本試題是否可以使用計算機：☑可使用 ，☐不可使用 （請命題老師勾選）

1. (10%) Determine transfer function $\frac{Y(s)}{U(s)}$ for the block diagram shown in Fig. 1.

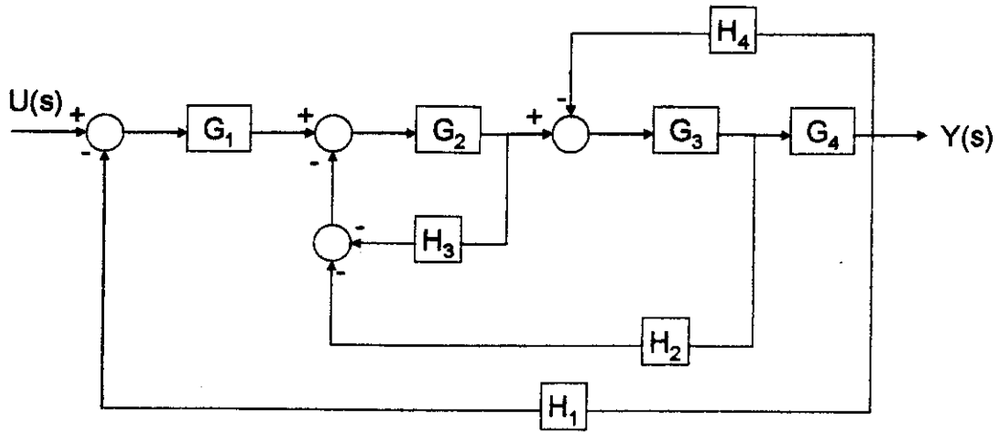

Fig. 1

2. (20%) For the mass-damper-spring mechanical system shown in Fig. 2 (neglecting all frictions)

(a) Find $G(s)=\frac{Y(s)}{U(s)}$ (8%)

(b) Let $x_1=y$, $x_2=\dot{x}_1$.

$$\dot{x}=Ax+Bu$$
$$y=Cx+Eu$$

Determine A, B, C, and E matrices. (7%)

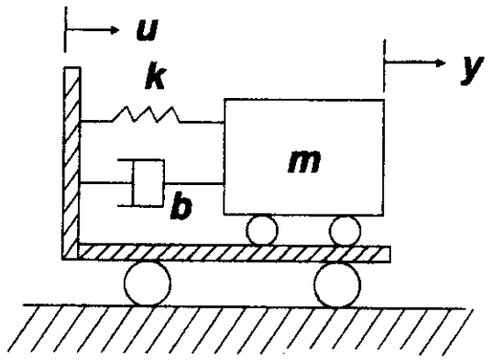

Fig. 2

(c) For m=5 Kg, k=10 N/m, b=15 Ns/m, find the state transition matrix $\phi(t)$. (5%)

3. (20%) As shown in Fig. 3,

(a) Find the steady-state error in terms of K and K_t when the input is a unit-ramp function. Give the constraints on the values of K and K_t so that the answer is valid. Let n(t)=0 for this part. (10%)

(b) Find the steady-state value of y(t) when n(t) is a unit-step function. Let r(t)=0. Assume that the system is stable. (10%)

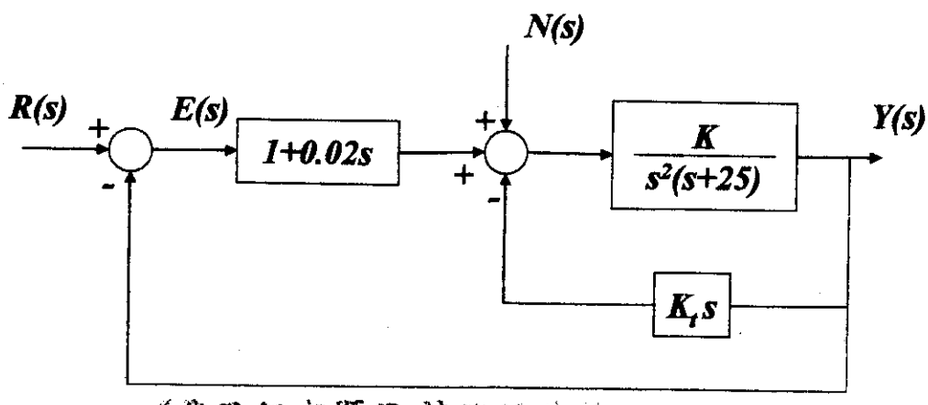

Fig. 3

（背面仍有題目，請繼續作答）

4. (25%) For the control system shown in Fig 4,

(a) Find K_I so that the ramp-error constant K_v is 10. (12%)

(b) Find K_p so that the magnitude of imaginary parts of the complex roots of the characteristic equation for the system is 15 rad/sec. (8%) Determine the roots of the characteristic equation. (5%)

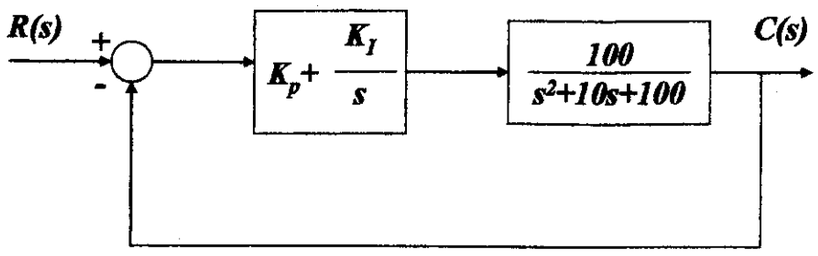

Fig. 4

5. (25%) A control block diagram is shown in Fig. 5, with G_c to be determined from the following two cases.

(i) $G_c = \dfrac{9A}{(5+4A)+4s}$ $A>0$ or

(ii) $G_c = \dfrac{4(B+8)}{(B+8)+s}$ $B>0$

The system requires (I) damping ratio $1>\zeta\geq 0.707$, (II) settling time $t_s \leq 0.8$ and (III) steady-state error e_{ss}<2% for step input.

(a) Determine which one [case (i) or (ii)] can be used to achieve the above specification (15%)

(b) Estimate the range of A or B or both, for which the specification remains satisfied. (10%)

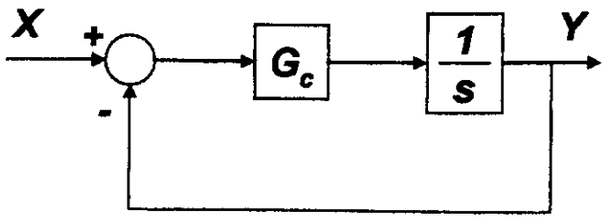

Fig. 5