國立彰化師範大學 100 學年度碩士班招生考試試題

系所：工業教育與技術學系　　組別：乙組　　科目：自動控制

☆☆請在答案紙上作答☆☆　　共 2 頁，第 1 頁

1. Consider the mechanical system shown in Figure 1. Assume that $u(t)$ is the force applied to the cart and is the input to the system. The displacement x is measured from the equilibrium position and is the output of the system. Suppose that the system is initially at rest [$x(0^-)=0$, $\dot{x}(0^-)=0$]. At $t = 0$, it is set into motion by a unit-impulse force. Determine the transfer function $X(s)/U(s)$ of the system and the solution $x(t)$. What is the initial velocity $\dot{x}(0^+)=0$ after the unit-impulse force is given to the cart? (25%)

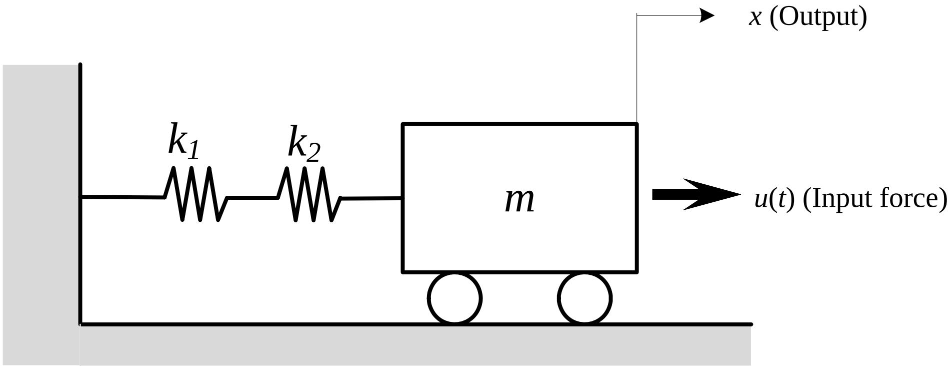

Figure 1.

2. A control system with

$$G(s)=\frac{K}{s^2(s+1.5)}, \qquad H(s)=1$$

is unstable for all positive values of the gain K.

Plot the root loci of the system. Using the plot, show that the system can be stabilized by adding a zero on the negative real axis or by modifying $G(s)$ to $G_1(s)$, where

$$G_1(s)=\frac{K(s+a)}{s^2(s+1.5)} \qquad (0 \le a < 1) \qquad (25\%)$$

3. A controlled process is modeled by the following state equations:

$$\dot{x}_1(t)=2x_1(t)-3x_2(t), \quad \dot{x}_2(t)=x_1(t)-x_2(t)+u(t)$$

The state feedback control is $u(t)=-k_1x_1(t)-k_2x_2(t)$, where k_1 and k_2 are the real constants.
Sketch and determine the region in the k_1 versus k_2 plane in which the closed-loop system is asymptotically stable. (Please put k_1 as the x-axis and k_2 as the y-axis.) (25%)

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4. Draw the block diagram and derive the transfer function $\frac{\Theta_m(s)}{E_a(s)}$ for the armature-controlled PM (permanent magnet) DC motor system shown in the following figure. The motor variables and parameters are defined as follows: (25%)

$e_a(t)$: applied voltage　　$i_a(t)$: armature current
$e_b(t)$: back-emf
$T_L(t)$: load torque　　$T_m(t)$: motor torque
$\omega_m(t)$: rotor angular velocity　　$\theta_m(t)$: rotor displacement
R_a : armature resistance　　L_a : armature inductance
k_i : torque constant　　k_b : back-emf constant
ϕ : magnetic flux in the air gap
J_m : rotor inertia　　B_m : viscous-friction coefficient