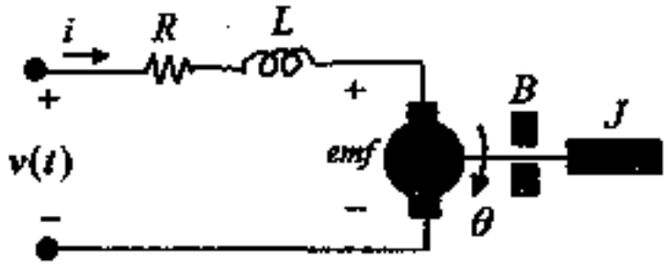
1. Consider the following system:

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$
$$y = [1 \quad 0]x$$

compute the observer (estimator) gain matrix L so that the two observer (estimator) error poles are at -1 and -2, respectively. (15%)

2. Please give the following meanings: (1) Gain margin; (2) Phase margin; (3) The Nyquist stability criterion; (4) Routh's stability criterion. (15%)

3. Given the following armature voltage controlled dc motor drive with constant field excitation, an inertia load J, damping coefficient B, electromagnetic torque $K\,i$ and back emf $K(d\theta/dt)$. Let $x_1 = i$, $x_2 = \theta$, $x_3 = d\theta/dt$ and output $y = \theta$ :
(1) Find the state and output equations of the drive system.
(2) Would you suggest a reasonable specification for the drive system and describe how to design a state feedback controller to satisfy the specification? Assume all the states are available for feedback control. (15%)

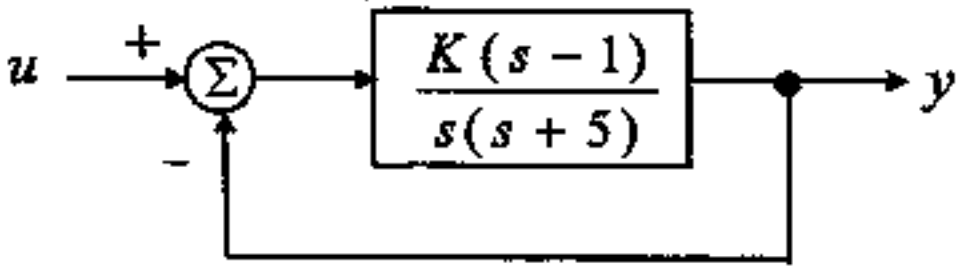



4. (1) Given the following closed-loop transfer function of an analog system with output feedback control

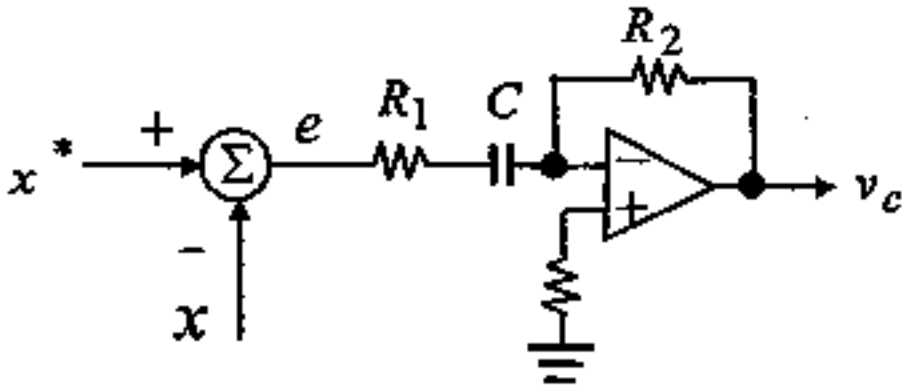
$$\frac{Y(s)}{U(s)} = \frac{3}{s(s+2)}$$

find a discrete algorithm corresponding to the above transfer function.
(2) What is the constraint which must be satisfied for this algorithm to result in a good approximation to the analog version. (10%)

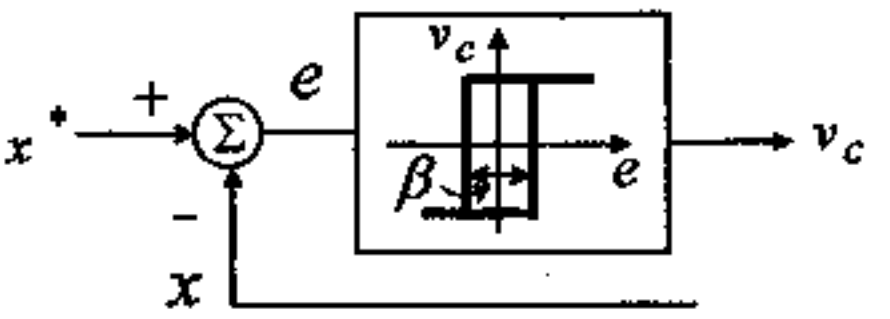
5. (1) Find the range of K for the following system to be stable.
(2) Plot the corresponding root locus for the stable range of K. (15%)




6. A feedback controller is realized as shown with $R_1 \ll R_2$
(1) Find the transfer function of the controller $G_c(s) \triangleq V_c(s)/E(s)$.
(2) Find the simplified models of $G_c(s)$ for low frequency and high frequency error signals, respectively.
(3) Describe the major function of $R_1$. (15%)




7. A bang-bang controller (or called ON/OFF controller) with hysteresis band $\beta = 0.1$ is to be realized using operational amplifier, design and draw the circuit. (10%)




8. The closed-loop control system is supposed to be stable, and its command and output trajectories are as shown. Sketch the trajectories of $e$ and $v_c$. (5%)