國立台灣科技大學九十六學年度碩士班招生試題

系所組別： 自動化及控制研究所碩士班乙組

科　　目： 控制系統

總分100分

1. A life support system is to be constructed in the outer space, and you are asked to stabilize its thermal subsystem so that it will ensure proper temperature in some chamber inside the construction. The temperature will increase when the external energy source (such as the sun light) sends thermal energy into the chamber; while the temperature will decrease when the chamber loses the thermal energy. In other words, the variation of the chamber temperature is proportional to the energy variation.

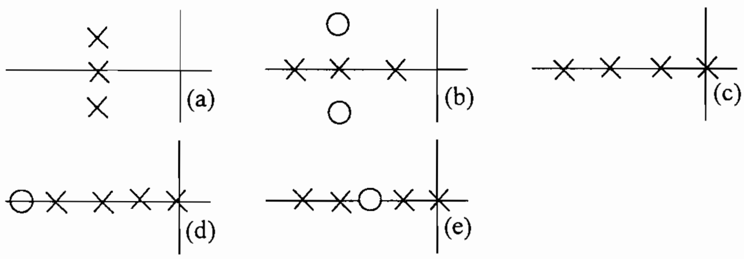
   (a) Please set up proper system variables and the output variable. (5%)

   (b) Model the system using differential equations. (5%)

   (c) Is it controllable? If yes, please design a controller so that the temperature is stabilized. If no, what would you do to have a stabilized temperature? (5%)

   Hint: You may have assumptions if necessary, but please state them explicitly.

2. Sketch possible root loci for the following open-loop pole-zero configurations without any computation. (15%)




3. Given two linear control systems

$$\text{System 1}: \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

$$\text{System 2}: \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u$$

   where $x_1$ and $x_2$ are system states and $u$ is the control signal. Suppose both systems share the same output function $y = x_1$.

   (a) Please analyze these two systems as much as you can do. (10%)

   (b) Design tracking controllers such that the output $y$ tracks the desired output $y_d$ asymptotically. Don't forget that, for a controller to be feasible, all internal signals should be bounded for all time $t$. If you are not able to design controllers for both systems, state the reason in detail. (10%)

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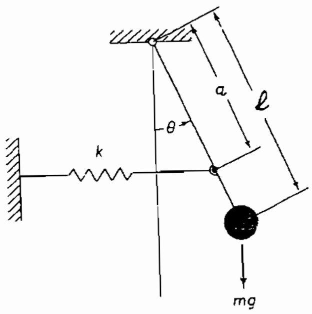
4. Derive the equation of motion for the pendulum system shown below. Assume that when the pendulum is vertical, there is no spring force; also, assume that $\theta$ is small. Finally, determine $\theta(t)$ when the pendulum is given initial conditions $\theta(0) = \theta_0$, and $\dot{\theta}(0) = 0$. (20%)

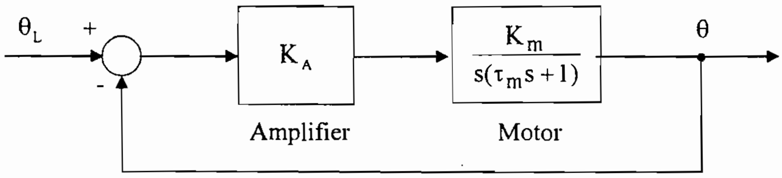



5. The feedback configuration as shown below is used to position a device in response to an input. The motor selected for this application has a gain constant $K_m = 0.5$ and a time constant $\tau_m = 0.1$. For an amplifier gain $K_A = 20$, determine the following:

(1) Undamped natural frequency, and damped natural frequency. (8%)

(2) Peak time, and peak overshoot. (8%)

(3) Steady-state error resulting from the application of unit-step input. (4%)




6. Determine the departure angles from the complex poles and the arrival angles at the complex zeros for the open-loop transfer function (10%)

$$GH = \frac{K(s+1+j)(s+1-j)}{s(s+2j)(s-2j)}, \quad K > 0$$