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：電機工程系乙一組、電機工程系乙二組

科　目：控制系統

共六題，滿分一百分。

Problem 1. (15%)

Find the inverse Laplace transform of the following transfer function

$$G(s) = \frac{4e^{-3t}}{s(s+2)^2}$$

Problem 2. (15%)

Consider a unity negative feedback system with the following open-loop transfer function

$$G(s) = \frac{K(1-s)}{s+1}\ , \quad K > 0.$$

Sketch the Nyquist plot of the system and use the Nyquist stability criterion to find the condition for stability.

Problem 3. (20%)

A unity negative feedback system has the following open-loop transfer function

$$G(s) = \frac{K(s+0.4)}{s^2(s+3.6)}\ , \quad K > 0.$$

Sketch the root locus and determine the range of K so that the system is stable. Specify the break-away or break-in points on the root locus.

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Problem 4. (15%)

Control engineers often face a system that would not meet the given specifications by merely adjusting a static gain K. One way to deal with the problem is to use a linear compensator such as a lead compensator. Performance analysis can then be exercised using either the root locus (contours) or the Bode plot. Give an example by yourself and explain how you would analyze a lead compensated system using the latter method.

Problem 5. (20%)

Consider a system with two inputs u_1 and u_2, and two outputs y_1 and y_2. The differential equations that govern the inputs and the outputs are

$$\dot{y}_1 + 3(y_1 + y_2) = u_1$$

and

$$\ddot{y}_2 + 4\dot{y}_2 + 3y_2 = u_2.$$

Derive, with all detailed steps shown, the model in state space for the system and describe in the general setting the advantages and disadvantages of the state space model compared with the differential equation description and the traditional I/O transfer function representation.

Problem 6. (15%)

Consider the system described by the dynamical equation

$$\dot{\mathbf{x}}(t) = \begin{bmatrix} \frac{-3}{4} & \frac{-1}{4} \\ \frac{-1}{2} & \frac{-1}{2} \end{bmatrix} \mathbf{x}(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t).$$

$$y(t) = \begin{bmatrix} 4 & 2 \end{bmatrix} x(t)$$

Determine the controllability and the observability of the system. Convert this state space description into transfer function representation and explain the meaning of the controllability and the observability in transfer function.