編號： 178

國立成功大學 104 學年度碩士班招生考試試題

系所組別：電機工程學系乙組

考試科目：控制系統

考試日期：0211，節次：2

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A unity feedback control system has the open-loop transfer function $G(s)=\dfrac{A}{s(s+\zeta\omega_n)}$. **(20%)**

(a) Compute the sensitivity of the closed-loop transfer function to changes in the parameter A. (5%)

(b) Compute the sensitivity of the closed-loop transfer function to changes in the parameter ζ. (5%)

(c) Compute the sensitivity of the closed-loop transfer function to changes in the parameter ω_n. (5%)

(d) If the unity gain in the feedback path changes to a value of positive $\beta \neq 1$, compute the sensitivity of the closed-loop transfer function to changes in the parameter β. (5%)

2. Suppose a function $\tilde{A}$ is defined by $\tilde{A}(\mathbf{M}_{n\times m}) \equiv \mathbf{A}_{n\times n}\mathbf{M}_{n\times m} + \mathbf{M}_{n\times m}\mathbf{B}_{m\times m}$ and η is an eigenvalue of $\tilde{A}$. Please show that $\eta_k = \eta_{ij} = \lambda_i + \mu_j$, for $i = 1, 2, \cdots, n$ and $j = 1, 2, \cdots, m$, where λ_i and μ_j are the eigenvalues of $\mathbf{A}$ and $\mathbf{B}$, respectively. **(10%)**

3. (a) For a linear time-varying system, please give the definition that an impulse response matrix $\mathbf{G}(t,\tau)$ is realizable. **(4%)**

(b) Please prove the theorem that a $q\times p$ impulse response matrix $\mathbf{G}(t,\tau)$ is realizable if and only if $\mathbf{G}(t,\tau)$ can be decomposed as $\mathbf{G}(t,\tau)=\mathbf{M}(t)\mathbf{N}(\tau)+\mathbf{D}(t)\delta(t-\tau)$, for all $t \geq \tau$, where $\mathbf{M}$, $\mathbf{N}$, and $\mathbf{D}$ are, respectively, $q\times n$, $n\times p$, and $q\times p$ matrices for some integer n. **(16%)**

4. Realize the lag-lead compensator $G_c(s)=\left(\dfrac{s+0.1}{s+0.01}\right)\left(\dfrac{s+1}{s+10}\right)$ with a passive network and an active network, respectively. **(25%)**

5. Using Laplace transform methods, solve for the state-transition matrix, the state vector, and the output $y(t)$ of the following system for a step input $u(t)$: **(25%)**

$$\dot{\mathbf{x}}=\begin{bmatrix}0 & 1\\ -8 & -6\end{bmatrix}\mathbf{x}+\begin{bmatrix}0\\ 1\end{bmatrix}u(t);\quad y=\begin{bmatrix}4 & 3\end{bmatrix}\mathbf{x};\quad \mathbf{x}(0)=\begin{bmatrix}1\\ 0\end{bmatrix}$$