總分 100 分

1. A PI-controller is used to improve the steady state error of a unity feedback control system as shown in Fig.1, where $D(s) = K_p + \frac{K_I}{s}$ is the controller and $G(s) = \frac{48500}{s(s+2.89)}$ is the plant.

(a) Determine the value of K_I to achieve e_{ss}=2% for a parabolic input. **(7%)**

(b) Plot the root locus of the system as a function of K_P by using the value of K_I in (a). **(10%)**

(c) Please find the value of K_P to achieve a real pole at -1, and solve the other two poles. **(8%)**

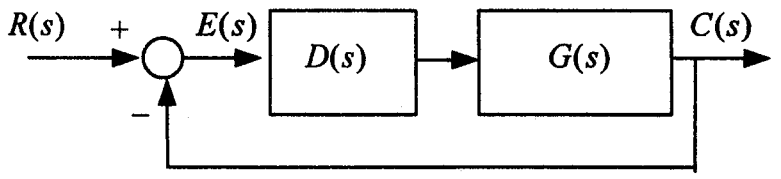

Fig.1

2. A DC motor drive system is shown in Fig. 2, where J is moment of inertia; N is gear number; D is damping ratio; R_a is armature resistance; e_a is input voltage; θ_L is output rotational angle. The torque T_m versus rotational speed ω_m relation of the DC motor is also given.

(a) Derive the differential equations of mathematical model for the overall system. **(10%)**

(b) Find the transfer function $G(s) = \theta_L(s) / E_a(s)$. **(15%)**

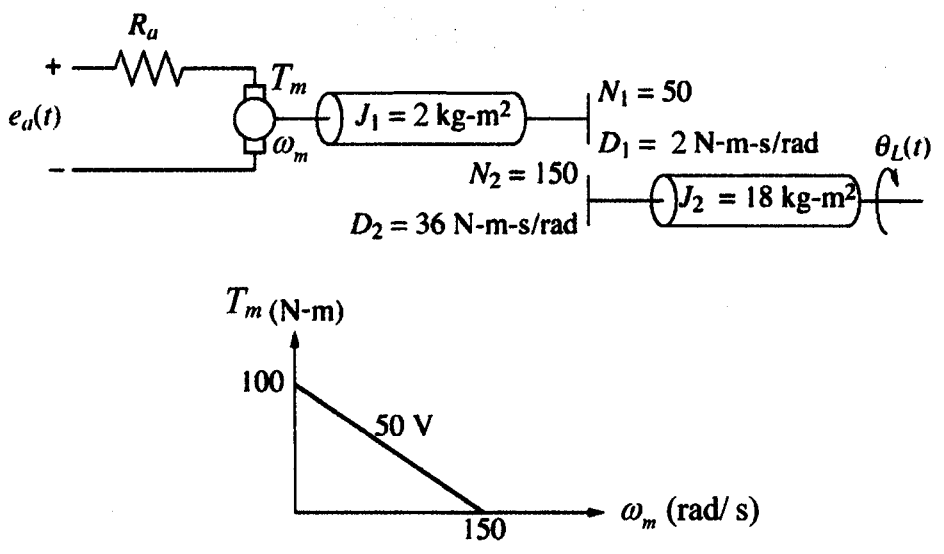

Fig. 2

見背面

3. A linear time-invariant causal control system can be described by the 2nd order differential equation as

$$m\ddot{y}(t) + d\dot{y}(t) + ky(t) = \dot{u}(t) + u(t)$$

(a) Derive the state equation with the state variables $x_1 = y(t),\ x_2 = \dot{y}(t)$ **(10%)**

$$\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t)$$
$$y(t) = \mathbf{C}\mathbf{x}(t) + \mathbf{D}u(t)$$

(b) Derive the initial state $\mathbf{x}(0)$ in terms of $\dot{y}(0), y(0)$ and $u(0)$. **(15%)**

4. A controller design in frequency domain problem is shown in Fig.3 with the controller $D(s) = K\dfrac{1+\alpha s}{1+\beta s}$ and the plant $G(s) = \dfrac{1}{s(s+2)}$.

Please design the controller $D(s)$ to match the design conditions of the steady state error less than 0.05 for unit ramp input and the phase margin 45 degree. **(25%)**

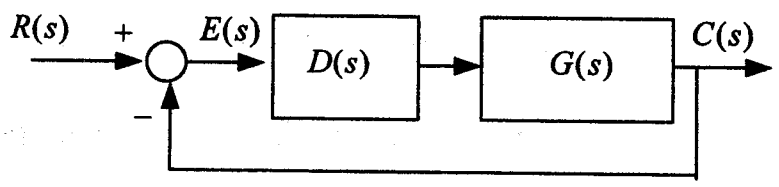

Fig.3

試題隨卷繳回