國立中山大學 101 學年度碩士暨碩士專班招生考試試題

科目：自動控制【機電系碩士班丙組】

題號：4093

1. (10%) Obtain the transfer function $\theta(s)/T(s)$ of the system shown in Fig. 1. If torque $T(t)$ is a unit step function with $K = 1\text{N-m/rad}$, $D = 0.2\text{N-m s/rad}$ and $J = 0.4444\text{kg-m}^2$, find the output response $\theta(t)$.

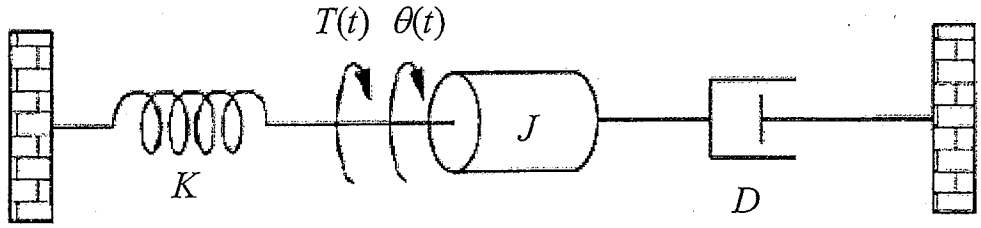

Fig. 1

2. (10%) Consider a unit-feedback control system with the closed-loop transfer function $\frac{C(s)}{R(s)} = \frac{4s+3}{s^2+10s+3}$, determine the open-loop transfer function $G(s)$. Also find the steady-state error in the unit-ramp response.

3. (10%) Consider a unit-feedback system with two different transfer functions $G_1(s) = \frac{K(s-2)}{(s+3)(s+6)(s+9)}$ and $G_2(s) = \frac{K(2-s)}{(s+3)(s+6)(s+9)}$, plot the root loci for these two systems, respectively.

4. (20%) Consider the system shown in Fig. 2. Design a PD controller (K_P and K_D) to satisfy the following performance specifications:
   Steady state error due to a unit-ramp input ≤ 0.001
   Maximum overshoot $\le 5\%$
   Rise time ≤ 0.005 sec
   Settling time ≤ 0.005 sec
   In addition, find the range of K_P and K_D so that the system is stable.

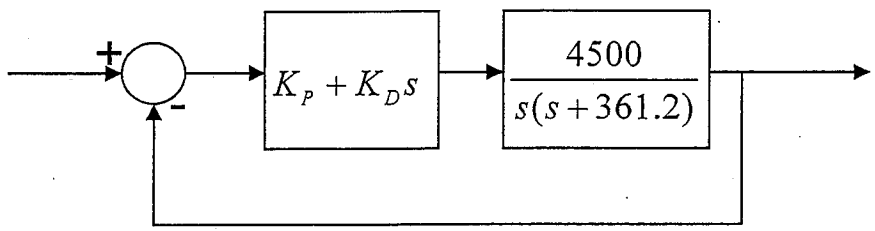

Fig. 2

5. (10%) Consider two dynamic systems with transfer functions $\frac{1000(s^2+2s+100)}{(s+1)(s+100)(s+1000)}$ and $\frac{100(s+1)e^{-0.01s}}{(s+10)(s+100)}$, respectively. Please draw the Bode diagrams and polar plots of these two systems.

6. (10%) Please discuss the reasons why the relative stability of a closed-loop control system can be measured from the phase and gain margins of its open loop transfer function.

7. (10%) Consider a unit-feedback control system as shown in Fig. 3. Based on the characteristics of the M-circle and N-circle, draw a polar plot of G(s)C(s) that the closed-loop control system can have a bandwidth better than 50 rad/sec and own a satisfactory stability.

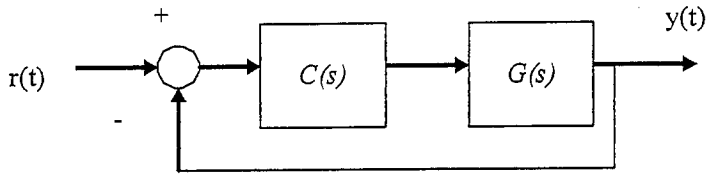

Fig. 3

8. (20%) Consider a dynamic system, whose Bode diagram and polar plot are shown in Fig.4 and 5, respectively. Please guess the possible transfer function of this system (discuss your answer in details). It is desired to control the system to have a bandwidth wider than 50 rad/sec. What kinds of control scheme and controller will you adopt to control the system? Why? In your viewpoint, can such a goal be achieved with a satisfactory stability? Why?

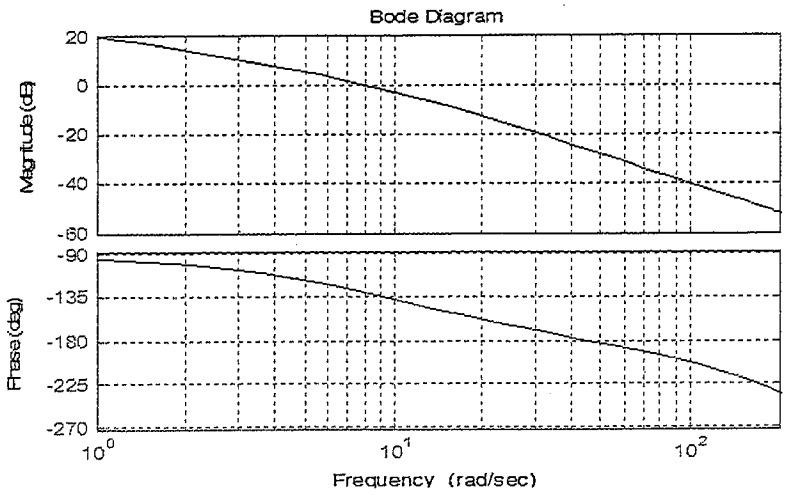
Bode Diagram
Magnitude (dB)
20
0
-20
-40
-60
Phase (deg)
-90
-135
-180
-225
-270
10^0
10^1
10^2
Frequency (rad/sec)

Fig 4

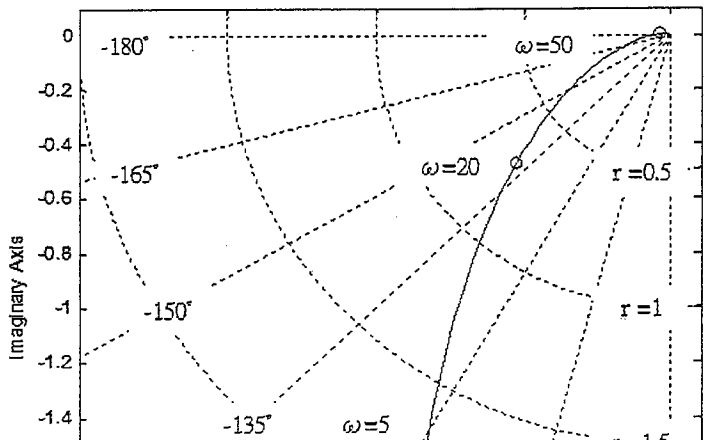
-180°
ω=50
-165°
ω=20
r =0.5
-150°
r =1
-135°
ω=5
r =1.5
-120°
-105°
r =2
Imaginary Axis
Real Axis
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-1.5
-0.5

Fig 5