總分 100 分 ※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。

1. A car active suspension control system with a pneumatic actuator in parallel with the passive suspension system is shown in Fig.1, where acceleration is measured by an accelerometer. The feedback signals of acceleration $\ddot{y}_m$ and velocity $\dot{y}_m$ are described in Fig.1. The transfer function of acceleration $\ddot{y}_m$ to the ground displacement y_g can be obtained as

$$\frac{\ddot{Y}_m(s)}{Y_g(s)} = \frac{s^2(Ds+K)}{(C_a+M)s^2+(C_v+D)s+K}$$ where M=1 and D=K=C_v=2 are given.

(a) Please sketch the root locus according to the variation of C_a and $C_a \geq 0$. **(10%)**

(b) Solve C_a to yield a damping ratio of 0.69 for closed-loop poles. **(10%)**

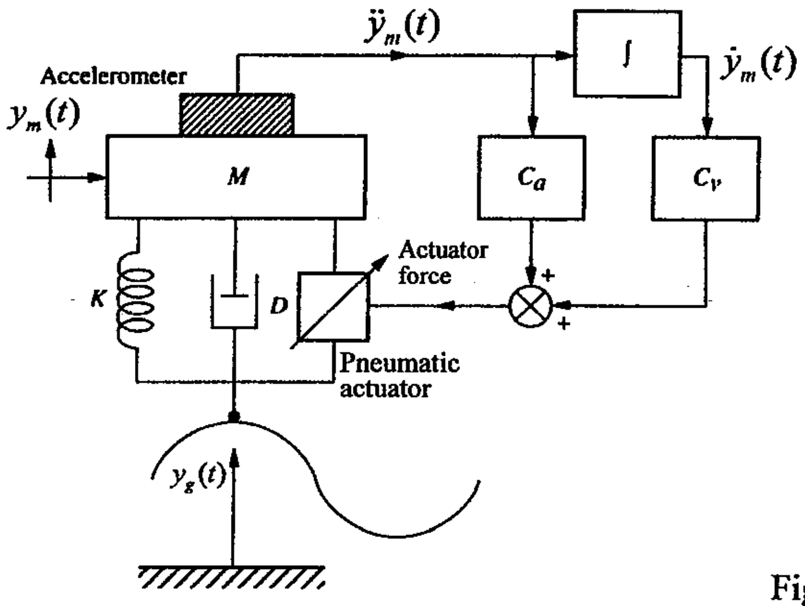

Fig.1

2. A flight control system is shown in Fig.2 with controller $D(s)$ and controlled plant $G(s)$.

(a) Plot the root locus if $D(s) = K$, including asymptotes, intersection points with imaginary axis and the corresponding value of K. **(8%)**

(b) If the controller is given as $D(s) = K\dfrac{s+2}{s+\alpha}$, please find the value of α to make the root locus pass through the desired point $(-1+j4)$. **(8%)**

(c) Please find the value of K at the desired point $(-1+j4)$ in (b). **(4%)**

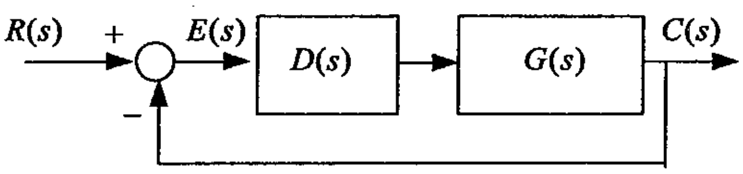

Fig. 2

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3. A hydraulic control system controlled by the state feedback with integral control is shown in Fig.3, where $\mathbf{A}=\begin{bmatrix}-3 & 1\\ 3 & -5\end{bmatrix}$, $\mathbf{B}=\begin{bmatrix}1\\0\end{bmatrix}$, $\mathbf{C}=\begin{bmatrix}0 & 1\end{bmatrix}$, $\mathbf{K}=\begin{bmatrix}k_1 & k_2\end{bmatrix}$, and k_I is the parameter of integral control.

(a)Please find the open loop transfer function. **(7%)**

(b)Solve **K** and k_I for the closed-loop poles at -2, -3 and -4. **(13%)**

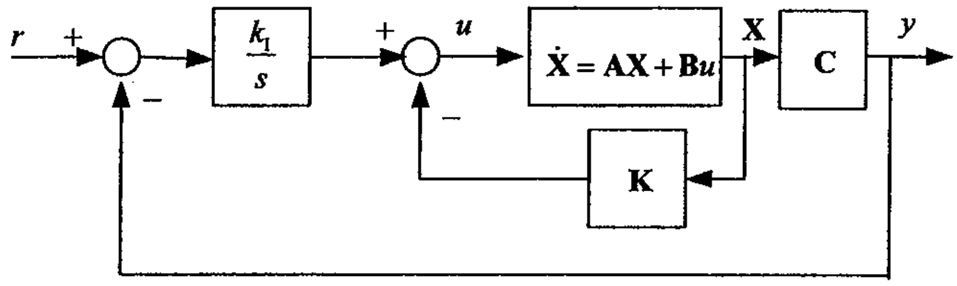

Fig. 3

4. A frequency domain controller design problem is shown in Fig.4.

(a)Please find the controller K and the gain crossover frequency to make the system have a phase margin of $50°$ **(13%)**

(b)Please find the gain margin in (a). **(7%)**

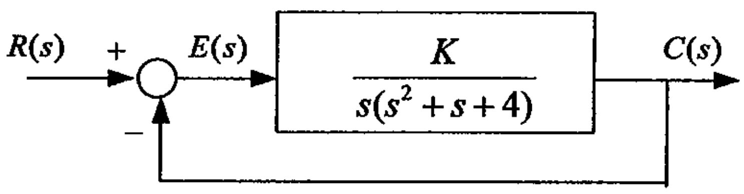

Fig. 4

5. Consider a unity negative feedback control system, as shown in Fig.5, which open loop transfer function is

$$G(s)=\frac{K(s+q)}{s(s+p)}.$$

In order to make the closed-loop control system achieve the specifications of the closed-loop poles at $(-1\pm j1)$ and the steady state error of 0.1 for ramp input, please solve the control parameters K, p, and q. **(20%)**

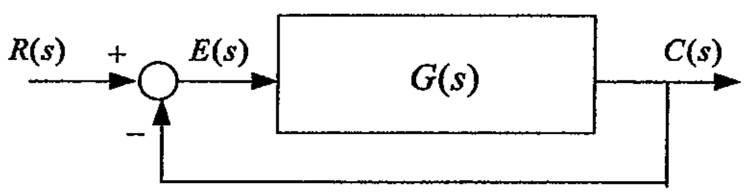

Fig.5

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