

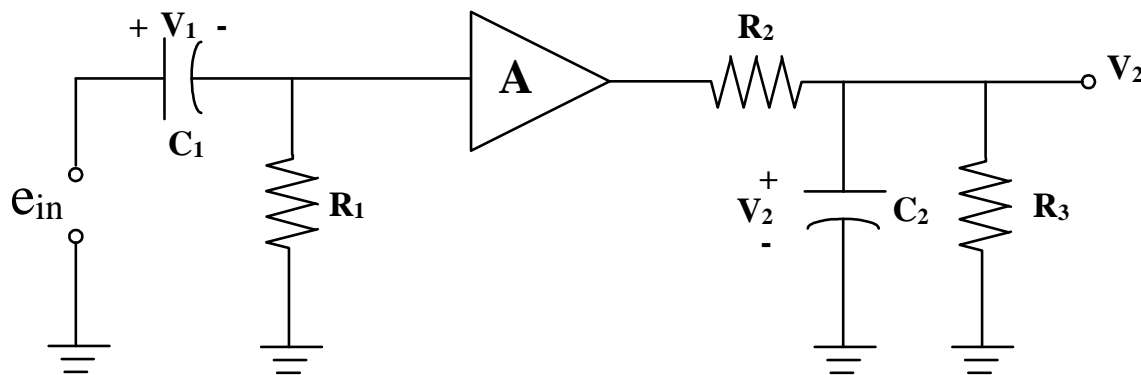
Lab Sheet - 2**Simulation of the R-C amplifier circuit (continuous system).**

Objectives: To develop the mathematical modeling of the continuous system.

Theory:

Simulation and modeling are used for building and analyzing of physical systems. They are mostly used in engineering design and analysis. Simulation and modeling enable us to predict the behavior of a system before it is actually built.

A continuous system is one in which the predominant activities of the system cause smooth changes in the attributes of the system entities. When such a system is modeled mathematically, the variables of the model representing the attributes are controlled by continuous functions. More generally, in continuous systems, the relationships describe the rates at which attributes change, so that the model consists of differential equation. Here we have used R-C amplifier circuit, which is a continuous system.



The system can be described by the following two differential equations. i.e mathematical modeling

Current entering through capacitor C_1 , at the input side, is

$$C_1 (dV_1/dt) = (e_{in} - V_1)/R_1 \quad \text{----- (1)}$$

$$dV_1/dt = (e_{in} - V_1)/R_1 C_1$$

Current entering through capacitor C_2 , at the output side, is

$$C_2 (dV_2/dt) = A/R_2 (e_{in} - V_1) - V_2 (R_2 + R_3)/R_2 R_3 \quad \text{----- (2)}$$

Hence we can get the two equations for simulation

$$dV_1/dt = A_{11} \times V_1 + B_1 \times e_{in} \quad \text{----- (3)}$$

$$dV_2/dt = A_{21} \times V_1 + A_{22} \times V_2 + B_2 \times e_{in} \quad \text{----- (4)}$$

Where,

$$A_{11} = -1/(R_1 C_1) = -B_1$$

$$A_{21} = -A/(R_2 C_2) = -B_2$$

$$A_{22} = -(R_2 + R_3)/(R_2 R_3 C_2)$$

By providing the values of these constant we can calculate the value of V_1 and V_2 .

For the calculation of the equation values, we use the Runge – Kutta - 4 methods.

$$m_1 = f(x_i, y_i)$$

$$m_2 = f(x_i + h/2, y_i + m_1 h/2)$$

$$m_3 = f(x_i + h/2, y_i + m_2 h/2)$$

$$m_4 = f(x_i + h, y_i + m_3 h)$$

$$y_{i+1} = y_i + ((m_1 + 2m_2 + 2m_3 + m_4)/6)h$$

Initial condition

For $t = 0$, $V_1 = 0$ and $V_2 = 0$

$h = 0.0002$ and $e_{in} = 1.5 \text{ V}$ ($t \geq 0$) { $n = 500$ data points }

$$= 0 \text{ V} \quad (t < 0)$$

$$A_{11} = -50 \text{ sec}^{-1}$$

$$A_{21} = -10000 \text{ sec}^{-1}$$

$$A_{22} = -21.5 \text{ sec}^{-1}$$