國立臺北科技大學 105 學年度碩士班招生考試

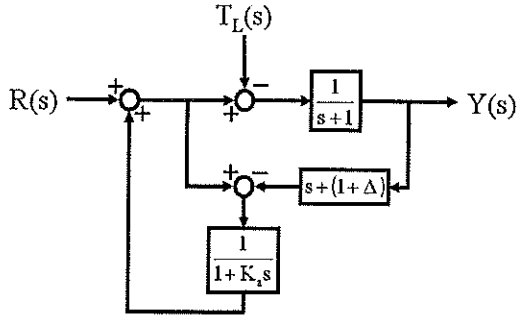
系所組別：1112 機械工程系機電整合碩士班甲組

第三節　自動控制　試題　（選考）

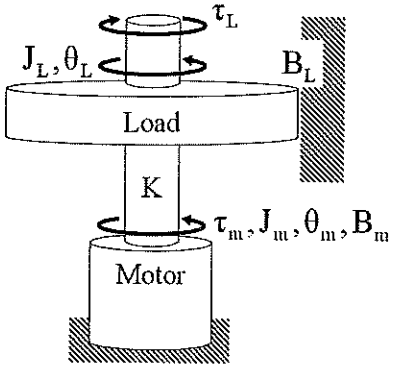
注意事項：

1. 本試題共 5 題，每題 20 分，共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

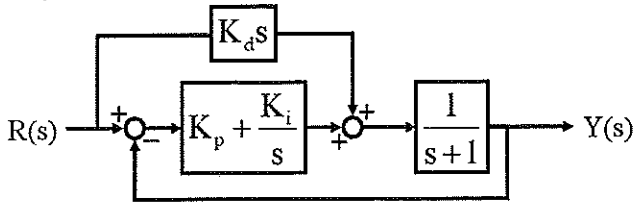
1. (20%) The following figure shows the block diagram of a feedback control system. Here, Δ denotes parameter uncertainty, and $|\Delta| < \rho$. Find the range of K_a for which the system is stable.



2. (20%) The following figure shows a mechanical system comprising a motor coupled to an inertial load through a shaft with a spring constant K. Here, system variables and parameters are defined as follows: $\tau_m(t)$ is the motor torque; $\tau_L(t)$, the load torque applied to the inertial load; J_m, the motor inertia; J_L, the load inertia; $\theta_m(t)$, the motor displacement; $\theta_L(t)$, the load displacement; B_m, the motor viscous friction coefficient; and B_L, the load viscous friction coefficient. Define state variables as $x_1(t) = \theta_m(t) - \theta_L(t)$, $x_2(t) = \dot{\theta}_L(t)$, and $x_3(t) = \dot{\theta}_m(t)$. Write the state space equations of the mechanical system.



3. Consider the block diagram of a feedback control system shown in the following figure.



(a) (10%) Find the ranges of control parameters K_p, K_i, and K_d for which the system is stable.

(b) (10%) Find the values of control parameters K_p, K_i, and K_d for which the damping ratio of the complex roots of the characteristic equation is $\frac{\sqrt{2}}{2}$.

4. The forward-path transfer function of a unity-feedback control system is given as

$$G(s) = \frac{K}{s(s^2 + 6s + 8)}$$

(a) (5%) Construct the root loci for $K \geq 0$. Find the value of K that makes the relative damping ratio of the closed-loop system equal to 0.707 if such solution exists.

(b) (5%) If a zero of $s = -5$ is adding to the G(s), repeat (a).

(c) (10%) Compare the solution of (a) with (b) and explain the effect of the addition of a zero to the original system.

5. The block diagram of a linear control system is shown in the following figure, where R(s) is the reference input and N(s) is the disturbance.

(a) (5%) Find the value of K_p so that the gain margin of the system is 20dB.

(b) (5%) Find the value of K_p so that the phase margin of the system is 60°.

(c) (10%) Find the bandwidth of the case (a). Let K= 1000 and K_t=0.1