Percentage of tilt RC high pass circuit

Title of the project:

Visual Analysis of Voltage and Tilt Percentage in RC high pass Circuits

Software required : Matrix Laboratories

Abstract:

This project presents a MATLAB simulation of the charging behaviour of an RC (Resistor-Capacitor) circuit, focusing on the time-dependent response of the capacitor voltage when subjected to a constant input voltage. Using the fundamental RC charging equation, the simulation calculates the output voltage across the capacitor (Vout V_{out}Vout) and visualizes its exponential rise as the capacitor charges over time. Additionally, a "tilt percentage" metric is introduced to represent the proportion of the input voltage achieved by the capacitor as a percentage, providing a more intuitive view of the charging progress. The simulation results are plotted in two subplots: one depicting the output voltage over time and the other showing the tilt percentage. This project offers an accessible visualization and understanding of the transient response characteristics in an RC circuit, emphasizing practical applications in circuit design and analysis.

Code:

```
% RC Circuit Parameters

R = 1e3; % Resistance in ohms (1k ohm)

C = 1e-6; % Capacitance in farads (1 uF)

 Vin = 5; % Input Voltage in volts

% Time Constants

 tau = R * C ;   % Time constant (tau)

% Time Vector

 t = linspace(0, 5*tau, 1000);  % Time from 0 to 5 tau

% Output Voltage across Capacitor

(Vout) Vout = Vin * (1 - exp(-t/tau)); % Charging equation

% Calculate Tilt Percentage

Tilt = (Vout / Vin) * 100;

% Plotting the Results

figure;

subplot(2,1,1);

 plot(t, Vout);

 xlabel('Time (s)');

 ylabel('V_{out} (V)');

title('Output Voltage across Capacitor');

subplot(2,1,2);
```

```
plot(t, Tilt);
xlabel('Time (s)');
ylabel('Tilt Percentage (%)');
title('Percentage of Tilt in RC Circuit');
grid on;
```

Description of code:

This MATLAB code simulates the charging behaviour of an RC (Resistor-Capacitor) circuit and provides a visual representation of both the output voltage across the capacitor and the percentage of charge accumulated (referred to as "tilt percentage") over time. Here's a breakdown of each part:

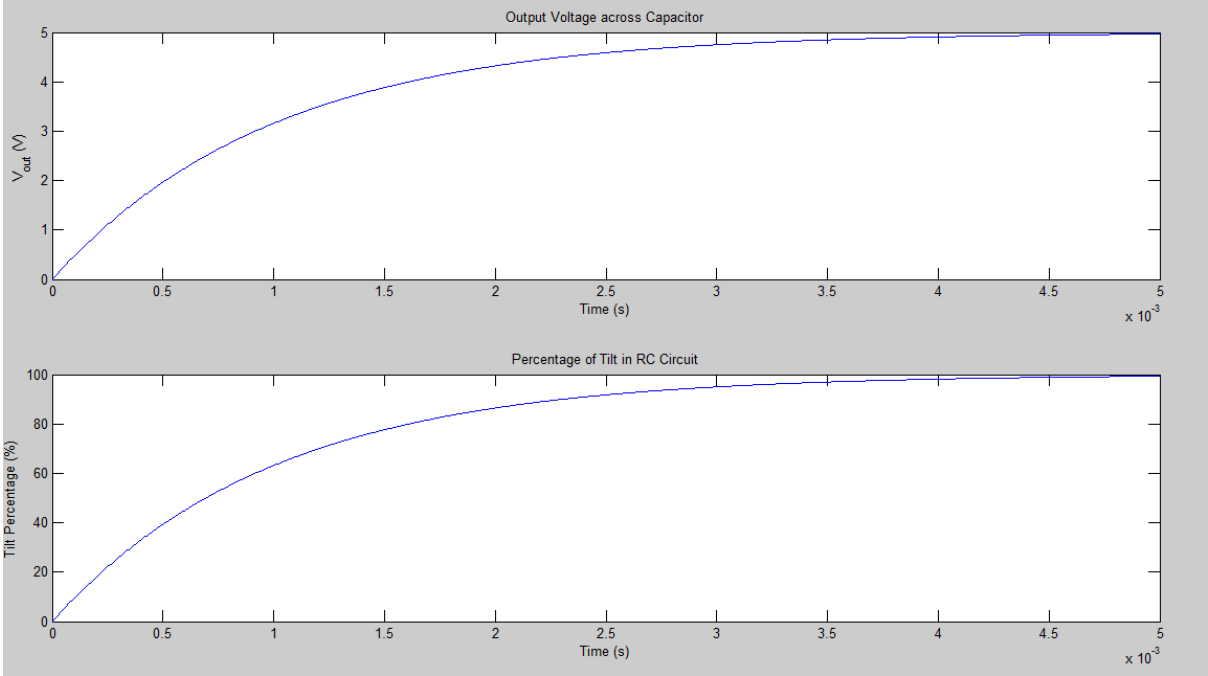
1. **Define RC Circuit Parameters**:
    - **Resistance RRR**: Set to 1,000 ohms (1kΩ).
    - **Capacitance CCC**: Set to 1 µF1 \, \mu F1µF (1 microfarad).
    - **Input Voltage Vin V_{in}Vin**: Set to 5 volts, representing the applied voltage across the circuit.
2. **Calculate the Time Constant**:
    - **Time Constant τ\tau τ**: Computed as τ=R×C\tau = R \times Cτ=R×C. The time constant, τ, determines how quickly the capacitor charges up to approximately 63% of the input voltage.
3. **Create a Time Vector**:
    - **Time Range**: Defined as a vector from 0 to 5×τ5 \times \tau5×τ with 1000 equally spaced points. This ensures the simulation covers the capacitor's full charging period, from 0 up to about 5τ, where the capacitor reaches over 99% of VinV_{in}Vin.
4. **Calculate Output Voltage Across Capacitor**:
    - **Output Voltage VoutV_{out}Vout**: Computed with the charging equation Vout=Vin×(1−e−t/τ)V_{out} = V_{in} \times (1 - e^{-t/\tau})Vout=Vin ×(1−e−t/τ), representing the voltage across the capacitor over time as it charges up to the input voltage.
5. **Compute Tilt Percentage**:
    - **Tilt Percentage**: Defined as the percentage of Vin V_{in}Vin that has been accumulated by the capacitor. It is calculated as Tilt= (Vout Vin)×100;{Tilt} = \left(\frac{V_{out}}{V_{in}} \right) \times 100Tilt=(VinVout)×100, providing insight into how fully charged the capacitor is relative to the input voltage.
6. **Plot Results**:

- **First Subplot (Voltage)**: Plots Vout V_{out}Vout vs. time, showing the exponential rise in capacitor voltage as it charges.
- **Second Subplot (Tilt Percentage)**: Plots the tilt percentage vs. time, showing how the charging progresses as a percentage of the input voltage.

The result is a clear visual of both the capacitor voltage increase and the rate of charge over time, illustrating the fundamental charging characteristics of an RC circuit

Resistance (Ω)	Time (s)	Tilt (%)
1,000	0.003	95.02
2,000	0.006	95.02
5,000	0.015	95.02
10,000	0.030	95.02
20,000	0.060	95.02

output:



Result:

The simulation shows the capacitor's voltage rising exponentially, reaching ~63% of input voltage at one time constant and over 99% by five. The tilt percentage plot confirms the expected charging pattern, illustrating RC circuit behaviour for practical applications.