※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (25%)

Consider a mechanical system including mass (*M*), dashpot (*C*), and spring (*K*). The system is relaxed initially and operated by input force (*f(t)*) to cause output displacement (*x(t)*) as shown in Figure 1. (25%)

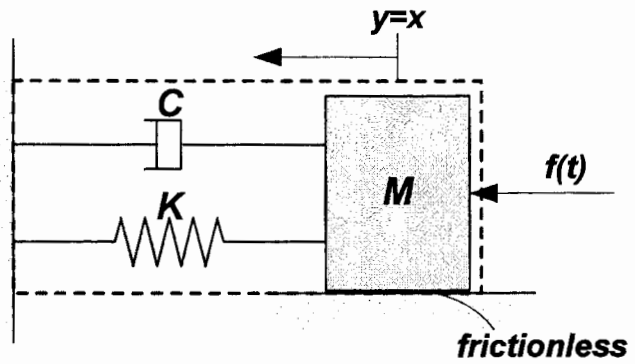

Figure 1

Utilize resistance (*R*), inductance (*L*), and capacitance (*C*) to construct an analog electrical circuit for simulating the dynamic behavior of the mechanical system. If the input of the mechanical system is a unit step force, characterize the time-domain performance in output response. (Note: You need to write down necessary equations to support your answer.)

(背面仍有題目,請繼續作答)

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2. (25%)

For a unity feedback control system with adjustable integral controller, the closed-loop system with fixed controller gain is identified as a third-order linear time-invariant system.

(1) (5%) Draw a block diagram and explicitly identify the transfer functions of the controller and plant.

(2) (10%) Find the maximum adjustable gain of the integral controller.

(3) (5%) Determine whether the closed-loop system is better employed as a regulator or tracker.

(4) (5%) If the input is a ramp signal, sketch the output response and indicate the time delay and error response in steady state.

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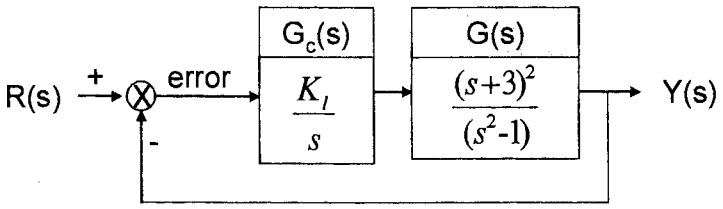
3. (25%)

Given a plant $G(s)$ and its closed-loop block diagram with controller $G_c(s)$ shown below,



(1) (10%) Draw the Nyquist diagram and use Nyquist stability criterion to determine the range of K_I such that the closed-loop system is stable.

(2) (10%) Assume that you design a controller with $K_I = 2$, please draw the Bode diagram of the open loop Gc(s)G(s) in the frequency interval 0.1~100 (rad/s).

(3) (5%) Continue (2); now, you are asked to implement your controller with hardware which will result in a pure time delay "T". Please find the range of T such that the closed-loop system is still stable. (*note: the gain cross over frequency in (2) is 3.3 (rad/s))*

4. (25%)

Plot the root locus of the closed-loop system shown below; where the control gain K varies from zero to positive infinity (you only need to specify the poles, zeros, and centroid of the asymptotes in your answer).