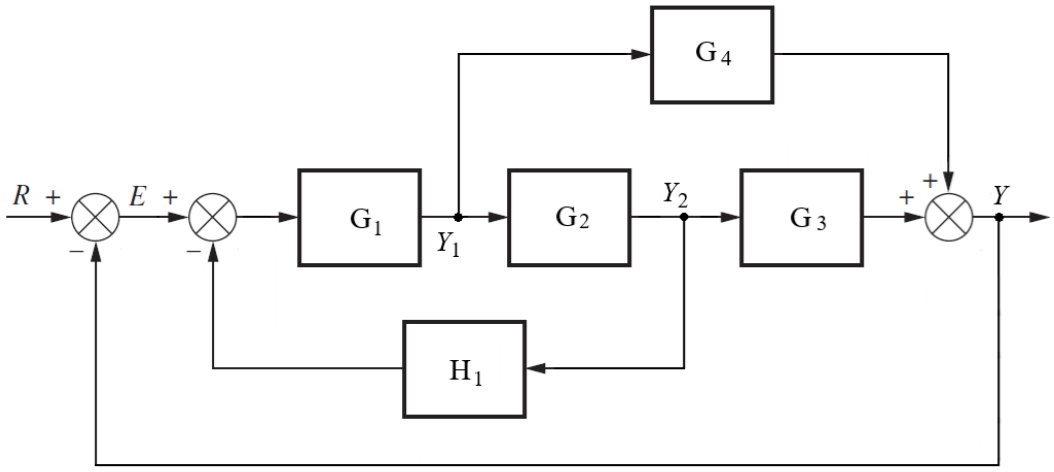
XMUT315 Control Systems Engineering

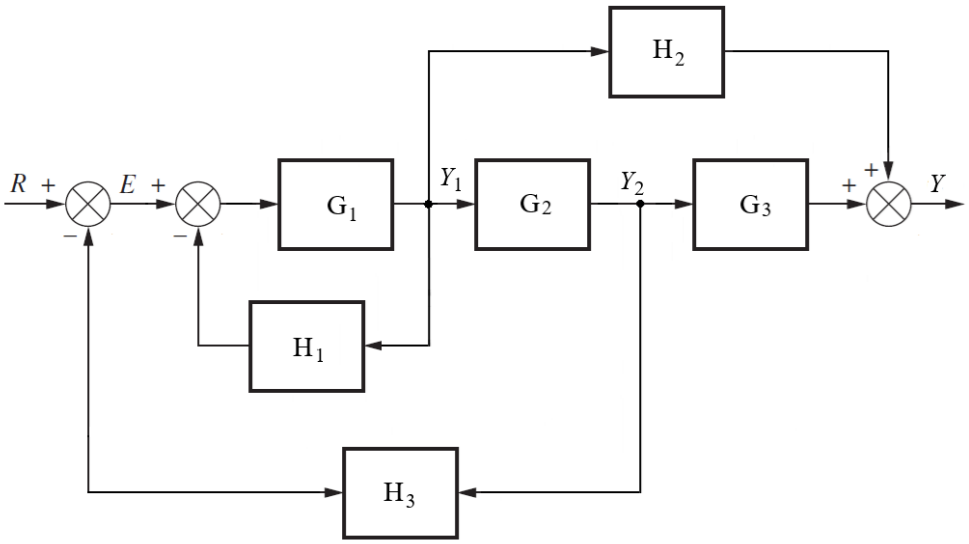
Tutorial 2: Block Diagram and Feedback

A. Block Diagrams

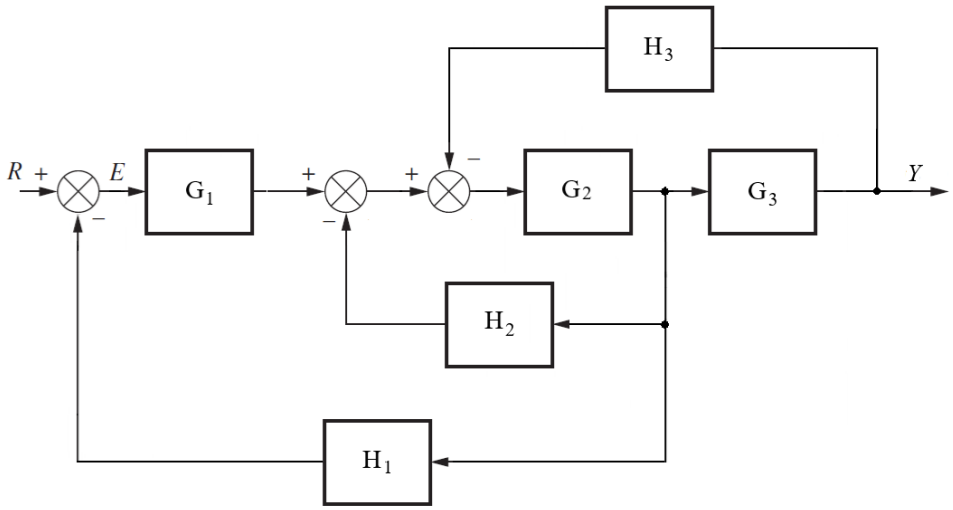
1. Reduce the following block diagram of a control system into a single block. [8 marks]



2. Reduce the block diagram shown below and find the Y/X. [10 marks]



3. Reduce the block diagram shown below to unity feedback form and find the Y/X. [10 marks]



B. Introduction to Feedback Systems

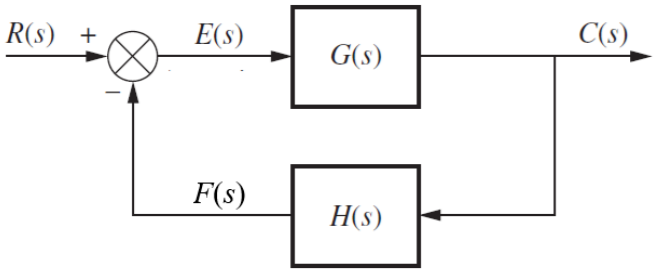
4. In control system engineering, feedback is typically introduced to influence the performance of the control system.

   a. What is feedback? [2 marks]

   b. List and describe types of feedback. [2 marks]

   c. Describe two improvements to the system when a feedback mechanism implemented in the system. [4 marks]

5. You are given a given feedback system as shown in the following diagram.



   a. List components of the feedback control system. [2 marks]

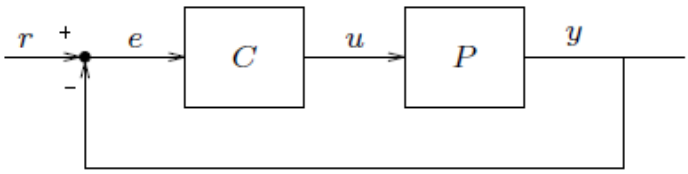
   b. Prove that the equation that represents the following feedback system is: [6 marks]

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$$

C. Feedback Control Systems

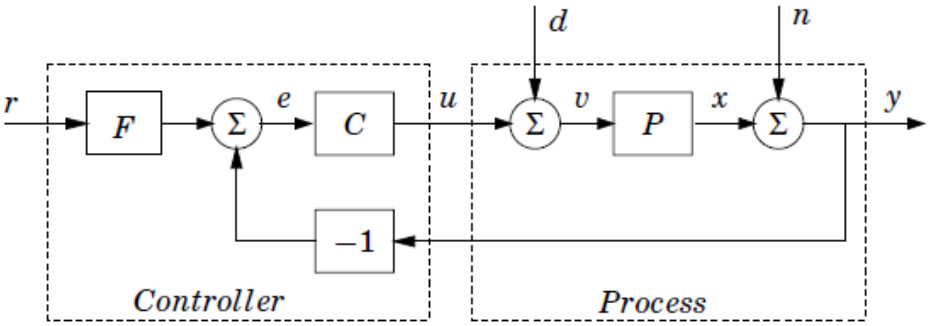
6. Describe the effect of feedback system if implemented in a given control system towards the following characteristics and behavior of the system:
   a. Noise or disturbance. [4 marks]
   b. Transient response. [4 marks]
   c. Steady-state condition. [4 marks]

7. Given the following feedback control system, perform the following tasks.



   a. Find the equivalent open loop of the feedback control system given above. [2 marks]
   b. Compare the open- and closed-loop arrangements of the system in terms of:
      i. Changes in P. [2 marks]
      ii. Input and output disturbance. [6 marks]
      iii. Sensor/measurement noise. [8 marks]

8. Given a block diagram model of a feedback control system as shown in the figure below, derive the equations for these signals in the control system.



   a. All relevant equations for the derivation process. [10 marks]
   b. Process variable signal $X(s)$: [14 marks]

$$X(s) = \left[\frac{P(s)}{1 + P(s)C(s)}\right] vD(s) - \left[\frac{P(s)C(s)}{1 + P(s)C(s)}\right] N(s) + \left[\frac{P(s)C(s)F(s)}{1 + P(s)C(s)}\right] R(s)$$

   c. Measured signal $Y(s)$: [14 marks]

$$Y(s) = \left[\frac{P(s)}{1 + P(s)C(s)}\right] D(s) + \left[\frac{1}{1 + P(s)C(s)}\right] N(s) + \left[\frac{P(s)C(s)F(s)}{1 + P(s)C(s)}\right] R(s)$$

d. Control variable signal $U(s)$: [14 marks]

$$U(s) = -\left[\frac{P(s)C(s)}{1 + P(s)C(s)}\right] D(s) - \left[\frac{C(s)}{1 + P(s)C(s)}\right] N(s) + \left[\frac{C(s)F(s)}{1 + P(s)C(s)}\right] R(s)$$

9. What are the inputs typically used for evaluating and testing in the control system? Why do we need to have various (different) inputs for these matters? [6 marks]

10. List and describe types of controllers in control systems engineering. [2 marks]

11. Why is compensator necessary for improving the performance and/or stability of a given control system? [4 marks]

12. List and describe basic compensators in control systems. What are the main differences between the controllers with the compensators? [6 marks]