

BLOCK DIAGRAM REDUCTION TECHNIQUE



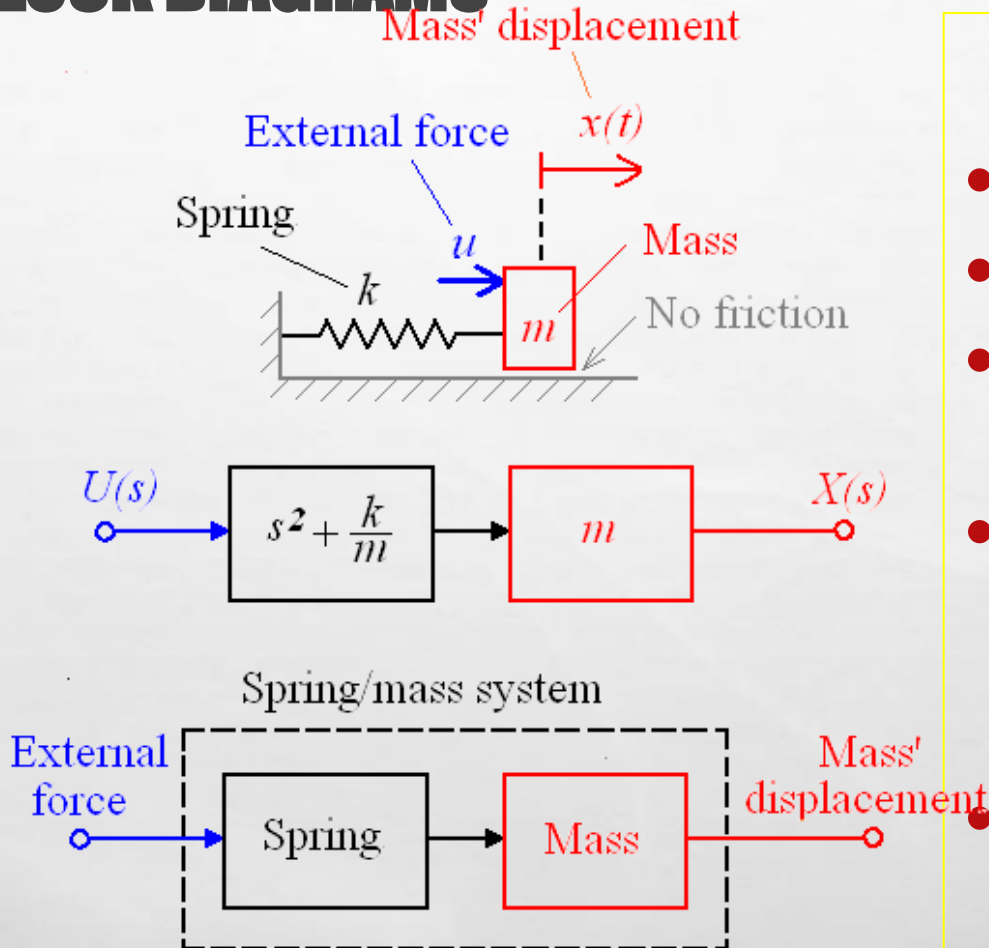
BLOCK DIAGRAM

- **IT REPRESENTS THE** STRUCTURE OF A CONTROL SYSTEM.
- IT HELPS TO ORGANIZE THE VARIABLES AND EQUATIONS REPRESENTING THE CONTROL SYSTEM.

IT IS COMPOSED OF:

- **BOXES, THAT REPRESENTS THE** COMPONENTS **OF THE SYSTEM** INCLUDING THEIR CAUSALITY;
- LINES WITH ARROWS, **THAT REPRESENT THE** ACTUAL DYNAMIC VARIABLES, **SUCH AS *SPEED, PRESSURE, VELOCITY,*** ETC..

SIMPLEST OPEN-LOOP CONTROL EXAMPLE & ASSOCIATED BLOCK DIAGRAMS

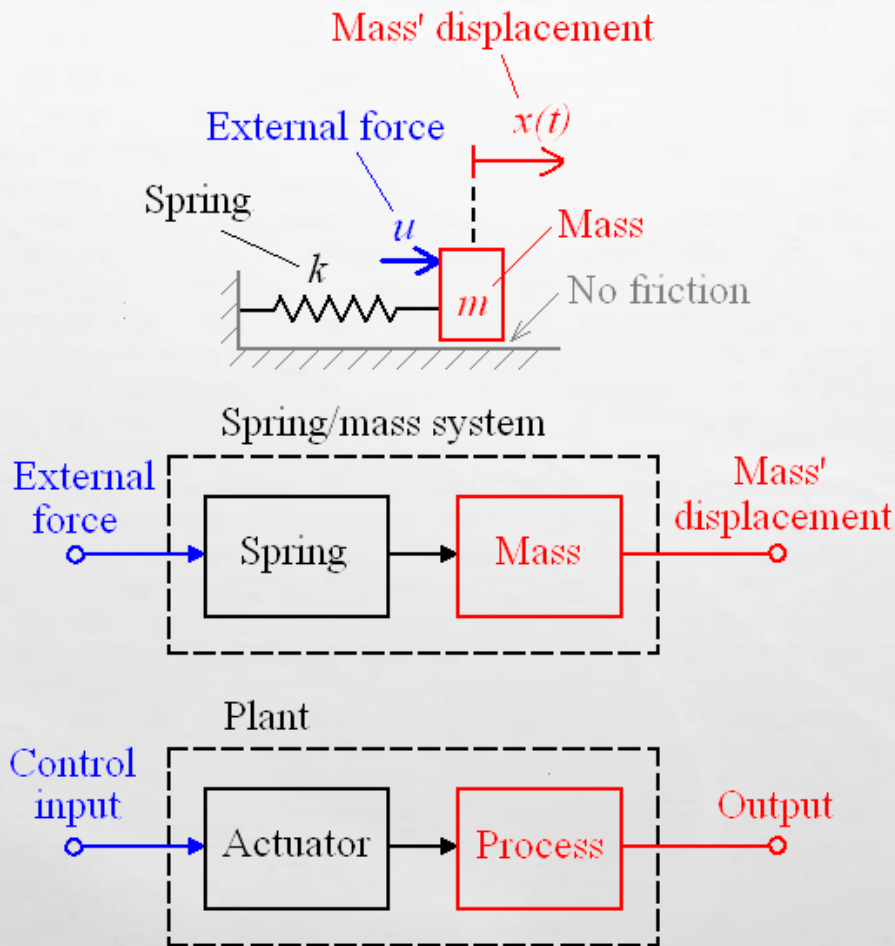


- **SYSTEM**= MASS + SPRING
- **CONTROL INPUT**: FORCE U
- **OUTPUT**: DISPLACEMENT $X(T)$

- **BLOCK DIAGRAM** (DERIVED USING LAPLACE TRANSFORMS, MORE ON THIS LATER)

- **COMPONENT BLOCK DIAGRAM** FOR THE SYSTEM EXAMINED

SPECIFIC & GENERIC COMPONENT BLOCK DIAGRAMS



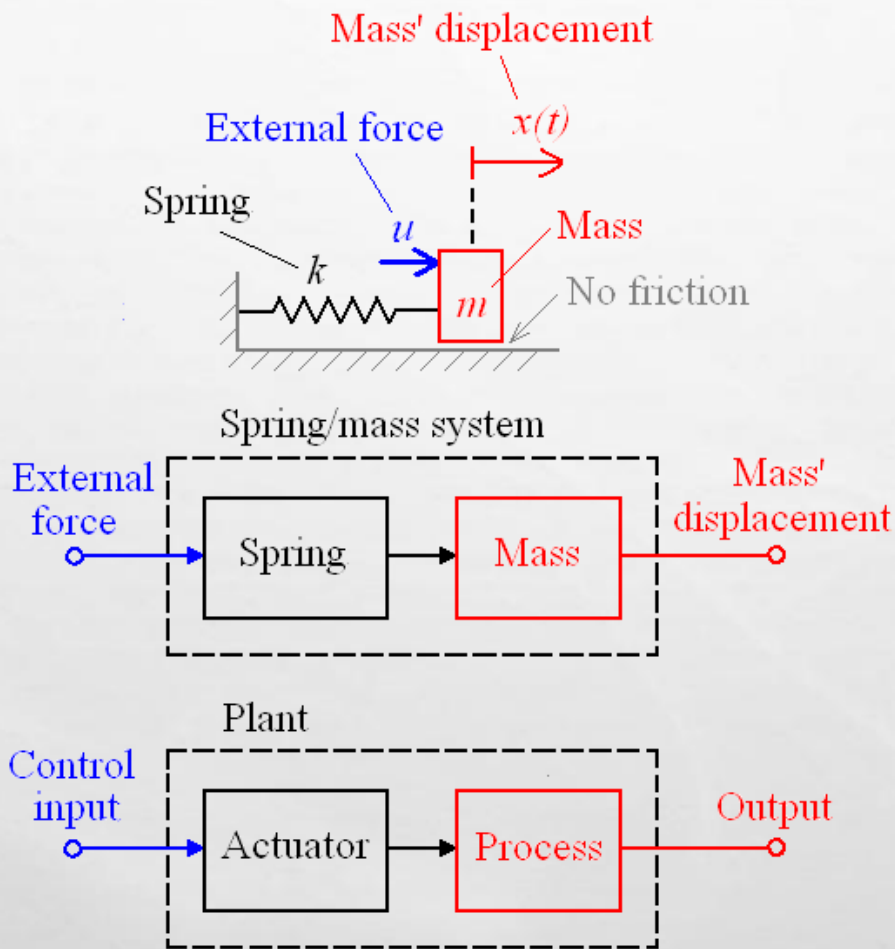
RECALL PREVIOUS SYSTEM

- **CONTROL INPUT: FORCE U**
- **OUTPUT: DISPLACEMENT $X(T)$**

COMPONENT BLOCK DIAGRAM FOR THE SYSTEM EXAMINED

GENERIC COMPONENT BLOCK DIAGRAM

DEFINITIONS OF PROCESS, ACTUATOR & PLANT



- **PROCESS** = COMPONENT WHOSE THE OUTPUT IS TO BE CONTROLLED

EX: MASS

- **ACTUATOR** = DEVICE THAT CAN INFLUENCE THE CONTROL INPUT VARIABLE OF THE PROCESS

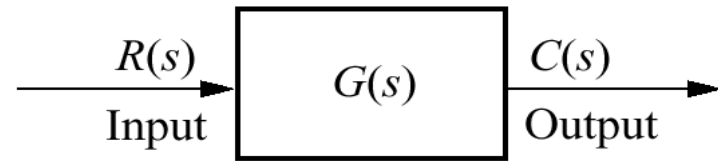
EX: SPRING

- **PLANT** = ACTUATOR +
EX: SPRING MASS SYSTEM

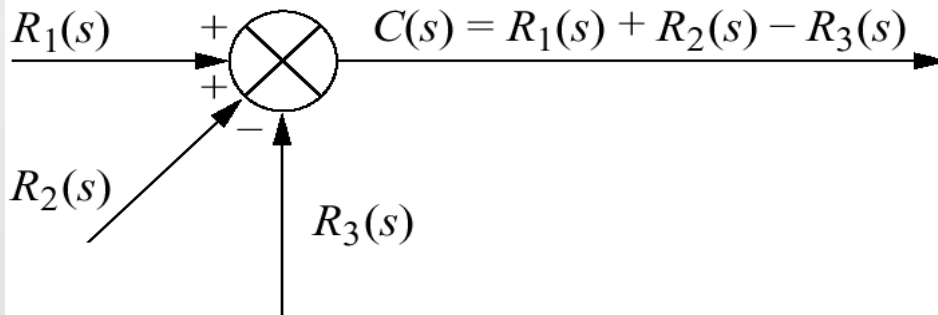
COMPONENTS OF A BLOCK DIAGRAM



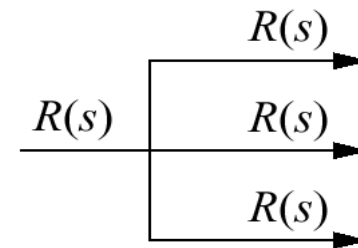
Signals
(a)



System
(b)

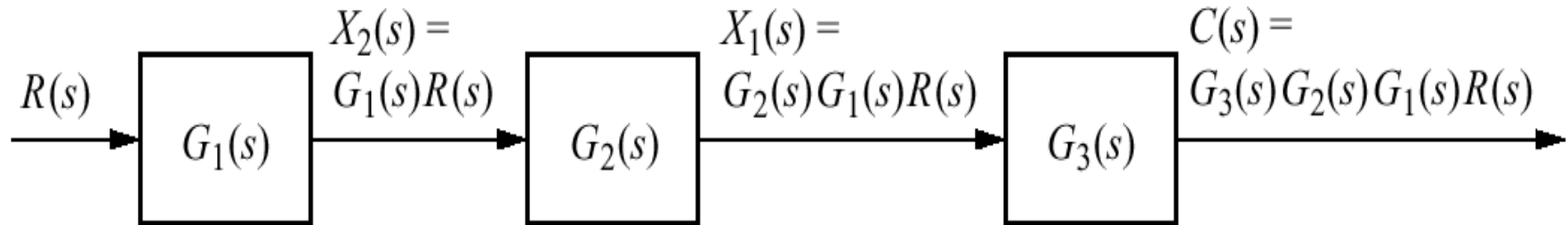


Summing junction
(c)

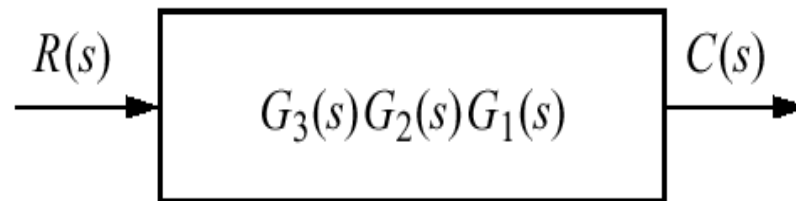


Pickoff point
(d)

A. CASCADED SUBSYSTEMS; B. EQUIVALENT TRANSFER FUNCTION

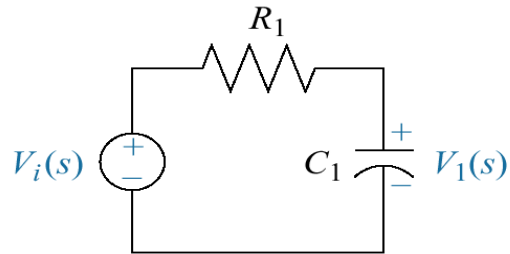


(a)



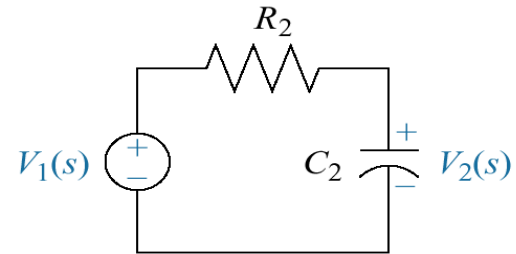
(b)

LOADING IN CASCADED SYSTEMS



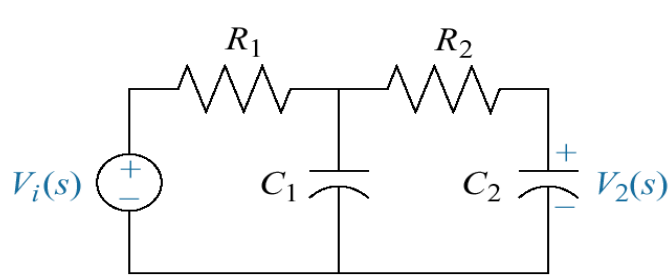
$$G_1(s) = \frac{V_1(s)}{V_i(s)}$$

(a)



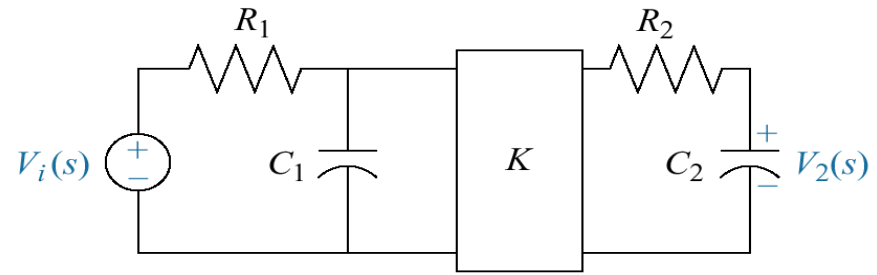
$$G_2(s) = \frac{V_2(s)}{V_1(s)}$$

(b)



$$G_T(s) = \frac{V_2(s)}{V_i(s)} \neq G_2(s)G_1(s)$$

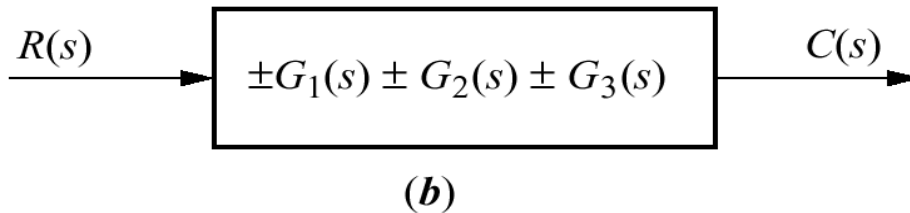
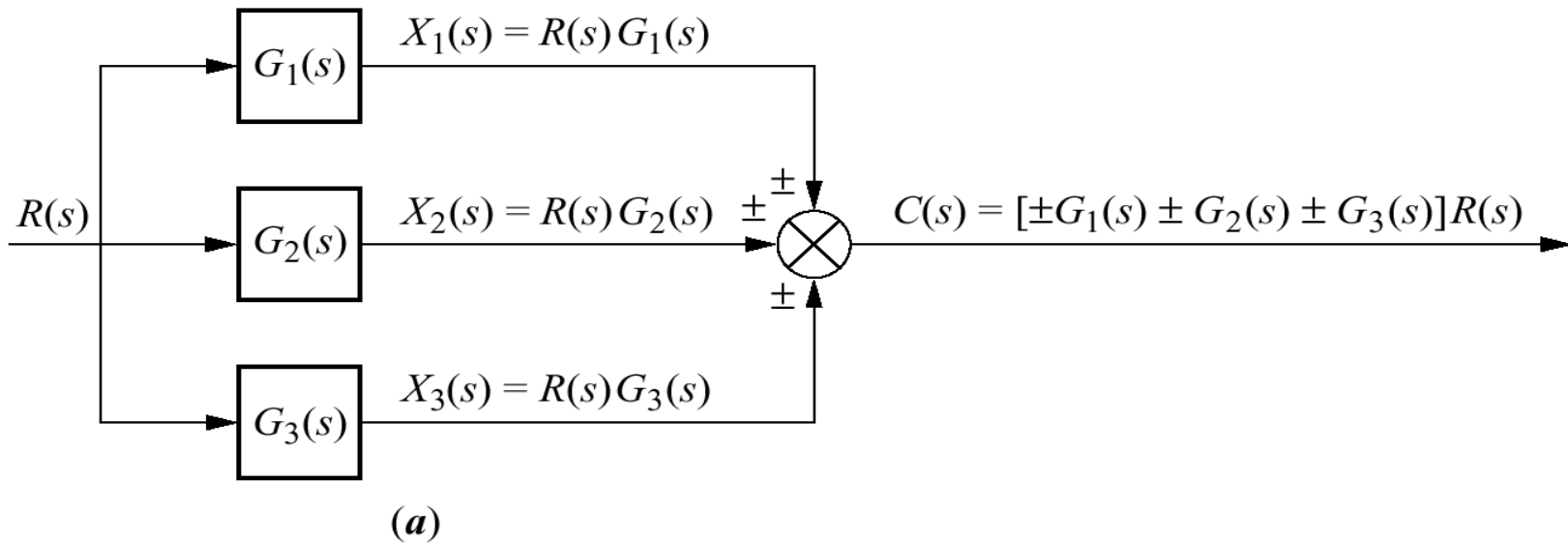
(c)



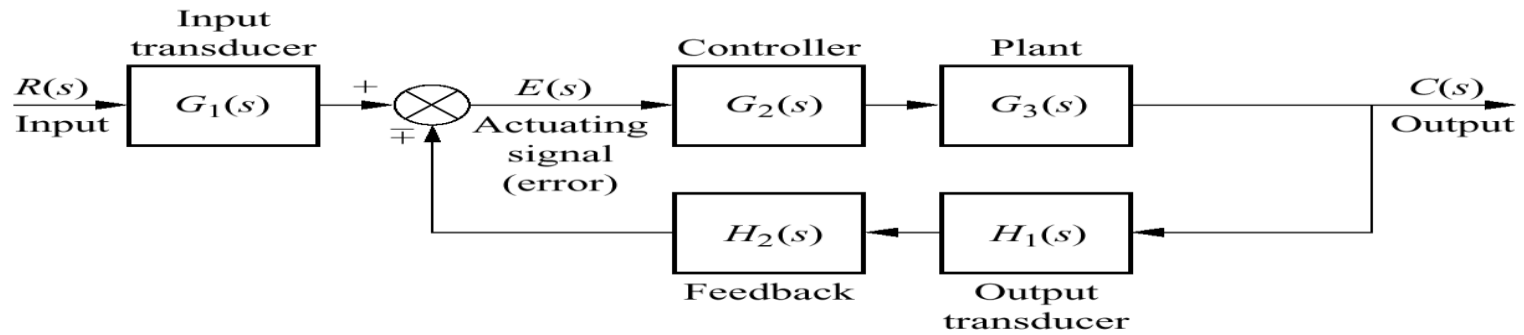
$$G_T(s) = \frac{V_2(s)}{V_i(s)} = KG_2(s)G_1(s)$$

(d)

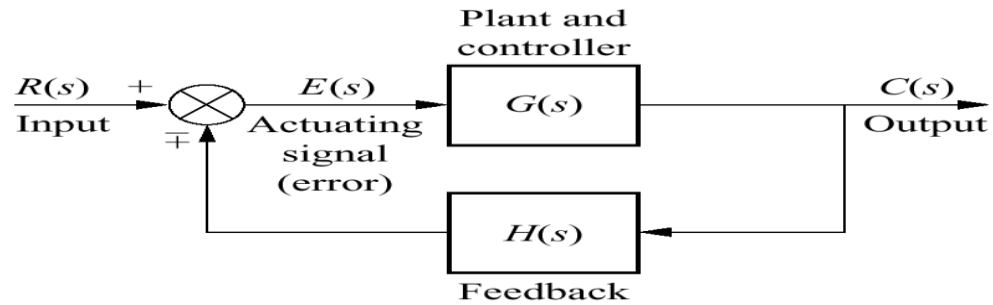
A. PARALLEL SUBSYSTEMS; B. EQUIVALENT TRANSFER FUNCTION



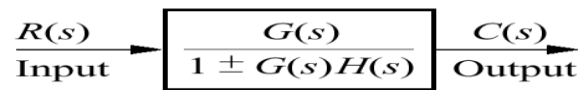
A. FEEDBACK CONTROL SYSTEM; B. SIMPLIFIED MODEL; C. EQUIVALENT TRANSFER FUNCTION



(a)



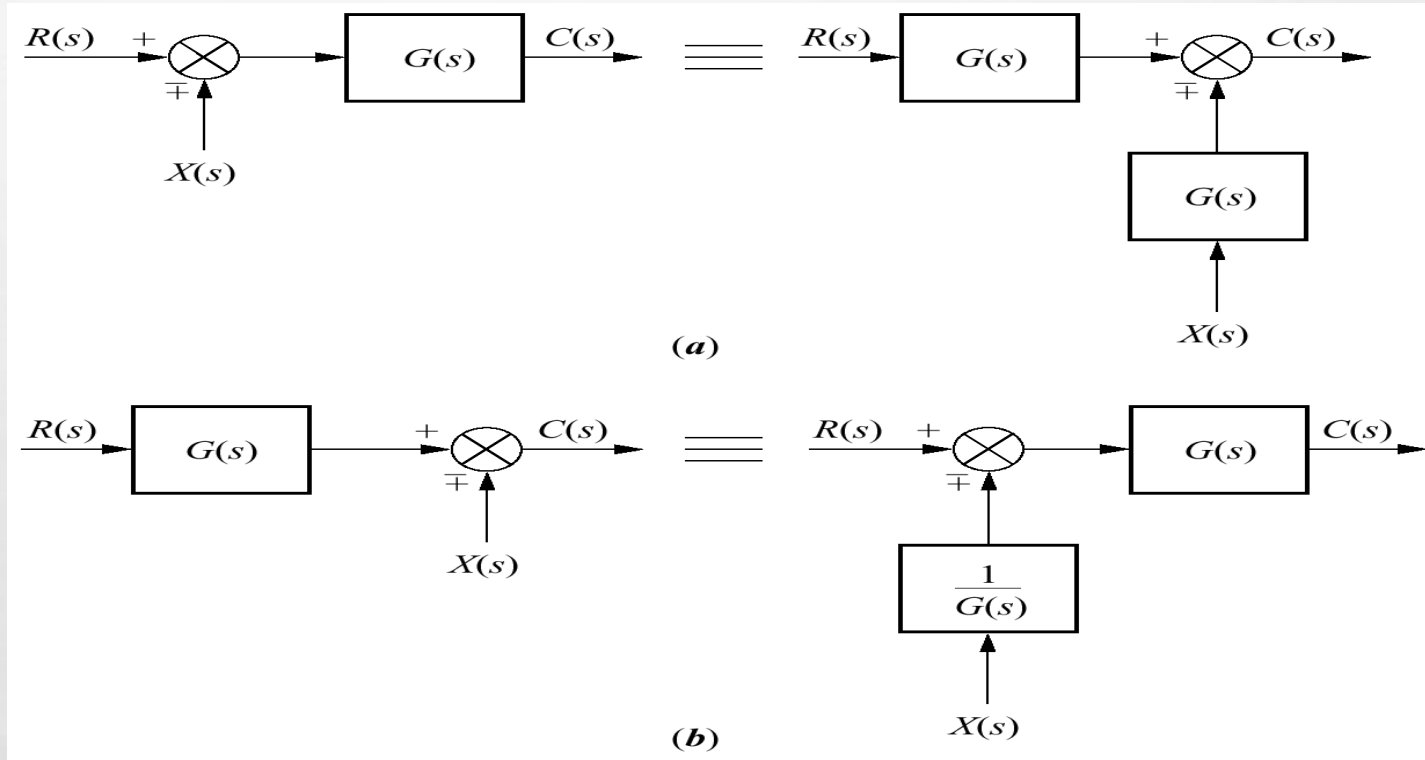
(b)



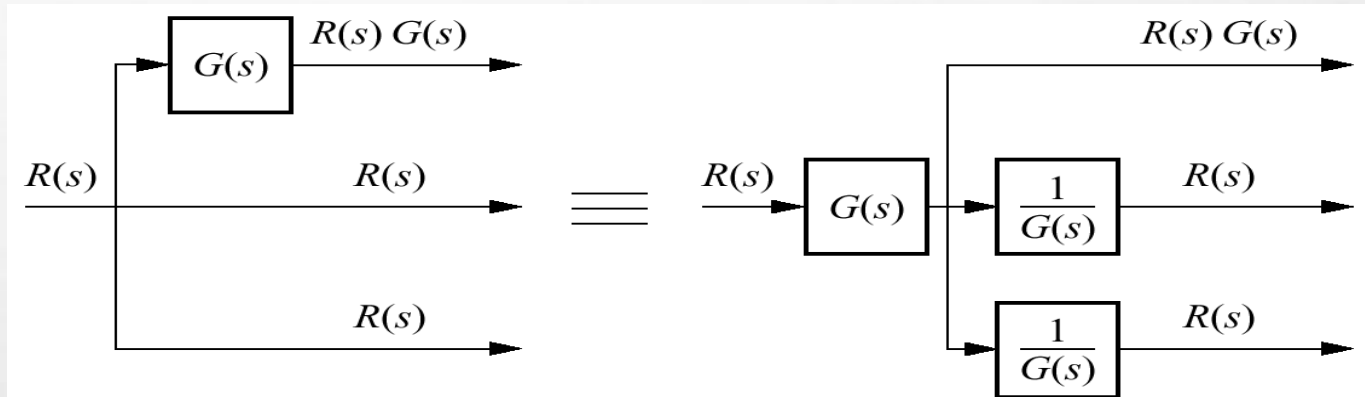
(c)

BLOCK DIAGRAM ALGEBRA FOR SUMMING JUNCTIONS—

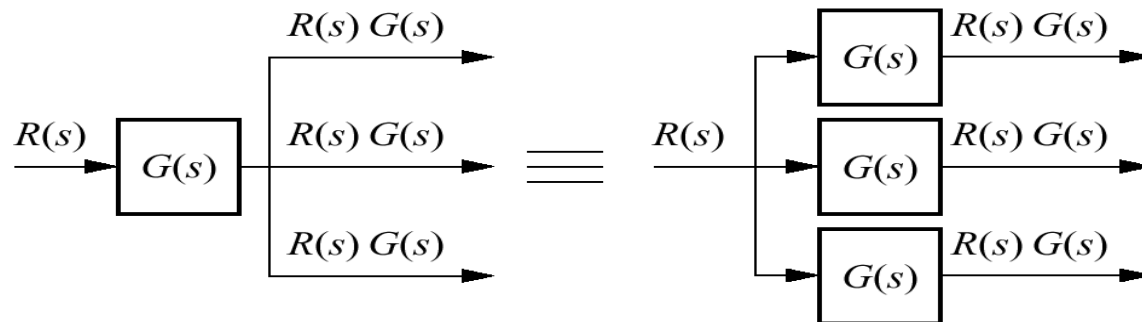
- A. TO THE LEFT PAST A SUMMING JUNCTION;
- B. TO THE RIGHT PAST A SUMMING JUNCTION



BLOCK DIAGRAM ALGEBRA FOR PICKOFF POINTS— EQUIVALENT FORMS FOR MOVING A BLOCK A. TO THE LEFT PAST A PICKOFF POINT; B. TO THE RIGHT PAST A PICKOFF POINT

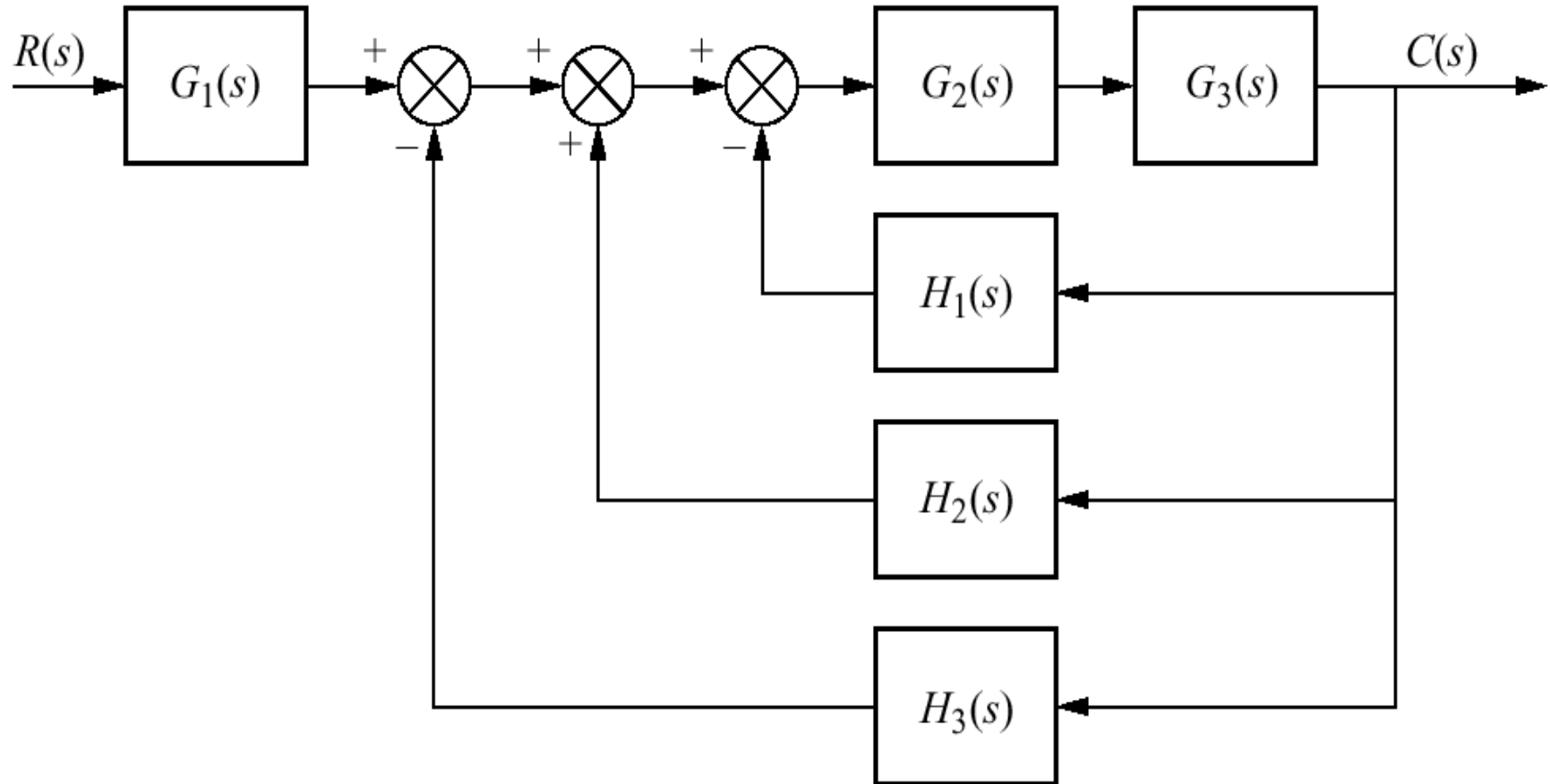


(a)



(b)

EXAMPLE



STEPS IN SOLVING EXAMPLE:

A. COLLAPSE SUMMING JUNCTIONS;

B. FORM EQUIVALENT CASCADED SYSTEM IN THE FORWARD PATH AND EQUIVALENT PARALLEL SYSTEM IN THE FEEDBACK PATH;

C. FORM EQUIVALENT FEEDBACK SYSTEM AND MULTIPLY BY CASCADED $G_1(S)$

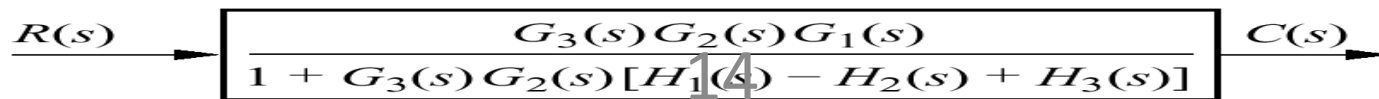
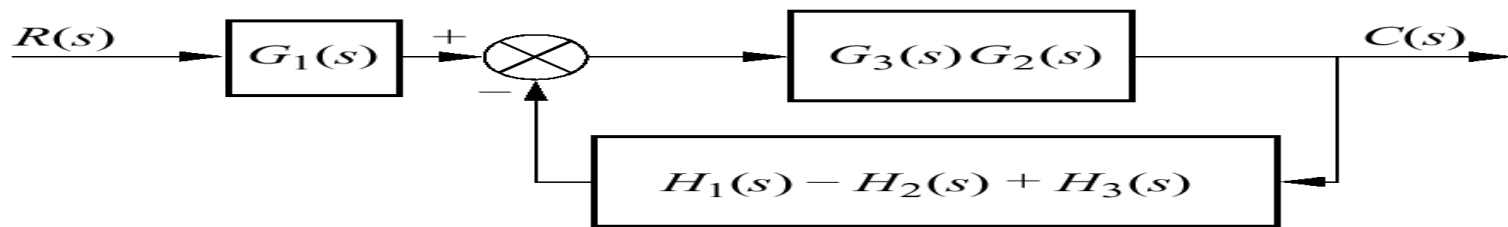
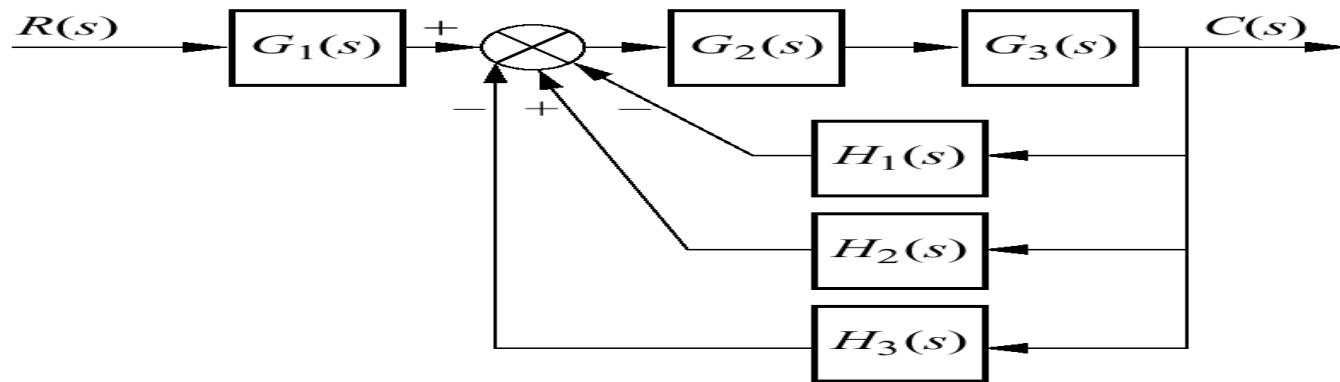
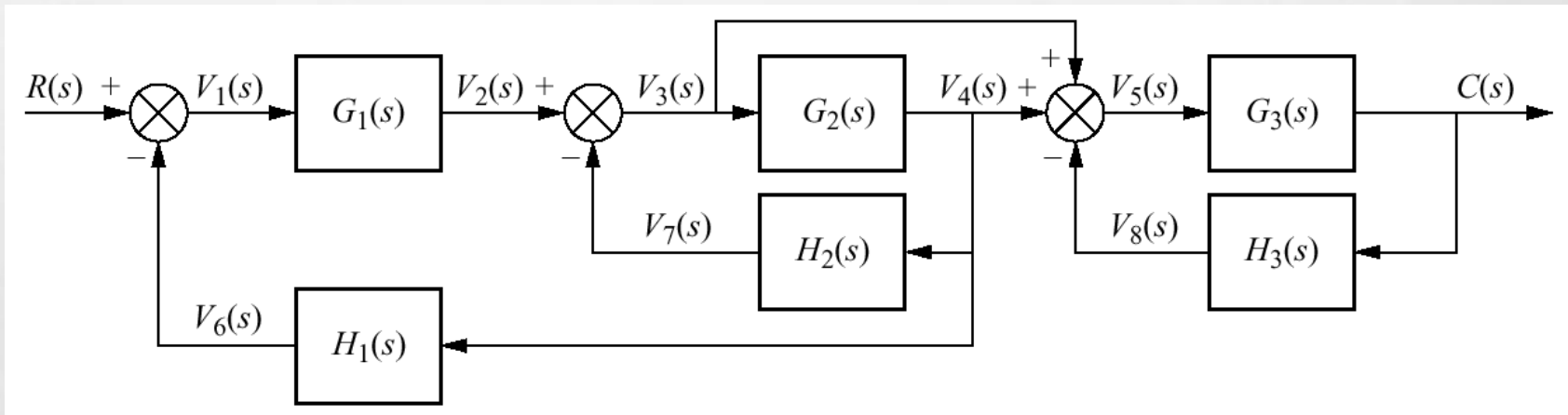
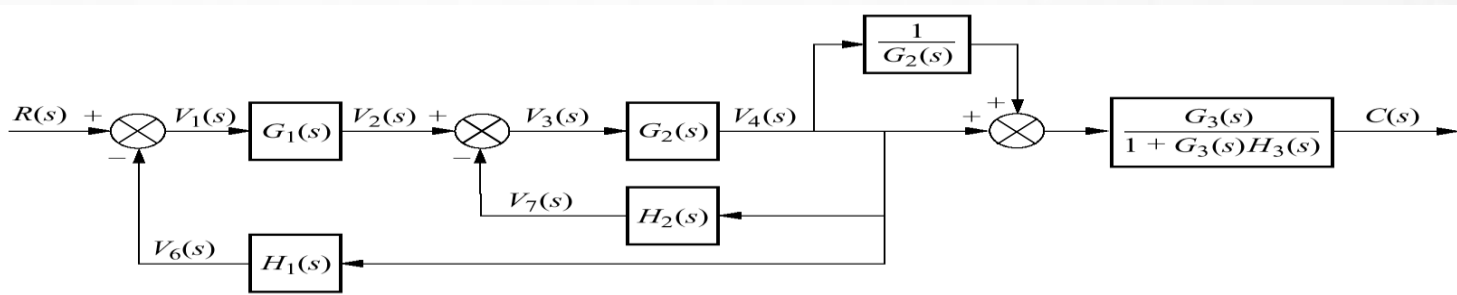
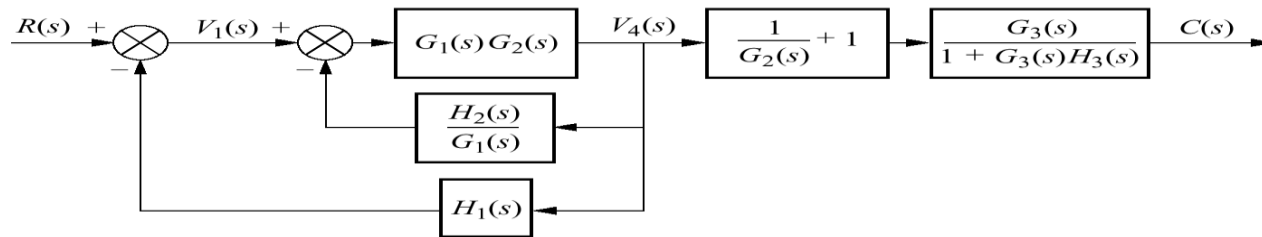


FIGURE BLOCK DIAGRAM FOR EXAMPLE

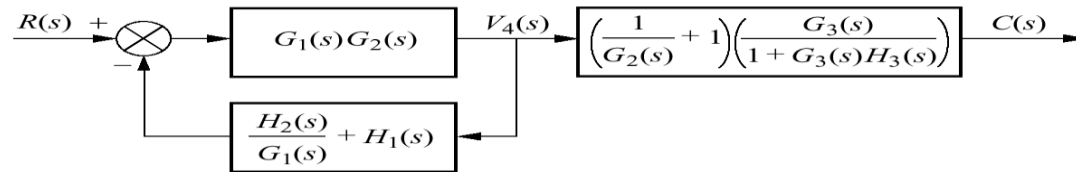




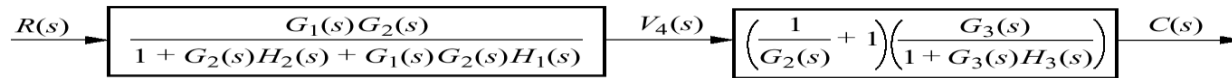
(a)



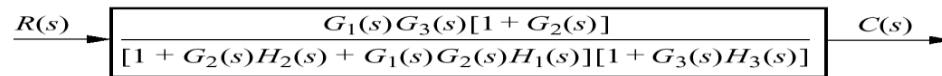
(b)



(c)



(d)



(e)