International Journal of Electronics Engineering (ISSN: 0973-7383)
Volume 10 • Issue 1 pp. 290-294 Jan 2018-June 2018 www.csjournals.com

Closed form solutions of Functionality of Windshield Wiper

1K P Naveen Reddy, 2Y Geyavalli, 3D Sujani, 4C. S .K Raju
1,2,3 Deptt. Of Computer Science and Engineering, [4]Department of Mathematics
Gandhi Institute of Technology and Management, Bangalore, Nagadenahalli, Karnataka, INDIA

Abstract: In this article, we studied the theoretical investigation of functionality of wind shield wipers. The operation of such wipers depends on the charging and discharging of capacitors. The wipers are a part of R.C Circuits whose time constant can be varied by selecting differential value of R (resistor) through a multi position switch. The time interval between the individual sweeps of the wipers is determined by the value of the time constant.

Keywords: windshield wiper, charging, discharging, time constant.

1. Introduction

A Windshield wiper is used to eliminatesnow, rain, ice wreckages from a windshield. Many automobiles include cars, trucks, train locomotives, watercrafts with a cabin and some aircrafts are equipped with windshield wipers that can operate intermediately during a light rainfall, snow, ice, etc. A wiper commonlycontains a metal arm, revolving at one end side and with anextended rubber cutting edgedevoted to the other end side. The arm is powered by a motor, often an electric motor, although pneumatic power is also utilized in some vehicles likepushing water, the blade is swung back and forth over the glass, or other precipitations from its surface. The wipers are part of an RC-circuit whose time constant can be varied by selecting the different values of R (resistor) through a multi position switch. The principalprocedures for the windscreen wipers are attributed to enhancement performance accompanist by Jozef Hofmann, and mills munitions, Birmingham who also claimed to have been the first to patent windscreen wipers in England. At least three inventors patented windscreen cleaning devices at around same time in 1903.

Fig. 1 Physical background of the Wiper.

2. Functionality

The functionality of such wipers depends on the charging and discharging of a capacitor. As the voltage across the capacitor increses,the capacitor reaches a point at which it discharges and triggers the wipers ,the circuit the circuit begins the another circle. The interval between the individual sweeps of the wipers is determined by the value of the time constant.

We divide this experiment into two parts

- Charging a capacitor in an RC-circuit.
- Discharging a capacitor in a an RC-circuit

3. Methodology

- **Charging a capacitor in an RC-circuit**

The following Figures shows a simple series RC-circuit

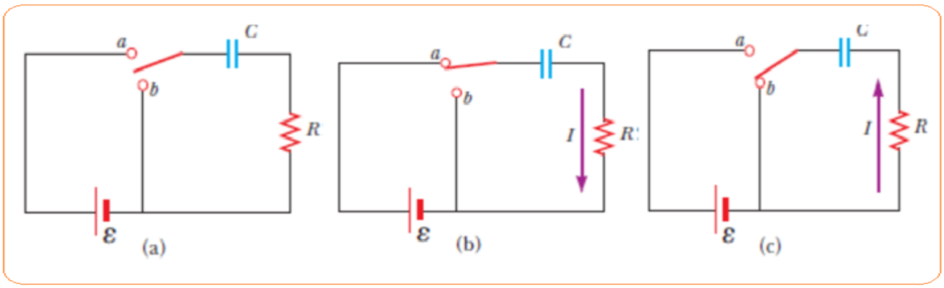

Figure 2 Functionality of Circuit diagram in wiper

- Assume the capacitor in this circuit in initially uncharged. There is no current while the switch is open in Figure (a).
- If the switch is thrown to position a at t=0 as shown in Figure (b) ,however, charge begins to flow ,setting up a current bin the circuit, and the capacitor begins to charge.
- During charging, charges do not jump across the capacitor plates because the gap between the plates represents an open circuit. Instead, the charge is transmittedamong each plate and it'sjoining wires because of the electric field generated in the wires by the battery until the capacitor is fully charged.
- As the plates are being charged ,the potential difference across the capacitor increses.The value of the maximum charges on the plates depends on the voltage of the battery.
- When the suprimum charge is attains, the electric current in the entire circuit is zero,since the potential difference through the capacitor equalsto that delivered by the battery.

To analyse this circuit quantitatively, apply Kirchhoff's loop rule to the circuit after the switch is thrown to position. Traversing the loop in Figure (b) clockwise gives

$$E - \frac{q}{c} - ir = 0 \quad (1)$$

Where q/c is the potential difference across the capacitor and is the potential difference across the resistor. The capacitor is traversed in the direction from the positive plate to the negative plate, which represents a decrease in potential. Therefore, we used the negative sign for the potential differences.

- Using equation (1) we can find the initial current in the circuit and the maximum charge on the capacitor.
- At the instant the switch is thrown to position a(t=0) the charge on the capacitor is zero.
- The initial current is a maximum and is given by *Ii=e/r*.
- At this time, the potential difference from the battery terminals appears entirely across the resistor.
- Once the capacitor is electrically charged to its extreme value Q,charges terminate to flow, at that time the electric current in the circuit is zero. The potential change from the battery workstationsperforms entirely through the capacitor.
- Substituting *I=0* into the equation (1) offers the maximum charge on the capacitor *Q=Ce* .
- To determine analytical solutions for the time dependence of the charge and current, let us substitute and rearrange the equation (1) ,we will get

$$\frac{dq}{dt} - \frac{e}{R} - \frac{q}{RC} \quad (2)$$

- Solving the linear differential equation using variable separable method, we will get an expression for q as

$$q(t) = C(1 - e^{\frac{t}{RC}}) = Q(1 - e^{-\frac{t}{RC}}) \quad (3)$$

The above equation indicates the charge as a function of time for a capacitor being charged. We can find an expression for the charging current by differentiating equation (3) with respect to time,
we get

$$I(t) = \frac{C}{R} e^{\frac{t}{RC}} \quad (4)$$

- The above equation denotes the current as a function of time for a capacitor being charged. The quantity *RC*, which appears in the exponents of equations (3) and (4) is called time constant of the circuit
- The time constant represents the time interval during which the current decreases to i/e of its initial value; that is after a time interval T,the current decreases to *0.3681Ii*
- After a time interval 2T,the current decreases to 0.632*Ce* and so forth. Likewise in a time interval *T*, the charge increases from zero.

Discharging a capacitor in RC circuit

- If the capacitor in Figure (b) is completely charged then a potential difference will exists across the capacitor and there will be zero potential across the resistor because I=0.
- If the switch is now thrown to position b at t=0 as shown in figure (c),the capacitor begins to discharge through the resistor.
- At some time during the discharge ,the current in the circuit is I and the charge on the capacitor is q.
- The circuit in figure (c)is the same as the circuit in figure (b)
- Expect for the absence of the battery. It

We eliminate the e.m.f from equation (1),we obtain the appropriate loop equation for the circuit.

$$-\frac{q}{C}-IR=0 \quad (5)$$

Then solving the differential equations, we will get the charge as a function of time for a discharging capacitor

$$q(t)=Q(e^{-\frac{t}{RC}}) \quad (6)$$

Differentiating the equation (6), we will get the current as a function of time for a discharging capacitor

$$I(t)=-\frac{Q}{RC}e^{-\frac{t}{RC}} \quad (7)$$

Where *Q/RC* is the initial current. The negative symbolspecifies as the capacitor discharges. The electric current direction is contradictoryto its direction when the capacitor was being charged

4. Results and Discussions

In this study, we are able to identify the behavior of windshield wipers (charging and discharging phenomenon during charging as the time increases the current increases and during discharging as the increase in time the current also decreases gradually.

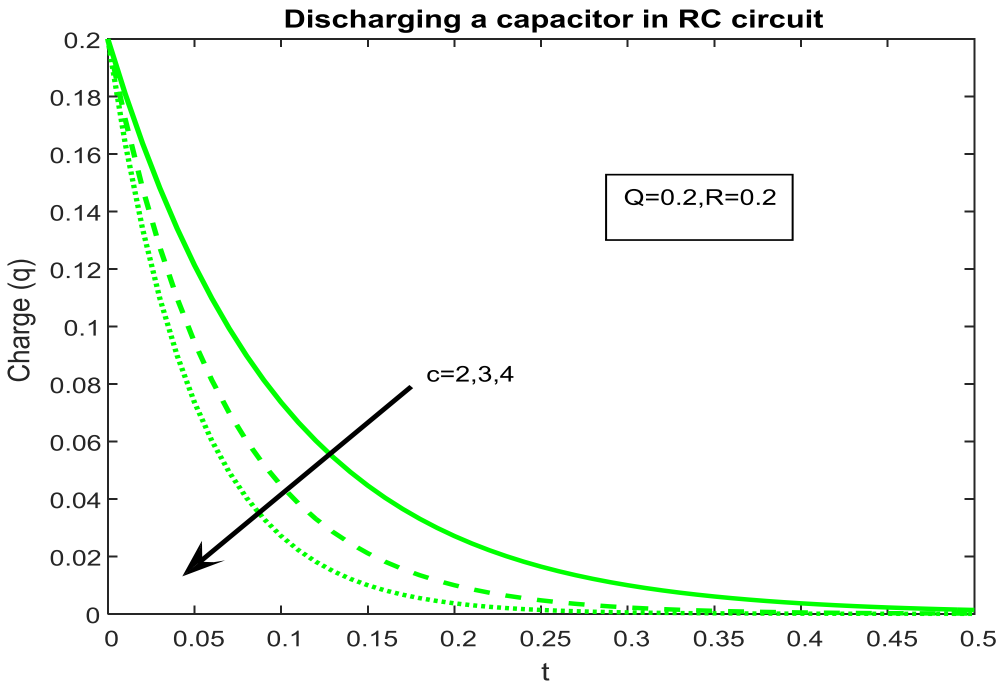

Fig. 3

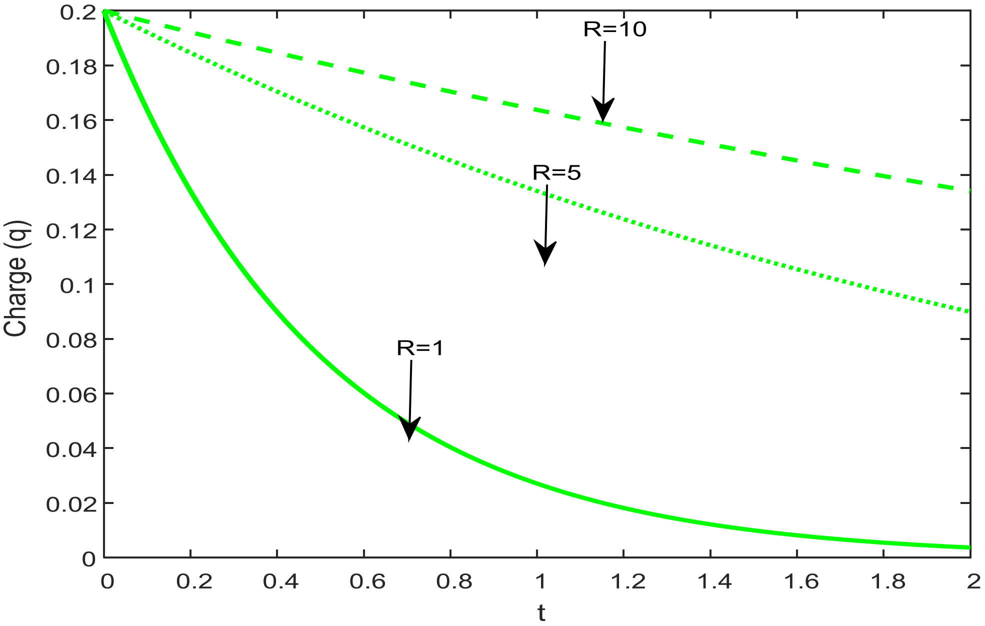

Fig. 4

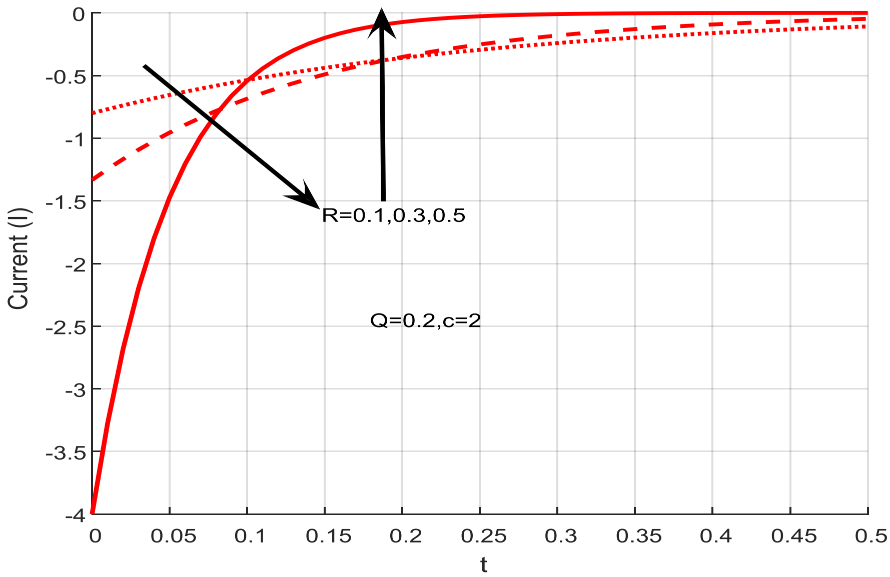

Fig. 5 Plot of current versus time for the above circuit.

- Figure 3and 4: Plot of capacitor charge versus time for the above circuit.

After a time interval equal to one time constant has passed, the charge is 63.2% of the maximum value *Ce* .The charge approaches its maximum value as *t* approaches infinity.

- Figure 5: Plot of current versus time for the above circuit.

The current has its maximum value $Ii=e/r$ at $t=0$ and decays to zero exponentially as *t* approaches infinity. After a time interval equals to one time constant *T* has passed, the current is 36.8% initial value.

6. Conclusions

In summary,

- We are able to identify the behavior of windshield wipers on functionality of charging and discharging.
- During charging as the time (t) increases then the current (I) also increases.
- During discharging as the time (t) increases then the current (i) decreses gradually
- Wipers are used in windshields so it is known as windshield wipers.
- These windshield wipers are used in vehicles and glass house cleaning processes.

6. REFERENCES

1. http://googleweblight.com/i?u=https://auto.howstuffworks.com/wiper.htm&hl=en-IN&tg=96&tk=2239825337465016083
2. http://googleweblight.com/i?u=https://en.m.wikipedia.org/wiki/windscreen_wper&hl=en-IN
3. http://www.windshieldwipersystems.com>.
4. http://www.federal-mogul.com/anco/wiper_anco.html>
5. http://www.en.m.wikipedia.org>wiki>windscreen_wipers>

AUTHORS:

K P NAVEEN REDDY, pursuing B.Tech degree (CSE Branch) in GITAM (Deemed to be University), Bangalore campus. Admitted in year 2017 through GAT-2017.Acquired 7.34 CGPA in first semester . Participated in National Mathematics Day-2017 competition held in GITAM campus , poster presentation made on “Functionality Of Wind Shield Wipers” in group.

Y GEYAVALLI ,pursuing B.Tech degree (CSE Branch) in GITAM (Deemed to be University), Bangalore campus. Admitted in year 2017 through GAT-2017.Acquired 7.31 CGPA in first semester . Participated in National Mathematics Day-2017 competition held in GITAM campus, poster presentation made on “Functionality Of Wind Shield Wipers” in group.

D SUJANI, pursuing B.Tech degree (CSE Branch) in GITAM (Deemed to be University), Bangalore campus. Admitted in year 2017 through GAT-2017.Acquired 6.27 CGPA in first semester. Participated in National Mathematics Day-2017 competition held in GITAM campus, poster presentation made on “Functionality Of Wind Shield Wipers” in a group.