國立臺灣科技大學
九十二學年度碩士班招生考試試題
系所組別：電機工程系碩士班乙二組
科　目： 控制系統

共六題 ， 總分 100 分

Problem 1. (20%)

The block diagram of a feedback control system is shown in Fig. P. 1.

(a) Sketch the root loci for $K \geq 0$ when the switch S is open.

(b) Determine the stability of the system as a function of K when the switch S is open. Show the information on the root loci also.

(c) Close the switch S so that the minor feedback loop is in effect. Set K=1 and show by a root locus plot how the system is stabilized when K_t varies.

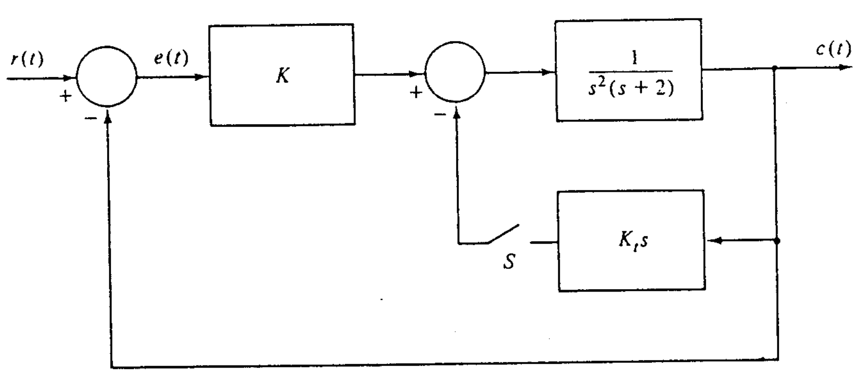

Fig. P. 1.

Problem 2. (10%)

A control system is represented by the following state equations:

$\dot{x}_1 = x_1 - 3x_2$

$\dot{x}_2 = 8x_1 + u$

The control is obtained from state feedback such that

$u = -g_1 x_1 - g_2 x_2$

where g_1 and g_2 are the real constants. Sketch and Determine the region in the g_2 versus g_1 plane in which the overall system is stable. Please put g_2 as the y-axis and g_1 as the x-axis.

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Problem 3. (20%)

Fig. P. 3. shows an inertial load driven by a permanent-magnet dc motor. The following system variables and parameters are given:

Motor:

i = motor current

K_i = motor torque constant

$T_m = K_i i$ = motor torque

J_m = motor inertia

B_m = motor viscous frictional coefficient

θ_m = motor shaft angle or motor displacement

Load:

K = torsional spring constant of shaft

J_L = load inertia

θ_L = load shaft angle or load displacement

(a) Write the differential equations of the system.

(b) Derive the transfer function $\theta_L(s)/I(s)$.

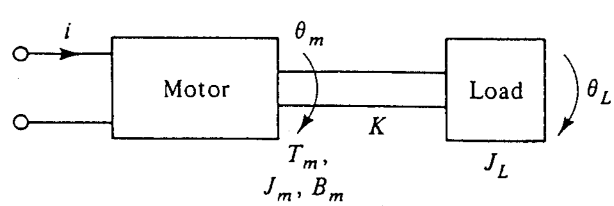

Fig. P. 3.

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Problem 4. (15%)

Consider a system with input-output transfer function $G(s) = \dfrac{Y(s)}{U(s)} = \dfrac{K e^{-sT}}{s(1+\tau s)}$.

If input $u(t) = \sin(10t)$ is applied to the system, and its steady-state output is measured as $y(t) = 0.2 + 0.1\sin(10t - 165^\circ)$, determine the plant parameters K, τ and T.

Problem 5. (20%)

Consider the closed-loop control system as shown in Fig. P. 5.

(a) Design the gains P and I so that the loop transfer function $L(s)$ has the gain crossover frequency $\omega_c = 10$ rad./sec and phase margin $PM = 60^\circ$.

(b) Find the steady-state response of the closed-loop system for input $r(t) = \sin(10t)$.

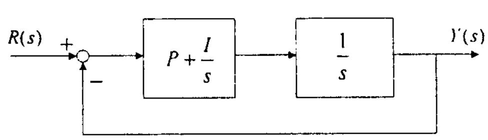

Fig. P. 5.

Problem 6. (15%)

Consider the RLC circuit as shown in Fig. P. 6, where $x(t) = [x_1(t), x_2(t), x_3(t)]^T$ are the state variables, $u(t)$ the input current source, and $y(t)$ the output current.

(a) Find the state space dynamic equation of the RLC circuit

$\dot{x}(t) = A\,x(t) + b\,u(t)$

$y(t) = c\,x(t) + d\,u(t)$.

(b) Is the RLC circuit completely controllable?

(c) Is the RLC circuit completely observable?

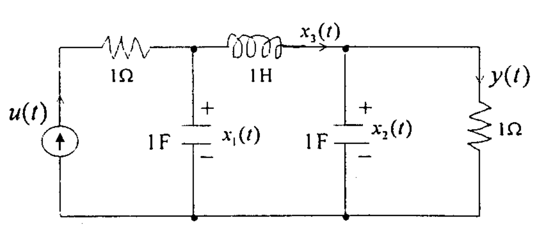

Fig. P. 6.

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