國立成功大學
111學年度碩士班招生考試試題

編　號：193

系　所：製造資訊與系統研究所

科　目：自動控制

日　期：0219

節　次：第 2 節

備　註：不可使用計算機

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※ 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。

題一：

The schematic diagram of a steel-rolling process is shown in Fig. 1. The steel plate is fed through the rollers at a constant speed of V ft/s. The distance between the rollers and the point where the thickness is measured is d ft. The rotary displacement of the motor, $\theta_m(t)$, is converted to the linear displacement $y(t)$ by the gear box and linear-actuator combination $y(t) = n\theta_m(t)$, where n is a positive constant in ft/rad. The equivalent inertia of the load that is reflected to the motor shaft is J_L.

The load friction torque (coulomb friction) T_L is assumed to be zero.

(a) Please draw a functional block diagram for the system. (10%)

(b) Please derive the forward-path transfer function $Y(s)/E(s)$ and the closed-loop transfer function $Y(s)/E(s)$. (15%)

Hint:

i_a = armature current　　R_a = armature resistance

L_a = armature inductance　　e_a = applied voltage

e_b = back emf　　K_b = back-emf constant

T_L = load torque　　T_m = motor torque

ω_m = rotor angular velocity　　θ_m = rotor displacement

J_m = rotor inertia　　K_i = torque constant

B_m = visous-friction coefficient

$$\frac{d^2\theta_m(t)}{dt^2} = \frac{1}{J_m}T_m(t) - \frac{1}{J_m}T_L(t) - \frac{B_m}{J_m}\frac{d\theta_m(t)}{dt}$$

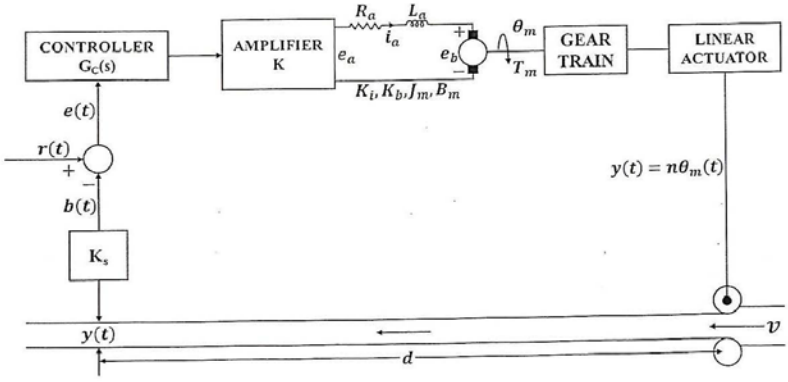

Fig. 1

題二：

Fig. 2 shows the block diagram of a servomotor. Assume $J = 1$kg-m^2 and $a = 1$N-m/rad/sec. If the maximum overshoot of the unit-step input and the peak time are 0.4 and 0.2 sec., respectively,

Hint:

ln	value	ln	Value
0.1	-2.303	0.6	-0.511
0.2	-1.609	0.7	-0.357
0.3	-1.204	0.8	-0.223
0.4	-0.916	0.9	-0.105
0.5	-0.693	1	0

(a) Please find its damping ratio and natural frequency. (5%)

(b) Please find the gain K and velocity feedback K_f. (5%)

(c) Please calculate the rise time and settling time. (5%)

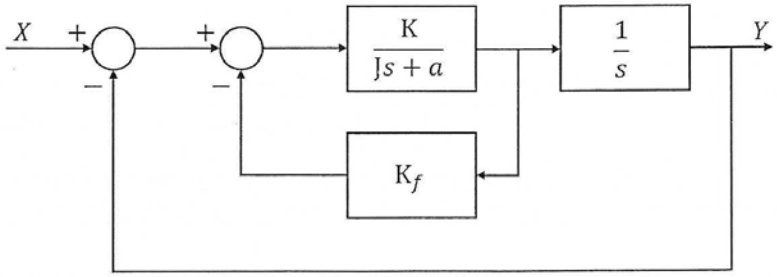

Fig. 2

題三：

The characteristic equation of linear control system is given by $s^3 + 5s^2 + (K + 6)s + K = 0$. Please construct the root loci for $K \geq 0$. (15%)

Hint: $s^3 + 4s^2 + 5s + 3$之三個根分別為$-2.466;\ -0.767 \pm j0.793$

題四：

The block diagram of a feedback control system is shown in Fig. 3, and $G(s) = \frac{K}{(s+2)(s+3)}$.

(a) Please apply the Nyquist criterion to determine the range of K for stability. (15%)
(b) Please check the answer obtained in part (a) with the Routh-Hurwitz criterion. (10%)

Hint: $\sqrt{2} = 1.414$ $\sqrt{3} = 1.732$ $\sqrt{5} = 2.236$ $\sqrt{6} = 2.449$ $\sqrt{7} = 2.646$

令$K^* = -2K^2$比較好計算

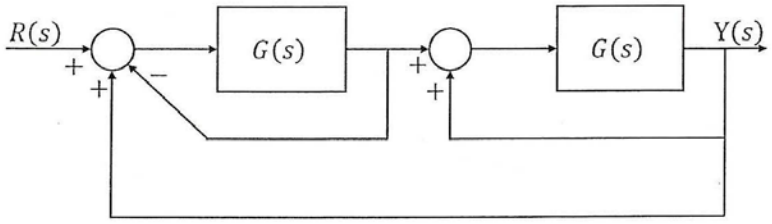

Fig. 3

題五：

The forward path of a unity-feedback control system that includes a disturbance signal $D(s)$ is given by $G(s) = \frac{1}{s^2+4s+10}$. Design a PID controller with the transfer function of $H(s) = \frac{K(\tau_1 s+1)(\tau_2 s+1)}{s}$ so that the s response to any step disturbance is damped in less than 2 sec at the 2% settling time. (20%)