1. Consider a rotating system with

$$\dot{\omega}(t) + 3\omega(t) = f(t) \quad \text{and} \quad \dot{\theta}(t) = \omega(t),$$

where $f(t)$ is the input torque, $\omega(t)$ is the angular rate, and $\theta(t)$ is the output angle of the system.

a) Draw a block diagram, including a controller K, and label with necessary symbols to represent a feedback control of the rotating system. (7%)

b) Find K for the above system damping ratio to be 0.6. (6%)

c) Use K in b) and derive time response $\theta(t)$ if desired angle $\theta_r = 1$ and initial conditions $\theta(0) = 0$ and $\omega(0) = 0$. (12%)

2. The controller and plant of a feedback system are given as

$$G_c(s) = \frac{ms + n}{s} \quad \text{and} \quad G_c(s) = \frac{1}{(s-1)(s^2 + 2s + 6)}.$$

a) Find the area on the $m - n$ plane for the system to be stable. Note that $m > 0$ and $n > 0$, and use m as horizontal and n as vertical axis. (15%)

b) For $n = 0$, determine m and the associated poles for the system to be oscillate continuously when it is excited. (10%)

(注意: 背面還有題目)

(背面仍有題目,請繼續作答)

(3). For the system shown in Figure 1 with $G(s)=\dfrac{1}{s(s+\alpha)}$, $\alpha>0$, we are interested in the variation of the closed-loop poles as the parameter α is changed.

a). Sketch the root locus as the parameter α is varied. (10%)

b). Find the range for the parameter α so that the system has underdamped step response. (10%)

c). Find the steady-state error for the ramp input $r(t)=t$, $t\geq 0$ if $\alpha=1$. (10%)

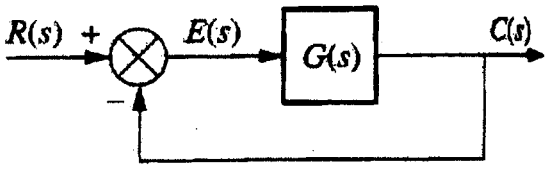

Figure 1

(4). For the system shown in Figure 1 with $G(s)=kG_p(s)$, Figure 2 shows the Bode diagram of the plant $G_p(s)$.

a). Find the following four quantities of the system for $k=1$. The phase crossover frequency ω_p, the gain margin GM, the gain crossover frequency ω_g and the phase margin PM. (10%)

b). $k=?$ if we want GM=6^{db}.(10%)

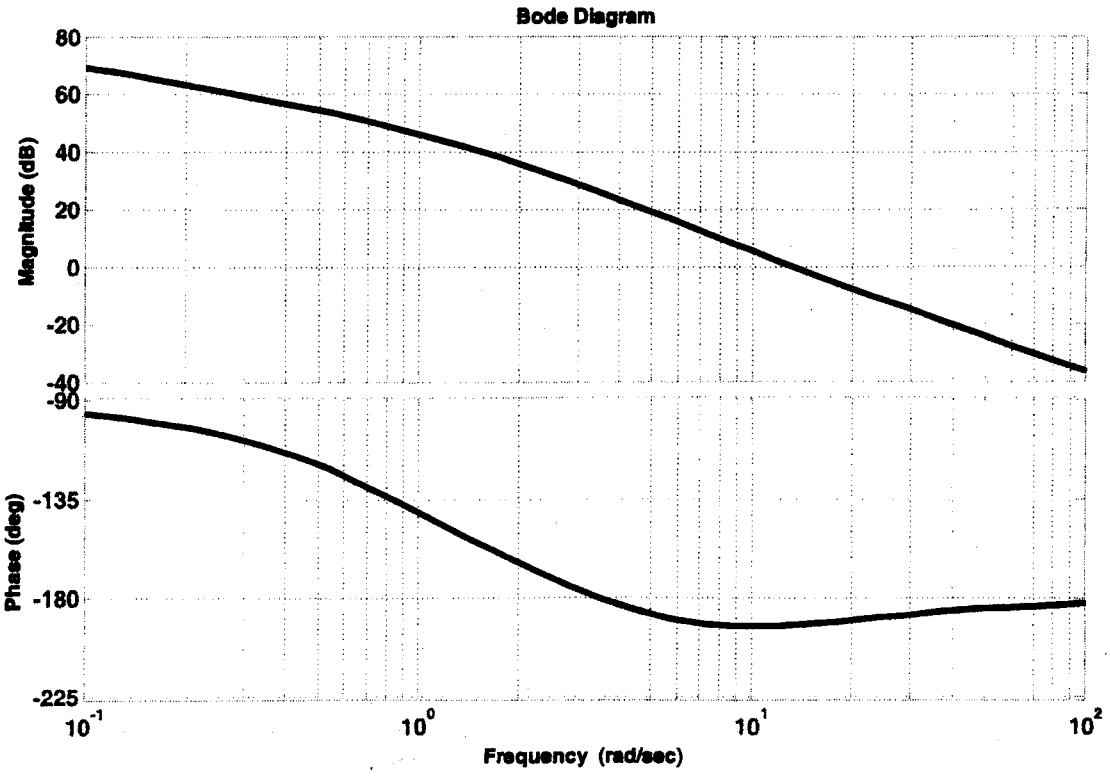

Figure 2