

1. (20%) Consider the RLC-circuit shown in Fig. 1.

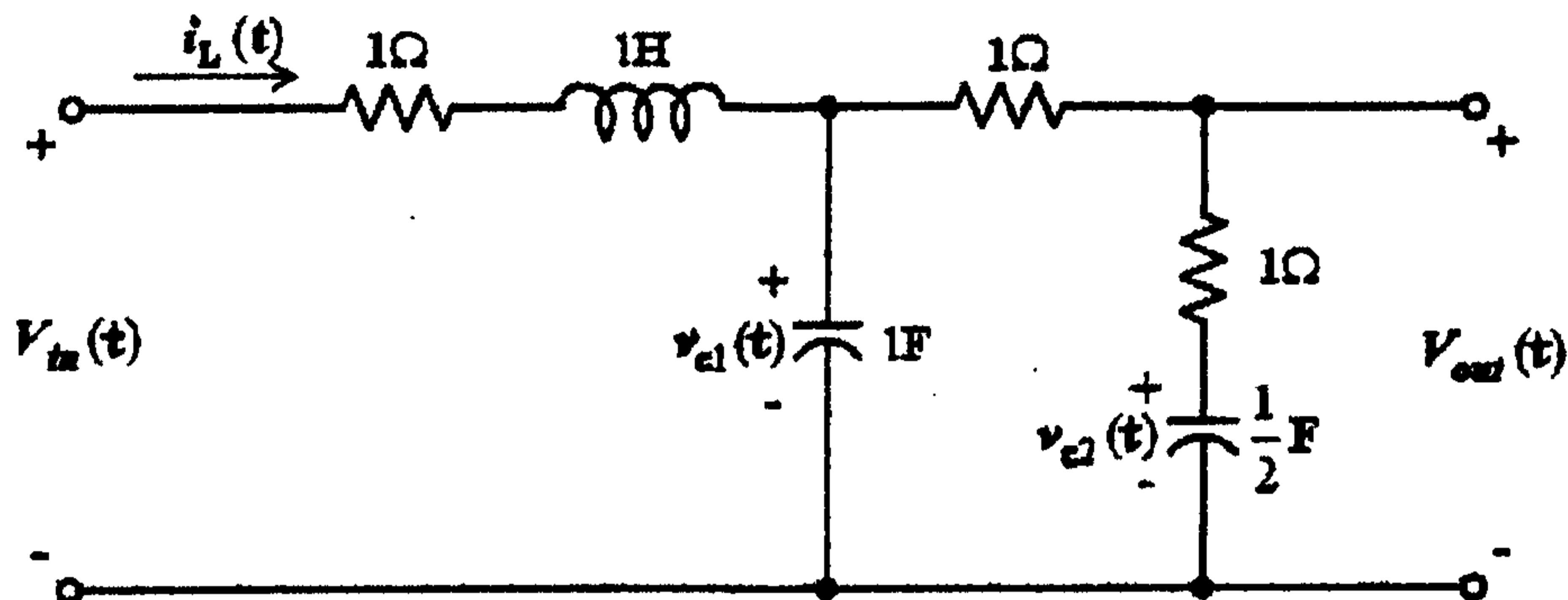


Figure 1

The inductor current, $i_L(t)$, and capacitor voltages, $v_{c1}(t)$ and $v_{c2}(t)$, are assigned as state variables $x_1(t)$, $x_2(t)$ and $x_3(t)$, respectively. All initial conditions are set to zero.

(a) (5%) Draw the state diagram using a minimum number of integrators.

(b) (5%) Find the transfer function $G(s) = \frac{V_{out}(s)}{V_{in}(s)}$ by applying the signal-flow graph gain formula.

(c) (5%) Write the state equation and output equation in the matrices form.

(d) (5%) Determine the $V_{out}(\infty)$ if $V_{in}(t) = 2$.

2. (20%) Consider a continuous-time linear feedback control system with

$$G_p(s) = \frac{2}{s^2 + s - 2} \text{ and } G_c(s) = K_p + \frac{K_I}{s} \text{ shown in Fig. 2.}$$

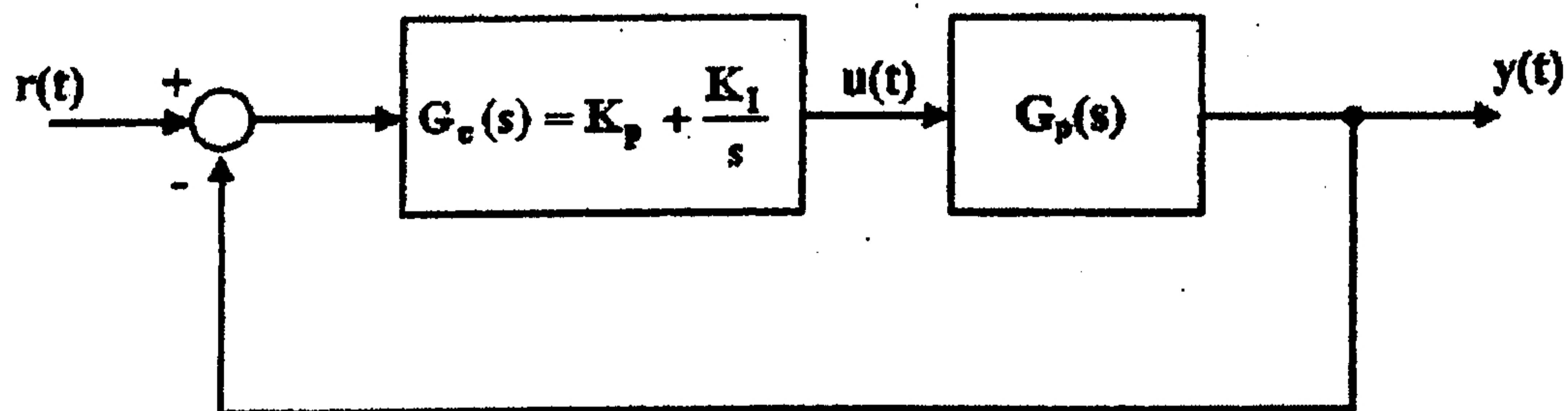


Figure 2

(a) (10%) If $K_p = 2$ and $K_I = 1$, find the transfer function of the closed-loop system and determine the differential equation from input $r(t)$ to output $y(t)$.

(背面仍有題目,請繼續作答)

(b) (5%) Find the range of the controller parameters K_p and K_I so that the closed-loop system is asymptotically stable.

(c) (5%) Draw the stable range of the controller parameters in the $K_p - K_I$ plane.

3. (20%) A continuous-time linear feedback control system with $G_p(s) = \frac{K_p}{s^2 + 4s + 3}$ is

shown in Fig. 3.

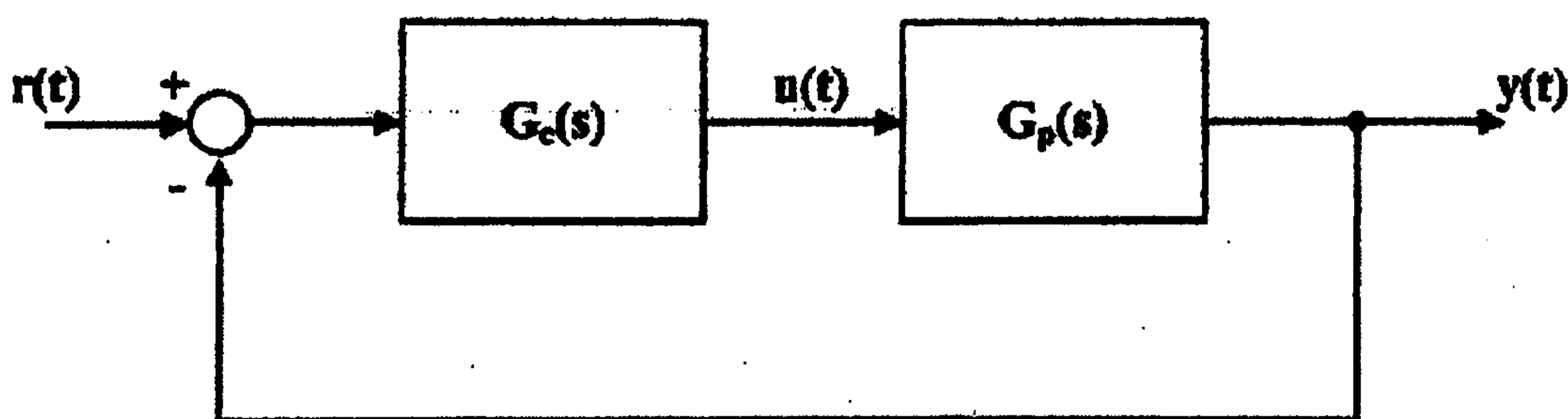


Figure 3

(a) (10%) Draw the root locus for $K_p \geq 0$ and $G_c(s) = 1$.

(b) (10%) If $K_p = 1$, design a controller $G_c(s)$ so that

- (i) the steady-state error is zero for step inputs;
- (ii) the closed-loop system has a time-constant $\tau = 0.5$;
- (iii) the closed-loop system has a damping ratio $\xi = 0.707$.

4. (20%) Consider a continuous-time linear system with the following transfer function

$$G(s) = \frac{s^2 + 5s + 8}{s^3 + 6s^2 + 11s + 6}$$

(a) (10%) Find the state space realization in the controllable canonical form.

(b) (10%) If the state space realization of the system is

$$\dot{X}(t) = \begin{bmatrix} A & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & B \end{bmatrix} X(t) + \begin{bmatrix} C \\ D \\ 0.5 \end{bmatrix} u(t)$$

$$y(t) = [1 \quad 1 \quad E] X(t).$$

Please determine the values of A , B , C , D and E .

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）

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5. (20%) The state space realization of a continuous-time linear system is given by

$$\dot{X}(t) = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix} X(t) + \begin{bmatrix} 2 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = [1 \ 0] X(t).$$

- (a) (10%) Design a state feedback control law so that the closed-loop system has two poles at -1 and -3 .
- (b) (10%) Design an observer to estimate the state so that the state error dynamics has two poles at 0 and -2 .