所別：機械工程學系碩士班 丁組(系統) 科目：自動控制
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1. (a) A mass-spring-damper system is shown in *Figure 1*, where $F(t)$ represents the input force, m represents the mass of the moving object, $y(t)$ represents its position (and v represents its velocity, i.e. $v(t)=dy(t)/dt$), k represents the spring constant of the spring and b represents the damping coefficient of the damper. Please derive the dynamic equation between $F(t)$ and $v(t)$. Also, please find the corresponding transfer function from the input force $F(t)$ to the object velocity $v(t)$. (10pts)
(b) A circuit system is shown in *Figure 2*, where $v_i(t)$ represents the input voltage, $v_c(t)$ represents the output voltage, R represents the resistance of the resistor, L represents the inductance of the inductor and C represents the capacitance of the capacitor. Please derive the dynamic equation between $v_i(t)$ and $v_c(t)$. Also, please find the corresponding transfer function from $v_i(t)$ to $v_c(t)$. (10pts)
(c) If the values of k 、b 、m 、R 、C 、L are all equal to 1, please compare the transfer functions in (a) and (b), describe what the difference between them, and explain the reasons. (5pts)

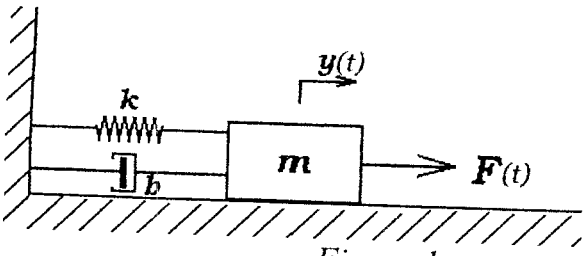

Figure 1

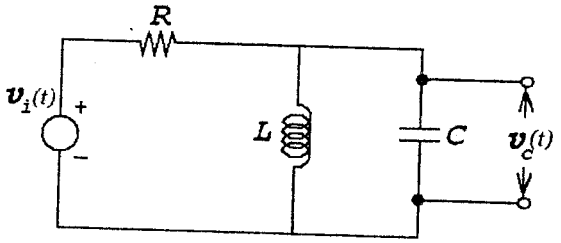

Figure 2

2. A unity feedback system where a plant transfer function $G(s)=K/s(\tau s+1)$ and a cascade controller transfer function $D(s)=K_0+K_1/s$ are shown in *Figure 3*. Please answer the following questions:
(a) What type of control is it? (2 pts) Write the control signal in time domain. (3 pts)
(b) What is the system-type number before and after the controller is implemented? (2 pts) Explain the practical significance of this number. (3 pts)
(c) Find the closed-loop characteristic equation. (5 pts)
(d) Applying Routh's test to determine the range in terms of K_0 and K_1 for a stable system. (10 pts)

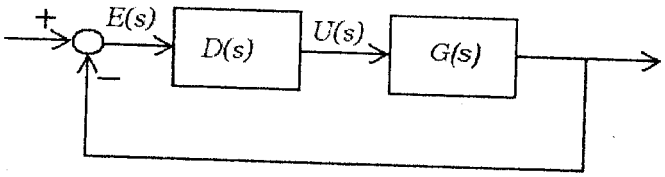

Figure 3

3. A unity feedback system shown in *Figure 3* has an open-loop transfer function $G(s)=1/s^2$. Please answer the following questions:
(a) The open loop forward system can process satisfactory steady-state error to both step and ramp inputs signals. Please explain why? (10 pts)
(b) But its closed-loop system has poor steady-state error. Please explain why? (10 pts)
(c) Can a proportional control $D(s)$ fix the closed-loop problem and why? (5 pts)

注意：背面有試題

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4. A closed loop system is shown in *Figure 4*, where *G(s)* represents the transfer function of a stable minimum phase system and *k* represents the gain of the controller. *Figure 5* shows the magnitude diagram of the Bode plot of *G(s)*.

(a) How many poles and zeros does *G(s)* have? (4%)
(b) Please write down the corresponding transfer function of *G(s)*. (6pts)
(c) Please draw the corresponding phase diagram of *G(s)*. (8pts)
(d) Please find the suitable region for *k* to stabilize the closed loop system. (7pts)

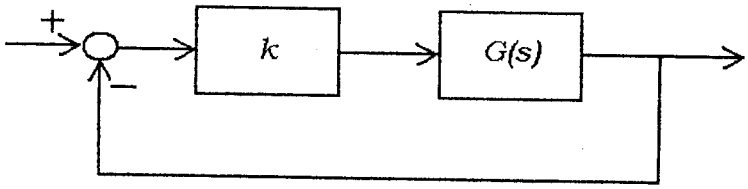

Figure 4

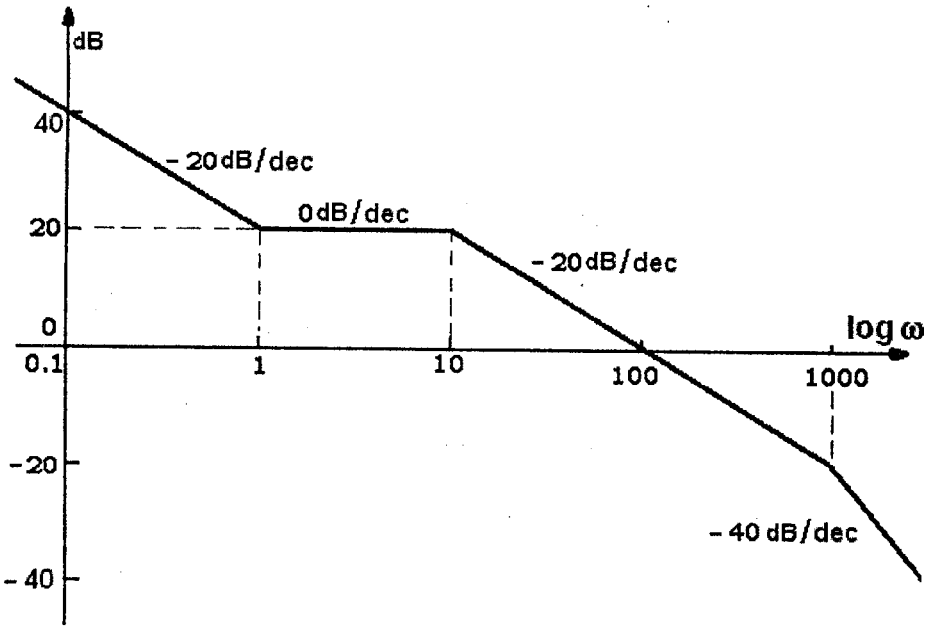

Figure 5