國立臺灣科技大學 104 學年度碩士班招生試題

系所組別：材料科學與工程系碩士班乙組

科　　目：控制系統

(總分為 100 分)

1. Consider the differential equation

$$\frac{d^2x}{dt^2}+5\frac{dx}{dt}+3x=f(x)$$

where f(x) is the input and is a function of the output, x.

If f(x)=sin x, linearize the differential equation for small excursions.

(a) $x=0$ (5%)
(b) $x=\pi$ (5%)

2. Find the transient and steady state responses of a system described by the differential equation

$$\frac{d^2y}{dt^2}+3\frac{dy}{dt}+2y=1+t$$

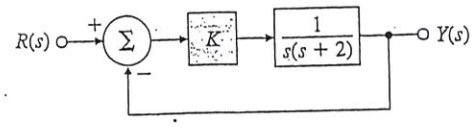
with the initial conditions y(0)=0 and $(dy/dt)\big|_{t=0}=1$. (10%)

3. The transfer function of a typical tape-drive system is given by

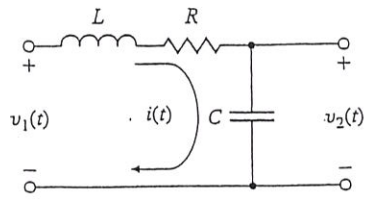
$$G(s)=\frac{K(s+4)}{s[(s+0.5)(s+1)(s^2+0.4s+4)]}$$

where time is measured in milliseconds. Using Routh's stability criterion, determine the range of K for which this system is stable when the characteristic equation is 1+G(s)=0. (10%)

4. For the unity feedback system as shown below, specify the gain K of the proportional controller so that the output y(t) has an overshoot of no more than 10% in response to a unit step. (10%)



5. For the electric circuit as shown below, assuming all initial conditions are zeros, find the transfer function $\frac{V_2(s)}{V_1(s)}$, the damping ratio, and undamped natural frequency of the system. (15%)



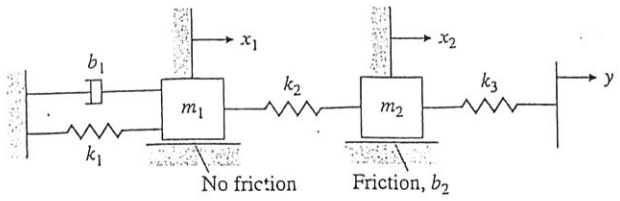
國立臺灣科技大學 104 學年度碩士班招生試題

系所組別：材料科學與工程系碩士班乙組

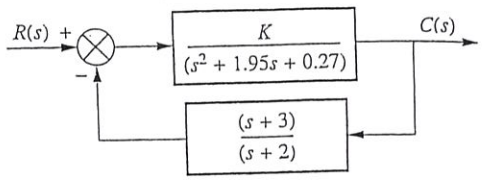
科　　目：控制系統

(總分為 100 分)

6. Write the differential equation for the mechanical system shown below. State whether you think the system will eventually decay so that it has no motion at all, given that there are non-zero initial conditions for both masses, and give a reason for your answer. (15%)



7. If the system of the figure shown below operates with a damping ratio of 0.517 for the dominant second-order poles, find the location of all closed-loop poles and zeros. (10%)



8. The equations of motion for the DC motor were given as

$$J_m\ddot{\theta}_m + (b + \frac{K_t K_e}{R_a})\dot{\theta}_m = \frac{K_t}{R_a} v_a$$

Assuming that

$J_m = 0.01$ kg·m^2, $b = 0.001$ N·m·sec, $K_e = 0.02$ V·sec, $K_t = 0.02$ N·m/A, $R_a = 10$ Ω.

(a) Find the transfer function between the applied voltage v_a and the motor speed $\dot{\theta}_m$. (5%)

(b) What is the steady-state speed of the motor after a voltage $v_a = 10$ V has been applied? (5%)

(c) Find the transfer function between the applied voltage v_a and the shaft angle θ_m. (5%)

(d) Suppose feedback is added to the system in part (c) so that it becomes a position servo device such that the applied voltage is given by

$$v_a = K(\theta_r - \theta_m),$$

where K is the feedback gain. Find the transfer function between θ_r and θ_m. (5%)