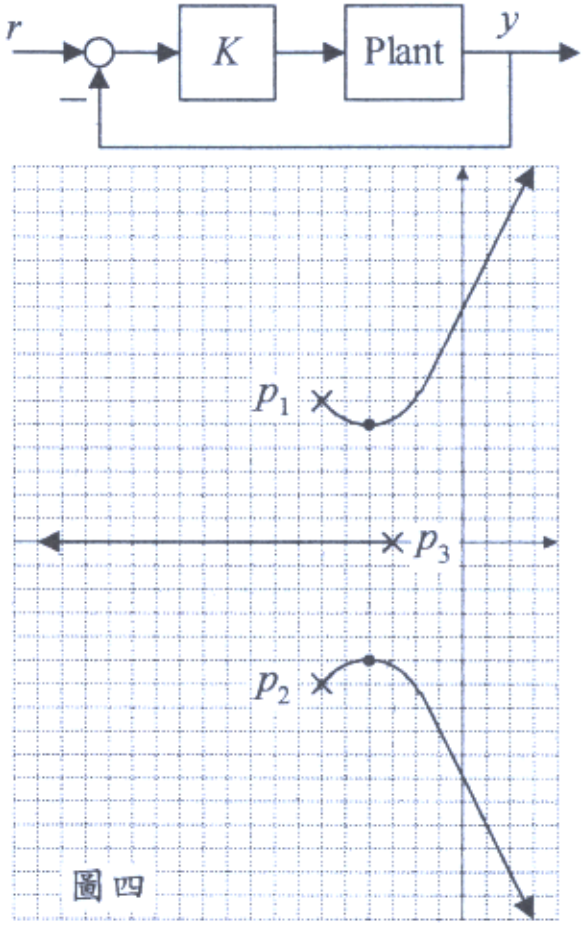
1) A feedback control system has the following characteristic equation:

$$s^3 + (4+K)s^2 + 6s + 16 + 8K = 0.$$

The parameter K must be positive. What is the maximum value K can assume before the system becomes unstable?(15%) When K is equal to the maximum value, the system oscillates. Determine the frequency of this oscillation. (10%)

2) 右圖為一個迴饋控制系統以及它的閉迴路根軌跡；其中，p_1、p_2及$p3$分別為開迴路系統的三個極點，而兩個圓點則為所欲的閉迴路 dominant mode 極點。求這個設計的 Gain margin (15%)。(注意：座標的尺寸並不影響答案。)



圖四

(背面仍有題目,請繼續作答)

E E10 4-3

3. (25%) Plot the Bode plot of the following transfer function $G(s)$ and check the stability of the closed-loop system $T(s)=\dfrac{G(s)}{1+G(s)}$ using the Nyquist stability criterion, where

$$G(s)=\frac{k(-s+5)}{s(s+10)},\ \text{with}\ k=8$$

4. (15%) Determine the closed-loop bandwidth and calculate the phase and gain margins with $k=5$.

5. (20%) Consider the system described by the following differential equations.

$$L\frac{d\,i(t)}{dt}=e(t)-R\,i(t)-e_b(t)$$

$$T_m(t)=K\,i(t)$$

$$e_b(t)=K_b\frac{d\theta(t)}{dt}=K_b\omega(t)$$

$$J\frac{d^2\theta(t)}{dt}=T_m(t)-T_L(t)-B\frac{d\theta(t)}{dt}$$

(a). Choose $[i(t)\ \ \omega(t)\ \ \theta(t)]$ as the system states, and represent the system by its state-space form.

(b). Determine the system transfer function from $T_L(t)$ to $\theta(t)$.

(c). Determine the system transfer function from $e(t)$ to $\theta(t)$.