總分 100 分

1. The block diagram of the control system with conjugate closed-loop poles $-\alpha \pm \beta j \ (\beta > 0)$ is shown in Fig.1, where $K > 0$ and $1 > T > 0$.

(a) Please determine the relation between T and K to make the damping ratio $\varsigma > \frac{1}{\sqrt{2}}$. **(10%)**

(b) According to the condition in (a), please sketch the root locus with respect to T as K=1. **(15%)**

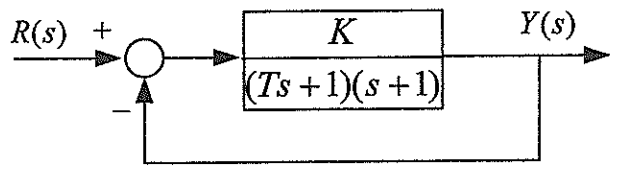

Fig. 1

2. Figure 2 shows that a boat is circling a ship using a tracking radar with the speed of 10 knots and a radius of 1 nautical mile, (1 knots = 1 nautical mile/hr). The model of the tracking system is shown in Fig. 2.

(a) Please find the angular velocity of boat. **(10%)**

(b) Please find value of K so that the boat can be kept in the center of the radar beam with no more than 0.1 degree error. **(15%)**

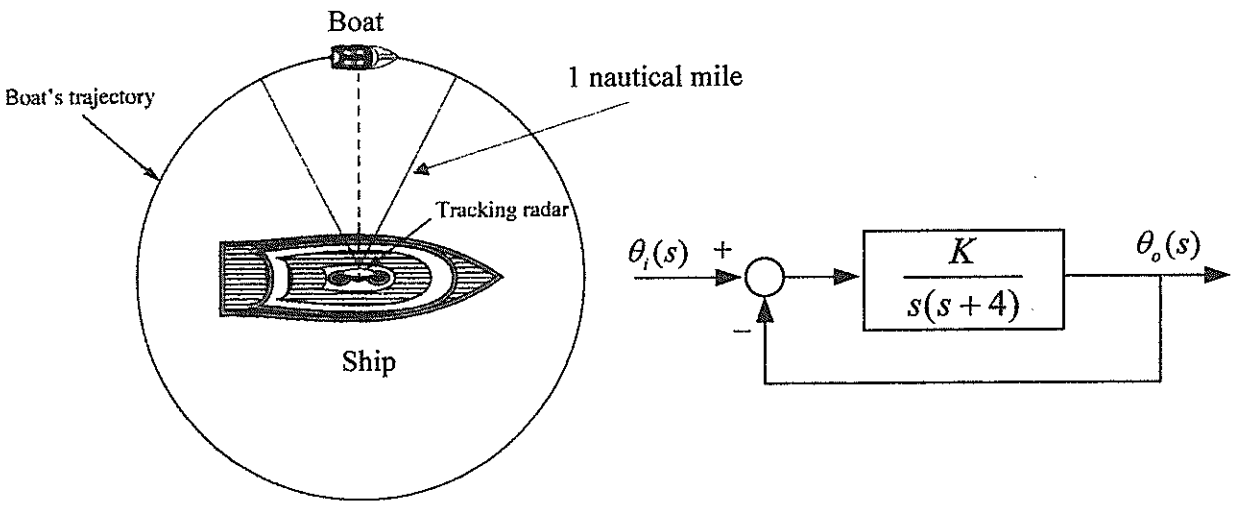

Fig. 2

見背面

3. The control system of a mobile robot can be described in Fig.3, where the state space equation of $G(s)$ is

$$\begin{aligned}\dot{\mathbf{x}}(t) &= \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t)\\ y(t) &= \mathbf{C}\mathbf{x}(t)\end{aligned}, \quad \mathbf{A}=\begin{bmatrix}0 & 0 & 0\\ 0 & -1 & 0\\ 0 & 0 & -2\end{bmatrix}, \quad \mathbf{B}=\begin{bmatrix}1\\ 1\\ 1\end{bmatrix}, \quad \mathbf{C}=\begin{bmatrix}1 & -2 & 1\end{bmatrix}, \quad \mathbf{x}=\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

(a) Determine the transfer function of $G(s)$. **(10%)**

(b) Please design a PD controller, $D(s) = K_P + K_D s$, to achieve the closed-loop control system with poles of $-0.75+1.5j$ and $-0.75-1.5j$. **(15%)**

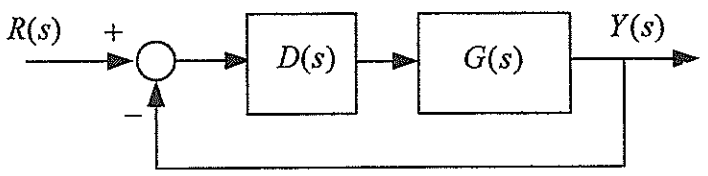

Fig.3

4. Consider a submarine motion control problem with transfer function G(s) and Bode plot as shown in Fig.4.

(a) Please determine the system type of $G(s)$. **(5%)**

(b) Determine the system model of G (s) like $G(s) = \dfrac{K(s-z_1)\ldots}{s^n(s-p_1)\ldots}$. **(10%)**

(c) Please sketch the phase plot of Bode plot for G (s). **(10%)**

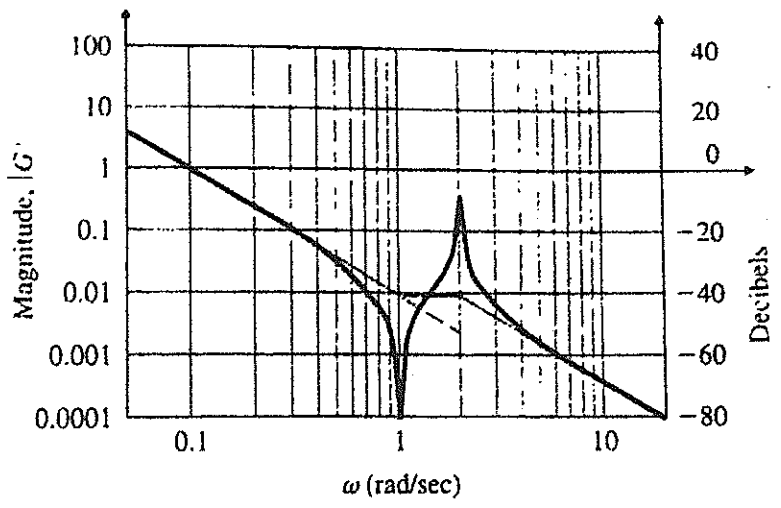

Fig.4

試題隨卷繳回