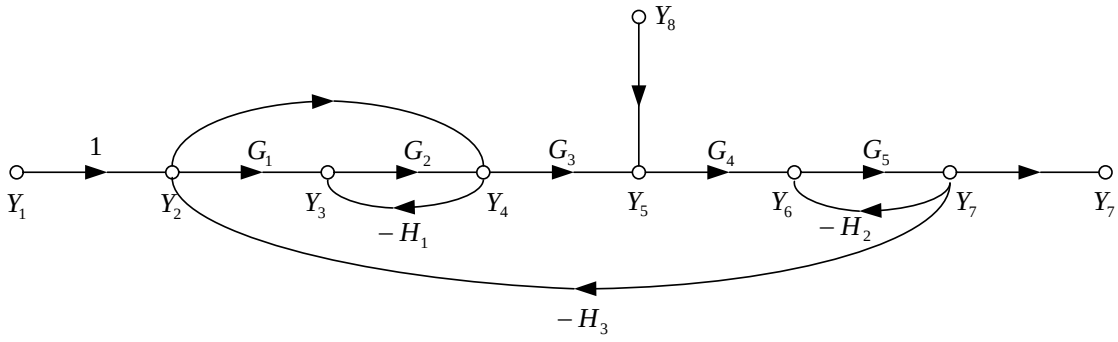

Fig. 2. Signal Flow Graph