Signal and Systems

By

Prof. Dr. Eng. Mohamed Ahmed Ebrahim Mohamed

E-mail: mohamedahmed_en@yahoo.com

mohamed.mohamed@feng.bu.edu.eg

Web site: http://bu.edu.eg/staff/mohamedmohamed033

كلية الهندسة بشبرا

FACULTY OF ENGINEERING- SHOUBRA

Lecture (1)

Course Title: **Signal and Systems**

Course Code: **ELE 115**

Contact Hours: **5.**

= [2 Lect. + 2 Tut + 1 Lab]

Assessment:

Final Exam: 75.

Midterm: ??.

Year Work & Quizzes: 50.

Experimental/Oral: 25.

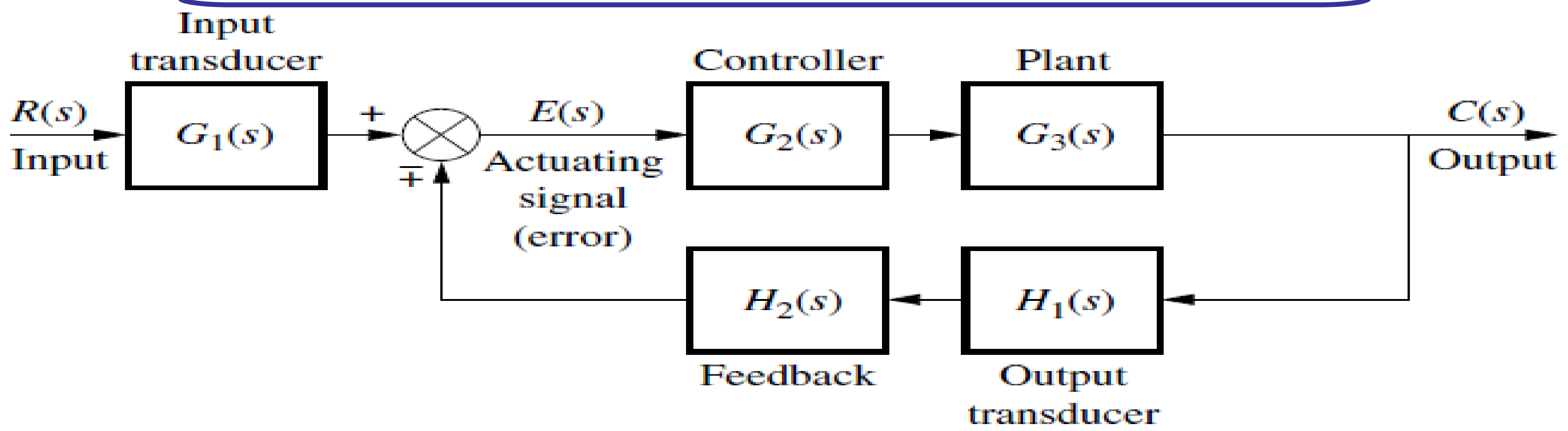
Textbook:

1- E. W. Kamen and B. S. Heck, Fundamentals of Signals and Systems Using the Web and MATLAB, 3rd ed., Pearson Hihgher Education, 2006.
2- Benjamin C. Kuo " Automatic control systems" 9th ed., John Wiley & Sons, Inc. 2010.
3- Katsuhiko Ogata, "Modern Control Engineering", 4th Edition, 2001.

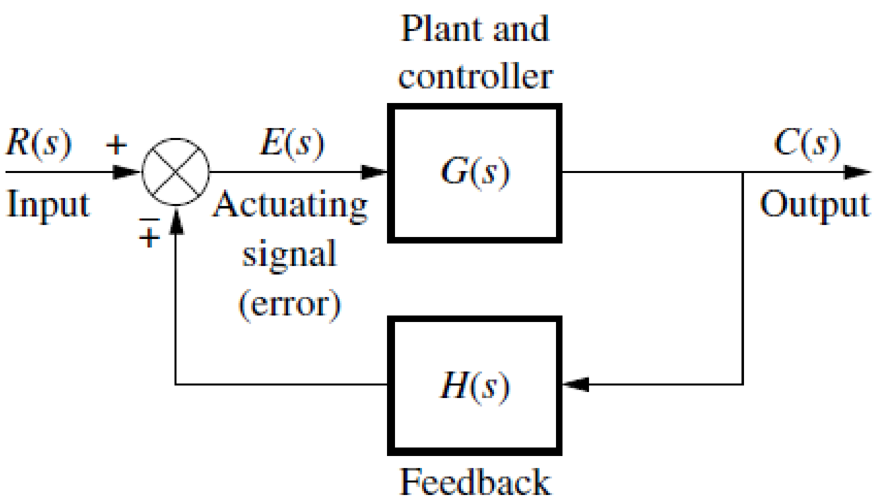
Course Description

- Introduction, fundamentals and basic properties of signals and systems, definition of open loop and closed loop systems, mathematical models of physical systems (mechanical, electrical, electromechanical systems …), control system components, block diagram simplification, signal flow graph, state variable models, Z-Transform and its properties, solving difference equations, pulse transfer function of discrete system, Fourier transforms, continuous and discrete signal analysis, transient response of first and second order control systems, real life applications such as analog and digital filters, introduction to basics of digital signal processor (DSP) and its features and capabilities of commercial applications.

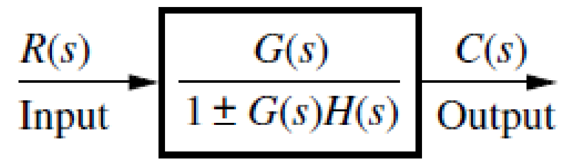
Feedback Form



(a)



(b)



(c)

Figure:

a) Feedback Control System.

b) Simplified Model or Canonical Form.

c) Equivalent Transfer Function.

The equivalent or closed-loop transfer function is

$$G_e(s) = \frac{G(s)}{1 \pm G(s)H(s)}$$

Characteristic Equation

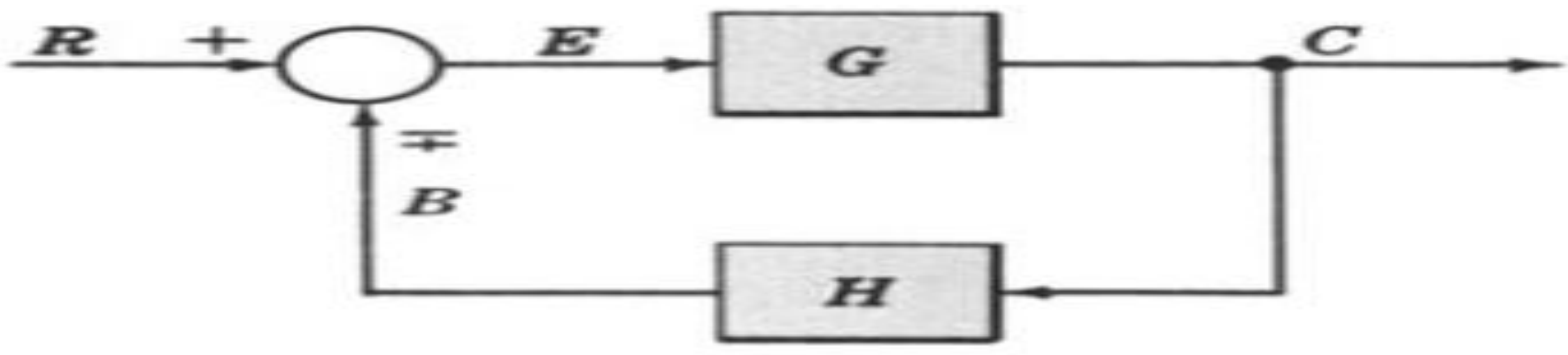
- The control ratio is the closed loop transfer function of the system.

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

- The denominator of closed loop transfer function determines the characteristic equation of the system.

- Which is usually determined as: $1 \pm G(s)H(s) = 0$

Canonical Form of a Feedback Control System



$G \equiv$ direct transfer function $\equiv$ forward transfer function

$H \equiv$ feedback transfer function

$GH \equiv$ loop transfer function $\equiv$ open-loop transfer function

$C/R \equiv$ closed-loop transfer function $\equiv$ control ratio $\quad \dfrac{C}{R} = \dfrac{G}{1 \pm GH}$

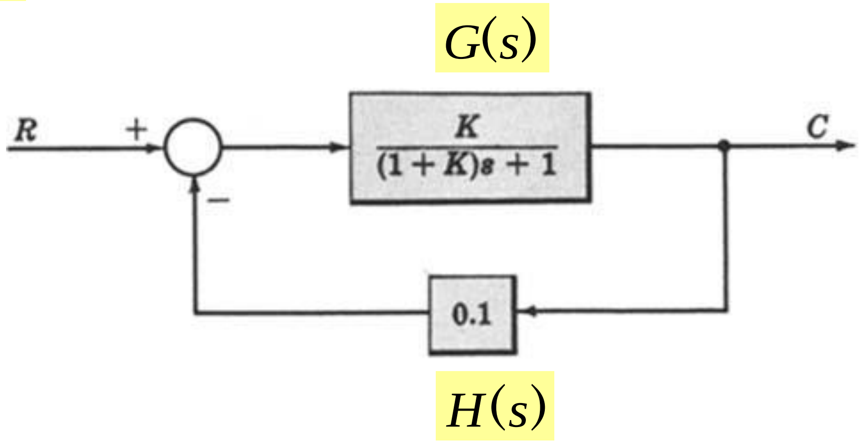
$E/R \equiv$ actuating signal ratio $\equiv$ error ratio $\quad \dfrac{E}{R} = \dfrac{1}{1 \pm GH}$

$B/R \equiv$ primary feedback ratio $\quad \dfrac{B}{R} = \dfrac{GH}{1 \pm GH}$

The system is said to have negative feedback if the sign at the summing junction is negative and positive feedback if the sign is positive.

Example (1)

1. Open loop transfer function $\frac{B(s)}{E(s)} = G(s)H(s)$
2. Feed Forward Transfer function $\frac{C(s)}{E(s)} = G(s)$
3. Control ratio $\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$
4. Feedback ratio $\frac{B(s)}{R(s)} = \frac{G(s)H(s)}{1+G(s)H(s)}$
5. Error ratio $\frac{E(s)}{R(s)} = \frac{1}{1+G(s)H(s)}$
6. Closed loop transfer function $\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$
7. Characteristic equation $1+G(s)H(s)=0$
8. Closed loop poles and zeros if K=10.



Characteristic Equation

$C/R \equiv$ closed-loop transfer function $\equiv$ control ratio

$$\frac{C}{R} = \frac{G}{1 \pm GH}$$

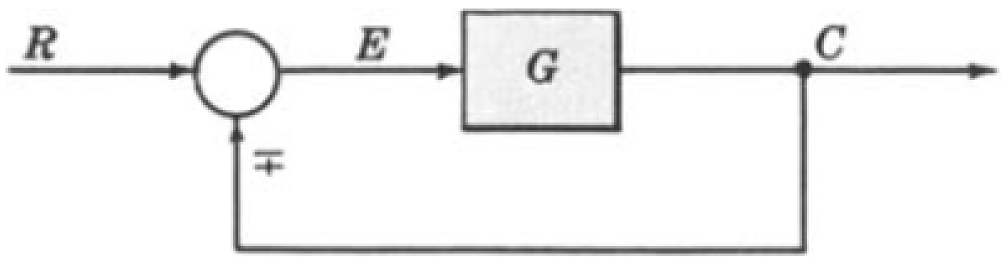
The denominator of C/R determines the *characteristic equation* of the system, which is usually determined from $1 \pm GH = 0$ or, equivalently,

$$D_{GH} \pm N_{GH} = 0$$

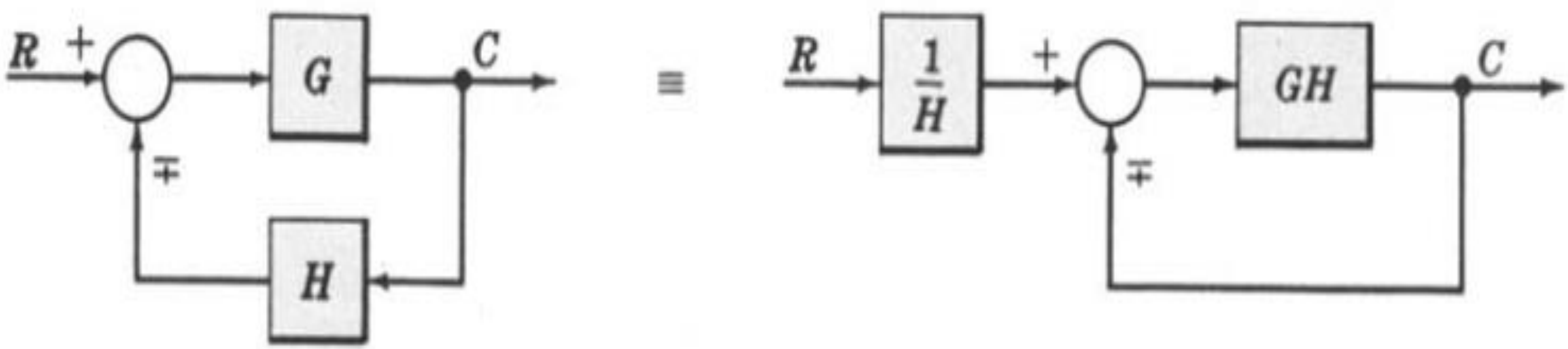
where D_{GH} is the denominator and N_{GH} is the numerator of GH

Unity Feedback System

A **unity feedback system** is one in which the primary feedback b is identically equal to the controlled output $H = 1$ for a linear, unity feedback system

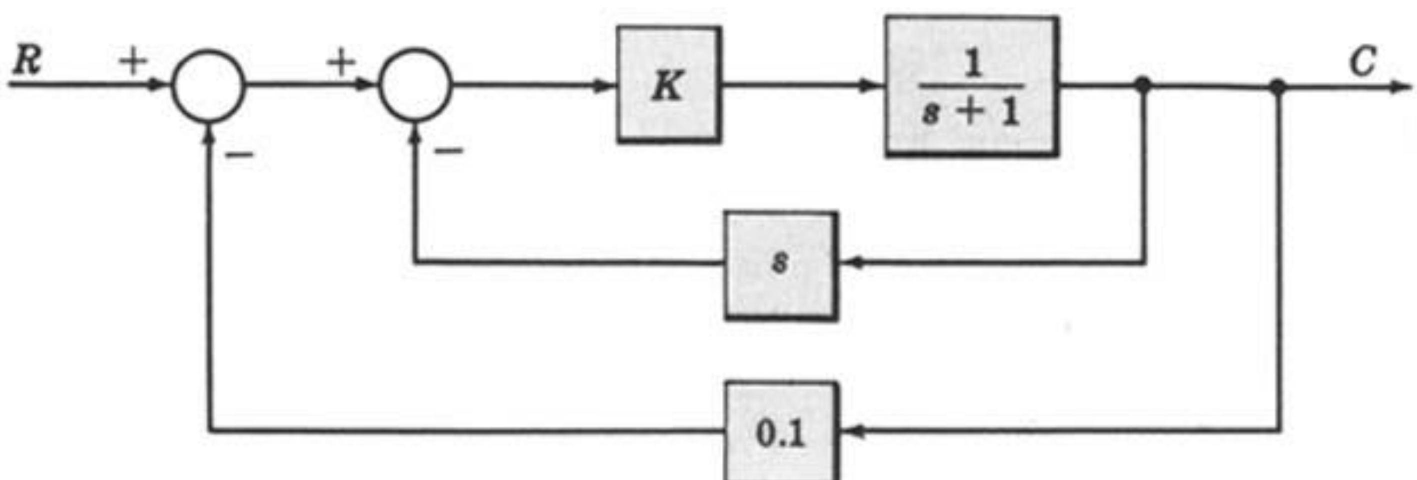


Any feedback system with only linear time-invariant elements can be put into the form of a unity feedback system by using Transformation 5.



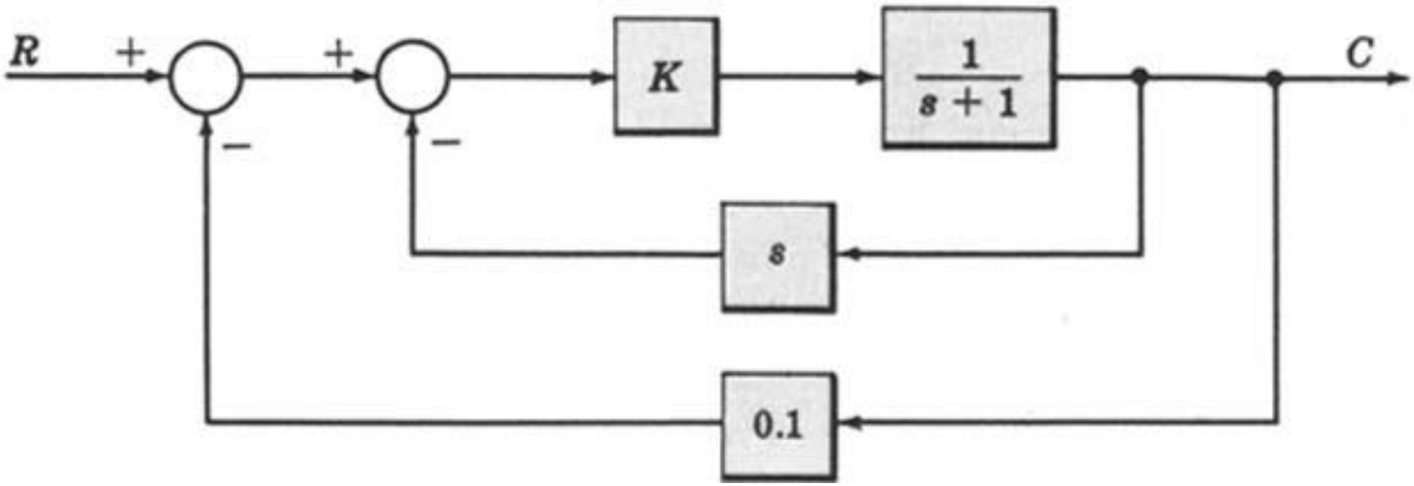
Example-2: For the system represented by the following block diagram determine:

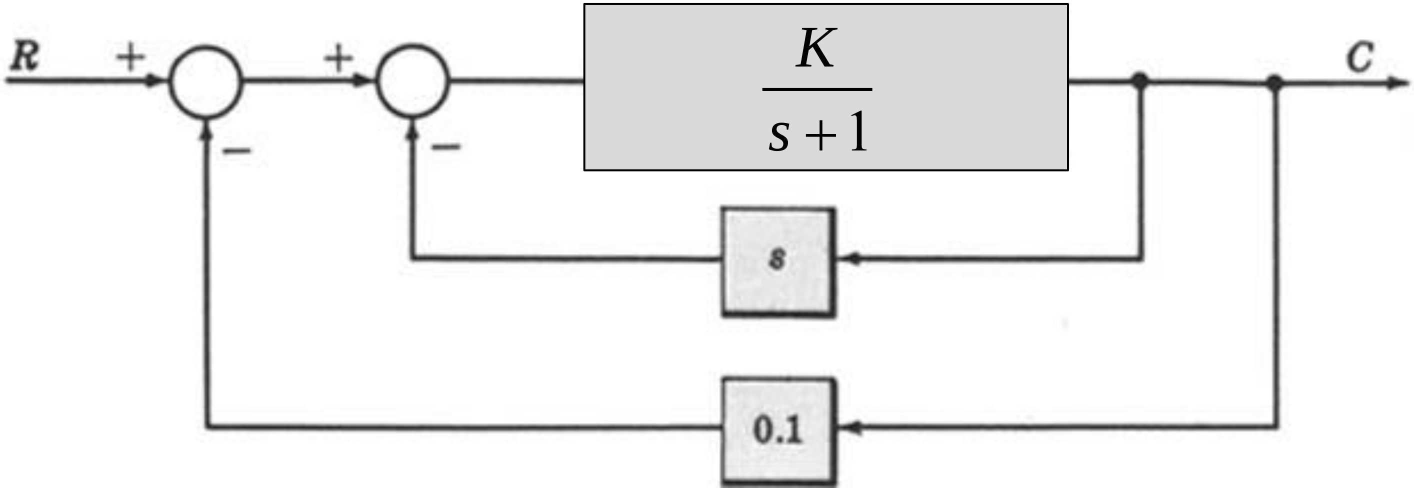
1. Open loop transfer function
2. Feed Forward Transfer function
3. control ratio
4. feedback ratio
5. error ratio
6. closed loop transfer function
7. characteristic equation
8. closed loop poles and zeros if K=10.



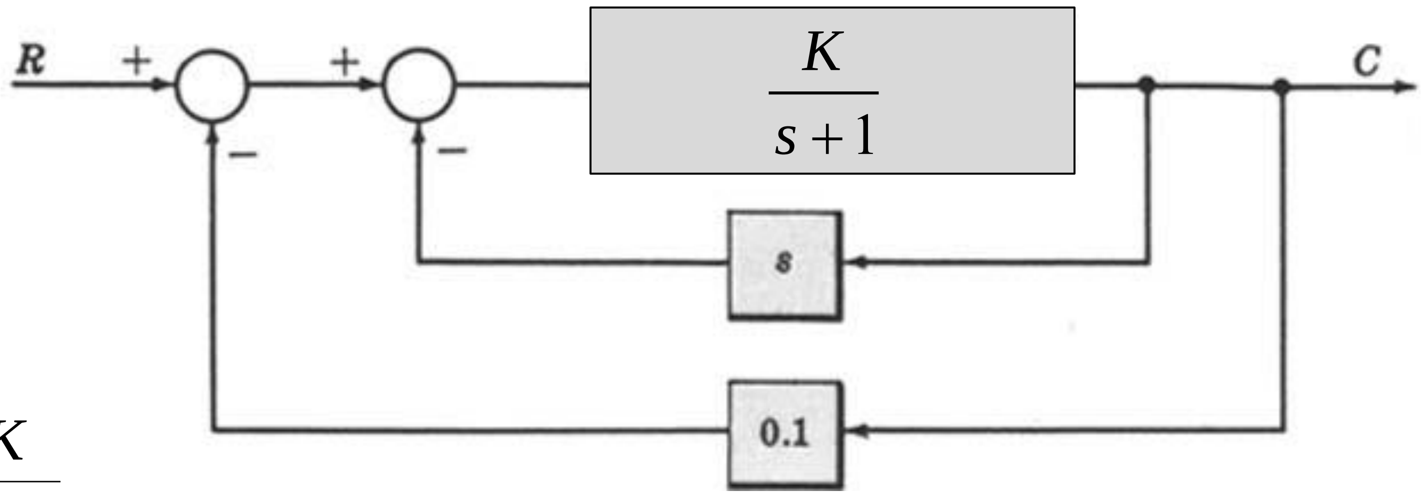
Example-2: Continue

- First, we will reduce the given block diagram to canonical form

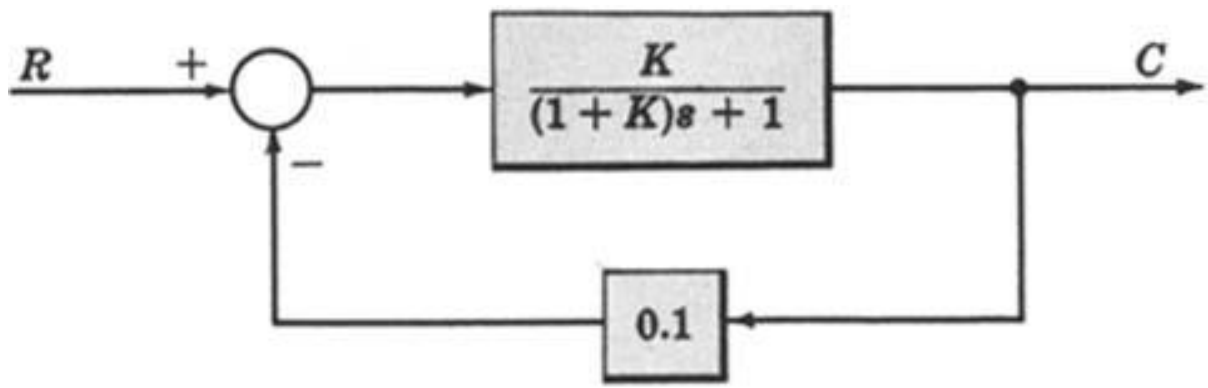




Example-2: Continue



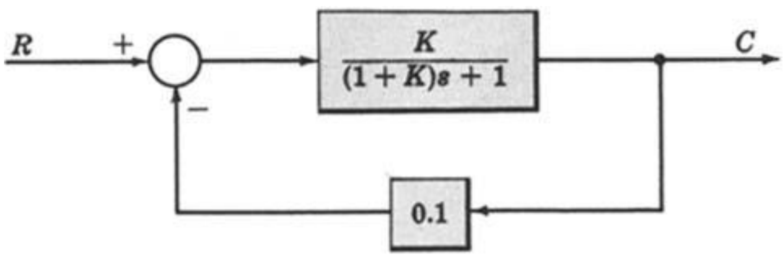
$$\frac{G}{1+GH} = \frac{\dfrac{K}{s+1}}{1+\dfrac{K}{s+1}s}$$



Example-2: Continue

1. Open loop transfer function $$\frac{B(s)}{E(s)} = G(s)H(s)$$
2. Feed Forward Transfer function $$\frac{C(s)}{E(s)} = G(s)$$
3. Control ratio $$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$$
4. Feedback ratio $$\frac{B(s)}{R(s)} = \frac{G(s)H(s)}{1+G(s)H(s)}$$
5. Error ratio $$\frac{E(s)}{R(s)} = \frac{1}{1+G(s)H(s)}$$
6. Closed loop transfer function $$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$$
7. Characteristic equation $$1+G(s)H(s) = 0$$
8. Closed loop poles and zeros if K=10.

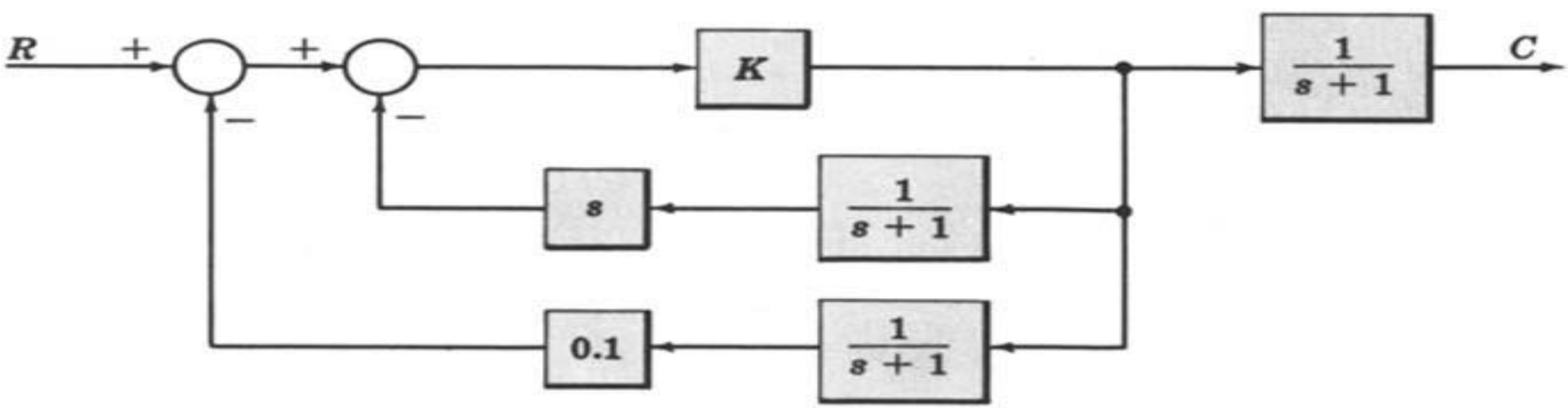
$G(s)$



$H(s)$

Example-3: For the system represented by the following block diagram determine:

1. Open loop transfer function
2. Feed Forward Transfer function
3. Control ratio
4. Feedback ratio
5. Error ratio
6. Closed loop transfer function
7. Characteristic equation
8. Closed loop poles and zeros if K=100.



With Our Best Wishes
Signals and Systems
Course Staff