國立臺灣大學101學年度碩士班招生考試試題

總分 100 分

1.

In order to reduce the ship's rolling motion, the active anti-rolling control is realized by the stabilizers, as shown in Fig. 1. The disturbance d generated by wave makes the ship rolling. The stabilizer's angle y is controlled to keep the ship's rolling angle $x = 0$.

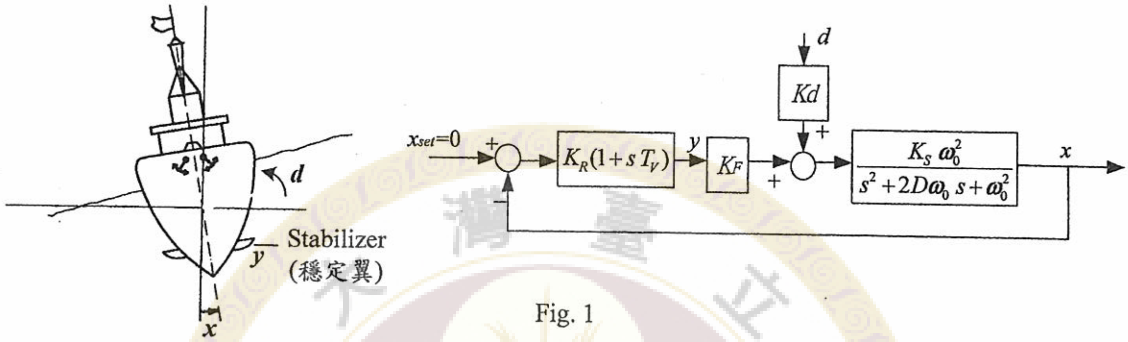

Fig. 1

(a) Find the disturbance transfer function $G_d(s) = X(s)/D(s)$, and the rolling angle $x(t)$ as $d(t)=\delta(t)$, where $\delta(t)$ is an impulse function. (8%)

(b) Solve the rolling angle $x(t)$ as $d(t) = D_0 \cos\omega_0 t$ for $t > 0$ with initial values of $x(t) = 0,\ \dot{x}(t) = 0$. (7%)

(c) PD-controller, $K_R(1+sT_V)$, is used to control the stabilizer in the closed-loop control system. Please solve the PD control parameters, K_R and T_V, to make the damping ratio D_C and the natural frequency ω_{0C} of the close-loop system keeping $D_C = 0.707$, $\omega_{0C} = 10\,s^{-1}$, where $D = 0.1$; $\omega_0 = 2\,s^{-1}$; $K_S K_d = 1$; $K_F / K_d = 3$; $D_0 = 4$. (10%)

2.

Consider a feedback control system as shown in Fig.2.

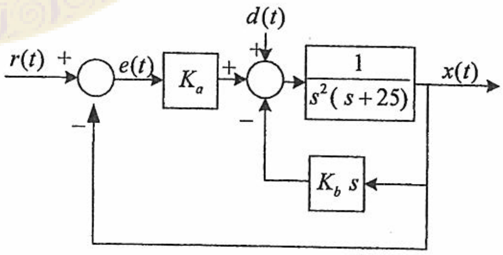

Fig.2

(a) Find the range of K_a, K_b to make the overall system stable. (7%)

(b) Find the range of K_a, K_b such that the steady-state error for ramp input is less than 5%. (8%)

(c) Find the range of K_a, K_b to achieve that the steady state value of output $x(t)$ is less than 0.05 for $r(t)$=0 and a unit step of $d(t)$. (10%).

3.

Consider a feedback control system of an airplane as shown in Fig.3.

(a) Please derive the state equations with the state variables x_1, x_2,x_3 in Fig.3. (10%)

(b) Please prove if the system controllable. (10%)

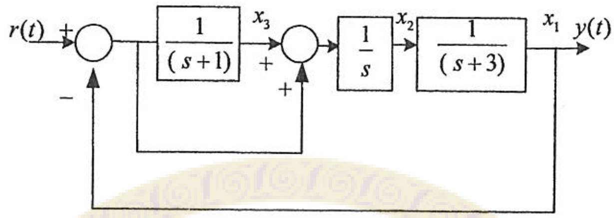

Fig.3

4.

Consider a unity feedback system as

$$G(s)=\frac{K(s-1)(s-2)}{s(s+1)}$$

(a) Sketch the root locus. (5%)

(b) Find the breakaway and break-in points. (5%)

(c) Find the range of K to make the system stable. (5%)

5.

Consider a Bode plot of a plant $G(s)$ used in a unity feedback system as shown in Fig.4.

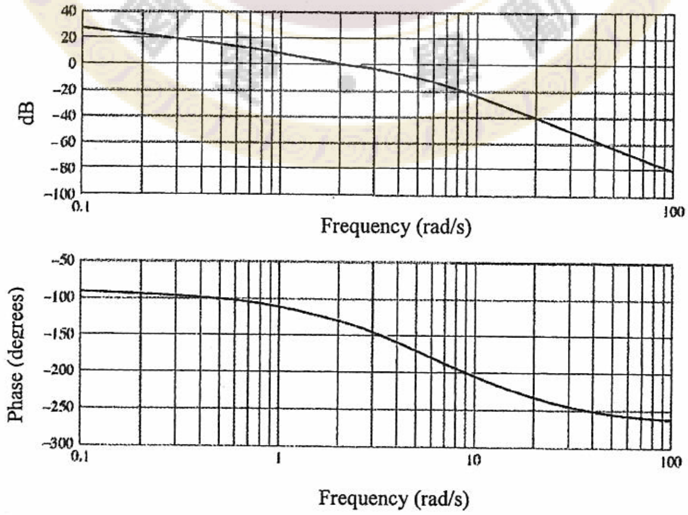

Fig.4

(a)Please find the gain margin, phase margin, and the closed-loop bandwidth. (7 %)

(b) Please estimate the damping ratio, percent overshoot, settling time, and peak time. (8%)

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