國立臺灣科技大學

九十二學年度博士班招生考試試題

系所組別：高分子工程系博士班丙組、高分子工程系在職教師丙組

科　目：控制工程

總分 100 分

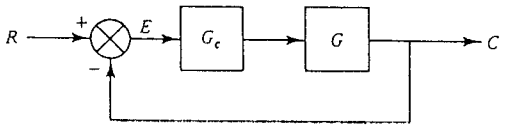
1. A unity feedback control system with PD controller has an open loop transfer function $G(s)=\frac{(K_P+K_D s)}{s(s+1)(s+3)(s+4)}$. If the desired velocity error constant is $K_v=5$, please find the proportional gain value K_P. For this proportional gain K_P, please use Routh criterion to determine the stability margin of K_D? (20分)

2. For a temperature control system with plant transfer function (20%)

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

(a) With P control $G_c(s) = k_p$, find k_p for a system damping ratio 0.5 and the corresponding steady-state error for a unit step input.

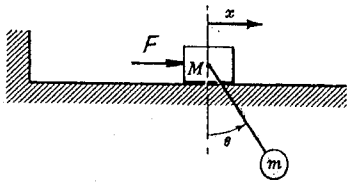
(b) With PD control $G_c(s) = k_p + k_d s$, find k_p and k_d if a system damping ratio 0.5 is required and the steady-state error for a unit step input is 5%.



3. A simple pendulum of length ℓ and weight mg is pivoted to the mass M which slides without friction on a horizontal plane as shown. Assume that the weight of the rod is negligible.

(1) Derive the equations of motion of the system. (10%)

(2) For small angles of oscillation, find the transfer function between $\theta(s)$ and $F(s)$. (10%)



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(20%)

4. A certain jet-powered ground vehicle is subjected to a nonlinear drag force. Its equation of motion, in British Engineering units, is $50\dot{v} = f - (20v + 0.05v^2)$

a) Find the vechicle's steady-state speed if the jet's force f is a step function of magnitude 8000 lb. (5%)

b) Linearize the model about the reference speed $v = 0$, and use the time constant of the linearized model to estimate how long it will take the vehicle to reach steady-state speed. (5%)

c) Repeat part b) using the steady-state as the reference speed. Compare the prediction with that of part b). (10%)

5. **Suppose a system is described by $\dot{x}$=Ax + Bu**

where $A=\begin{bmatrix} 0 & -1 \\ 2 & 3 \end{bmatrix}$ $B=\begin{bmatrix} 1 \\ 2 \end{bmatrix}$

(1) Diagonalize the matrix A. (8%)
(2) Calculate A^{20}. (6%)
(3) If $A^{20}=\alpha A+\beta I$, compute $(\alpha+\beta)^{20}$. (6%)