EE 2305 – Introduction to C Programming
Programming Project 01

Simple RC Circuit

Program Features: Sequential structure, variables and constants, data input and output, mathematical operators, function calls.

The electrical circuit shown in Figure 1 is called an RC circuit because it contains a resistance (*R*) and a capacitance (*C*). The behavior of the resistance is to resist the flow of electrical current in the closed loop. The behavior of the capacitance is to store electrical charge.

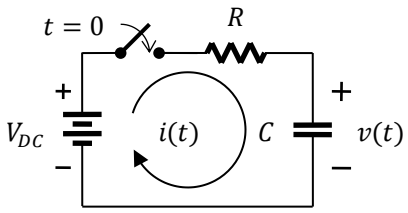


Figure 1: Simple RC Circuit.

After the switch is thrown at time $t = 0$, the current in the circuit is given by the formula

$$i(t) = \frac{V_{DC}}{R} \exp\left(-\frac{t}{RC}\right) \quad (Amps, t \geq 0)$$

and the voltage across the capacitor is given by the formula

$$v(t) = V_{DC}\left[1 - \exp\left(-\frac{t}{RC}\right)\right] \quad (Volts, t \geq 0)$$

Write a C++ program that defines V_{DC} (voltage in *Volts*), R (resistance in Ω), and C (capacitance in *Farads*) as constants (using the **`const`** keyword) and allows the user to input different values of t (time in *Seconds*). The program shall then calculate values for $i(t)$ and $v(t)$.

The **`exp()`** function call requires the **`<cmath>`** library.

Let the values of the constants be

$V_{DC} = 10$ Volts
$R = 10$ kΩ (kilo-ohms, $\times 10^3$, or $\times 1000$)
$C = 100$ pF (pico-Farads, $\times 10^{-12}$, or $\times 0.000000000001$)

Write the program to prompt the user to input a time t in micro-seconds (μS, $\times 10^{-6}$, or $\times 0.000001$, using the **`cin`** function). Convert the time to seconds to perform the calculation.

Run the program using the values of t shown in the table below. Use the results of the program to fill in the table. The program shall report the current in milliamps (mA, $\times 10^{-3}$, or $\times 0.001$) and the voltage in volts (V).

Table I: Current and Voltage in an RC Circuit

Time (t) (μS)	Current, $i(t)$ (mA)	Voltage, $v(t)$ (V)
0	1	0
0.1	0.9999	0.00099995
0.2	0.9998	0.0019998
0.5	0.9995	0.00499875
1.0	0.999	0.009995
2.0	0.998002	0.01998
5.0	0.995012	0.0498752

To document your program, create a *Word* document and include all of the following sections in the document.

A. Program Description:
Write a short description of the purpose of the program. Include a description of the inputs and the outputs. Describe the basic program structure (branching, looping, etc.).

B. Program Flowchart:
Draw a flowchart of the program using the Word graphics shapes. Include each section of the program in the flowchart.

C. Source Code
Insert the C++ Source Code into the document.

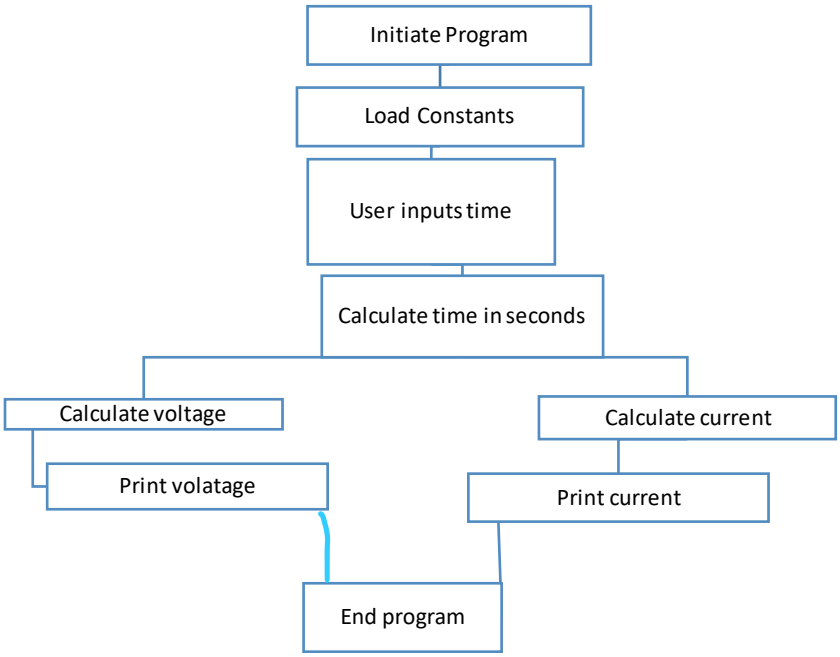
D. Program Test Results:
Insert a screen image of the program output that demonstrates the operation of the program.

E. Tabulated Data.
Collect the data and insert the values in the chart shown above. Verify that the program produces the correct results.

Save the document as a *PDF* file and submit the *PDF* document to *Blackboard*.

A. This program is meant to take a time input and use that to calculate the voltage and current of a circuit. The inputs are the voltage, resistance, capacitance, and time, which the user inputs. The outputs are the voltage and current. The code uses constants, an input, and character outputs to perform the required tasks.

B.



C.

```cpp
#include <iostream>
#include <cmath> //Import libraries
using namespace std;

int main()
{
    const int Vdc = 10;
    const int R = 10;
    const int C = 100; //Create constant values for equations
    double t; //Create variable for user input

    cout << "Give me a time in micro-seconds. " << endl;//Ask for user input
    cin >> t;//Take user input

    double seconds = t * pow(10, -6); //Make user input seconds

    double it = (Vdc / R) * exp(-t / (R * C));//Find current
    double vt = Vdc * (1 - exp(-t / (R * C)));//Find voltage

    cout << "The current of the circuit is " << it << " milliamps." << endl;//Print current
    cout << "The voltage of the circuit is " << vt << " volts." << endl;//Print voltage


    system("pause");
    return 0;
}
```

D.

```
Give me a time in micro-seconds.
5
The current of the circuit is 0.995012 milliamps.
The voltage of the circuit is 0.0498752 volts.
Press any key to continue . . .
```

Give me a time in micro-seconds.
5
The current of the circuit is 0.995012 milliamps.
The voltage of the circuit is 0.0498752 volts.
Press any key to continue . . .