

國立臺灣科技大學

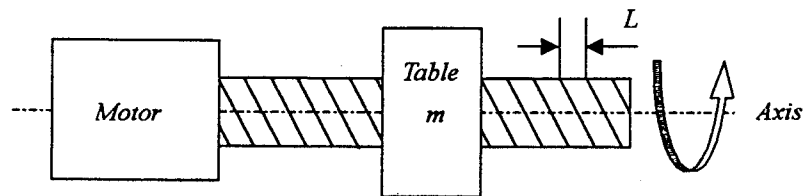
九十一學年度碩士班招生考試試題

系所組別：纖維及高分子工程系丙組

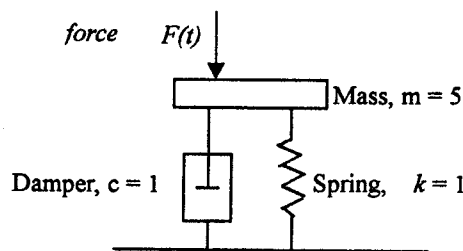
科目：控制系統

總分 100

1. A motor drives a table of mass m by a lead screw shown as following Figure. The inertia of the motor is I_m , the inertia of the lead screw is I_L , and the lead pitch of the lead screw is L . The rotating friction is proportional to the angular velocity of the lead screw. If the system's input is motor torque T , and the output is screw's angular velocity ω , please derive the transfer function for output to input. (15%)



2. Force oscillation problem: there is a mass-spring-damper system shown as following Figure. The $u(t)$ means unit step function. Find the total response of the system, if the driving force is $F(t) = 10u(t) - 10u(t-3)$, and initial condition is $y(0) = 5, \dot{y}(0) = 3$. (15%)



3. The following model describes a mass supported by a nonlinear spring. The mass is $M = 5$ kg, y is the position of the mass, and the g is gravitational acceleration constant. (20%)

$$M\ddot{y} = Mg - (900y + 1700y^3)$$

- (a) Find the equilibrium position y_r , obtain a linearized model using the equilibrium as the reference operating condition, and compute the oscillation frequency of the linearized model.
- (b) Find the free response of the linearized model in terms of $x(t) = y(t) - y_r$, for the initial conditions: $x(0) = 0.002$ m and $\dot{x}(0) = 0.005$ m/s.



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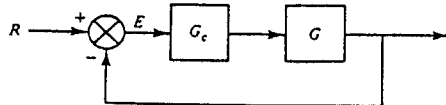
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4. For the unity feedback system with

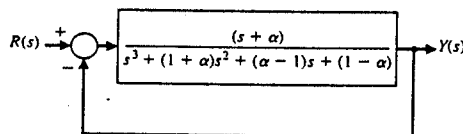
$$G(s) = \frac{1}{(s+1)(s+5)}$$

- (a) For P control $G_c(s) = K$, find the value of K to yield a system damping ratio of 0.7. (6%)
- (b) For PD control $G_c(s) = K_1 + K_2s$, find the values of K_1 and K_2 so that the system responds to a unit step input with a maximum overshoot of 5% and a settling time of 1 second (2% criterion). (9%)



5. A control system is shown below. It is desired that the system be stable and the steady-state error for a unit step input be less than or equal to 0.05.

- (a) Determine the range of α that satisfies the error requirement. (5%)
- (b) Determine the range of α that satisfies the stability requirement. (8%)
- (c) Select an α that meets both requirements. (2%)



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6. A block diagram of the system with the input u and the output y is shown in the figure.

- (a) Derive a state-space representation of the system with state variables x_1 and x_2 defined in the block diagram. Is the system completely state controllable? (7%)
- (b) Find the transfer function $Y(s)/U(s)$. (5%)
- (c) The control is obtained through state feedback with

$$u(t) = -k_1 x_1(t) - k_2 x_2(t) + r(t)$$

where k_1 and k_2 are real constants and $r(t)$ is the reference input. Find the values of k_1 and k_2 to place the closed-loop poles at $-5 \pm j$. (8%)

