國立臺灣科技大學 107 學年度碩士班招生試題
系所組別：材料科學與工程系碩士班乙組
科　　目：控制系統

總分為100分。

1. The closed-loop transfer function of a system is

$$T(s)=\frac{s^2+K_1 s+K_2}{s^4+K_1 s^3+K_2 s^2+5s+1}$$

Determine the range of K_1 in order for the system to be stable. What is the relationship between K_1 and K_2 for stability? (6%)

2. For the transfer function below, find the constraints on K_1 and K_2 such that the function will have only two $j\omega$ poles. (6%)

$$T(s)=\frac{K_1 s+K_2}{s^4+K_1 s^3+s^2+K_2 s+1}$$

3. Determine the output Laplace transform $Y(s)$ of the system for an input $u(t)=5\sin t$. (7%)

$$\frac{d^3y}{dt^3}+3\frac{d^2y}{dt^2}-\frac{dy}{dt}+6y=\frac{d^2u}{dt^2}-u$$

where $y=$ output, $u=$ input, and initial conditions are

$$y(0^+)=(\frac{dy}{dt})_{t=0^+}=0,\quad (\frac{d^2y}{dt^2})_{t=0^+}=1.$$

4. Determine (a) the damping ratio, (b) the time constant, (c) characteristic equation for the second-order system given by

$$\frac{d^2y}{dt^2}+5\frac{dy}{dt}+9y=9u$$ (6%)

5. Please answer the following questions:
(a) Define the transfer function. (3%)
(b) Name the three major design criteria for control systems. (3%)
(c) What kind of compensation improves the steady-state error? (3%)
(d) Functionally, how do closed-loop systems differ from open-loop systems? (3%)
(e) What would happen to a physical system that becomes unstable? (3%)

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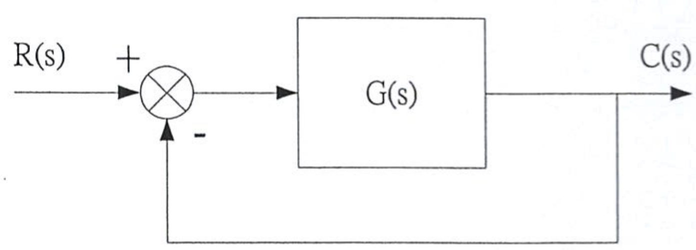
6. For each pair of second-order system specifications below, find the location of the second-order pair of poles.
   (a) Percent overshoot = 15%; Peak time = 0.25 second (8%)
   (b) Settling time = 5 seconds; Peak time = 2 seconds (Use a 2% settling time) (7%)

7. For the unity feedback system, where

$$G(s) = \frac{K(s+2)(s+1)}{(s-2)(s-1)} \qquad K \geq 0$$

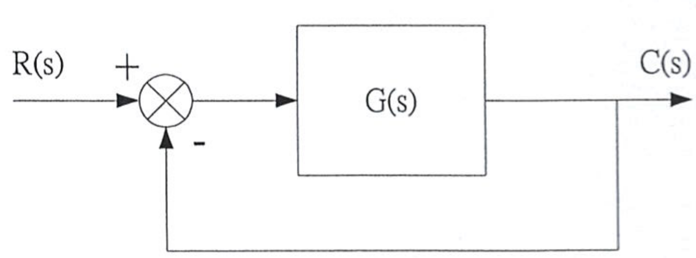
   (a) find the breakaway and break-in points, and sketch the root locus. (10%)
   (b) find the value of K that yields a stable system with critically damped second-order poles. (5%)



8. For the unity feedback system shown below, with

$$G(s) = \frac{K(s+1)}{s(s+4)(s+9)(s+a)} \qquad K \geq 0$$

it is desired that the root-locus plot go through the point $s = -4 + j3$. Apply the angle condition to determine the value of a such that the plot does go through this point. Determine the value of the gain K at this point. (15%)



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9. Design the values of K and G in the system shown below to meet the following specifications: steady-state error component due to a unit step disturbance is -0.000012; steady-state error component due to a unit ramp input is 0.003. (15%)