請於答案卷上作答，於試題卷上作答者，不予計分。

【題目共 6 題】

1. The block diagram of a motor-control system with tachometer feedback is shown in **Fig. 1**. (a) Find the transfer function of the system.【計分：4 分】(b) Write the characteristic equation of the system.【計分：3 分】(c) Find the range of the tachometer constant K_t so that the system is asymptotically stable.【計分：8 分】

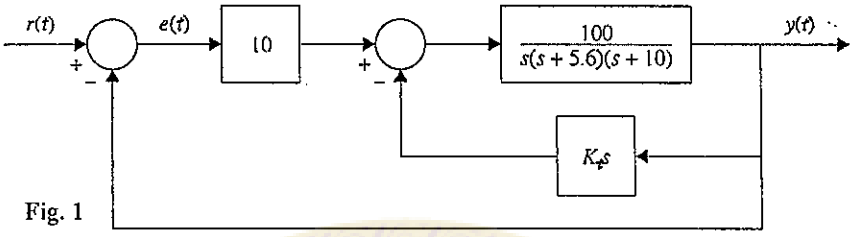

Fig. 1

2. **Fig. 2** shows the block diagram of a servomotor. Assume J = 1 kg-m^2 and B = 1 N-m/rad/sec. If the maximum overshoot of the unit-step input and the peak time are 0.2 and 0.1 sec, respectively. (a) Find the damping ratio and the natural frequency.【計分：4 分】(b) Find the gain K and the velocity feedback K_f. Also, calculate the rising time and settling time.【計分：8 分】(c) If K_f = 0.2, determine the range of K for stability using the Nyquist criterion.【計分：8 分】

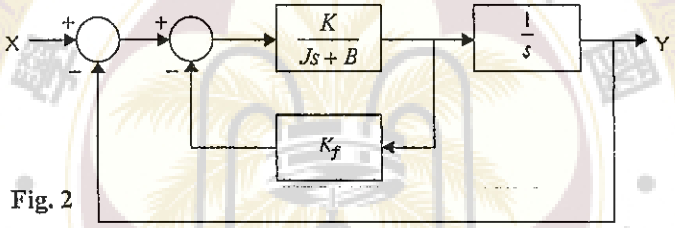

Fig. 2

3. Consider a feedback control system shown in **Fig. 3(a)**. The root loci of the feedback control system are shown in **Fig. 3(b)**. (a) Find the parameters a, b, c, and d indicated in the forward-path transfer function of **Fig. 3(a)**.【計分：4 分】(b) Find the gain K that the root loci of the system intersects the imaginary axis.【計分：5 分】(c) Find the breakaway point of the root loci indicated in **Fig. 3(b)**.【計分：6 分】

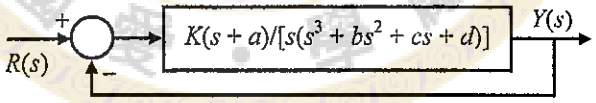

Fig. 3(a)

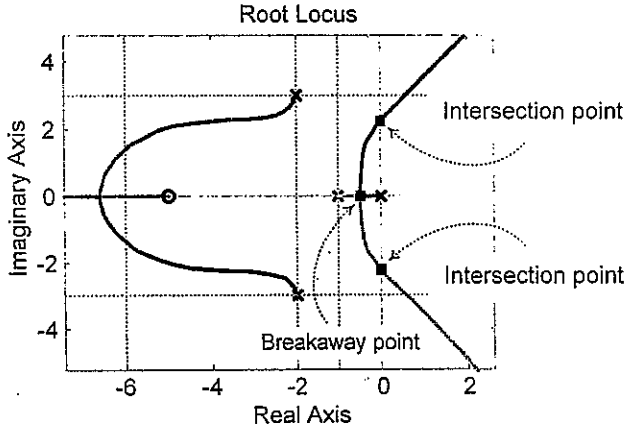

Fig. 3(b)

4. Given a linear input/output system: $\frac{dx}{dt} = Ax + Bu, y = Cx + Du$,

where $A = \begin{bmatrix} -1 & -2 \\ 1 & 0 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 3 \end{bmatrix}, C = \begin{bmatrix} 1 & 1 \end{bmatrix}, D = 0$

Please calculate the steady state response of output y with respect to (1) a unit step input【計分：8 分】(2) a sinusoidal input u=2sin(t) 【計分：10 分】

5. The mobile robot with two actuated wheels is shown in the figure below, where 2b is the width of the mobile robot and r is the radius of the wheel. O-*xy* is the world coordinate system and P_o-XY is the coordinate system fixed to the mobile robot. P_0 is the origin of the coordinate system P_o-XY and the middle between the right and left driving wheels. The center of mass of the mobile robot is P_c, which is on the X-axis, and the distance from P_o to P_c is d.

(1) If we assume the wheels roll and do not slip, then please write the equations to describe the motion of the vehicle related to the angular velocities of the wheels (assume that ω_r and ω_l are the angular velocities of the right and left wheels respectively.) 【計分：15 分】

(2) If write the above kinematic model as the form: $\frac{d}{dt}\begin{bmatrix} x \\ y \\ \varphi \end{bmatrix} = A\begin{bmatrix} \omega_r \\ \omega_l \end{bmatrix}$, please find A=? 【計分：7 分】

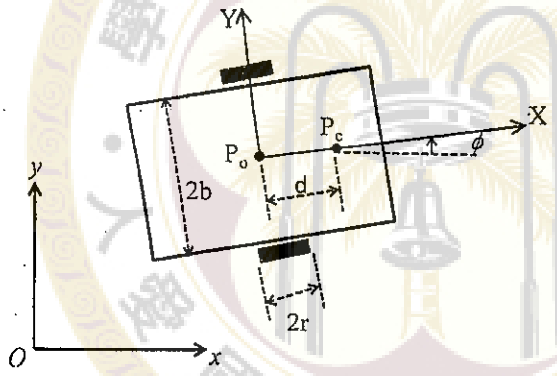

Figure for problem 5.

6. Please design a control gain K so that the steady state error of the output to the reference input r(t)=2 is less than 0.1【計分：10 分】

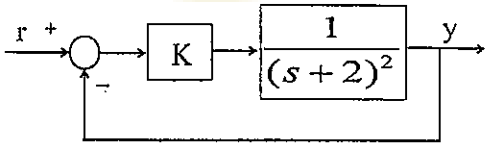

Figure for problem 6.

試題隨卷繳回