※ 考生請注意：本試題不可使用計算機

1. Please derive the state space representation for the following DC motor model. (15%)

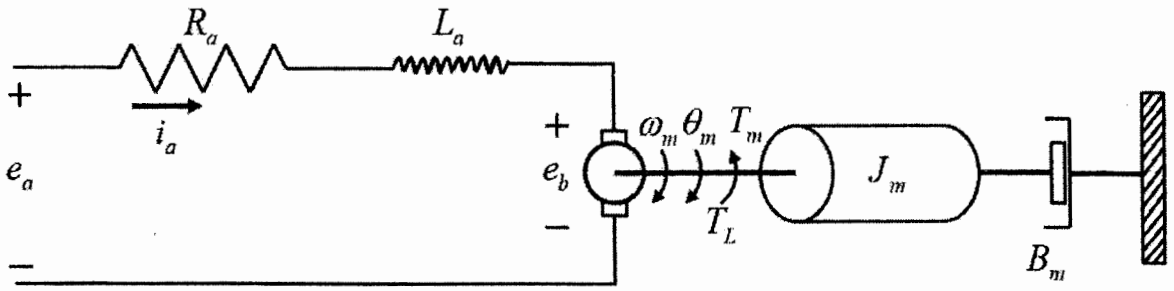
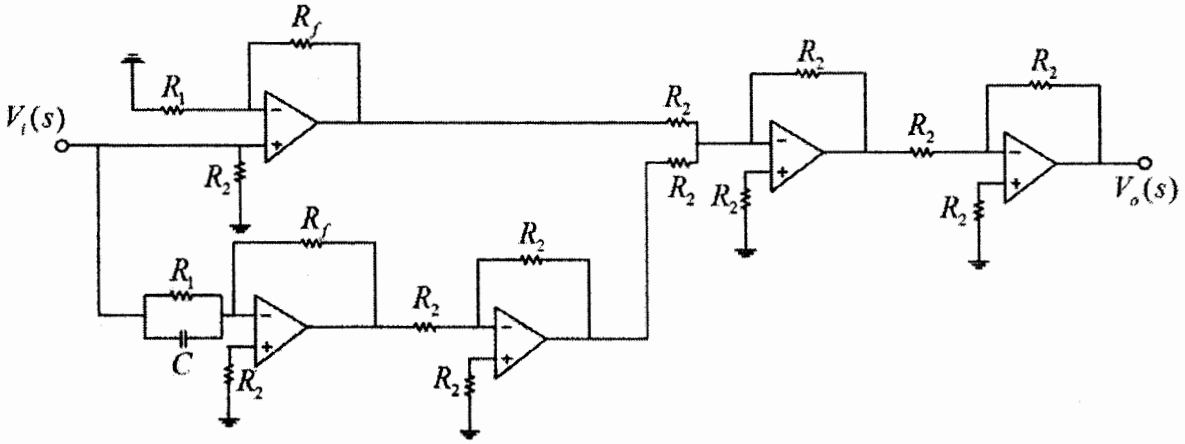


Figure 1. Illustration of a separately excited motor

2. (a) Please use Bode plot to verify that is this a lowpass, highpass, bandpass or bandstop filter? (15%), and (b) which kind of the controller it is $V_o(s)/V_i(s) = ?$ (5%)



where $R_1 = 20\text{k}\Omega$, $R_2 = 10\text{k}\Omega$, C=25μF and $R_f = 40\text{k}\Omega$.

3. (a) Figure 2 shows a feedback control system with a disturbance $D(s)$ injected between the controller $G_1(s)$ and the plant $G_2(s)$. Please derive the expression of the steady-state error e_{ss} and (b) calculate the value of e_{ss} with external disturbance $D(s) = 5$ and the reference input is $R(s) = \frac{1}{s^2}$. (15%)

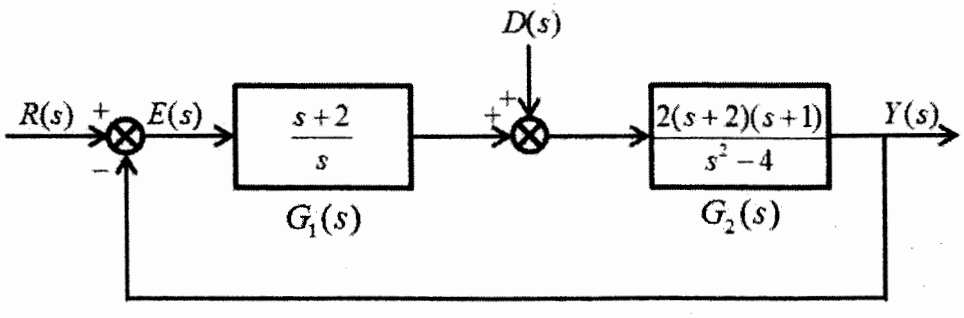


Figure 2. A feedback system with a disturbance

(背面仍有題目,請繼續作答)

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(b) Find the steady-state error e_{ss} of the system as shown in Figure 3 with a input $r(t)=5u(t)$. (10%)

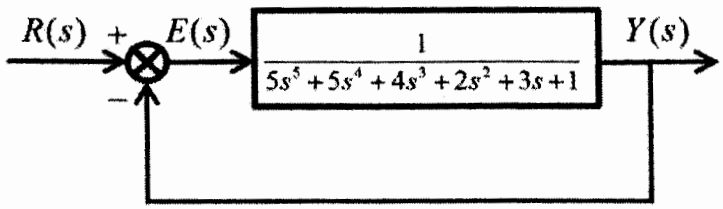

Figure 3

4. Consider the following linear system, and (a) please derive the "Separation Principle" for it. (10%)

$$\dot{x}(t)=Ax(t)+Bu(t)$$

$$y(t)=Cx(t)$$

(b) what's the physical meaning of "Separation Principle"? (10%)

5. Consider the state equation of a second-order digital control system that is represented by

$$x(k+1)=Ax(k)+Bu(k)$$

where

$$A=\begin{bmatrix}1 & -1\\ 0 & 1\end{bmatrix} \text{ and } B=\begin{bmatrix}1\\ 1\end{bmatrix}$$

Please find the feedback gain matrix G for the state feedback controller $u(k)=-Gx(k)$ such that the characteristic roots of the closed-loop system are $z_1=0.4$ and $z_2=0.6$. (20%)