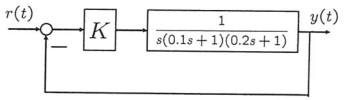
元智大學 107 學年度 碩士班 招生試題卷

系(所)別：電機工程學系碩士班　組別：甲組　科目：控制系統　用紙第 1 頁共 1 頁

●不可使用電子計算機

1. Consider the following feedback system with a controller K, which is a constant gain.



Here, r is a reference signal, y is the output, and the gain K must be tuned so that
(i) the feedback system is stable,
(ii) the steady state error for a **unit step input** $r(t) = u_s(t)$ is zero,
(iii) the steady state error for a **unit ramp input** $r(t) = tu_s(t)$ is at most 0.1.

Answer the following questions. **Explain your answers properly.**
(a) Is the open-loop system stable, marginally stable, or unstable? Why? (6%)
(b) Find the closed-loop transfer function from $R(s)$ to $Y(s)$. (6%)
(c) Compute the DC gain of the closed loop system. (2%)
(d) Find the range of K for the condition **(i)** above. (6%)
(e) Find the range of K for the conditions **(i)** and **(ii)** above. (6%)
(f) Find the range of K for the conditions **(i)** and **(ii)** and **(iii)** above. (6%)
(g) Sketch the root locus for $K > 0$. In the sketch, include as much information (such as breakaway point, intersection points with imaginary axis, angle of asymptotes, value of K, etc.) as you can. (10%)
(h) If you want zero steady-state error for a unit ramp input, what kind of controller do you use, instead of a gain controller? (You do not need to find the controller parameters; just write the transfer function form of the controller.) Why do you use that controller? (8%)

2. Consider a system described by the differential equation: $y(t)'' - y(t)' - 2y(t) = u(t)$
where $y(t)$ and $u(t)$ are input and output of the system, respectively.
(a) Please find the transfer function of the system. (5 %)
(b) What are the poles of the system? Is the system stable? (5 %)
(c) Please find $y(t)$ when $y(0)' = 0$, $y(0) = 1$ and $u(t) = 0$. (5 %)
(d) Write the system in state-space form by choosing state variables: $x_1(t) = y(t)$ and $x_2(t) = y(t)'$. (5 %)
(e) Show that the system is controllable and observable. (5 %)
(f) Determine the estimator gain $\mathbf{L} = \begin{vmatrix} l_1 \\ l_2 \end{vmatrix}$ to place the estimator error poles at -2 and -3. (5 %)
(g) Use the estimator in (f) to construct a state feedback controller $u(t) = r(t) + \boldsymbol{Kx} = r(t) + [k_1 \quad k_2]\boldsymbol{x}$, to place the poles of the system at -1±j. (5 %)

3. Please choose the correct statements. (15%)
(a) PD controller can improve the relative stability of the closed-loop system.
(b) PD controller usually can increase the bandwidth of the closed-loop system.
(c) PI controller is a low-pass filter.
(d) PI controller can improve the steady-state error of the closed-loop system.
(e) PI controller will degrade the relative stability of the closed-loop system.