每題 10 分，共 10 題，合計 100 分

1. Determine the number of roots of each equation that is in the right-half s-plane.

   (a) $S^3 - 3S^2 + 2 = 0$

   (b) $S^6 + S^5 - 2S^4 - 3S^3 - 7S^2 - 4S - 4 = 0$

2. Reduce the block diagram shown in Fig.1 to unity feedback form and find the Y/X.

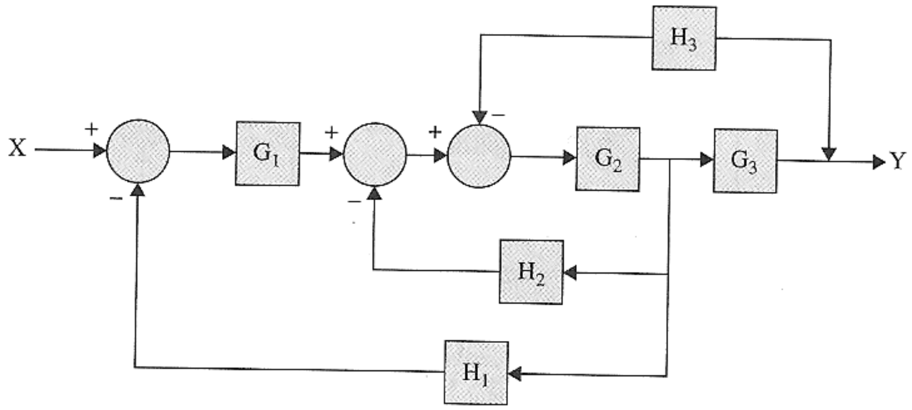

Fig.1

3. A spring-mass-friction system is described by the following differential equation:

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + y(t) = r(t)$$

Define the state variables as $x_1(t) = y(t)$ ， $x_2(t) = \dfrac{dy(t)}{dt}$.

   (a) Write the state equations in vector-matrix form.

   (b) Find the state-transition matrix $\phi(t) = e^{At}$.

4. The block diagram of a system is shown in Fig. 2, and

$$G1(s)=\frac{1}{s+1},\quad G2(s)=\frac{-4}{s+2},\quad U(s)=\frac{1}{s}.$$

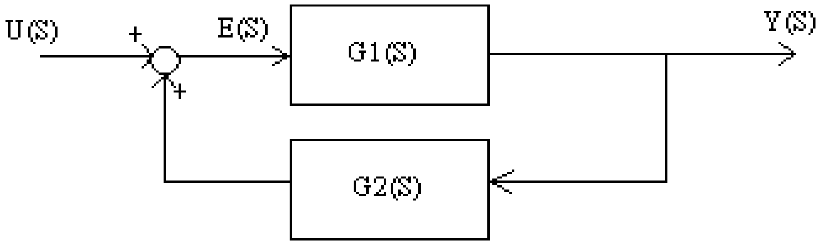

Fig. 2

Please find the steady state error of this system.

5. As shown in Fig. 3, both the forward-path transfer function matrix and the feedback-path transfer function matrix of the system are given as follows.

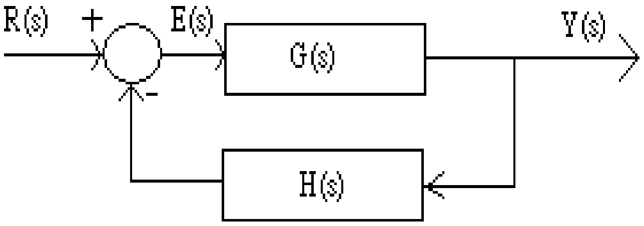

Fig. 3

$$G(s)=\begin{bmatrix}\frac{2}{s(s+2)} & 10\\ \frac{5}{s} & \frac{1}{s+1}\end{bmatrix}\qquad H(s)=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$$

Find the closed-loop transfer function matrix $[I+G(s)H(s)]^{-1}G(s)$

6. As shown in Fig. 4, determine the critical value of T for stability.

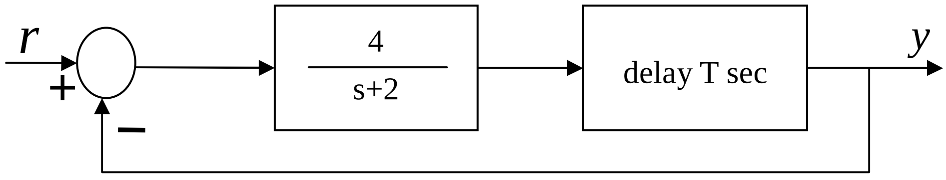

Fig. 4

7. As shown in Fig. 5, find the root locus of the closed system with $K > 0$.

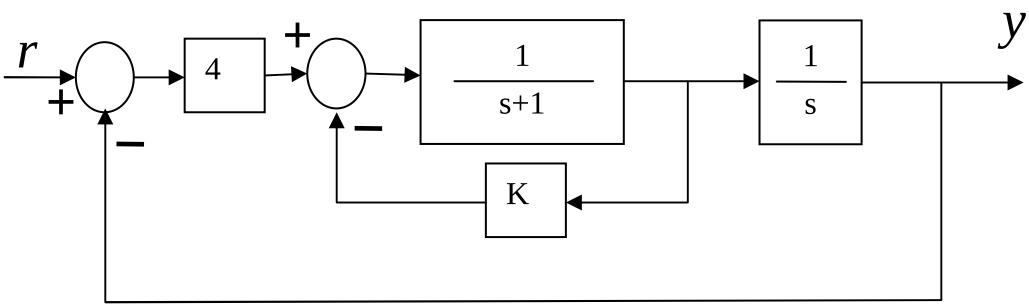

Fig. 5

8. Please see the Fig. 6. Employ the Nyquist criterion to determine the stability of the feedback system shown in the below for all $-\infty < K < \infty$

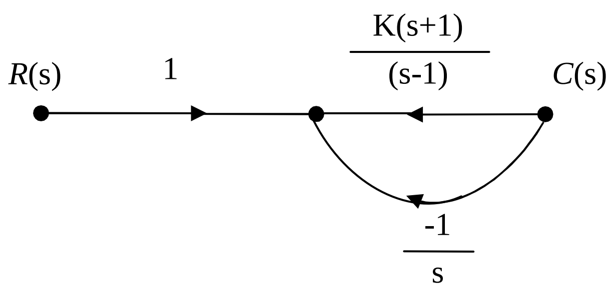

Fig. 6

9. The characteristic equation of a certain system is $s^3 + s + K(s^2+b) = 0$, $0 \leqq K \leqq \infty$. Sketch the root locus for (a) b=1/3, (b) b=1/9.

10. As shown in Fig. 7, try to find out the ranges of the parameters k and h and show it in the k-h plane, which can make the pole of the feedback system at s=-1 by using the PI controller $k+(h/s)$ to improve the system $G(s)=1/[s(s+4)]$.

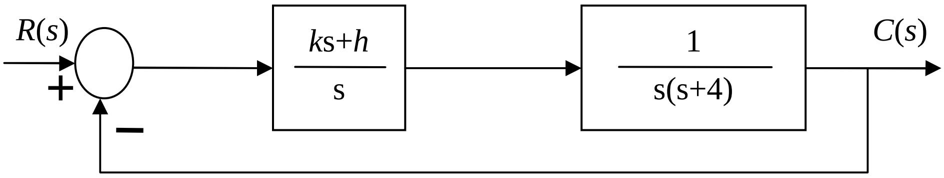

Fig. 7