淡江大學八十七學年度碩士班入學考試試題

系別： 航空太空工程學系　　　科目： 自動控制

本試題共 2 頁

1. Given a system whose amplitude curve $M = |G(j\omega)|$ has the following straight-line approximation:
   a) (7%) Determine the transfer function G(s). Assume that the system has minimum phase.
   b) (8%) Sketch the corresponding **asymptotic** phase shift curve.
   c) (5%) Solve for the actual values of $M(dB)$ and φ (phase angle) at $\omega = 10\, rad/\sec$.

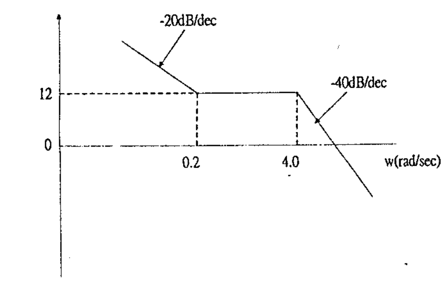

Fig.P1

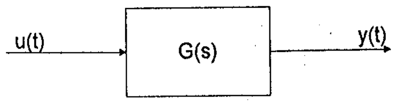

Fig. P2

2. (10%) For a stable system, $G(s)$, shown in Fig. P2 where $u(t) = e^{j\omega t}$, $\omega \in R$. Find the steady state response $y_{ss}(t) \triangleq \lim_{t \to \infty} y(t)$.

3. Consider the closed-loop system given in Fig. P3 where $G(s) = \dfrac{D}{Js + D}, J > 0, D > 0$. Assume that the system is subjected to a disturbance $d(t)$. Please design a stabilizing controller $G_c(s)$ and show that in the **steady state** the disturbance can be eliminated when
   a) (7%) $d(t) = A$, where A is an unknown constant.
   b) (8%) $d(t) = A\sin(\omega t)$, where ω is a known frequency however A is an unknown constant.

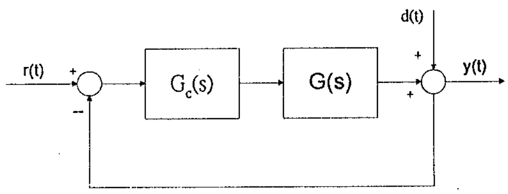

Fig.P3

4. Consider an electromagnetic system shown in Fig.P4, where the electromagnetic force $F_m(t) = \dfrac{i^2(t)}{y(t)}$. The objective of the system is to control $y(t)$, the position of the steel block M, by adjusting the current $i(t)$ in the electromagnet through the **input** voltage $e(t)$. Assume that at the **static** equilibrium point (steady state) the spring position is $y(t) = y_0$ (measured from unstretched position), and the corresponding current is $i(t) = i_0$. Let's define

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$e(t)$ = input voltage, $y(t)$ = position of mass M, $i(t)$ = winding voltage,
R = winding resistance, L = winding inductance, M = mass of steel block,
K = spring constant, f = damping coefficient of damper, g = gravitational acceleration.

a) (5%) Find the relationship between y_0' and i_0.

b) (7%) Linearize the system differential equations about the above equilibrium point.

c) (8%) For the **linearized** system, determine the corresponding transfer function $T(s)=Y(s)/E(s)$, where $Y(s)=\mathrm{L}(y(t))$, $E(s)=\mathrm{L}(e(t))$.

d) (5%) Give one **state space realization** of the transfer function you found in part c). That is, find proper matrices A, B, C, D such that $T(s)=C(sI-A)^{-1}B+D$. (You have to define the state variables.)

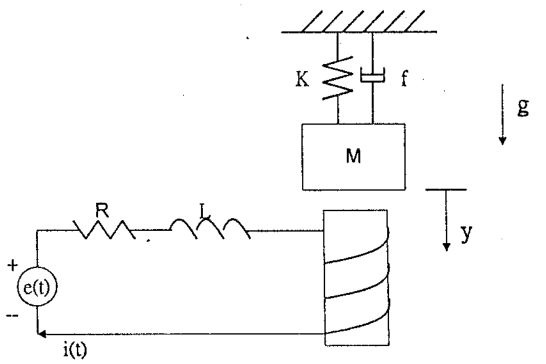

Fig. P4

5. The design specifications for the closed-loop system given in Fig. P5 are as follows: the closed-loop poles lie to the left of $s=-2$ in the s-plane, and the damping ratio $\varsigma \geq 0.5$.

a) (5%) Identify the desired area in the s-plane for the closed-loop poles.

b) (10%) Find the range of "K" and "T" when the design specifications are satisfied.

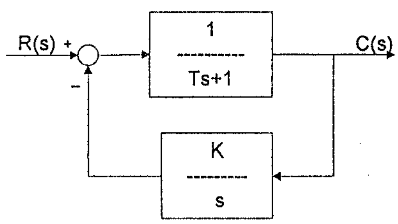

Fig. P5

6. (15%) Assume that the characteristic equation of a closed-loop system is $s^3+10s^2+Ks+K=0$. Sketch the root loci for $K \geq 0$. Find the break-away and/or break-in points if there is any.