國立高雄第一科技大學 101 學年度 碩士班 招生考試 試題紙

系 所 別：系統資訊與控制研究所　　　　組 別：控制組

考科代碼：2154　　　　考 科：自動控制

注意事項：

1、本科目得使用本校提供之電子計算器。

2、請於答案卷上規定之範圍作答，違者該題不予計分。

1.(12分) 請分別就下列各種補償控制器(Compensator)說明其轉移函數、功用效果(Function)、及其特性(Characteristics)：(a)PI Compensator (b)Lag Compensator (c) PD Compensator (d)Lead Compensator (e)PID Compensator (f)Lead-Lag Compensator.

2.(12分) For the system shown below, K=5, α=2, do the following:

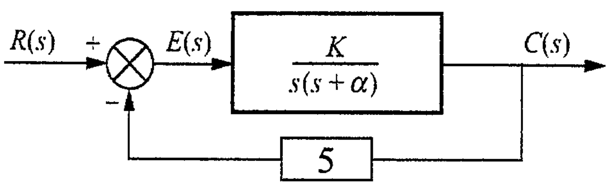
(a) Find the closed-loop transfer function T(s) = *C* (s) / *R* (s).

(b) Draw the poles in s-plane, and find ζ, ωn, %OS, Ts, and Tp

(c) Let *r*(t) =10 u(t), roughly plot the response *c*(t)

(d) Find K and α to yield a settling time of 0.8 second and a 5 % overshot.

(for %OS < 5%, you can approximate $\zeta = \cos\theta = 0.707$, or $\theta = 45^\circ$)



Hints: $\%OS = e^{-(\zeta\pi/\sqrt{1-\zeta^2})} \times 100$

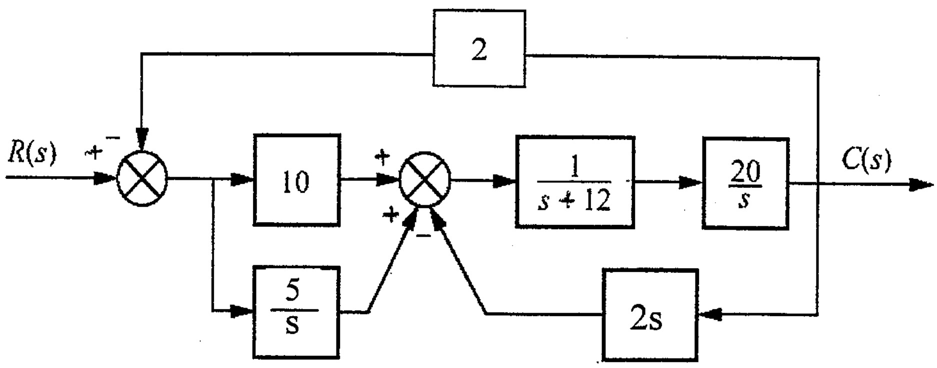
$$T_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} = \frac{\pi}{\omega_d}$$

$$T_s = \frac{4}{\zeta\omega_n} = \frac{4}{\sigma_d}$$

3. (12分)

(a)Find the closed-loop transfer function, T(s)=C(s)/R(s) for the system shown below, using block diagram reduction method

(b) Whether is this system stable, unstable, or marginally stable? Why?



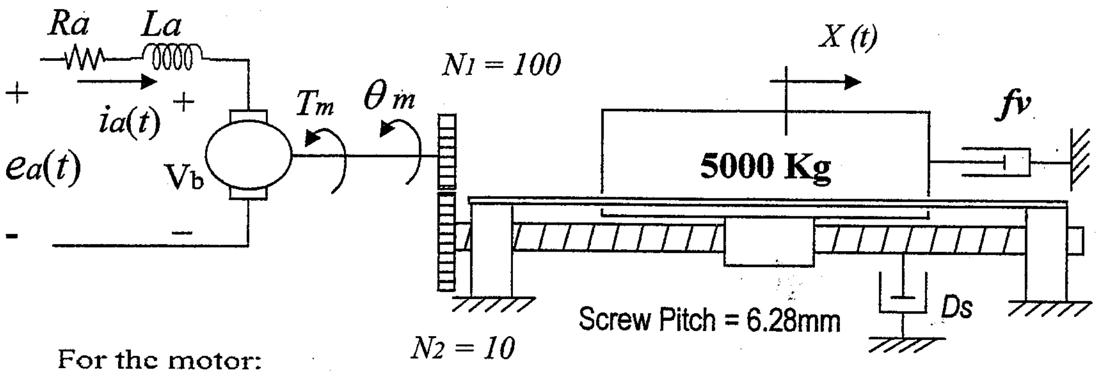
4.(20分) Given the dc-motor driven system as shown below with fixed field,

(a) if the gear pair, N_1 and N_2, is uncoupled, i.e., the motor is under free run without loading, derive and draw the system block diagram with input voltage $E_a(s)$, armature current $I_a(s)$, motor torque $T_m(s)$, motor speed $\omega_m(s)$, and motor angular displacement $\theta_m(s)$.

(b) in the case (a), find the transfer function, $\theta_m(s) / E_a(s)$

(c) under gear coupled, derive the total inertia J_m and total damping D_m, both refer to the motor axis

(d) in the case (d), find the transfer functions, $X(s) / E_a(s)$.



For the motor:

$J_a = 1$ kg-m^2

$D_a = 1$ N-m-s/rad

$R_a = 1\ \Omega$ $\quad La = 5$ mH

$K_b = 1$ V-s/rad

$K_t = 1$ N-m/A

Ds = 0.005N-m-s/rad

fv = 2000N-s/m

5. (12分)

(a) A system represented in state space as

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$

can be transformed to a similar system with x = Pz. Derive the transformed system.

$$\dot{z} = A'z + B'u$$
$$y = C'z + D'u$$

(b)Given the system as follows, find the diagonal system that is similar

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -10 & -7 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$
$$y = \begin{bmatrix} 2 & 2 \end{bmatrix} x + 5u(t)$$

6. (16分) Given a unity feedback system as shown below,

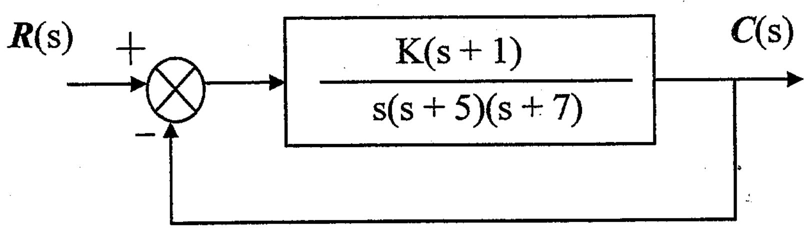
(a) Sketch the root locus with the asymptotes real-axis intercept, σ_a, θ_a, and the break-away point.

(b) Find the value of K for the uncompensated system to operate at 5% overshot, and find the settling time T_s and steady-state error for step input.

(for %OS < 5%, you can approximate $\zeta = \cos\theta = 0.707$, or $\theta = 45^\circ$)

(c) Design a PD controller so that the system can operate with a settling time that is one-third of the uncompensated system at 5% overshot.

(d) Sketch the root locus for the PD compensated system.



7.(16分) Given a unity feedback system as shown below,

(a) Plot the Bode diagram with Gc(s) = K = 20

(b) Find the phase margins and bandwidth of the uncompensated system (a) from the Bode plot.

(c) Design a lag compensator Gc(s) for the system to have phase margin of 60° with the same steady-state error specification as (a)

(d) Estimate the bandwidth of the compensated system (c).