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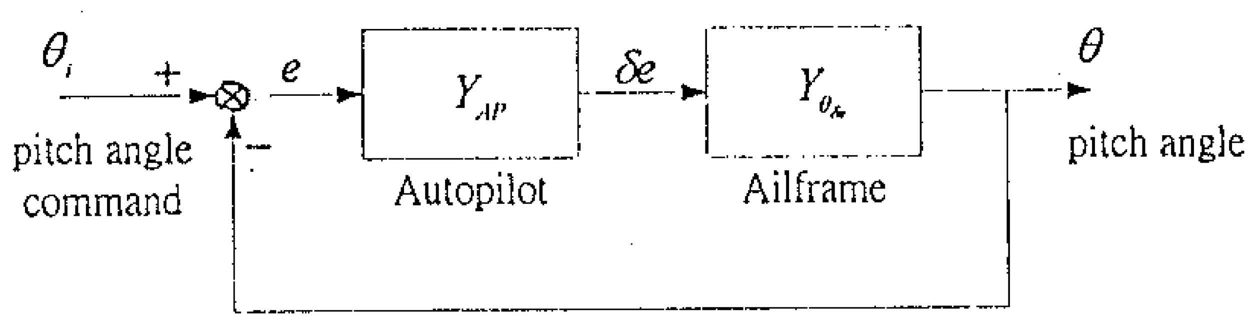
淡江大學八十八學年度碩士班招生考試試題

系別：航空及太空工程學系　　科目：自動控制　　本試題共 乙 頁

請在提供的方格紙及 **Semi-log** 格紙上做圖並清楚的標明題號。

1. Consider the pitch autopilot system below,



For an airplane flying at Mach 0.7, 40,000ft altitude, the airframe transfer function relating pitch angle θ to elevator displacement δ_e is the following:

$$\frac{\theta}{\delta_e} = Y_{\theta\delta_e} = \frac{1.141(1+1.5726s)}{s(0.12555s^2+0.24967s+1)}$$

(a) Find the zero and poles of the airframe. (5%)

(b) Let the autopilot tranfer function, Y_{AP}, be a gain-constant K. Sketch the root locus for the closed-loop system for $0<K<\infty$. (10%)

(c) Show that in your root-locus plot in (b) that the locus depart from the complex poles with the angle of 77.1°. (5%)

(d) We now add realizable rate control to the autopilot, so that

$$Y_{AP} = \frac{K(1+s)}{1+\tau s}.$$

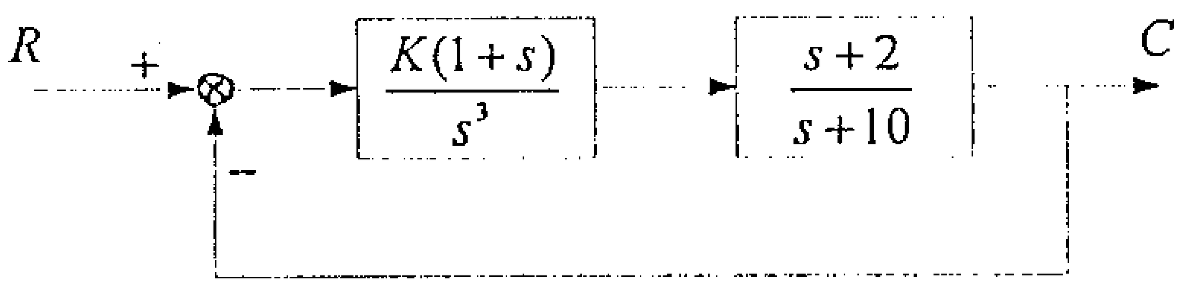
Find the time constant τ such that the root locus passes through $\lambda=-2+3j$. Determine the gain constant K such that $\lambda=-2+3j$ is a closed-loop root. (10%)

2. (20%) Sketch the Nquist diagram for the system described by the open-loop transfer function

$$GH(s) = \frac{s+z}{s^2(s+p)}$$

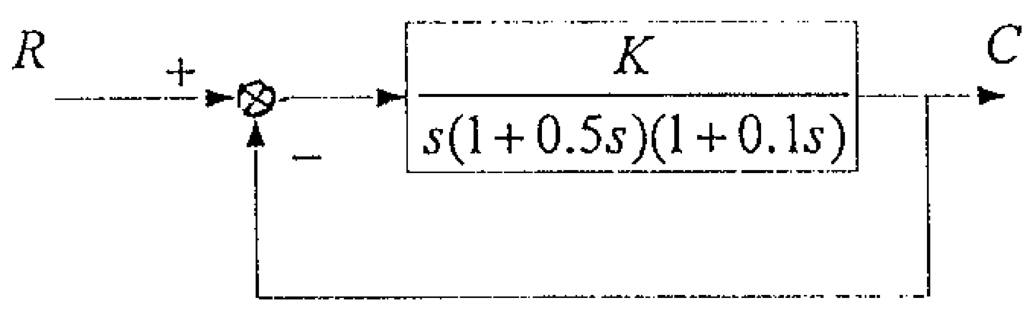
for the two cases (a) $z=1, p=2$ and (b) $z=2, p=1$. Comment on the stability for the case and compare your result by sketching the root-locus.

3. (15%) Consider the unity-feedback gain system below.



Sketch the Bode diagram and determine the gain and phase margins when the Bode gain is unity and maximum value of K for which the system is stable. Confirm the result by using Routh's stability criterion.

4. Consider the system shown below.



Design a phase lead cascade compensation filter that will provide the corresponding closed-loop system with the following characteristics. (10%)

(1) steady-state error due to a unit ramp input of less than 25% and

(2) a closed-loop damping ratio of about 0.7.

If a phase lag compensation network is used, compare the step response to that with phase lead compensation. (10%)

5. (15%) An open-loop, third-order system is described by the equation

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

Using the state-feedback, find a suitable gain vector $\mathbf{k}$ such that the closed-loop system is dominated by a pair of closed-loop poles having a damping ratio $\zeta = 0.707$ and a time constant of 0.5 rad/s.