

# 淡江大學 102 學年度碩士班招生考試試題

系別：航空太空工程學系

科目：自動控制

考試日期：3月10日(星期日) 第3節

本試題共 五 大題， 乙 頁

1. (20 points) The unit step response for a second-order system is given by

$$y(t) = 1 - \frac{1}{\beta} e^{-\zeta\omega_n t} \sin(\omega_n \beta t + \theta).$$

Show that the percent overshoot is

$$P.O. = 100e^{-\zeta\pi/\sqrt{1-\zeta^2}}.$$

2. (20 points) A unity negative feedback control system has the plant transfer function

$$G(s) = \frac{K}{s(s + \sqrt{2K})}.$$

- (a) Determine the percent overshoot and settling time (using a 2% settling criterion) due to a unit step input.  
 (b) For what range of  $K$  is the settling less than 1 second.
3. (20 points) A feedback control system has a characteristic equation

$$s^3 + (1 + K)s^2 + 10s + (5 + 15K) = 0.$$

The parameter  $K$  must be positive. What is the maximum value of  $K$  can be before the system becomes unstable? When  $K$  is equal to the maximum value, the system oscillates. Determine the frequency of the oscillation.

4. (20 points) For the unit feedback system of the transfer function,

$$G(s) = \frac{K}{(s+1)(s+2)(s+3)(s+4)}$$

Sketch the root locus and find the following:

- (a) Asymptotes,  
 (b) Breakaway points,  
 (c) The range of  $K$  for stability,  
 (d) The value of  $K$  to yield a 0.7 damping ratio for the dominant second-order pair.
5. (20 points) For each transfer functions given below, sketch the Bode asymptotic magnitude and asymptotic phase plots.

(a)  $T(s) = \frac{1}{s(s+2)(s+4)}$

(b)  $T(s) = \frac{(s+3)(s+5)}{s(s+2)(s+4)}$