# Homework 1b
EEET-427-01:Controls Systems

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For each problem:

1. Find the differential equation that relates V_{out} to V_{in}.
2. Rewrite the differential equation in Laplace form.
3. Make an unreduced block diagram.
4. Reduce the block diagram into a single block.
5. Find the transfer function of the system.
6. Find the DC gain of the transfer function.
7. Find the time constant of the circuit.

1 Problem 1

$$where \ i_C = C\frac{dV_c}{dt}$$

1)
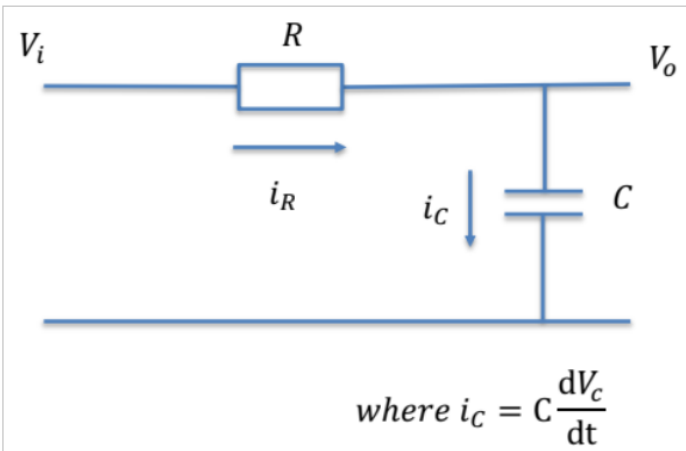
$$i_R = i_C$$
$$\frac{v_R}{R} = C\frac{dv_C}{dt}$$
$$v_R = v_i - v_o; \ v_C = v_o$$
$$\frac{v_i - v_o}{R} = C\frac{dv_o}{dt}$$
$$\frac{1}{RC}(v_i) = \frac{dv_o}{dt} + \frac{1}{RC}(v_o)$$

(1)

2)

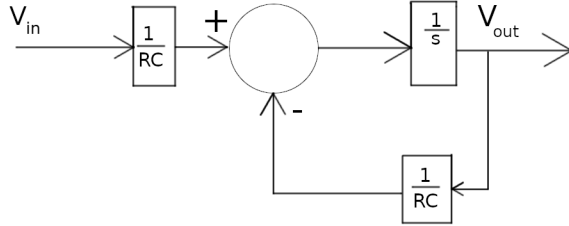$$\frac{1}{RC}V_i = sV_o + \frac{1}{RC}V_o \tag{2}$$

3) .
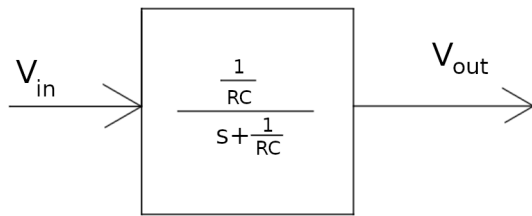

Figure 1: Problem 1 Unreduced Block Diagram
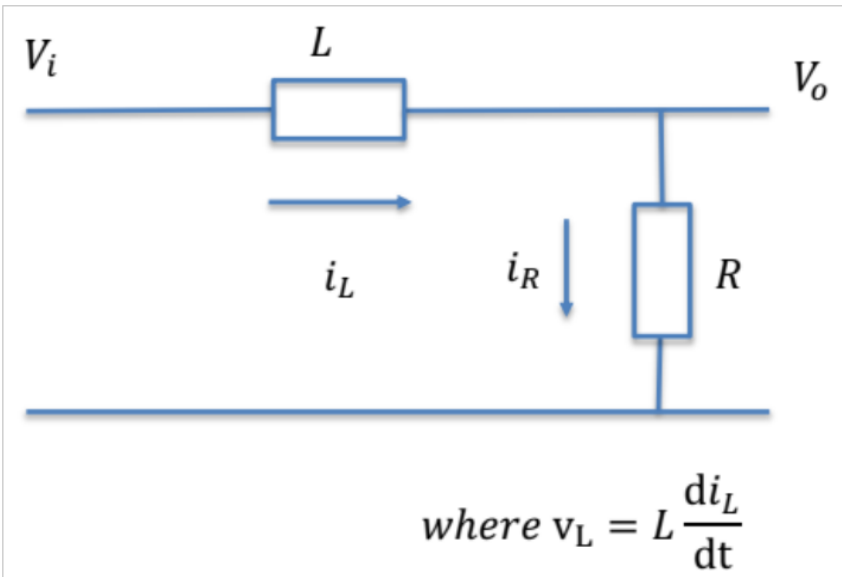
4) .

Figure 2: Problem 1 Reduced Block Diagram

5)

$$\frac{V_o}{V_i} = \frac{\frac{1}{RC}}{s + \frac{1}{RC}} \tag{3}$$

6) DC gain $= 1$

7)

$$\tau = RC \tag{4}$$

2 Problem 2

$$\text{where } v_L = L\frac{di_L}{dt}$$

1)

$$i_R = \frac{v_i - v_o}{R} = i_L$$

$$v_L = L\frac{di_L}{dt} = v_o \tag{5}$$

2)

$$\frac{1}{RC}V_i = sV_o + \frac{1}{RC}V_o \tag{6}$$

3) .
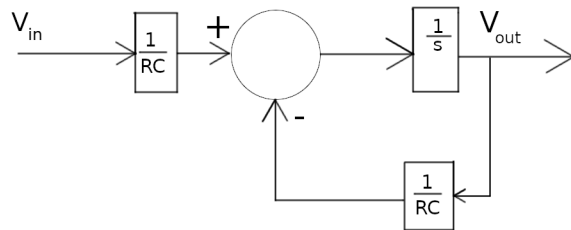

Figure 3: Problem 1 Unreduced Block Diagram

4) .

5)

$$\frac{V_o}{V_i} = \frac{\frac{1}{RC}}{s + \frac{1}{RC}} \tag{7}$$

$$V_{in} \quad \boxed{\dfrac{\frac{1}{RC}}{s+\frac{1}{RC}}} \quad V_{out}$$

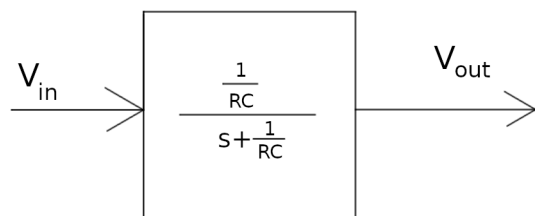Figure 4: Problem 1 Reduced Block Diagram

6) DC gain = 1

7)

$$\tau = RC \qquad (8)$$