# 國立成功大學 105 學年度碩士班招生考試試題

系　　所：航空太空工程學系

考試科目：自動控制

考試日期：0227，節次：1



※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. **(30%)** Consider the one-degree-of-freedom robot arm shown in Figure 1. Its moment of inertia is $J$ and the torsional damping is $b$. A motor applies a torque $\tau$ at the center of rotation, and the angle of the arm is given by $\theta$. (*Note*: you can ignore the motor dynamics.)

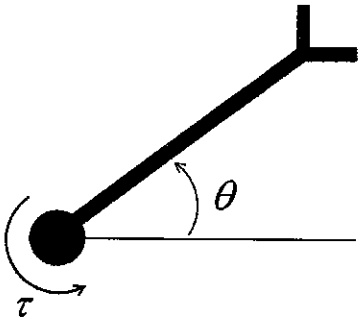


Figure 1

(a.) Obtain the equation of motion for this system.
(b.) Find the transfer function from torque input to angle output. Assume zero initial conditions.
(c.) Look at the characteristic function of the transfer function, what kind of system modes will you expect?
(d.) Draw a feedback control system block diagram that will control the arm angle to track a reference input using unity feedback and proportional gain $K$.
(e.) For what values of $K$ is this system stable?.

2. **(20%)**

(a.) Find the impulse response $y_1(t)$ for a system with a transfer function:

$$\frac{Y_1(s)}{U(s)}=\frac{1}{s(s+2)}$$ and sketch the response versus time.

(b.) Now consider a new system: $\frac{Y_2(s)}{U(s)}=\frac{(s+3)}{s(s+2)}$, find the impulse response $y_2(t)$ and sketch the response versus time.

(c.) Explain the differences between part (a.) and part (b.).

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3.

The block diagram of a control system with tachometer feedback is shown in Fig. 3.

(a) Construct the root loci of the characteristic equation for $K > 0$ when $K_t = 0$. (10%)

(b) Set $K = 10$. Construct the root loci of the characteristic equation for $K_t > 0$.(14%)

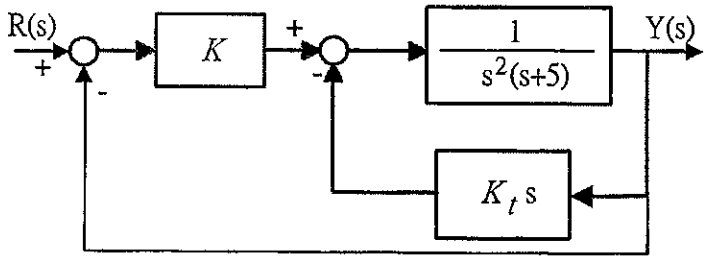


Fig. 3

4.

The gain-phase plot of the forward-path transfer function of $G(j\omega)/K$ of a unity-feedback control system is shown in Fig. 4. Find the following performance characteristics of the system.

(a) Gain-crossover frequency (rad/sec) when $K = 1$.(2%)

(b) Phase-crossover frequency (rad/sec) when $K = 1$. (2%)

(c) Gain margin (dB) when $K = 1$. (2%)

(d) Phase margin (deg) when $K = 1$. (2%)

(e) Resonance peak $M_r$ when $K = 1$. (2%)

(f) Resonant frequency $\omega_r$ (rad/sec) when $K = 1$. (2%)

(g) Bandwidth of the closed-loop system when $K = 1$. (2%)

(h) The value of $K$ so that the gain margin is 20 dB.(4%)

(i) The value of $K$ so that the system is marginally stable. Find the frequency of sustained oscillation in rad/sec.(4%)

(j) Steady-state error when the reference input is a unit-step function.(4%)

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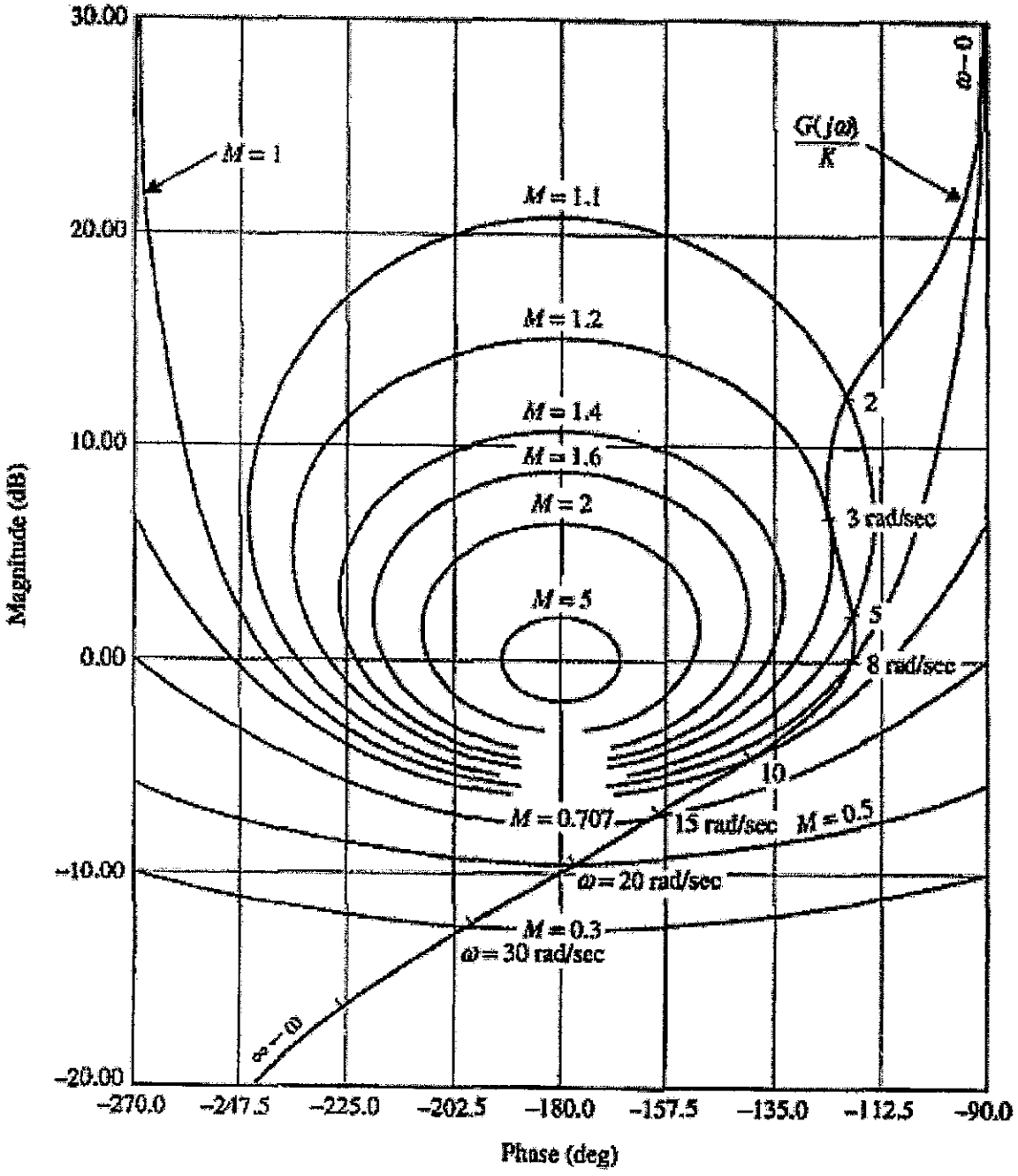


Fig. 4. Gain-phase plot of $G(j\omega)/K$