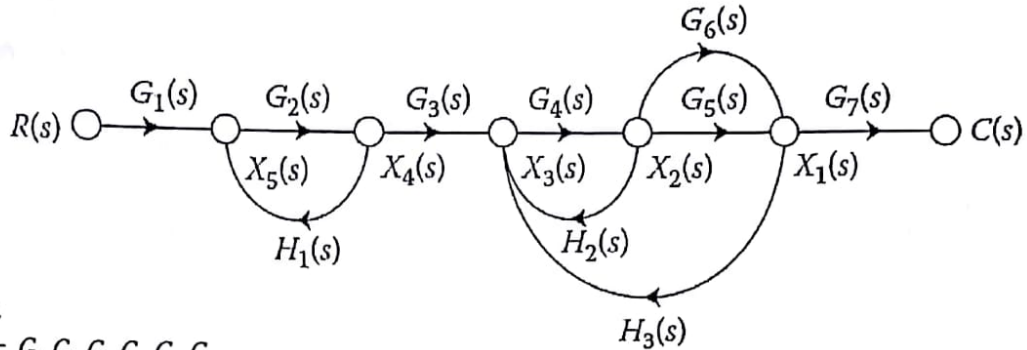
ديناميكا عمليات

Model Answer

1-



N=2

$F_1 = G_1G_2G_3G_4G_5G_7$

$F_2 = G_1G_2G_3G_4G_6G_7$

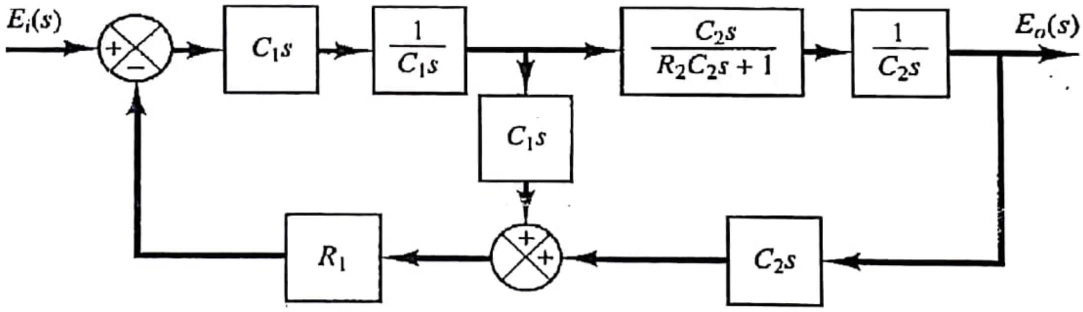
loops gains

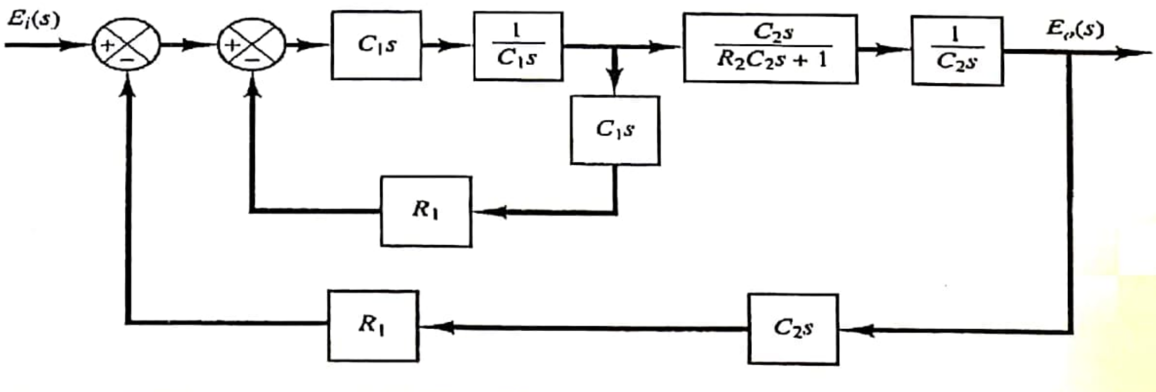
$L_1 = G_2H_{1,} \quad L_2 = G_4H_{2,} \; L_3 = G_4G_5H_{3,} \; L_4 = G_4G_6H_{3,}$

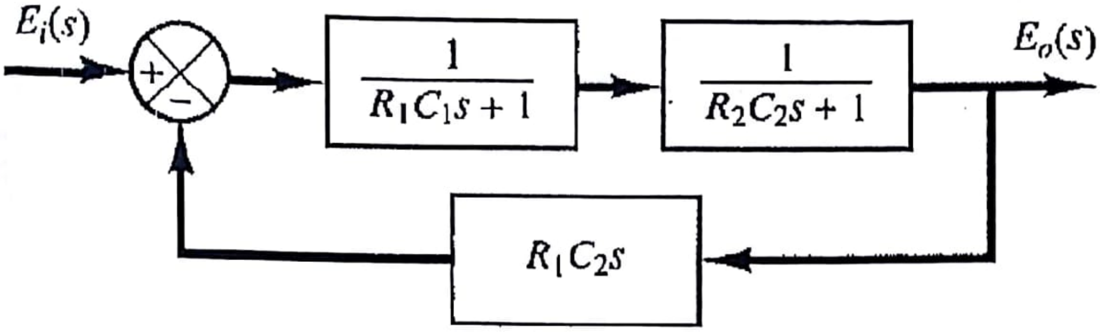
$$\Delta = 1 - (L_1 + L_2 + L_3 + L_4) + (L_1L_2 + L_1L_3 + L_1L_4)$$
$$\Delta_1 = 1 - 0 = 1$$
$$\Delta_2 = 1 - 0 = 1$$

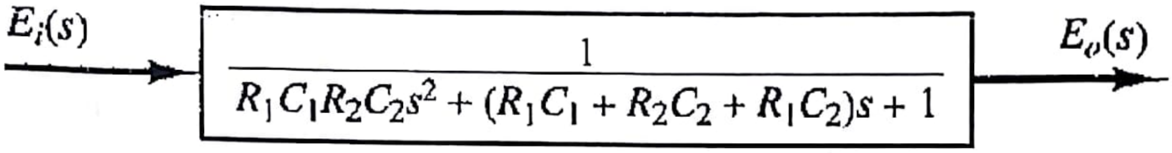
$$T.F = \frac{C}{R} = \frac{F_1\Delta_1 + F_2\Delta_2}{\Delta}$$
$$= \frac{G_1G_2G_3G_4G_5G_7 + G_1G_2G_3G_4G_6G_7}{1 - G_2H_1 - G_4H_2 - G_4G_5H_3 - G_4G_6H_3 + G_2G_4H_1H_2 + G_2G_4G_5H_1H_3 + +G_2G_4G_6H_1H_3}$$

2-









3-

For a given electromechanical systems in Fig. 1 a,b. Explain the system operation and state the advantages and disadvantages of each system. (5 marks)

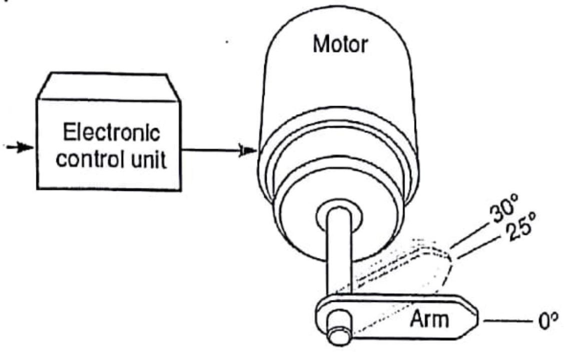


Fig. 3-a

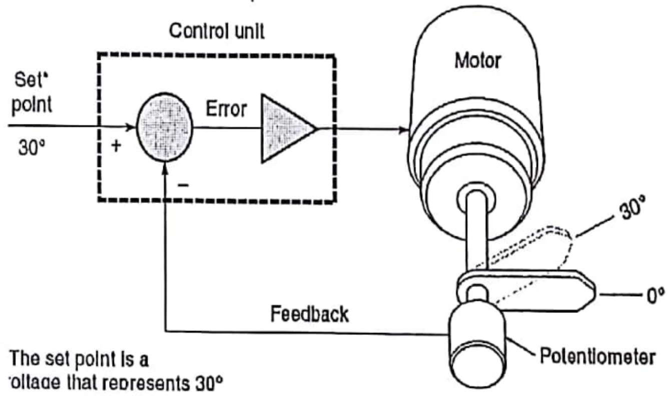


Fig. 3-b

Figure 3.a shows an open-loop control system. The actuator is a motor driving a robot arm. In this case, the process is the arm moving, and the controlled variable is the angular position of the arm. Earlier tests have shown that the motor rotates the arm at 5 degrees/second (deg/s) at the rated voltage. Assume that the controller is directed to move the arm from 0° to 30°. Knowing the characteristics of the process, the controller sends a 6-second power pulse to the motor. If the motor is acting properly, it will rotate exactly 30° in the 6 seconds and stop. On particularly cold days, however, the lubricant is more viscous (thicker), causing more internal friction, and the motor rotates only 25° in the 6 seconds; the result is a 5° error. The controller has no way of knowing of the error and does nothing to correct it.

Open-loop control systems are appropriate in applications where the actions of the actuator on the process are very repeatable and reliable. Relays and stepper motors are devices with reliable characteristics and are usually open-loop operations. Actuators such as motors or flow valves are sometimes used in open-loop operations, but they must be calibrated and adjusted at regular intervals to ensure proper system operation.
Figure 3.b shows a closed-loop control system, the output of the process (controlled variable) is constantly monitored by a sensor, as shown in Figure 3.b. The sensor samples the system output and converts this measurement into an electric signal that it passes back to the controller. Because the controller knows what the system is actually doing, it can make any adjustments necessary to keep the output where it belongs. The signal from the controller to the actuator is the forward path, and the signal from the sensor to the controller is the feedback (which “closes” the loop). In Figure 3.b the feedback signal is subtracted from the set point at the comparator (just ahead of the controller). By subtracting the actual position (as reported by the sensor) from the desired position (as defined by the set point), we get the system error. The error signal represents the difference between “where you are” and “where you want to be.” The controller is always working to minimize this error signal. A zero error means that the output is exactly what the set point says it should be. Using a control strategy, which can be simple or complex, the controller minimizes the error.

1- **open-loop control system** A control system that does not use feedback. The controller sends a measured signal to the actuator, which specifies the desired action. This type of system is not self-correcting.

closed-loop control system A control system that uses feedback. A sensor continually monitors the output of the system and sends a signal to the controller, which makes adjustments to keep the output within specification.

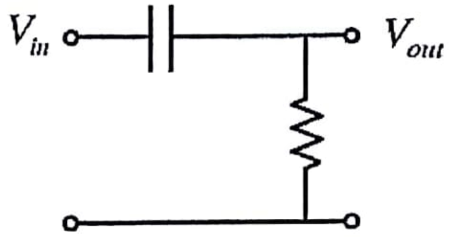
	open-loop control system	**closed-loop control system**
Adv.	1- simple in construction and design 2- low cost 3- easy in maintanence	1- reliable and accurate system o/p 2- self correct the system output. 3- regard the system output.
Disadv.	1- Not self correct the system output 2- unreliable and unaccurate system o/p 3- regardless the system output.	1- Complex in construction and design 2- expensive or high cost 3- Difficult in maintanence
examples	Toaster machine, light traffic system	Liquid level machine, boillers , CNC

4- Solve the RC circuit in Fig. 4. to obtain the unit step response output using Laplace's transform (5 marks) C

Fig. 4 R

3

$v_{in}(t) = v_c + v_R = \frac{1}{C}\int i\,dt + iR$



$V_{in}(s) = \frac{I(s)}{CS} + I(s)R$

$v_{out}(t) = v_R = iR$

$V_{out}(s) = I(s)R$

$$T.F = \frac{V_{out}(s)}{V_{in}(s)} = \frac{I(s)R}{\frac{I(s)}{CS} + I(s)R} = \frac{RCS}{1 + RCS}$$

$$V_{out}(s) = T.F \times V_{in}(s)$$

For unit step input $V_{in}(s) = 1/S$

$$V_{out}(s) = \frac{RCS}{S(1 + RCS)} = \frac{RC}{(1 + RCS)} = \frac{1}{(1/RC + S)}$$

$$v_{out}(t) = e^{\frac{-t}{RC}}$$

7