1. A single-loop negative feedback system has a loop transfer function

$$GH(s) = \frac{K(s+1)^2}{s(s^2+1)(s+4)}$$

(a) Sketch the root locus for $0 \le K \le \infty$ to indicate the significant features of the locus. (10%)

(b) Determine the range of the gain K for which the system is stable? (5%)

(c) For what value of K in the range $K \ge 0$ do purely imaginary roots exist? what are values of these roots? (5%)

(d) Would the use of the dominant roots approximation for an estimate of settling time be jstified in the case for a large magnitude of gain (K>10)? (5%)

2. A spring-mass damper system is shown in the Fig.1. The Bode diagram obtained by experimental means using a sinusoidal forcing function is shown in the Fig.2 Determine the numerical values of m, f,and k. (10%)

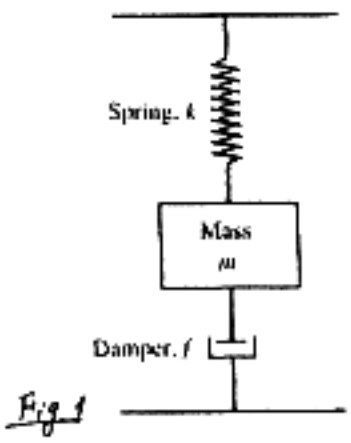

Fig.1

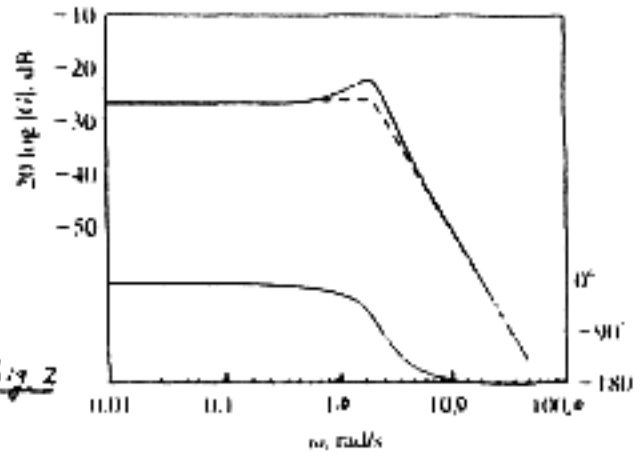

Fig.2

3. A controller is used to regulate the temperature of a mold for plastic part fabrication, as shown in the fig.3. The value of the delay time is estimated as 1.2 seconds.

(a) Utilizing the Nyquist criterion, determine the stability of the system for Ka=K=1 (8%)

(b) Determine a suitable value of Ka for a stable system when K=1 that will yield a phase margin greater than 50 degree. (7%)

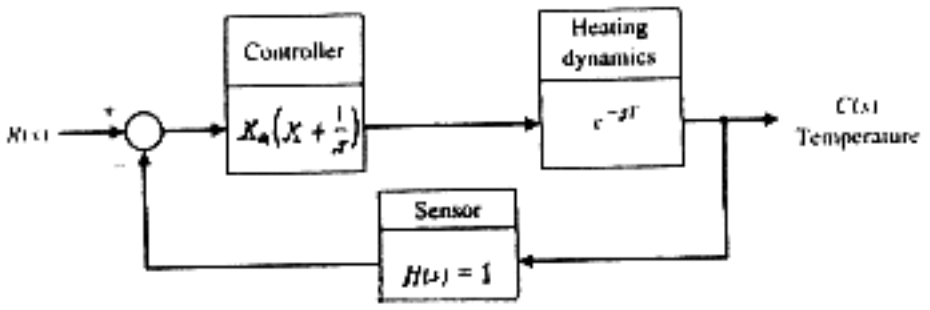

Fig.3

(背面仍有題目,請繼續作答)

715007D

4. (15%) What is disturbance in a control system? How to reduce or eliminate influence of disturbance on the output (or controlled variable) of a feedback system? Using an example to support your arguments.

5. (20%) Given the following system, show that by using state feedback the closed-loop poles can be assigned to anywhere in the s-plane. Can this property be extended to any systems described in state-space equation? If not, what is the condition for this?

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{pmatrix} 0 \\ 2 \end{pmatrix} u$$
$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

6. (15%) A feedback system has a characteristic equation of :

$$S^3 + (K+1)S^2 + 10S + (15K+5) = 0, \quad (K>0)$$

Determine the range of K such that the system is absolutely stable? When K reaches its upper bound the system starts to oscillate with what frequency?