Mathematical Modelling of Simple Passive RC Filters Using Floating Admittance Technique

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Abstract:
This article describes mathematical modeling of simple L−, T− and π-type filters focused with the solutions using Floating Admittance approach. The solution using Floating Admittance Matrix is very attractive for any kind of circuits considering the size and complexity.

Keywords: Filters, Low-Pass, High-Pass, Band-Pass, Mathematical model.

1. 1 Introduction:

The filter is a device that segregates one desired size of the solid particle from mixture of all other sizes of solids. For an instance, during building construction, good quality sand is required. For that a sieving device is used for separating a particular size sand and of lesser sizes only from the mixture of many sizes of broken rock solids present as the sand. In our school days, we used a filter paper to separate solids from the mixture of solid and liquid. An electrical filter functions the same way allowing to pass or reject through it up to a range of frequencies and blocks voltages of all other frequencies or vice versa. There is a filter that rejects only one frequency and passes all other frequencies through it.

In order to demonstate the filter function, a very simple electrical low-pass filter has been arranged combining only one resistor and one capacitor in series. Thereafter, two resistor and or two capacitors were combined to result into the same types of filter functions covering low-pass and high-pass filters. Hence, very crudely we can define a filter that passes a band of frequencies while attenuates voltages of all other frequencies. There are many types of filters. One way of classifying the filters is based on the use ~~basis~~ of frequencies it passes such as (a) low-pass, (b) high-pass, (c) band-pass, (d) band reject etc. A special filter that falls in the categoty of band reject filter, is the notch filter that rejects only one frequency, say 50Hz, and passes without any alteration in the magnitude of the signal. Other way of classifying the filter is based on the use of components such (a) passive filters and (b) active filter. The passive filters use only passive components and hence the response of the filter is not good. The cut-off frequency is not very sharp because the quality factor of the passive circuit is very poor. The a*ctive filters*; for the time being, is covered here to the extent of definition only. The active filters use active components such as operational amplifiers, these days. The circuits using Op. amp. are availale that simulates active inductor, both grounded and floating, using resistors and capacitors. Even, capacitor multiplier circuits are used in the active filters. The frequency dependent negative resistance is used in the active filter to increase the quality factor of the circuit.

The practical situations occur wherein the signal has to be separated from the noise before it goes to the measuring device or actuators. The signal is the voltage in which the observer is interested and noise is also the voltages of not of interest for the observer.

In this article, we will take up the problems relating to the modeling of simple passive electrical circuits consisting of resistors, capacitors, voltage source and current source. Generally, we avoid using passive inductors as because the planar spiral inductors are heavy and takes more space and dissipates considerable power w.r.t. resistors and capacitors. On the contrary, the simulated inductances are often used in the filter to obtain good performance, but that is the domain of active filters. The conventional methods of solving the basic networks consisting of resistances, capacitances, voltage sources and current sources, uses either mesh equations or node equations, or Thevenin or Norton equivalent methods. These techniques do not conform to the state space form of mathematical model or even latter also it cannot be converted to the state space form.

It is very well known that the planar spiral type of inductor occupies more space and is associated with the low-quality factor, is normally not used in the filter circuits. For this reason, paper [1] used simulated inductance to achieve high quality factor for RF applications.

The use of shunt filters for the better system performance [2] was discussed in the domain of multi-objective functions.

Paper [3] demonstrated the optimal design technique to effectively utilize cables and transformermers for harmonically contaminated voltages and currents accounting the frequency dependent loss of power.

The simple knowledge of characterization of transfer function give enough information to decide that the correct functioning has been achieved. The variation in the input and output impedances, power supply copling, and uncoupling, variation in the circuit components and or other dynamic behaviour in the structure of the filters are important parameters.

The paper [5] presented in depth the modelling and designing procedure of *LCR* filter, especially, for inverter design to be used for the alternative energy sources such as a solar system.

Heuristic method is supposed to be the easiest and best for the optimized solution of the single tuned passive filters, but depends on the tapping of its important parameters; which very difficult. Such techniques provide a reasonable solution in short time because it uses less iterations.

An approach, called, Response Surface Methodology (RSM) [6] was presented to solve the issues related in the above paper [5]. This approach seemed to minimize the harmonic distortion in voltage and current.

Mathematical modelling based on admittance matrix model [7-8] uses older components such as nullators and norators. Papers [9-17] suggested modelling techniques for the measurement of different parameters of any three terminal active devices such as FETS and BJTs. The circuits synthesis composed of resistors, inductors, and capacitors are discussed in detail [18-22].

Frequency-selective circuits pass the signals through it without alteration in the frequency response of the input signal to the output side. The pass-band of the filter passes the signal without alteration in its magnitude to the output. However, the magnitude of the signal passed is reduced drastically, ideally to zero value, outside the pass-bad. The input and output currents of such circuits are not of importance and hence the current transfer functions are not considered for its representation. In the following subsection, we will take up all types of RC filters, one by one, using floating admittance matrix approach.

1.2 Inverted L low-pass RC Filter

A simple RC circuit of a low-pass filter and its reponse under step input excitation voltage is shown in Fig. 1. The input excitation is connected across the series combination of the resistor and capacitor and the output is tapped across the capacitor as in Fig. 1.

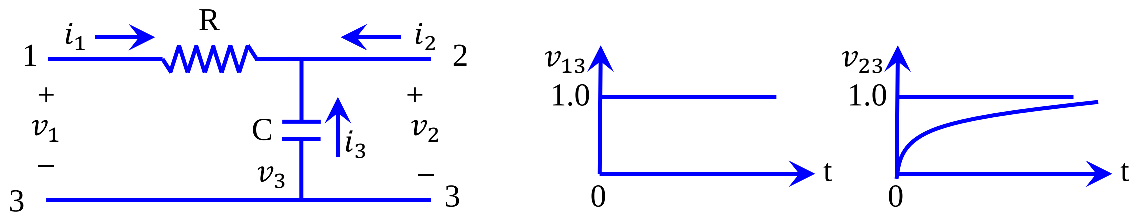

Fig. 1 Low pass RC L- Filter and step input along with its response

The node voltages and branch currents in the circuit of Fig. 1 is expressed in floating admittance matrix approach as;

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} G & -G & 0 \\ -G & G + sC & -sC \\ 0 & -sC & sC \end{bmatrix} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \quad (1)$$

The voltage transfer function between the output voltage and the input excitation voltage of Fig. 1 using Eq. (1) can be expressed as;

$$A_v|_{13}^{23} = sgn(2-3)sgn(1-3)(-1)^9 \frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} \quad (2)$$

$$A_v|_{13}^{23} = \frac{v_{2(s)}}{v_1(s)} = \frac{v_{23(s)}}{v_{13}(s)} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} \quad (3)$$

$$\frac{v_{23(s)}}{v_{13}(s)} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{-G}{G+sC} = \frac{1}{1+sCR} = \frac{1}{(s+1/CR)CR}$$

$$v_{23}(s) = \frac{v_{13}(s)}{(s+1/CR)CR} \quad (4)$$

If the excitation input to this circuit in Fig. 1 is a step input, the output oltage in then Laplace trasform is written as;

$$v_{23}(s) = \frac{1}{s\left(s+\frac{1}{CR}\right)CR} = \frac{A}{s} + \frac{B}{\left(s+\frac{1}{CR}\right)} \quad (5)$$

$A|_{s\to 0} = \frac{1}{\left(0+\frac{1}{CR}\right)CR} = 1$ and $B|_{s\to -1/CR} = \frac{1}{\left(-\frac{1}{CR}\right)CR} = -1$

Now, $v_{23}(s) = \frac{1}{s} - \frac{1}{\left(s+\frac{1}{CR}\right)}$ (6)

The time domain otput is gven as;

$$v_{23}(t) = 1 - e^{-\frac{t}{CR}} \quad (7)$$

At $t \to 0, (f \to \infty)$, $v_{23}(t) = 0$, and $t \to \infty, f \to 0$, $v_{23}(t) = 1$

This indicates that the response of the RC low-pass filter with step input excitation will increase exponentially and will ultimately reach maximum of the input i.e. unity, though after very long time.

This frequency response of the the circuit in Fig. 1 can be explained physically, as;

(a) For, $f \to \infty$ (t→0), capacitor C acts as short circuit and the output voltage $v_O = v_{23}(t) = 0$.

(b) For, $f \to 0$(t→∞), capacitor C functions as open circuit and the output voltage $v_O = v_{23}(t) = v_{13}\ (v_i)$.

Hence, the output voltage of this circuit is equal to the input excitation voltage at low frequency (t→∞) only and almost zero at high frequency (t→0). So, the time domain response of Fig. 1 looks like that of a low-pass filter.

1.3 Inverted L type RC High-Pass Filter

The low-pass filter circuit in Fig. 1 reduces to the high-pass filter in Fig. 2 simply by interchanging the positions of the capacitor and resistor. The frequency response under the step input excitation voltage is also drawn just right to this circuit of Fig. 2.

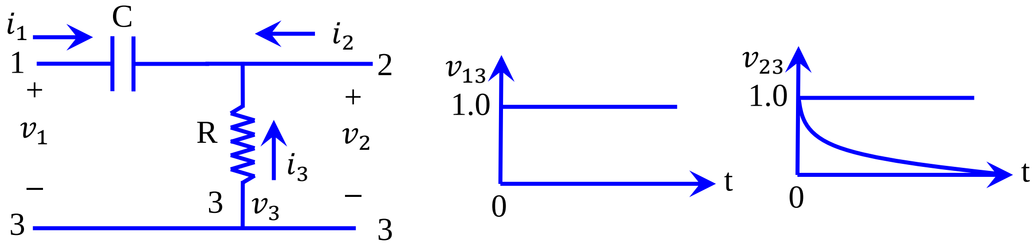

Fig. 2 RC high pass L-filter and step input along with its response

The node voltages and branch currents in the circuit of Fig. 2 is expressed in floating admittance matrix approach as;

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{array}{c} \begin{array}{ccc} 1 & 2 & 2 \end{array} \\ \begin{bmatrix} sC & -sC & 0 \\ -sC & G+sC & -G \\ 0 & -G & G \end{bmatrix} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \tag{8}$$

The voltage transfer function between the output voltage and input excitation voltage of Fig. 2 using Eq. (8) can be expressed as;

$$A_v|_{13}^{23} = sgn(2-3)sgn(1-3)(-1)^9 \frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} \tag{9}$$

$$A_v|_{13}^{23} = \frac{v_2(s)}{v_1(s)} = \frac{v_{23}(s)}{v_{13}(s)} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{-sC}{G+sC} = \frac{s}{s+1/CR} \tag{10}$$

$$v_{23}(s) = \frac{s}{s+\frac{1}{CR}} v_{13}(s) = \frac{s}{s+\frac{1}{CR}} x \frac{1}{s} = \frac{1}{s+1/CR} \tag{11}$$

$$v_{23}(t) = e^{-t/RC} \tag{12}$$

At $t \to 0, (f \to \infty), v_{23}(t) = v_O = 1$, and $t \to \infty, (f \to 0), v_{23}(t) = v_O = 0$

Physically, the frequency response of the the circuit in Fig. 2 can be explained as;

(a) For $f \to \infty$ (t→0), capacitor C functions as a short circuit and the output voltage $v_O = v_{23}(t) = v_{13}(t) = v_i = 1$.

(b) For, $f \to 0$(t→∞), capacitor C acts as open circuit and the output voltage $v_O = v_{23}(t) = 0$.

The time domain output voltage of this circuit in Fig. 2 at high frequency is the same as the input voltage and hence this ciruit is called a high-pass RC filter.

1.4 T-type High-Pass Circuit

Another circuit of a high-pass RC filter is arranged as in Fig. 3 using two capacitors and one resistor. The two capacitors form the series arm and the capacitor form s the shunt arm of the high-pass filter in Fig. 3 The node voltages and branch currents of the circuit in Fig. 3 is expressed in floating admittance matrix approach as;

$$
\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{array}{c} \begin{array}{cccc} \quad 1 & \qquad 2 & \qquad 3 & \qquad 4 \end{array} \\ \begin{bmatrix} sC & -sC & 0 & 0 \\ -sC & G + 2sC & -sC & -G \\ 0 & -sC & sC & 0 \\ 0 & -G & 0 & G \end{bmatrix} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} \tag{13}
$$

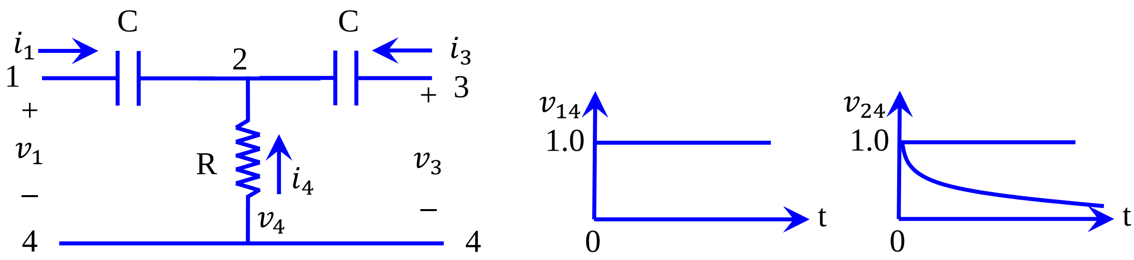

Fig. 3 High pass RC T-filter and step input along with its response

The voltage transfer function between the output volage and the input excitation voltage in Fig. 3 using Eq. (13) can be expressed as;

$$
A_v|_{14}^{34} = sgn(3-4)sgn(1-4)(-1)^{12}\frac{|Y_{34}^{14}|}{|Y_{14}^{14}|} = \frac{|Y_{34}^{14}|}{|Y_{14}^{14}|} \tag{14}
$$

$$
|Y_{14}^{14}| = \begin{vmatrix} G + 2sC & -sC \\ -sC & sC \end{vmatrix}
$$

$$
= sCG + 2s^2C^2 - s^2C^2 = s^2C^2 + sCG
$$

$$
A_v|_{14}^{34} = \frac{v_3(s)}{v_1(s)} = \frac{v_{34}(s)}{v_{14}(s)} = \frac{|Y_{34}^{14}|}{|Y_{14}^{14}|} = \frac{s^2C^2}{sC(sC+G)} = \frac{s}{(s+1/RC)}v_{14} = \frac{s}{(s+1/RC)}x\frac{1}{s}
$$

$$
v_{34}(s) = \frac{s}{(s+1/RC)}v_{14} = \frac{s}{(s+1/RC)}x\frac{1}{s} = \frac{1}{(s+1/RC)} \tag{15}
$$

The time domain output response of the circuit in Fig. 2 with the simple excitation input of step function turn out to be;

$$
v_{34}(t) = e^{-t/RC} \tag{16}
$$

At $t \to 0(f \to \infty)$, $v_{23}(t) = v_O(t) = 1$, and $t \to \infty(f \to 0)$, $v_{23}(t) = v_O(t) = 0$

This mathematical response of the the circuit in Fig. 3 can be explained physically, as;

(a) For, $f \to \infty$ (t→0), capacitors C acts as a short circuit and the output voltage $v_{24}(t) = v_O(t) = v_{14}(t) = v_i(t)$.
(b) For, $f \to 0$ (t→∞), capacitors C acts as an open circuit and the output voltage $v_{24}(t) = v_O(t) = 0$.

Hence, the frequency response of circuit in Fig. 3 looks like that of a high-pass RC filter. It blocks the low frequency signals appearing at its input to reach the output.

1.5 T-type Low-Pass RC Filter

The T-type arrangement of low-pass RC circuit is another variant in its family shown in Fig. 4 using two resistances and one capacitance. The two resistors form the two series arms and the only capacitor froms the shunt arm of the filter in Fig. 4. The step input excitation is given to the series combination of a resistor and capacitaor and the open circuit output is taken from node 3.

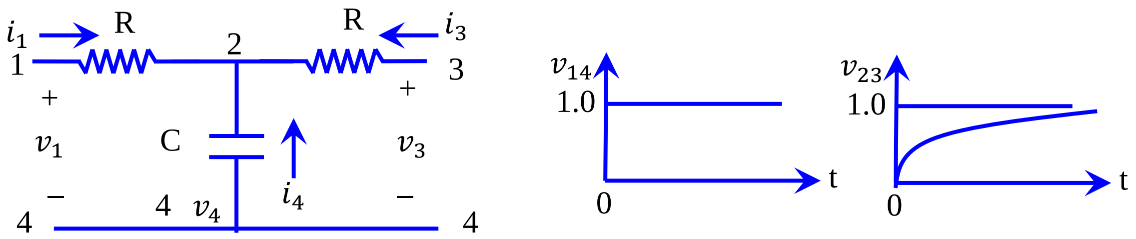

Fig. 4 Low pass RC T-filter and step input along with its response

The node voltages and branch currents in the circuit of Fig. 3 is expressed in floating admittance matrix approach as;

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} G & -G & 0 & 0 \\ -G & 2G + sC & -G & -sC \\ 0 & -G & G & 0 \\ 0 & -sC & 0 & sC \end{bmatrix} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} \quad (17)$$

The voltage transfer function between the output voltage and the input excitation voltage of Fig. 4 using Eq. (17) can be expressed as;

$$A_v|_{14}^{34} = sgn(3-4)sgn(1-4)(-1)^{12}\frac{|Y_{34}^{14}|}{|Y_{14}^{14}|} = \frac{|Y_{34}^{14}|}{|Y_{14}^{14}|} \quad (18)$$

$$|Y_{14}^{14}| = \begin{vmatrix} 2G + sC & -G \\ -G & G \end{vmatrix}$$

$$= sCG + 2G^2 - G^2 = G^2 + sCG = G(G + sC)$$

$$A_v|_{14}^{34} = \frac{v_3(s)}{v_1(s)} = \frac{v_{34}(s)}{v_{14}(s)} = \frac{|Y_{34}^{14}|}{|Y_{14}^{14}|} = \frac{G^2}{G(G+sC)} = \frac{1}{s+1/RC} \quad (19)$$

$$v_{34}(s) = \frac{1}{s+\frac{1}{RC}}v_{14}(s) = \frac{1}{s+\frac{1}{RC}}x\frac{1}{s} = \frac{1}{s\left(s+\frac{1}{RC}\right)} = \frac{A}{s} + \frac{B}{\left(s+\frac{1}{RC}\right)}$$

$$= \frac{1}{s} - \frac{1}{(s+1/RC)} \quad (20)$$

The time domain output of the T-type low-pass RC filter in Fig. 4 is given as;

$$v_{34}(t) = 1 - e^{-t/RC} \quad (21)$$

At $t \to 0(f \to \infty)$, $v_{34}(t) = v_O(t) = 0$, and $t \to \infty(f \to 0)$, $v_{34}(t) = v_O(t) = 1 = v_{14}(t)$.

This mathematical frequency response of the the circuit in Fig. 3 can be explained physically as;

(a) For, $f \to \infty$ (t→0), capacitor C acts as a short circuit and the node voltage $v_{24}(t) = 0$, then $v_{34}(t) = v_O(t) = 0$.

(b) For, $f \to 0$ (t→∞), capacitor C functions as open circuit and the output voltage $v_{24}(t) = = v_O(t) = v_{14}(t)$.

Hence, the frequency response of the circuit in Fig. 4 looks like that of a low-pass RC filter. It blocks the high frequency signals appearing at its input to reach the output.

1.6 RC π- (Low-Pass)

Another RC low-pass circuit in the form of π-topology is shown in Fig. 5; where in two capacitors form the two shunt arms; one at the input side and the other at the output side and a single resistor forms the seris arem that joines the input and output nodes.

The node voltages and branch currents in the circuit of Fig. 5 is expressed in floating admittance matrix approach as;

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} G+sC & -G & -sC \\ -G & G+sC & -sC \\ -sC & -sC & 2sC \end{bmatrix} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \tag{22}$$

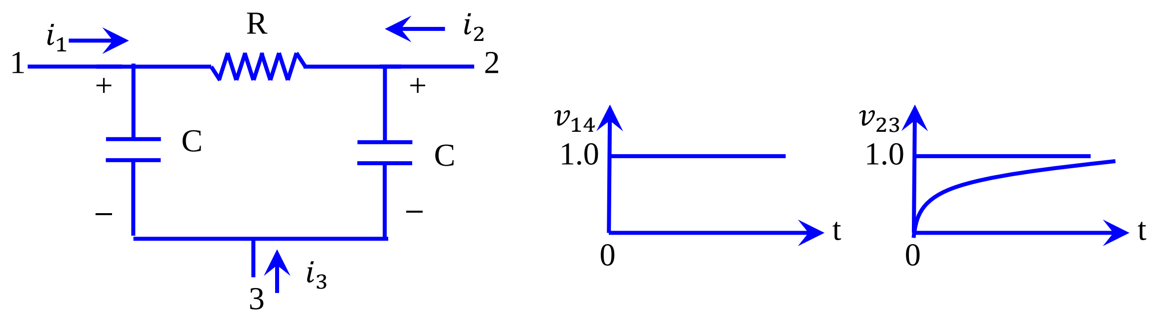

Fig. 5 RC Low pass π-filter and step input along with its response

The voltage transfer function between the output voltage and input excitation voltage of Fig. 5 using Eq. (22) can be expressed as;

$$A_v|_{13}^{23} = sgn(2-3)sgn(1-3)(-1)^9 \frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} \tag{23}$$

$$A_v|_{13}^{23} = \frac{v_2}{v_1} = \frac{v_{23}(s)}{v_{13}(s)} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{-G}{G+sC} = \frac{1}{(s+1/RC)RC} \tag{24}$$

$$v_{23}(s) = \frac{1}{\left(s+\frac{1}{RC}\right)RC} v_{13}(s) = \frac{1}{s\left(s+\frac{1}{RC}\right)RC} = \frac{1}{s} - \frac{1}{\left(s+\frac{1}{RC}\right)} \tag{25}$$

The time domain output with step input excitation of Fig. 5 is written as;

$$v_{23}(t) = 1 - e^{-t/RC} \tag{26}$$

At $t \to 0 (f \to \infty)$, $v_{23}(t) = v_O(t) = 0$, and $t \to \infty (f \to 0)$, $v_{23}(t) = v_O(t) = 1 = v_{13}(t)$.

This mathematical response of the the circuit in Fig. 5 can be explained physically, as;

(a)For, $f \to \infty$ (t→0), capacitor C acts as a short circuit and the node voltage $v_{23}(t) = v_{23}(t) = 0$. Hence, $v_{23}(t) = v_O(t) = 0$.

(b)When , $f \to 0$ (t→∞), capacitor C functions as an open circuit and the output voltage $v_{23}(t) = v_O(t) = v_{13}(t)$.

Hence, the frequency response of the circuit in Fig. 5 looks like that of a high-pass RC filter. It blocks the low frequency signals appearing at its input to reach the output.

1.7 RC π-type High-Pass filter

Another RC high-pass circuit, once again, in π-topology is shown in Fig. 6; wherein two resistors form the two shunt arms; one at the input side and the other at the output side and a single capacitor forms the series arm that joines the input and the output nodes. The node voltages and branch currents in the circuit of Fig. 6 is expressed in floating admittance matrix as;

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} G + sC & -sC & -G \\ -sC & G + sC & -G \\ -G & -G & 2G \end{bmatrix} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \tag{27}$$

The voltage transfer function between the output voltage and input excitation voltage using Eq. (27) can be expressed as;

$$A_v|_{13}^{23} = sgn(2-3)sgn(1-3)(-1)^9 \frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} \tag{28}$$

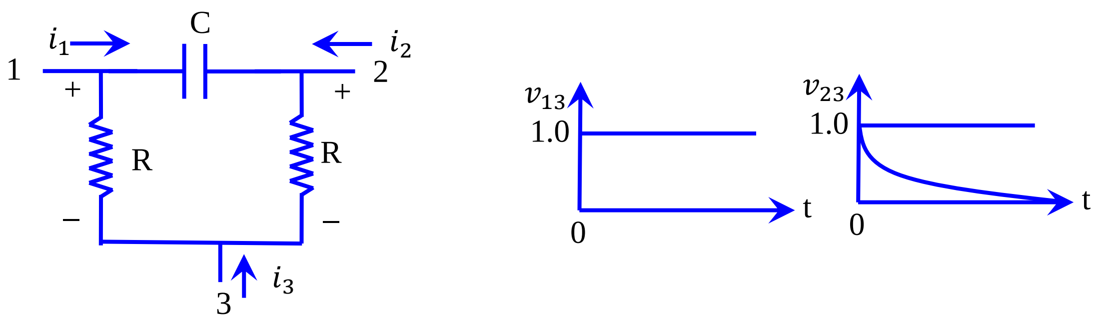

Fig. 6 RC High pass π-filter and step input along with its response

$$A_v|_{13}^{23} = \frac{v_2}{v_1} = \frac{v_{23}(s)}{v_{13}(s)} = -\frac{|Y_{23}^{13}|}{|Y_{13}^{13}|} = -\frac{-sC}{G+sC} = \frac{s}{s+1/RC} \tag{29}$$

$$v_{23}(s) = \frac{s}{s+\frac{1}{RC}} x v_{13}(s) = \frac{s}{s+\frac{1}{RC}} x \frac{1}{s} = \frac{1}{s+\frac{1}{RC}} \tag{30}$$

The time domain output of the circit in Fig. 6 under step input excitation voltage is given as;

$$v_{23}(s) = e^{-t/RC} \tag{31}$$

At $t \to 0 (f \to \infty)$, $v_{23}(t) = v_O(t) = 1 = v_{13}(t)$, and $t \to \infty (f \to 0)$, $v_{23}(t) = v_O(t) = 0$.

This mathematical response of the the circuit in Fig. 3 can be explained physically as;

(a)When , $f \to \infty$ (t→0), the capacitor C acts as a short circuit and the output voltage $v_{23}(t) = v_O(t) = 1 = v_{13}(t)$.

(b) When , $f \to 0$ (t→∞), the capacitor C functions as an open circuit and the output voltage $v_{23}(t) = v_O(t) = 0$.

Hence, the frequency response of the circuit in Fig. 6 looks like that of a high-pass RC filter. It blocks the low frequency signals appearing at its input to reach the output.

2.0 Discussions and Conclusions:

The floating admittance matrix model presented here is so simple that any body having no knowledge of electronics but having the knowledge of matrix maneuvering can analyse the circuits to derive all types of transfer functions very well, provided the parameters of devices are known to him/ her. The analysis and design of any circuit using floating admittance matrix model is based on pure mathematical maneuvering of elements of matrices. The transfer functions are expressed as ratio of minors with proper signs, called cofactors of first and or second order. The mathematical modelling using FAM approach provides a leverage to the designer to adjust their style of design comfortably, at any stage of analysis.

The response of the RC filters depends on the characteristics of the passive components R and C used. Very important characteristics of R and C are the devitations in the values of these components on account of its aging and tolerances. So, better tolerance will yield lesser variations in the filter response. Tagged with low Q, signal loss, and dissipation, the problem arises in the response of the passive RC filter circuits due to lack of precision components used in the circuit. Hence, selection of precise values of resistances and capacitances with better tolerances, yield better response. Here, we would like to give a look in the behaviour of general-purpose resistances and capacitances.

2.1 Resistor selection:

The resistances are available with tolerances of ±1%, ±2%, ±5%, ±10%, and ±20%. For the general purposes, these toleances give ideas of the circuit behavior and are adequate in less critical circuits. But if we are interested in knowing the exact cut-off and pass bands of the filter circuit, precise value of resistances should be used. The Carbon track resistor may be suitable if its measured values on better bridge circuits such as Wayne-Kerr bridge is taken. The other type of suitable resistor for such circuit could be Cermet track variable resistor to give better reliability.

2.2 Capacitor selection:

Silver Mica: These capacitors have tolerances of ±1%, but the maximum value available is 4.7 nF. They have good temperature stability. Hence, such capacitors are suitable where the filter has to operate in the environment of wide temperature arrange of variation.

Polystyrene: These capacitors are most suitable for fiters on accont of their close tolerances and available in large capacitance range. They also have excellent tempearute stability.
Ceramic: The ceramic capacitances acome in three forms; namely, metallized, resin dipped and disck types. The metallized ceramic capacitor has good tolerance (±2%) and temperature stability. The rasin dipped type of ceramic capacitor has ±5% tolerance. The disk type type has very poor tolerance, making them unsuitable for filter use.

Polyster:
For large valus of capacitor, this type may be of the choice. Their tolerances are between ±5% to ±10%. Also, their temperature stability is very poor.
Electrolytic: These capacitors have tolerances of as large as ± 20% or even more and its values is likely to change with uses. This alongwith the reason that they are polarized, makes them unsuitable for filters.

3.0 Referances:

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