



NEAR EAST UNIVERSITY

**DEPARTMENT OF ELECTRICAL AND
ELECTRONICS ENGINEERING**

EE 400

TITLE: LADDER NETWORKS

SUBMITTED BY:

HASSAN SOHAIL MUNNAWR (940016)

WAHEED UDDIN HYDER (940015)

SUBMITTED TO:

MR. MEHRDAD KHALDI

ACKNOWLEDGEMENT

Our heartily appreciation's go to our supervisor **Mr. Mehrdad khaldi** whose kind co-operation went a long way towards the completion of this project.

We will also like to thank our friend **Mr. Zaygham Nawaz** whose untiring help was a great asset to us.

TABLE OF CONTENTS

PREFACE

PAGES

	i
SUMMARY	ii
1.0 ELECTRICAL PRELIMINARIES	1
1.1 TWO-PORT NETWORKS AND THEIR TRANSFER FUNCTIONS	1
1.2 ELECTRICAL WAVE FILTERS	3
1.3 CLASSIFICATION OF THE ELECTRICAL WAVE FILTERS	3
1.3.1 CLASSIFICATION IN TERMS OF PASSBAND	4
1.3.1.1 LOWPASS FILTERS	4
1.3.1.2 HIGHPASS FILTERS	5
1.3.1.3 BANDPASS FILTERS	5
1.3.1.4 STOPBAND FILTERS	6
1.3.1.5 OTHER TYPE FILTERS	6
1.3.2 CLASSIFICATIONS IN TERMS OF CIRCUIT CONFIGURATIONS	7
1.3.2.1 THE LATTICE NETWORK	7
1.3.2.2 THE LADDER NETWORK	8
1.3.2.3 THE BRIDGED-T NETWORK	12
1.3.2.4 THE TWIN-T NETWORK	12
1.4 INSERTION LOSS AND INSERTION PHASE.	13
2.0 COMPUTER PROGRAM	16
2.1 THE AIM OF THE COMPUTER PROGRAM FOR THE ANALYSIS OF THE LADDER NETWORKS	16

2.2 SOME DEFINITIONS AND PROPERTIES USED IN LADDER NETWORK ANALYSIS COMPUTER PROGRAM.	17
2.2.1 THE CALCULATION OF CONTINUANTS	17
2.2.2 THE CALCULATION OF INSERTION LOSS AND INSERTION PHASE FUNCTIONS	19
2.3 HOW TO USE THE LADDER NETWORK ANALYSIS COMPUTER PROGRAM	20
2.3.1 INPUT QUANTITIES	20
2.3.2 REACTIVE ELEMENT CONFIGURATIONS	21
2.3.3 RUNNING OF THE LADDER NETWORK ANALYSIS COMPUTER PROGRAM	22
2.3.4 AN EXAMPLE OF RUNNING THE LADDER NETWORK ANALYSIS COMPUTER PROGRAM	24
2.4 EXAMPLES	27
2.5 DOCUMENT OF THE WRITTEN PROGRAM	42
2.5.1 VARIABLES	42
2.5.2 LADDER NETWORK ANALYSIS COMPUTER PROGRAM IN FORTRAN 77	43
CONCLUSION AND DISCUSSION	51
LIST OF REFERACES	52

PREFACE

In this report a "Ladder Network Analysis Computer Program" is presented. Electrical wave filters which are used in the fields of electrical and electronic engineering's are actually posses ladder like structures. Therefore the program is capable of analysing the electrical filters.

Calculation of filter characteristics are very important , since after the design of a filter one can ask the question "Does the designed filter satisfy the prescribed specifications or not ?". If not the program may be used interactively.

The calculation of the insertion loss and the insertion phase characteristics are the most important information about the filter operation. However their calculations require quite long time. For this reason , computers must be used to calculate these characteristics in a very short time with reliability and precision.

One of the most important type of filters is of the from of a ladder network , because of the fact that ladder networks are least sensitive to variation of parameters. On the other hand other type of filters may be converted to the ladder type filters to take advantage of this property of ladder networks. In this sense lattice filters are very sensitive to variations of parameters and they are not preferred in applications.

SUMMARY

In this report , the definitions an equations which are used in the Ladder Network Analysis Computer Program are discussed.

The first part of the report is about the mathematical base of the written computer program. In this part continuant , bracket symbol and continued fractions are discussed briefly.

In the second part of the report , electrical wave filters and their phase and attenuation characteristics are discussed. The two main classifications of the electrical wave filters are given i.e. , the passband classification and configuration classifications. The ladder network and its attenuation and phase characteristics are discussed in detail. In addition , lattice type , twin-T and bridged-T networks are discussed briefly.

In the last part of the report , the ladder network analysis computer program is presented the details , further , the computation subprogram for continuants , and computation subprogram for attenuation and phase characteristics are given in FORTRAN 77 computer programming language; the process of running the written computer program is explained step by step through the use of an example.

As a result , in this report , the ladder network analysis computer program is presented with its mathematical and as well as electrical bases.

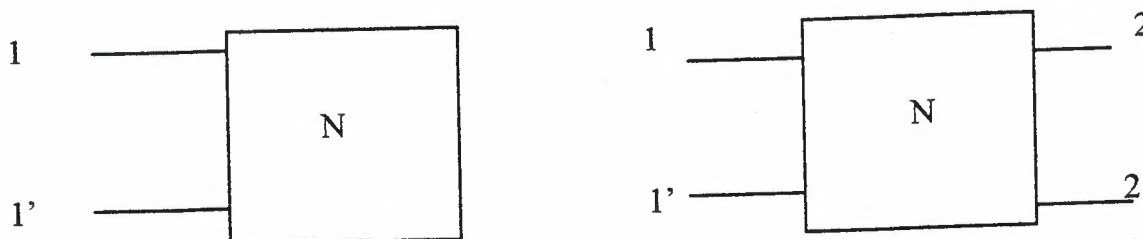
In writing a computer program for ladder network analysis, a mathematical tool, so called the "continuants" is used. Continuants are important since its use simplifies the analysis procedure. For this reason, in this report first the properties of continuants are discussed for some length.

1.0 ELECTRICAL PRELIMINARIES

1.1 Two Port Networks and Their Transfer Functions

Consider an arbitrary network N enclosed in a box if access to the interior of the network is effected by means of a conductor soldered to any node, the end of the conductor outside the box is named a terminal. To be useful, a network must be capable of being excited by a driving force (e.g., a voltage or current source) or being connected to the another network (e.g., an output resistor). In any case at least two terminals are needed for making the connection since both sources and loads each have two terminals. Furthermore, the available terminals must be grouped in pairs in order to effect such connections. Any pair of the associated terminal is called a port. A port places a restriction only on the termination of the network, call the terminal conditions, not on the network itself.

Special important cases of the general n-port network are the one-port and two-port networks which are shown in Fig (1.1.1) (a) (b), respectively.



Fig(2.1..1) The one-port and two-port representations of a network

(a) one-port (b) two-port

Generally, the terminals 1-1' (the input port) in each case are connected to a driving sources. Because of this, port one in each case is known as the driving point of the network. The terminals 2-2' (the output port) of the two port network are usually connected to a load. In the case of a two-port, the network performs the function of modifying the driving source in some prescribed fashion before applying the energy of the source to the load.

Consider a two-port network as in fig. (1.1.1) (a) the two currents I_1 and I_2 may be expressed in terms of V_1 and V_2 from the loop equations.

$$V_1 = Z_{11} \cdot I_1 + Z_{12} \cdot I_2 \quad (2.1.1.1)$$

$$V_2 = Z_{21} * I_1 + Z_{22} * I_2 \quad (2.1.1.2)$$

Applying Cramer's rule we have ,

$$I_1 = \frac{D_{11}}{D} * V_1 + \frac{D_{21}}{D} * V_2 \quad (2.1.1.3)$$

$$I_2 = \frac{D_{12}}{D} * V_1 + \frac{D_{22}}{D} * V_2 \quad (2.1.1.4)$$

Where D is determinant of the coefficient impedance matrix Z_m in (1.1.1.1) and D_{ij} is the cofactor of Z_{ij} in Z_m . units of admittance , we define

$$\frac{D_{ij}}{D} = Y_{ij} \quad ; \quad i,j=1,2$$

hence

$$I_1 = Y_{11} * V_1 + Y_{12} * V_2 \quad (1.1.1.5)$$

$$I_2 = Y_{21} * V_1 + Y_{22} * V_2 \quad (1.1.1.6)$$

Since we may write

$$Y_{11} = \left. \frac{I_1}{V_1} \right|_{V_2=0} \quad Y_{12} = \left. \frac{I_2}{V_2} \right|_{V_1=0} \quad (1.1.1.7)$$

$$Y_{21} = \left. \frac{I_2}{V_1} \right|_{V_2=0} \quad Y_{22} = \left. \frac{I_2}{V_2} \right|_{V_1=0} \quad (1.1.1.8)$$

It can be seen that the Y_{ij} may be obtained physically by making measurements under short-circuit conditions. Therefore it is natural to call the Y_{ij} the short-circuit admittance's of the network.

Similarly from (1.1.1.1) and (1.1.1.2)

$$Z_{11} = \left. \frac{V_1}{I_1} \right|_{I_2=0} \quad Z_{12} = \left. \frac{V_1}{I_2} \right|_{I_1=0} \quad (1.1.1.9)$$

$$Z_{21} = \left. \frac{V_2}{I_1} \right|_{I_2=0} \quad Z_{22} = \left. \frac{V_2}{I_2} \right|_{I_1=0} \quad (1.1.1.10)$$

therefore Z_{ij} are called the open circuit impedance's of the two-port network.

Evidently the Z_{ij} and Y_{ij} themselves network functions, being ratios of outputs to inputs under open-circuit or short-circuit conditions. In general network function $Y(s) / X(s)$ is defined to be transfer function. If Y and X are measured voltage and current variables at different ports, and a driving-point function if Y and X are measured at the same ports. Therefore Z_{11} , Z_{22} , Y_{11} and Y_{22} are driving point functions, whereas the other parameters are the transfer functions.

The two-port parameters Z_{ij} and Y_{ij} may be used to obtain general expression for the various network functions. As an example if $H(s) = V_2/V_1$ for open circuit secondary ($I_2=0$), we have

$$\frac{V_2}{V_1} = \frac{Z_{21}}{Z_{11}} \quad (1.1.1.11)$$

which is called the voltage to Voltage Ratio Transfer Function.

1.2 ELECTRICAL WAVE FILTERS

An electrical wave filter is a two-port network that transforms an input signal in some specified way to yield a desired output signal. The signals may be considered in frequency domain or time domain, and correspondingly, the output requirements of the filter may be stated in terms of time or frequency.

A filter is often a frequency-selective device which passes signals of certain frequencies and blocks or attenuates signals of other frequencies. The frequency ranges are called passbands, where the signal components are transmitted, and stopbands, where they are not transmitted.

An ideal filter is one which has a linear phase response in its passband, zero loss in passband and infinite loss in its stopband.

1.3 CLASSIFICATION OF THE ELECTRICAL WAVE FILTERS

Electrical wave filters have importance in almost every phase of engineering design and, as with two-ports, can be classified in many different ways. For example, classification may be in terms of electromagnetic wave spectrum configuration, element character or passband character. In addition these may be further classified active or passive well as analogue and digital. A brief classification of passive filters is given in fig. (1.3.1).

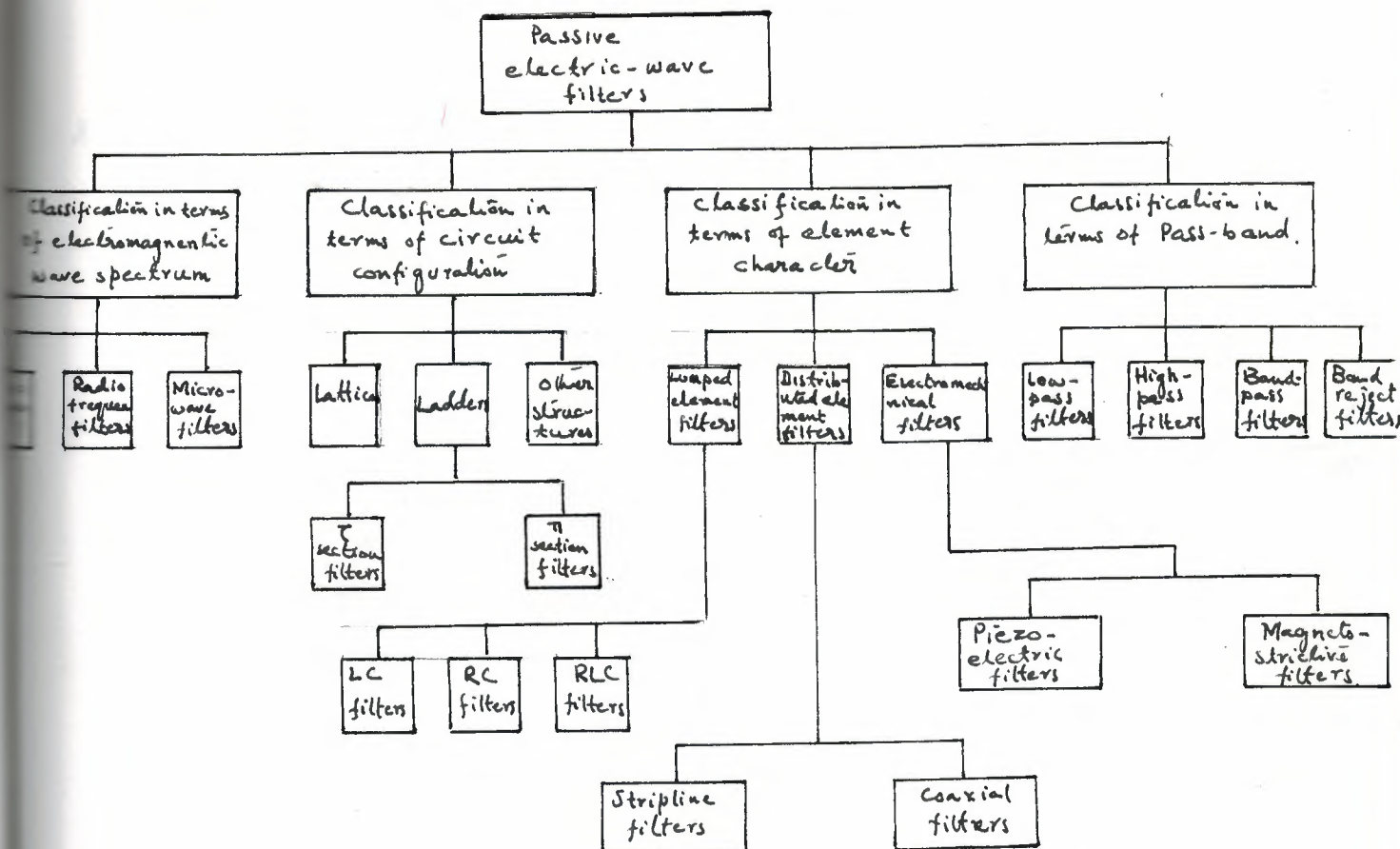


Fig. (1.3.1) A brief classification of passive filters.

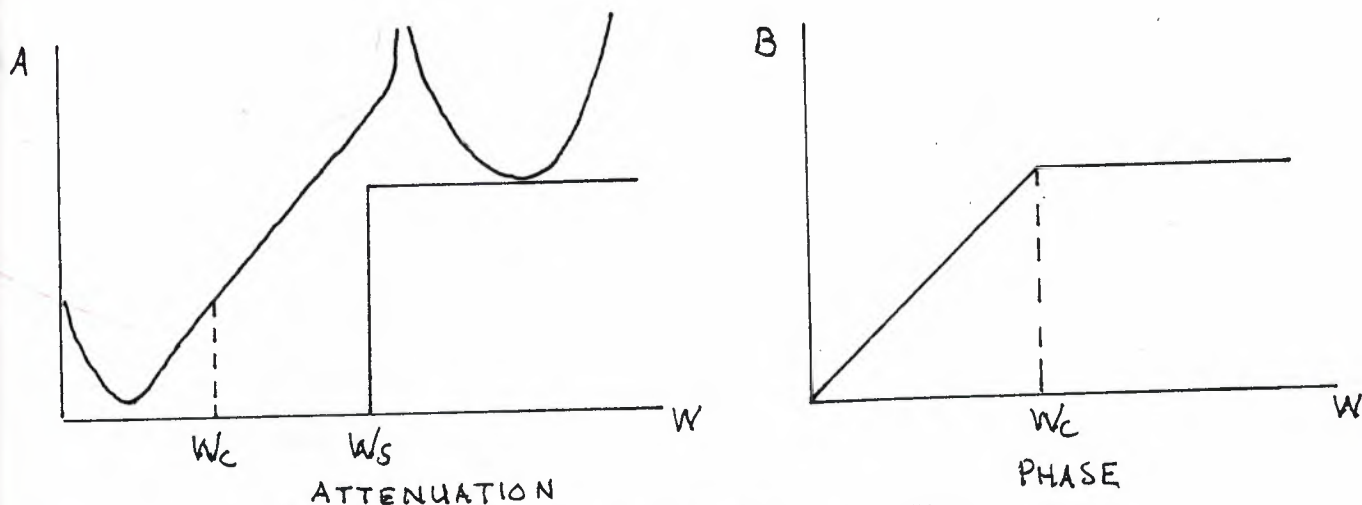
The most important classification is in Terms of Passband.

1.3.1 CLASSIFICATION IN TERMS OF PASSBAND

1.3.1.1 Lowpass Filters

A lowpass filter includes a passband in the frequency range $[0, W_c]$, and a stopband defined by range $[W_s, \infty]$, with $W_s > W_c$.

It's characteristics are shown in Fig. (1.3.2). Where 'A' is the attenuation while 'B' is the phase characteristics of the filter. Note that W_s and W_c are closed each other and the interval (W_c, W_s) is called transition range.



Fig(1.3.2) The attenuation and phase curves of the lowpass filter.

1.3.1.2 Highpass Filters

A highpass filter includes a passband in the frequency range $[W_c, \infty]$, and a stopband defined by the range $[0, W_s]$, with $W_s < W_c$. Its characteristics are shown in Fig. (1.3.3).

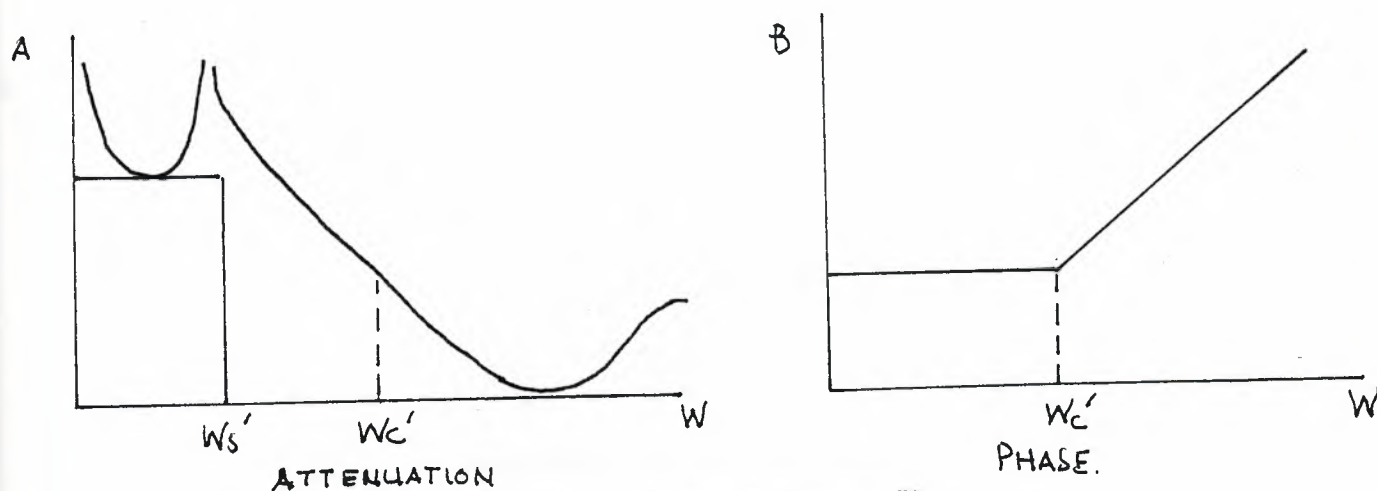
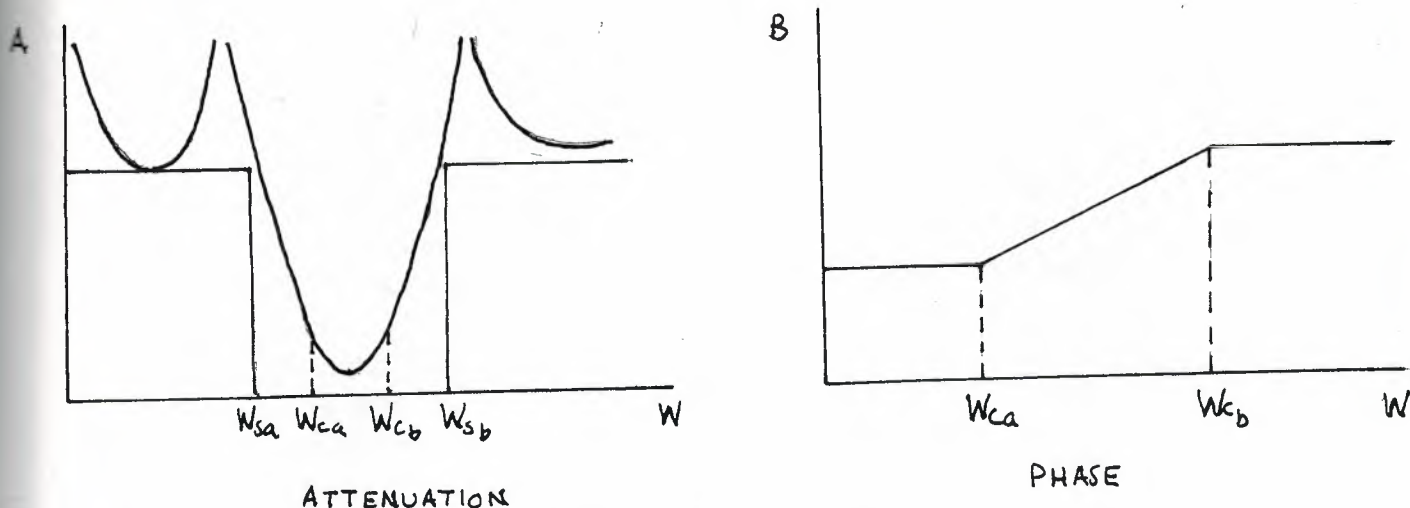


Fig (1.3.3) The attenuation and phase curves of highpass filter.

1.3.1.3 Bandpass Filters

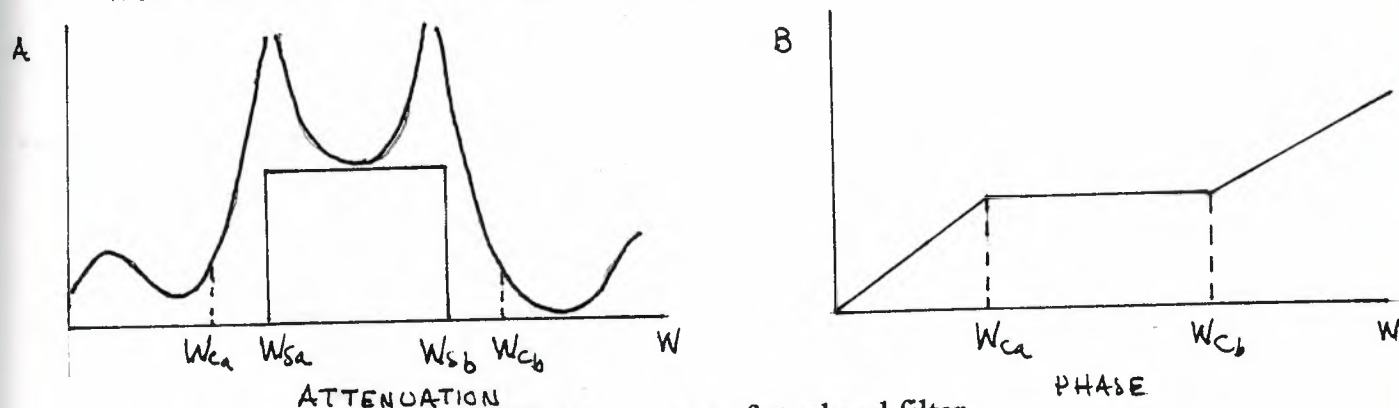
A bandpass filter has a passband $[W_{ca}, W_{cb}]$, set between two stopbands $[0, W_{sa}]$ and $[W_{sb}, \infty]$, with $W_{sa} < W_{ca}$ and $W_{cb} < W_{sb}$. Its characteristics are shown in Fig. (1.3.4).



Fig(1.3.4) The attenuation and phase curves of bandpass filter.

1.3.1.4 Stopband Filters

A stopband filter has a stopband defined by the range $[W_{sa}, W_{sb}]$, set between two passbands $[0, W_{ca}]$ and $[W_{cb}, \infty]$, with $W_{sa} > W_{ca}$ and $W_{cb} < W_{sb}$. Its characteristics are shown in Fig.(1.3.5).



Fig(1.3.5) The attenuation and phase curves of stopband filter.

1.3.1.5 Other Type Filters

It is possible to define filters having more than one passbands and stopbands. Although such filters are not considered in this report, the ladder network analysis network program presented here can also be used to analyse these type of filters with the same capability.

1.3.2 Classification in Terms of Circuit Configuration

1.3.2.1 The Lattice Network

The network shown in Fig. (1.3.5) is named unsymmetrical lattice. If $Z_a=Z_c$ and $Z_b=Z_d$ the resulting symmetrical network is called symmetrical lattice or, more commonly, simply lattice. The lattice is an important structure to the network designer.

The schematic diagram of a lattice is shown in Fig. (1.3.5). Its simplified representation is portrayed in Fig. (1.3.6), while in Fig(1.3.7) the lattice is redrawn to show its bridge character.

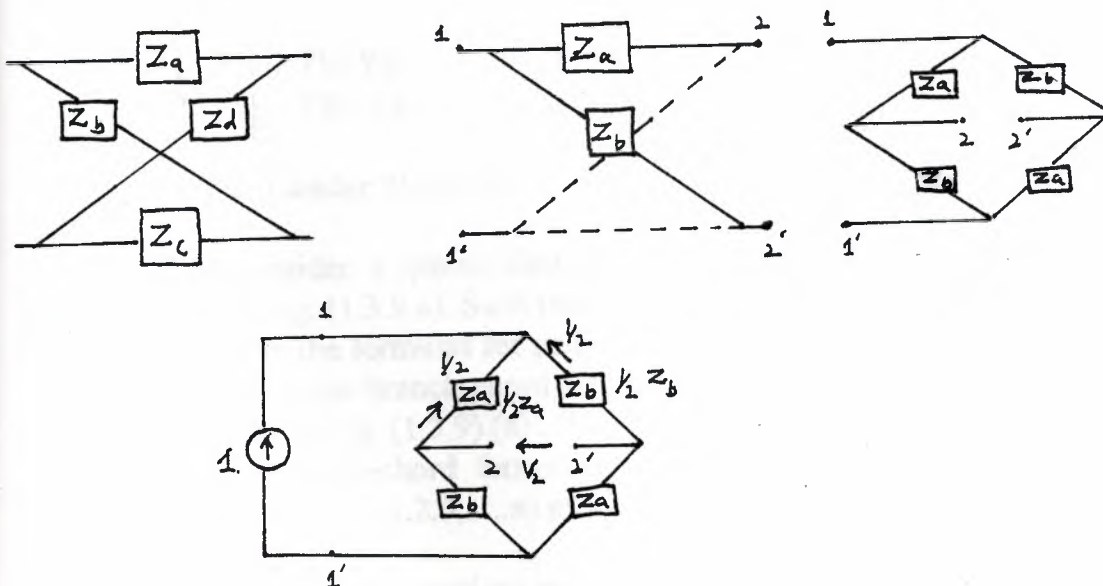
From Fig. (1.3.5)

$$Z_{11} = \frac{1}{2} * (Z_a + Z_b) = Z_{22} \text{ by symmetry} \quad (1.3.1.1)$$

Since

$$Z_{21} = \frac{V_2}{I_1} \Big|_{I_2=0} \quad (1.3.1.2)$$

If we apply $I_1=1$ to the lattice and calculate V_2 then $Z_{21}=V_2$ (1.3.1.3)



Redrawing Fig. (1.3.7) as in Fig. (1.3.8) , with the currents and voltages as indicated , then

$$Z_{21} = \frac{1}{2} * (Z_b - Z_a) = Z_{12} \quad (1.3.1.4)$$

Thus the Z matrices for the lattice is given by

$$[Z] = \frac{1}{2} * \begin{bmatrix} Z_b + Z_a & Z_b - Z_a \\ Z_b - Z_a & Z_b + Z_a \end{bmatrix} \quad (1.3.1.5)$$

Since

$$Y_{11} = Y_{22} = \frac{Z_{22}}{|Z|} = \frac{1}{2} * (Y_b + Y_a) \quad (1.3.1.6)$$

and

$$Y_{12} = Y_{21} = - \frac{Z_{21}}{|Z|} = - \frac{1}{2} * (Y_b - Y_a) \quad (1.3.1.7)$$

The Y matrix for lattice is

$$[Y] = \frac{1}{2} * \begin{bmatrix} Y_b + Y_a & Y_b - Y_a \\ Y_b - Y_a & Y_b + Y_a \end{bmatrix} \quad (1.3.1.8)$$

1.3.2.2 The Ladder Network

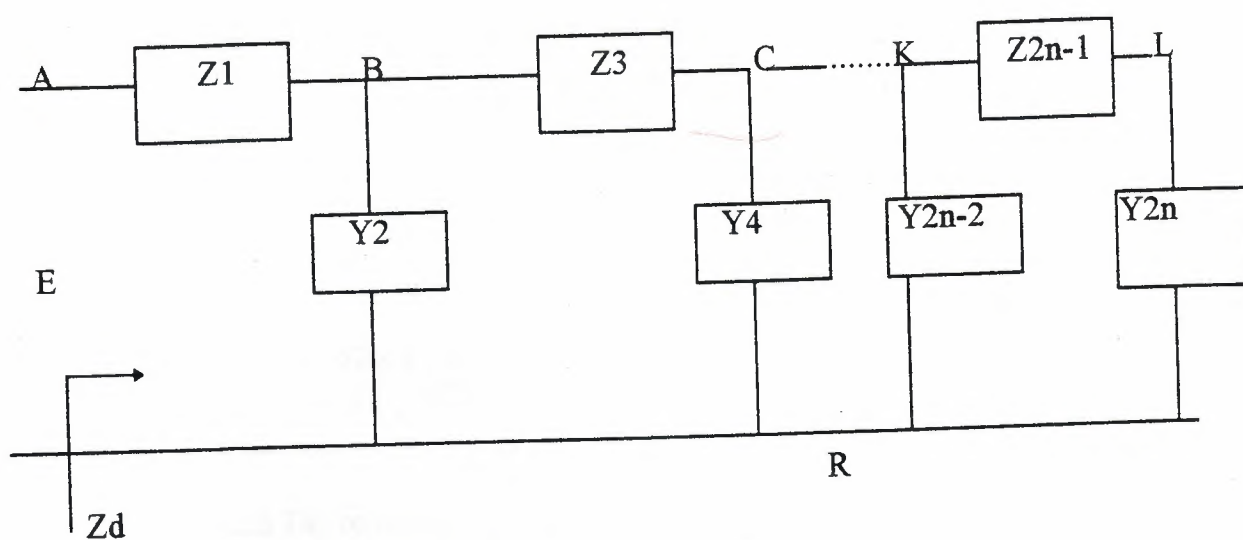
Now consider a special kind of configurations of a two port network , which is shown in Fig. (1.3.9.a). Such two-port network is called LADDER NETWORK.

To obtain the formulas for certain network functions of the ladder network , it is expedient to use branch-chord formulation. The network graph with the selected tree is shown in Fig. (1.3.9) (a) , (b).

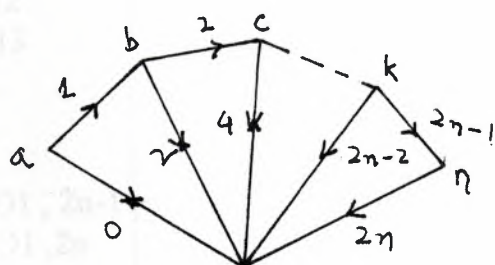
The branch-chord formulation will contain the voltage variables of the admittance's Y_{2i} ($i=1,2,3,\dots,n$) and the current variables of the impedance's Z_{2i-1} ($i=1,2,3, \dots,n$).

The terminal equations are

$$\begin{bmatrix} Z1 & & & \\ & Y2 & & \\ & & Z3 & \\ & & & \ddots \\ & & & & Y2n \end{bmatrix} \begin{bmatrix} I1 \\ V2 \\ I3 \\ \vdots \\ V2n \end{bmatrix} = \begin{bmatrix} V1 \\ I2 \\ V3 \\ \vdots \\ I2n \end{bmatrix} \quad (1.3.2.1)$$



Fig(1.3.9) (a) ladder network



(b) branch-chord tree

$$\begin{bmatrix} V_1 \\ I_2 \\ V_3 \\ \vdots \\ V_{2n-1} \\ I_n \end{bmatrix} = \begin{bmatrix} 0 & -1 & & & \\ 1 & 0 & -1 & & \\ 0 & 1 & 0 & -1 & \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ & & & & 0 & 1 \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \\ I_3 \\ \vdots \\ I_{2n-1} \\ V_{2n} \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \\ \vdots \\ \vdots \\ \vdots \\ 0 \end{bmatrix} * E$$

The desired formulation can be gotten combining this two equation.

If D and D_{ij} represent the determinant and the cofactors of the coefficient matrix, respectively, then the last equation can be written as follows.

D and D_{ij} can be written in terms of bracket symbols
 $D = [Z_1, Y_2, Z_3, \dots, Z_{2n-1}, Y_{2n}]$

$$D_{11} = [Y_2, Z_3, \dots, Y_{2n}]$$

(1.3.2.5)

..

..

..

..

$$D_{1, 2n-1} = [Y_{2n}]$$

$$D_{1, 2n} = [1]$$

So all the chord currents branch voltages in (1.3.2.4) can be expressed in terms of the bracket symbols.

In particular

$$V_{2n} = \frac{1}{D} * E$$

$$= \frac{1}{[Z_1, Y_2, Z_3, \dots, Z_{2n-1}, Y_{2n}]} * E \quad (1.3.2.6)$$

On the other hand, driving-point impedance of the ladder network is

$$Z_d = \frac{E}{D} = \frac{[Z_1, Y_2, Z_3, \dots, Z_{2n-1}, Y_{2n}]}{[Y_2, Z_3, \dots, Z_{2n-1}, Y_{2n}]} \quad (1.3.2.7)$$

and eq. (1.3.2.7) can be written as continued fraction also

$$Z_d = Z_1 + \frac{1}{Y_2 + \frac{1}{Z_3 + \dots + \frac{1}{Z_{2n-1} + \frac{1}{Y_{2n}}}}} \quad (1.3.2.8)$$

1.3.2.3 Bridged - T Network

A useful configuration is bridged-T network shown in fig.(1.3.10). It can be redrawn as either a parallel or a series interconnection of two simple ladders. These two decomposition's of the bridged-T are shown in fig. (1.3.11).

The bridged-T can be analysed by superposition the results of analysis of the component ladders.

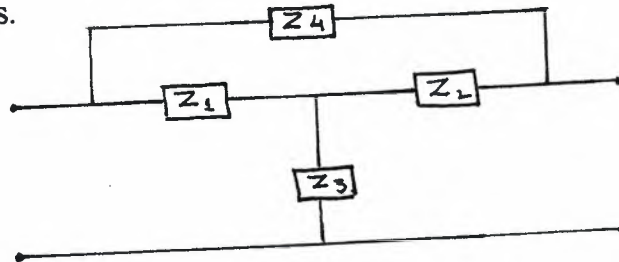


Fig. (1.3.10) A bridged-T network

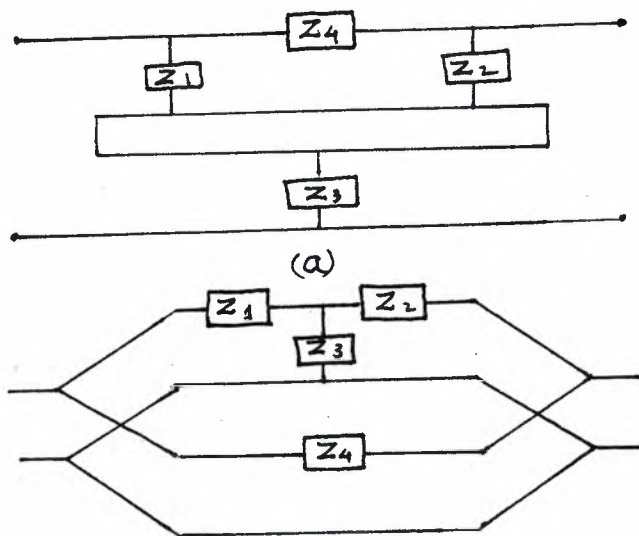


Fig.(1.3.11) Decomposition of a bridged-T in to (a) Series interconnected ladders.
(b) parallel interconnected ladders.

1.3.2.4 Twin-T Network

The twin-T network configuration is shown in Fig. (1.3.12). This network is redrawn in Fig (1.3.13) as a decomposition in to two parallel inter connected ladders. The analysis of the component ladders.

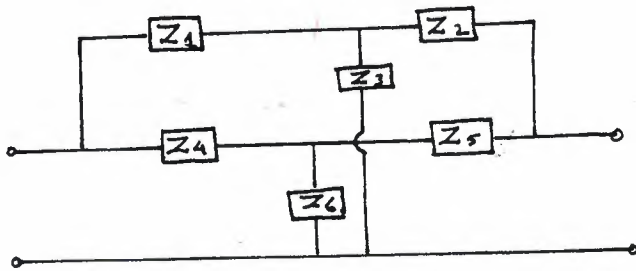


Fig.(1.3.12) A Twin-T network

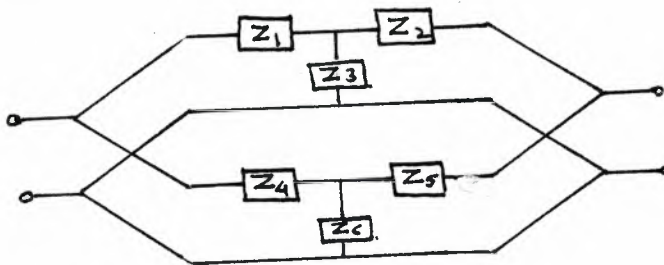


Fig.(1.3.13) Decomposition of the twin-T network in to two parallel interconnected ladders.

1.4 Insertion Loss and Phase Calculations

Consider , a doubly terminated network consisting of a lossless two-port network terminated in a resistor R_{th} at the source port and in a resistor at R_L the load part , as shown in Fig.(1.4.1). Such a network is capable of providing greater power flow in the passband with the consequence that the circuit is less sensitive at passband frequencies to change in its element values.

The circuit of Fig. (1.4.1) may be thought of as an LC network inserted between the input and the output resistors. If P_2 is the power delivered to the load with the network inserted , and P_{20} is the power that would be delivered to the load without the inserted network , as shown in Fig. (1.4.2).

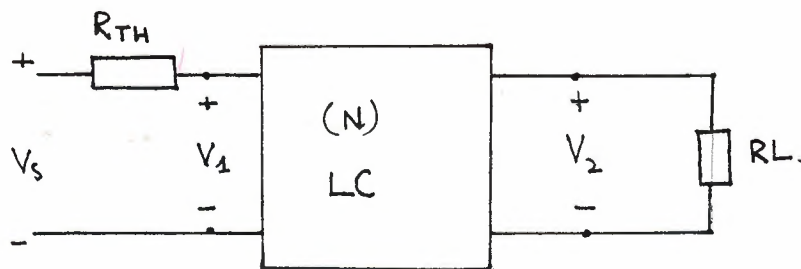


Fig.(1.4.1) A doubly terminated LC network

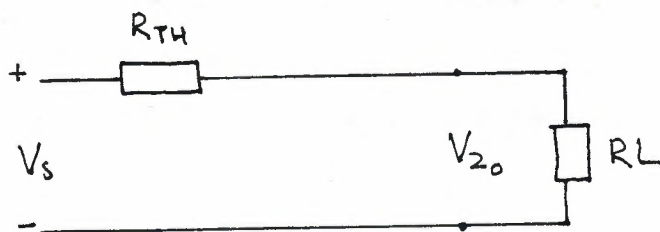


Fig.(1.4.2) The system without the inserted network.

The insertion loss is ratio of maximum available power at sources terminals to the power delivered to load with N inserted.

By definition of insertion loss

$$h = P_{20}/P_2$$

where $P_{20} = |V_{20}|^2 / R_L$ and $P_2 = |V_2|^2 / R_L$

Hence

$$h = \frac{|V_{20}|^2}{|V_2|^2}$$

or

$$h = 20 \log \left| \frac{V_{20}}{V_2} \right| \quad \text{in dB} \quad (1.4.1)$$

In order to find V_2 , in terms of circuit elements, the continuant can be used as

$$V_2 = \frac{V_s}{[Z_1, Y_2, Z_3, \dots, Y_{2n}]} \quad (1.4.2)$$

where $Z_1 = R_{TH} + \text{first series element of the LC network}$
 $Y_{2n} = 1/R_L + \text{last shunt element of the LC network}$

Also, V_{20} can be determined, in terms of circuit elements, by using voltage divider rule as

$$V_{20} = \frac{R_L}{R_L + R_{TH}} * V_s \quad (1.4.3)$$

by substituting expressions in (1.4.2) and (1.4.3) into (1.4.1), we get

$$h = 20 \log \left| \frac{[Z_1, Y_2, \dots, Y_{2n}] * R_L}{R_L + R_{TH}} \right| \quad (1.4.4)$$

Hence

$$h = 20 \log [(|D_k| * R_L) / (R_L + R_{TH})] \quad (1.4.5)$$

where $D_k = [Z_1, Y_2, \dots, Y_{2n}]$

The h and phase of the A_k gives, attenuation characteristic and phase characteristic of the given network.

2- COMPUTER PROGRAM

Computers are used to solve a wide range of problems which can be related with science , engineering , business , etc. However , it must be stated that a computer can not solve a problem by itself . It is only a tool which can aids our mental powers by depositing and retaining large volumes of information , performing computations according to the commands or instructions given to it at very high speed and with precision and reliability.

2.1 The Aim of the Computer Program for the Analysis of the Ladder Networks

It is needed that the phase and the attenuation characteristics of a ladder type filter be calculated in a given frequency interval. For that reason , calculations for the same filter network must be repeated at a large number of different frequencies for the input signal.

The calculations of the phase and the attenuation functions take a long time. However a computer program ease this calculation , with more precision and reliability.

In this section it will be seen that the computer analysis of a given Lcl ladder network by the written program. The analysis is based on calculations of insertion loss and insertion phase functions by using continuants . Specifically , the problem considered here is the following.

GIVEN: A ladder network , its element values , a frequency interval and termination resistors (R_{th} and R_l).

FIND: The attenuation and phase values of the voltage ratio V_2/V_1 .

The form of the ladder network which will be analysed by the written program must be as in Fig. (2.1).

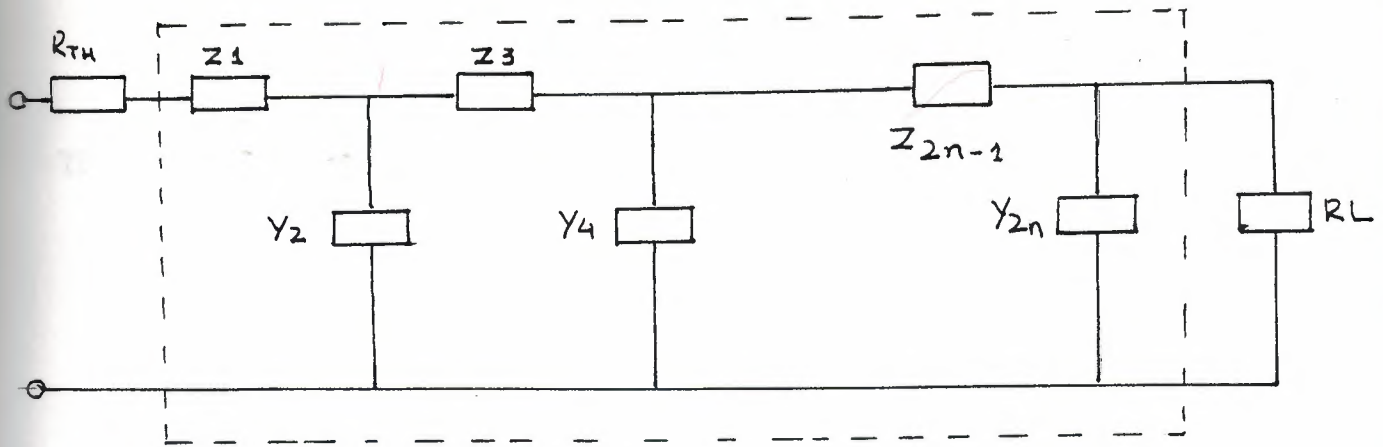


Fig.(2.1) A ladder circuit terminated between two termination resistor.
As it is shown in Fig.(2.1) the output arm is a shunt branch and the input arm a series branch, and the ladder network terminated by the resistors R_{th} and R_L . In addition, the elements of the arms are considered ideal.

2.2 Some Definitions and Properties used in Ladder Network Analysis Program

Calculations which are required in the ladder network analysis program are based on some new definitions and the properties of the continuants. These are already discussed briefly in the previous sections.

In this section we are mainly interested in to know as to how the various expressions are calculated in the ladder network analysis program.

2.2.1 The Calculations of Continuants

A continuant with complex elements is calculated for a given specific frequency interval by the written program. This program as a subroutine of the ladder network analysis computer programs described in the following.

```

DO 100 L=1, KL
H(J+2,L)=0
H(J+1,L)=1
DO 181 I=J, 1, -1
H(I,L)= Z(I,L) * H(I+1,L) + H(J+2,L)
181 CONTINUE
100 CONTINUE

```

The flowchart of this subroutine is shown in Fig. (2.2.1.1)

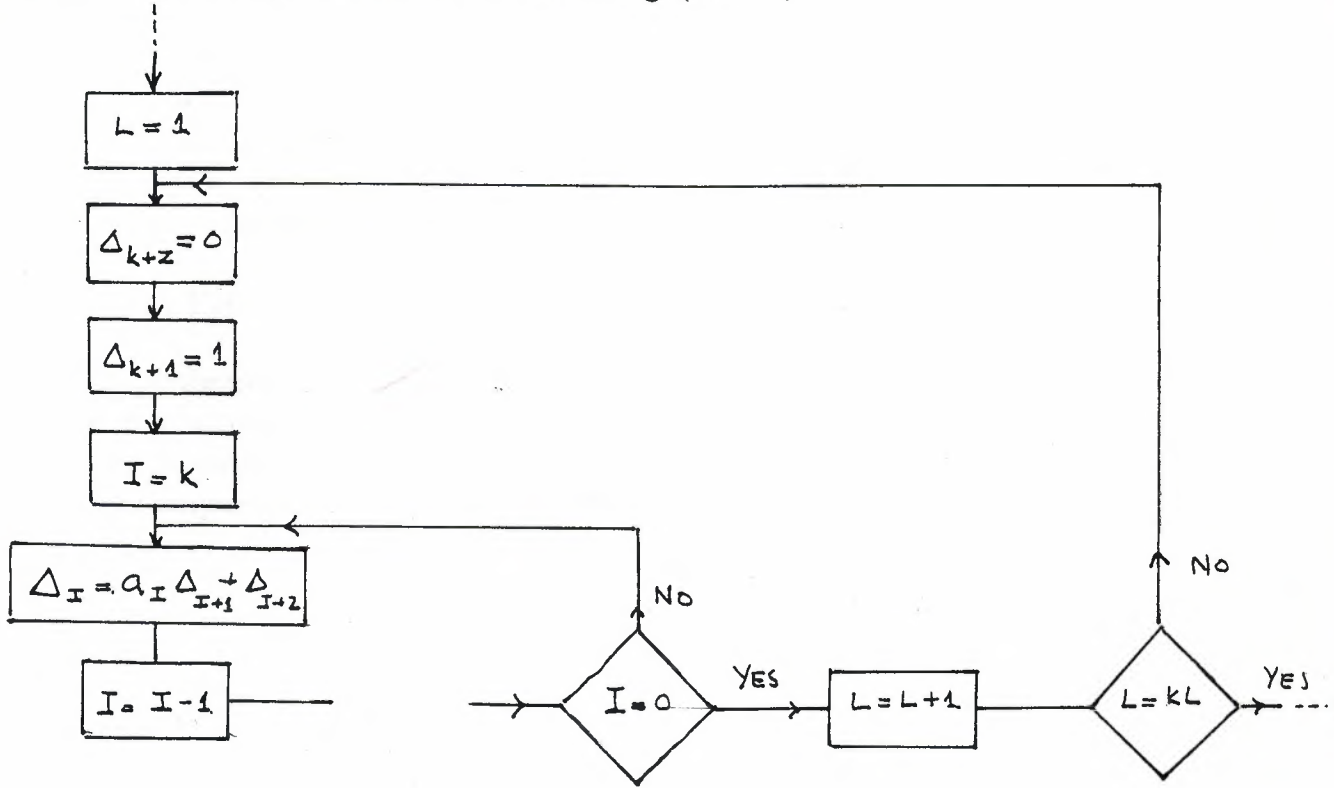


Fig. (2.2.1.1) The flowchart of the calculation of continuant.

Where KL is the number of the frequency and L is the counter of the frequency.

The continuant is calculated for each frequency and L is the counter of the frequency.

The continuant is calculated for each frequency value. In this program the formula.

$$D_k = a_k * D_{k+1} + D_{k+2}$$

is used. Where the bracket symbol is expanded, so that the last two terms of the continuant are found from formula, in which by definition, $D_{k+2} = 0$ and $D_{k+1} = 1$

Therefore $[a_{k-1}, a_k]$ and $[a_k]$ can be found.

As an example; let $k=3$. Then

$$\begin{aligned}
D_{k+2} &= D_5 = 0 \\
D_{k+1} &= D_4 = 1 \\
D_3 &= a_3 * D_4 + D_5 = a_3 \\
D_2 &= a_2 * D_3 + D_4 = a_2 * a_3 + 1 \\
D_1 &= a_1 * D_2 + D_3 = a_1 * a_2 * a_3 + a_1 + a_3
\end{aligned}$$

Hence D_1 is the desired expression for the continuant.

2.2.2 The Calculation of Insertion Loss and Insertion Phase Functions

The definition and the method of calculation of the insertion loss and phase were given in section 1.4.

For the calculation of insertion loss and phase of a given ladder network by a computer program, the following subroutine is developed

```

DO 102 L=1, KL
M(L)= H (1,L) * RL / (RTH+RL)
E=REAL(M(L))

S= AIMAG(M(L))
MA (L) = SQRT (E*E + S*S)
IF (RL.EQ.RTH) THEN
LMA (L) = 20* ALOGIO(MA(L))
ELSE
LMA (L) = 20*ALOGIO(MA(L)) + 20*ALOGIO((RTH + RL) /
(2*SQRT(RL+RTH)))
ENDIF
IF(E.EQ.0) GO TO 159
TE(L) = ATAN (S/E)
GO TO 102
159 TE(L) = P/2
102 CONTINUE

```

where $M(L)$

E

S

$MA(L)$

$LMA(L)$

$TE(L)$

indicates V_{20}/V_2

indicates the real part of $M(L)$

indicates the imaginary part of $M(L)$

indicates the magnitude of $M(L)$

indicates the attenuation in dB

indicates the phase in radians

The flowchart of this subroutine is shown in Fig. (2.2.2.1)

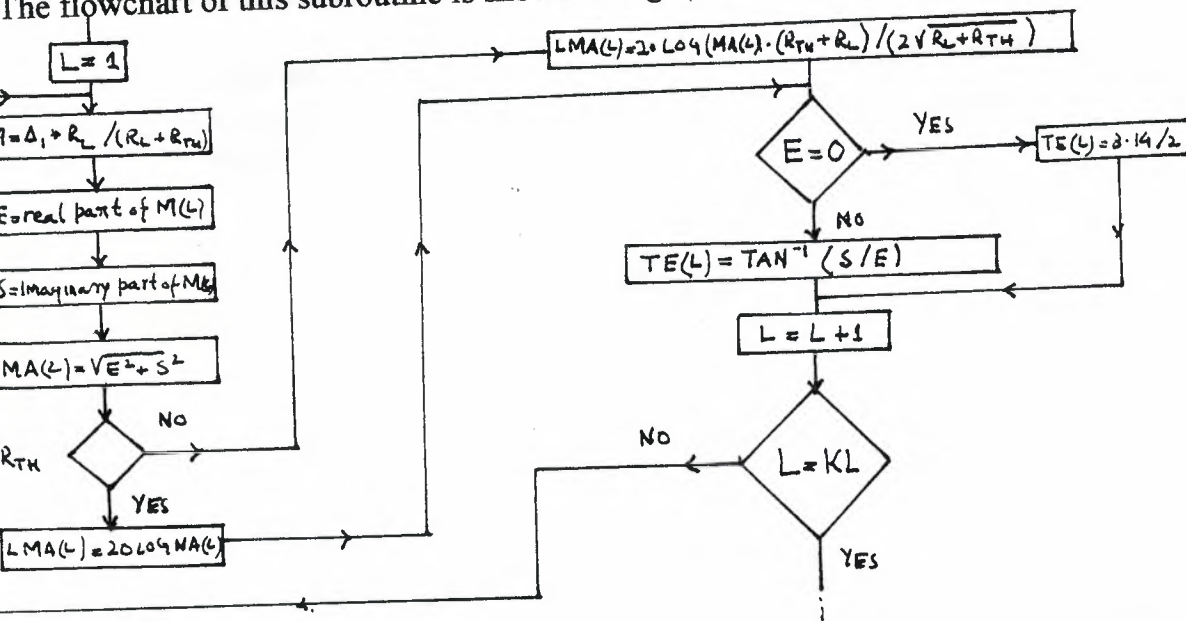


Fig.(2.2.2.1) The flowchart of subroutine for the insertion loss and insertion phase.

2.3 How to Use the Ladder Network Analysis Computer Program

A computer program is meaningful if it takes some data from keyboard, punched charts, files, etc., and, if it computes certain expressions for the given data and if it presents the result to the outside world by means of a monitor, a printer, etc.

2.3.1 Input Quantities

The input quantities, for the ladder analysis program, are followings

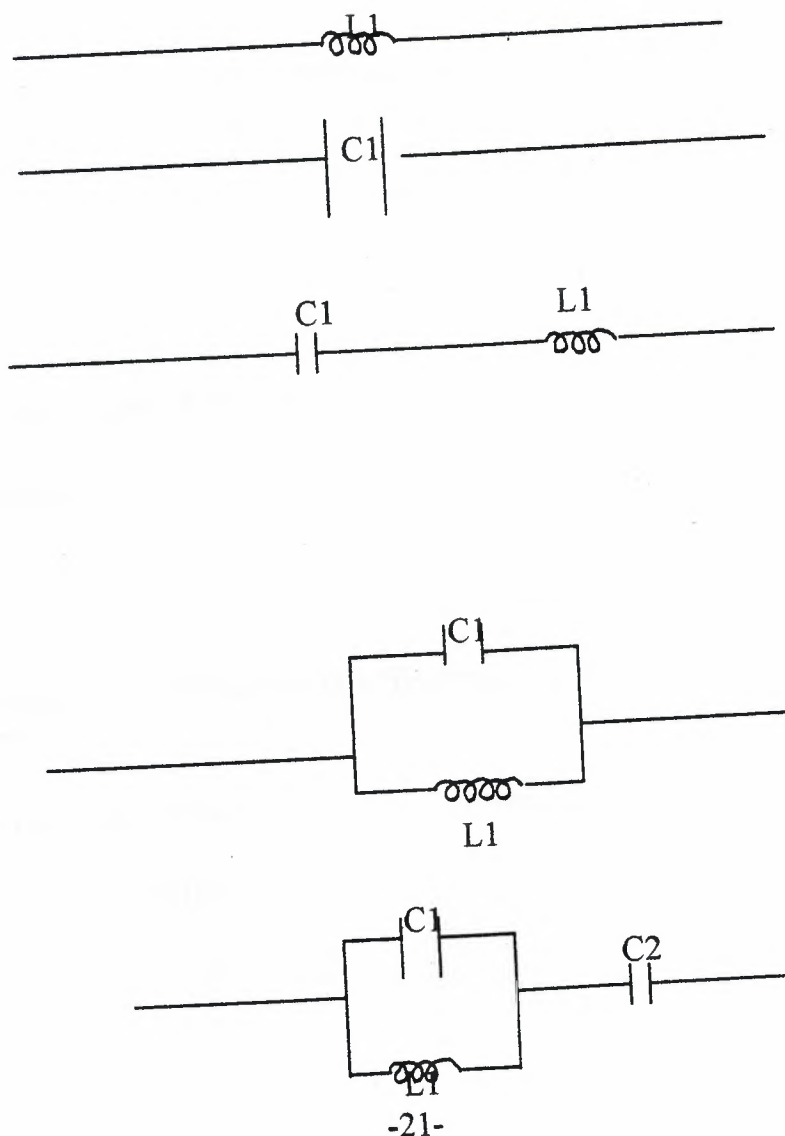
- 1) A file name, if the results are stored in to a file
- 2) Termination's resistors.
- 3) Node number.
- 4) Frequency range and its increment value.

- 5) Reactive element configuration code.
- 6) Capacitor and inductor values.

After inputting the input data , the attenuation and the phase values are displayed on the monitor.

2.3.2 Series and Shunt Element Configurations

Reactive element configurations , in the Fig. (2.3.2.1) , are available in the ladder network analysis computer program. Its means that written program calculates reactance's only following type of reactive components.



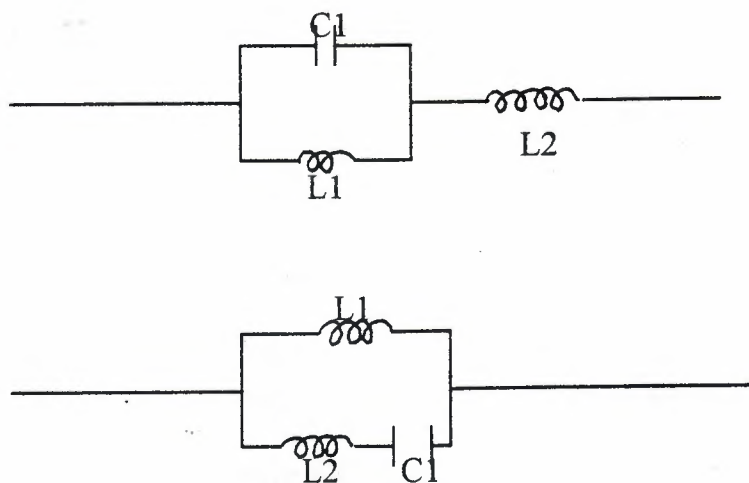


Fig. (2.3.2.1) The reactive element configurations.

If Z1 or Y2n or both of them do not exist in the filter which will be analysed by written program (see Fig. (2.1))

For Z1; select configuration code 1 and enter the value of the inductor zero ,

For Y2n; select configuration code 2 and enter the value of the capacitor zero.

2.3.3 Running of the Ladder Network Analysis Computer Program

Let investigate step by step what will be happened when we run the written program;

STEP 1: DO YOU WANT TO KEEP THE RESULT IN A FILE ? : (Y OR N)

If you want to keep the results in a file press y or Y button , otherwise press n or N button.

STEP 1.1 : If you press the Y or y button , the following line is displayed.

PLEASE ENTER THE NAME OF FILE

now enter a name which will be the name of the file which the results are stored in it.

STEP 1.2: If you press n or N button STEP 1.1 will be skipped.

STEP 2: PLEASE ENTER THE VALUE OF THE INPUT RESISTANCE

In this step , enter the value of the input termination resistor.

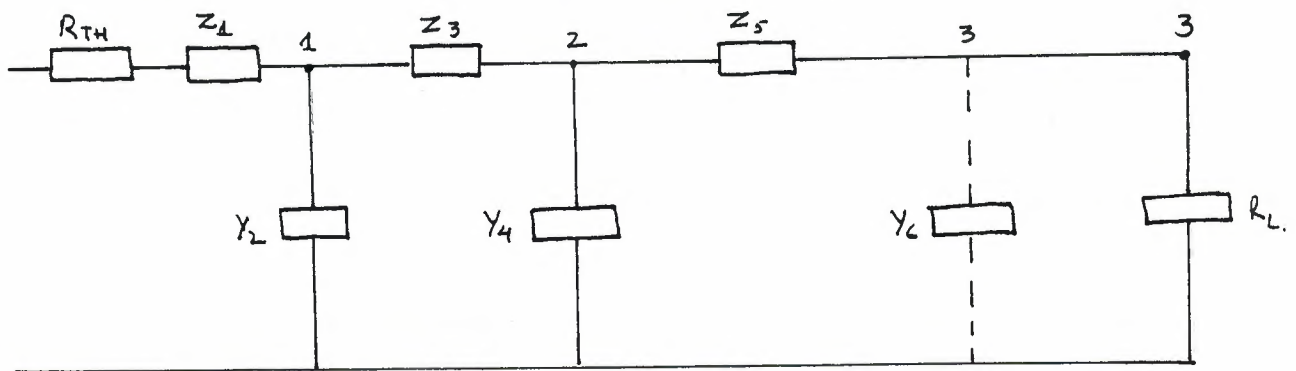
STEP 3: PLEASE ENTER THE VALUE OF THE LOAD RESISTANCE

Now , enter the value of the ending termination resistor.

STEP 4: PLEASE ENTER THE NODE NUMBER

Enter the node number of the ladder network which will be analysed by the written program. Here , there is a restriction that is maximum node number can be at most 15.

As an example ; assume that we have following filter



In this circuit there are three node. Therefore , when the question in step four is displayed , 3 must be entered.

STEP 5: PLEASE ENTER THE FREQUENCY RANGE W1,W2,W3

In this step enter the frequency range and the its increment value where the analysis is done in this range.

Where

W1 is the starting value of the frequency

W2 is the ending value of the frequency

W3 is the increment value of the frequency

STEP 6: In this step the filter circuit is constructed firstly the configurations of the elements and the following question are displayed.

PLEASE ENTER THE CONFIGURATION CODE

STEP 6.1: If 1 is entered for configuration code

PLEASE ENTER THE VALUE OF L1

is displayed. Now , enter the value of the inductance.

STEP 6.2: If 2 is entered for configuration code

PLEASE ENTER THE VALUE OF THE C1

is displayed. Now , enter the value of the capacitance.

STEP 6.3: If 3 or 4 is entered for configuration code

PLEASE ENTER THE VALUE OF THE L1

is displayed. Now , enter the value of the inductance. After the entering the inductance value the following line is displayed.

PLEASE ENTER THE VALUE OF THE C1

now , enter the value of the capacitance.

STEP 6.4: If 5 is entered for configuration code

PLEASE ENTER THE VALUE OF THE L1

PLEASE ENTER THE VALUE OF THE C1

PLEASE ENTER THE VALUE OF THE C2

are displayed. Now , enter the values of the inductance , first capacitance , and second capacitance , respectively.

STEP 6.5: If 6 or 7 is entered for configuration code

PLEASE ENTER THE VALUE OF THE L1

PLEASE ENTER THE VALUE OF THE L2

PLEASE ENTER THE VALUE OF THE C1

are displayed. Now , enter the values of the first, inductance , second inductance and capacitance , respectively.

The **STEP 6** is repeated node number*2 times. The entering operation of the data is finished after the last element value is entered.

STEP 7: After data entering operation , the frequency values , the phase values and the attenuation values are displayed on the monitor , where the attenuation's are in dB , the phases are in radian.

STEP 8: DO YOU WANT TO CHANGE ANYTHING ? (Y OR N)

STEP 8.1 : If your answer is no (n or N) , then the program goes to step 9.

STEP 8.2 : If your answer is yes (y or Y) (It means that you want to change something in input quantities) , then the following lines are displayed.

FREQUENCY RANGE : 1
INPUT RESISTOR : 2
LOAD RESISTOR : 3
ELEMENT VALUE : 4

then

INPUT THE NUMBER OF ITEM WHICH WILL BE CHANGED

STEP 8.2.1 If you enter 1, then following line is displayed
PLEASE ENTER THE NEW FREQUENCY RANGE w_1, w_2, w_3
now enter new starting frequency value , ending frequency
value , and increment value .

STEP 8.2.2 If 2 is entered
PLEASE ENTER THE NEW INPUT RESISTANCE VALUE
is displayed . Enter now , new input resistor value.

STEP 8.2.3 if 3 is entered
PLEASE ENTER THE NEW LOAD RESISTANCE VALUE
is displayed .Now , enter the new load resistor value.

STEP 8.2.4 if 4 is entered
PLEASE ENTER THE BRANCH NUMBER
is displayed . Here , the branch number is the of resonant
configuration, as an example ; consider following circuit

After inputting the branch number , the program wants the new values of
elements of this branch .

The ladder network analysis computer program recalculates the
attenuation and the phase values after the step 8 .

The 8 is displayed after new values of the attenuation and the phase
values are displayed.

STEP 9 : DO YOU WANT TO RUN AGAIN ? (Y OR N)

This step is the last step of the ladder network analysis
computer program.

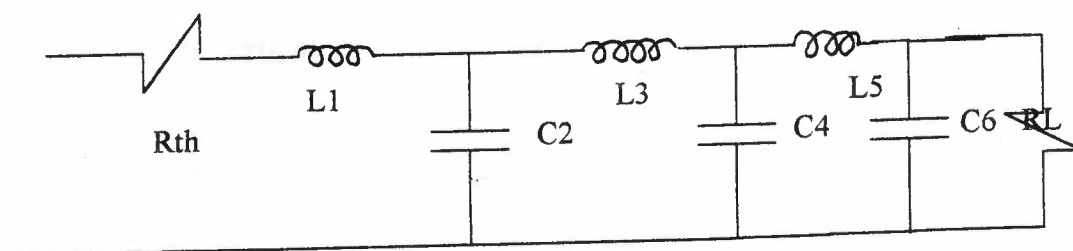
Here if you wish to run again press y or Y button After this ,
program starts from Step 2.

If you do not want to run the written programs press n or N button ,
this operation stops the program.

2.4 - Examples

EXAMPLE :1

Consider following filter



Where $L1=0.8303$

$C2=2.7042$

$L3=1.2912$

$C4=2.8721$

$L5=1.2372$

$C6=1.9557$

$RTH=0.5$

$RL=1$

circuit elements are normalised.

PLEASE ENTER THE VALUE OF RESISTANCE OF INPUT SIGNAL
0.5000000

PLEASE ENTER THE VALUE OF LOAD RESISTANCE
1.000000

HOW MANY NODES ARE THERE ON FILTER CIRCUIT?
3

PLEASE ENTER THE RANGE ON FREQUENCY W1,W2,W3
0.0100000 1.200000 0.0100000

PLEASE ENTER THE CONF. CODE
1

PLEASE ENTER THE VALUE OF L1

0.8303000
 PLEASE ENTER THE CONF. CODE
 2
 PLEASE ENTER THE VALUE OF C1
 2.7042000
 PLEASE ENTER THE CONF. CODE
 1
 PLEASE ENTER THE VALUE OF L1
 1.2912000
 PLEASE ENTER THE CONF. CODE
 2
 PLEASE ENTER THE VALUE OF C1
 2.8721000
 PLEASE ENTER THE CONF. CODE
 1
 PLEASE ENTER THE VALUE OF L1
 1.2372000
 PLEASE ENTER THE CONF. CODE
 2
 PLEASE ENTER THE VALUE OF C1
 1.955700

FREQUENCY	ATTENUATION	PHASE
0.01	0.50969	0.04751
0.02	0.50419	0.09507
0.03	0.49510	0.14274
0.04	0.48254	0.19056
0.05	0.46667	0.23860
0.06	0.44770	0.28690
0.07	0.42587	0.33551
0.08	0.40149	0.38447
0.09	0.37488	0.43381
0.10	0.34641	0.48359
0.11	0.31651	0.53382
0.12	0.28561	0.58453
0.13	0.25418	0.63575
0.14	0.22270	0.63749
0.15	0.19169	0.73974
0.16	0.16166	0.79252
0.17	0.13311	0.84582
0.18	0.10655	0.89961
0.19	0.08246	0.95387
0.20	0.06130	1.0085

FREQUENCY

ATTENUATION

PHASE

0.21	0.04346	1.06367
0.22	0.02930	1.11913
0.23	0.01913	1.17489
0.24	0.01317	1.23089
0.25	0.01157	1.28708
0.26	0.01440	1.34339
0.27	0.02164	1.39976
0.28	0.03319	1.45612
0.29	0.04887	1.51242
0.30	0.06839	1.56859
0.31	0.09144	-1.51700
0.32	0.11757	-1.46123
0.33	0.14634	-1.40572
0.34	0.17721	-1.35050
0.35	0.20964	-1.29559
0.36	0.24302	-1.24101
0.37	0.27676	-1.18677
0.38	0.31026	-1.13284
0.39	0.34289	-1.07923
0.40	0.37408	-1.02590

FREQUENCY

ATTENUATION

PHASE

0.41	0.40326	-0.97282
0.42	0.42988	-0.91995
0.43	0.45344	-0.86725
0.44	0.47350	-0.81464
0.45	0.48964	-0.76208
0.46	0.50153	-0.70948
0.47	0.50887	-0.65678
0.48	0.51145	-0.60388
0.49	0.50912	-0.55072
0.50	0.50183	-0.49719
0.51	0.48959	-0.44321
0.52	0.47252	-0.38868
0.53	0.45081	-0.33351
0.54	0.42479	-0.27761
0.55	0.39485	-0.22087
0.56	0.36152	-0.16322
0.57	0.32543	-0.10457
0.58	0.28732	-0.04485
0.59	0.24802	0.01602
0.60	0.20848	0.07808



FREQUENCY	ATTENUATION	PHASE
0.61	0.16973	0.14137
0.62	0.13284	0.20591
0.63	0.09894	0.27170
0.64	0.06916	0.33872
0.65	0.04459	0.40692
0.66	0.02624	0.47623
0.67	0.01499	0.54655
0.68	0.01155	0.61777
0.69	0.01637	0.68976
0.70	0.02967	0.76238
0.71	0.05133	0.83547
0.72	0.08092	0.90889
0.73	0.11765	0.98249
0.74	0.16041	1.05617
0.75	0.20778	1.12983
0.76	0.25804	1.20341
0.77	0.30927	1.27690
0.78	0.35931	1.35034
0.79	0.40590	1.42381
0.80	0.44670	1.4974

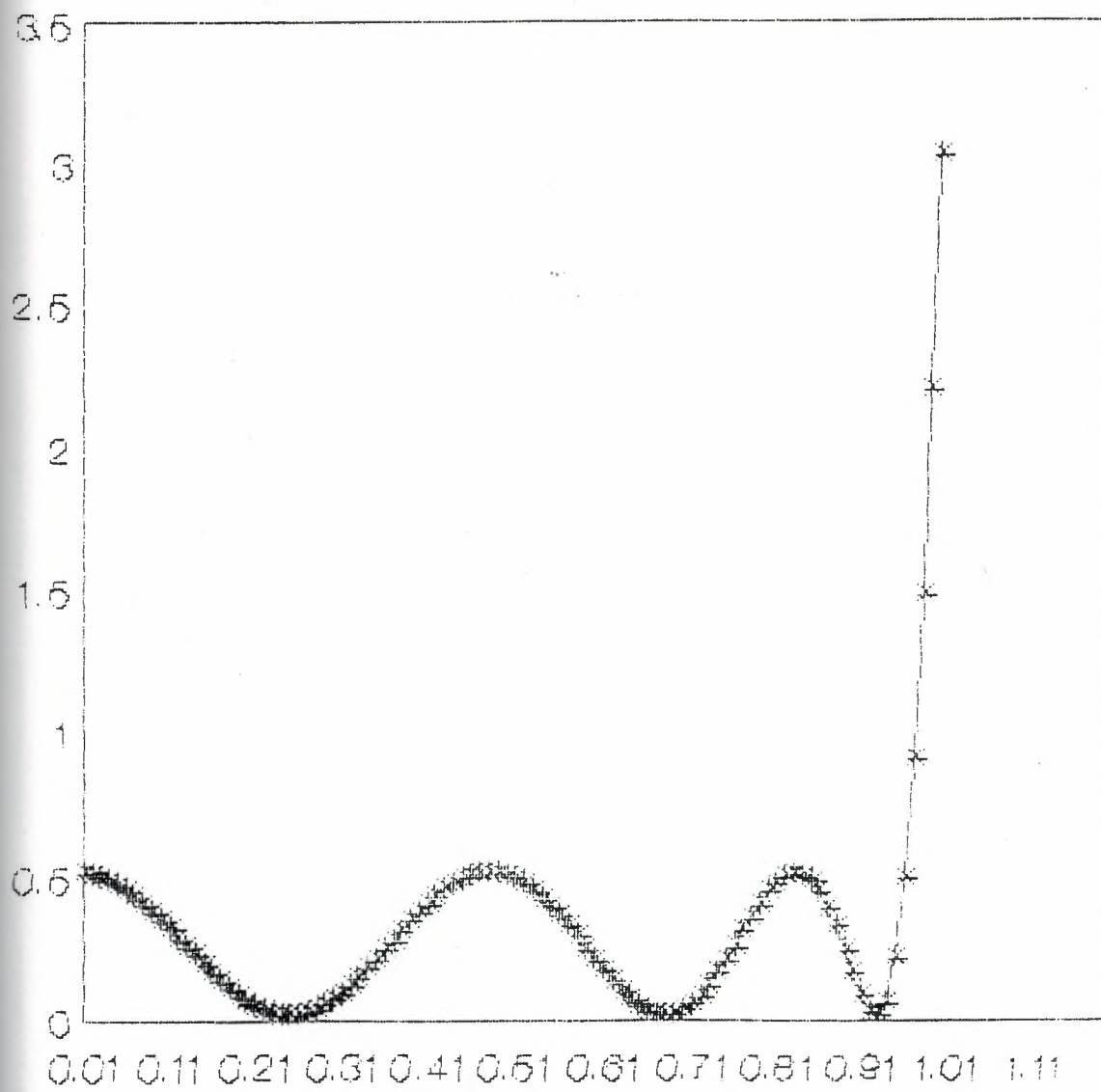
FREQUENCY	ATTENUATION	PHASE
0.81	0.47935	-1.57005
0.82	0.50158	-1.49527
0.83	0.51127	-1.41941
0.84	0.50656	-1.34198
0.85	0.48604	-1.26241
0.86	0.44895	-1.18001
0.87	0.39548	-1.09393
0.88	0.32726	-1.00321
0.89	0.24792	-0.90676
0.90	0.16396	-0.80334
0.91	0.08572	-0.69172
0.92	0.02845	-0.57075
0.93	0.01302	-0.43965
0.94	0.06564	-0.29834
0.95	0.21567	-0.14787
0.96	0.49086	0.00931
0.97	0.91085	0.16942
0.98	1.48141	0.32788
0.99	2.19249	0.48024
1.00	3.02138	0.62302

FREQUENCY	ATTENUATION	PHASE
1.01	3.93897	0.75413
1.02	4.91594	0.87283
1.03	5.92686	0.97938
1.04	6.95184	1.07468
1.05	7.97641	1.15988
1.06	8.99065	1.23621
1.07	9.98818	1.30482
1.08	10.96512	1.36678
1.09	11.91935	1.42300
1.10	12.84995	1.47424
1.11	13.75675	1.52118
1.12	14.64013	1.56438
1.13	15.50072	-1.53729
1.14	16.33935	-1.50023
1.15	17.15693	-1.46572
1.16	17.95443	-1.43345
1.17	18.73279	-1.40319
1.18	19.49295	-1.37473
1.19	20.23580	-1.34787
1.20	20.96219	-1.32248

DO YOU WANT TO CHANGE ANYTHING ?(Y OR N) N

DO YOU WANT TO RUN AGAIN ? : (Y OR N) N

attenuation

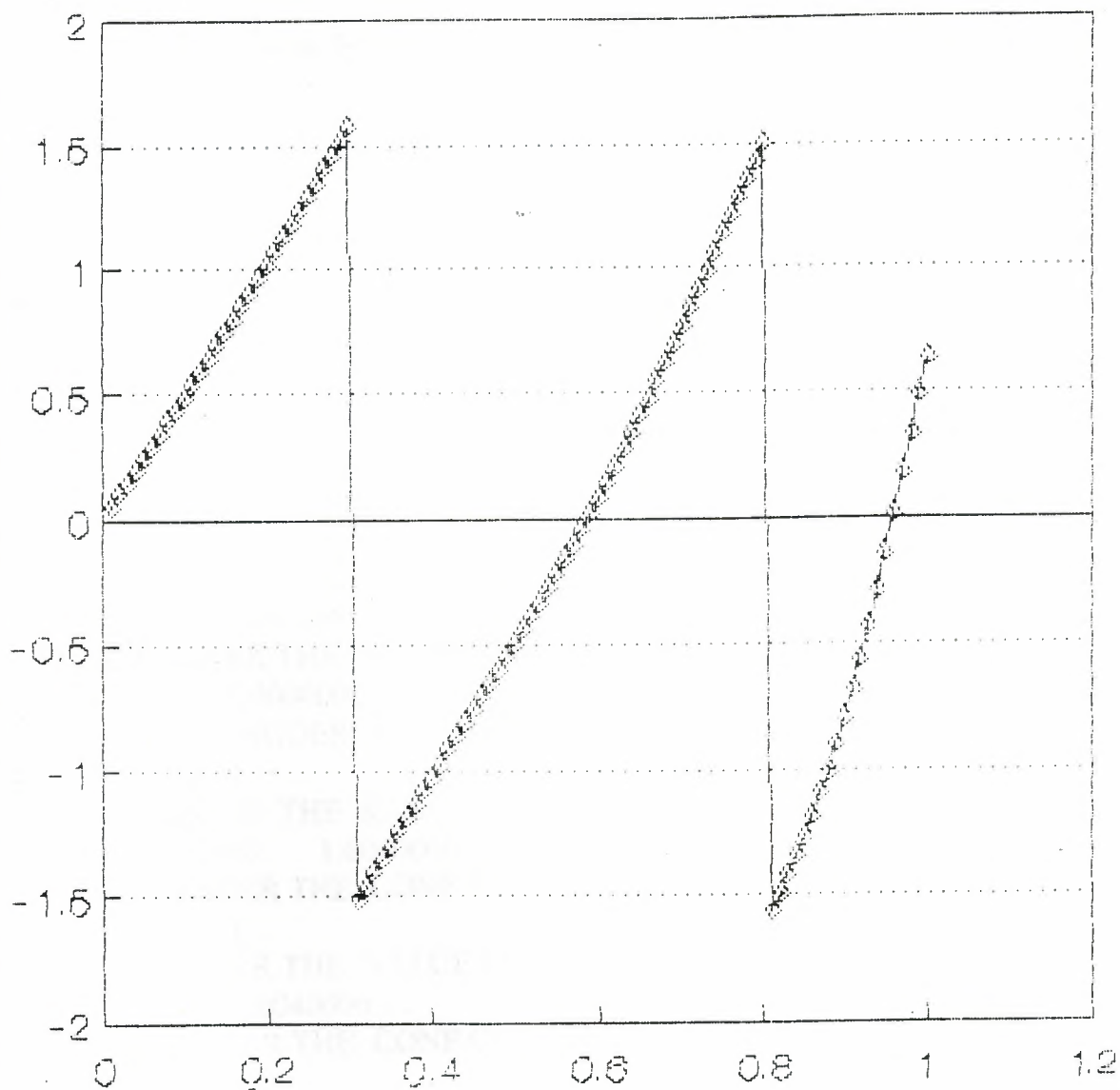


frequency

Series 3

ATTENUATION CHARACTERISTIC OF THE FIRST EXAMPLE

phase

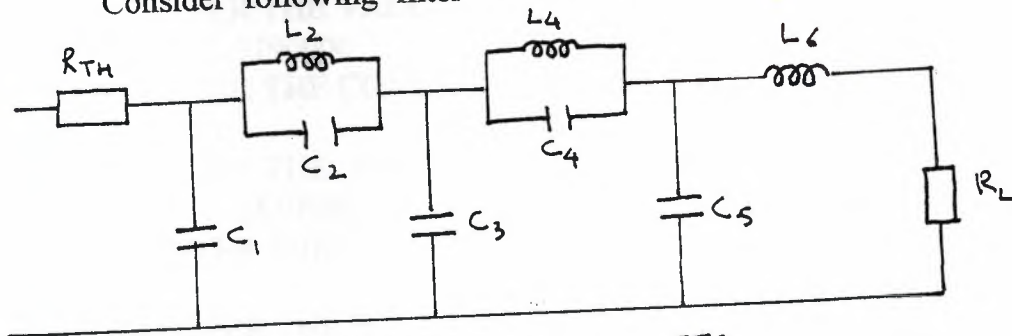


frequency

Series 6
PHASE CHARACTERISTIC OF THE FIRST EXAMPLE

EXAMPLE 2 :.

Consider following filter



WHERE

$C_1 = 1.004$	$C_4 = 0.2772$
$L_2 = 1.331$	$C_5 = 1.329$
$C_2 = 0.1609$	$L_6 = 1.151$
$C_3 = 1.513$	$R_L = 1$
$L_4 = 1.374$	$R_{TH} = 1$

PLEASE ENTER THE VALUE OF RESISTANCE OF INPUT SIGNAL

1.000000

PLEASE ENTER THE VALUE OF LOAD RESISTANCE

1.0000000

HOW MANY NODES ARE THERE ON FILTER CIRCUIT ?

4

PLEASE ENTER THE RANGE OF FREQUENCY W1,W2,W3

0.100000 1.600000 0.0100000

PLEASE ENTER THE CONF. CODE

1

PLEASE ENTER THE VALUE OF C1

1.0040000

PLEASE ENTER THE CONF.CODE

4

PLEASE ENTER THE VALUE OF L1

1.3310000

PLEASE ENTER THE VALUE OF C1

0.1601000

PLEASE ENTER THE CONF. CODE

2

PLEASE ENTER THE VALUE OF C1

1.5130000

PLEASE ENTER THE CONF CODE

4

PLEASE ENTER THE VALUE OF L1

1.3740000
PLEASE ENTER THE VALUE OF C1
0.2772000
PLEASE ENTER THE CONF. CODE
2
PLEASE ENTER THE VALUE OF C1
1.3290000
PLEASE ENTER THE CONF.CODE
1
PLEASE ENTER THE VALUE OF L1
1.1510000
PLEASE ENTER THE CONF. CODE
2
PLEASE ENTER THE VALUE OF C1
0.0000000

FREQUENCY	ATTENUATION	PHASE
0.01	0.00000	0.03851
0.02	0.00000	0.07703
0.03	0.00001	0.11556
0.04	0.00004	0.15411
0.05	0.00009	0.19269
0.06	0.00018	0.23130
0.07	0.00033	0.26995
0.08	0.00056	0.30864
0.09	0.00090	0.34738
0.10	0.00135	0.38618
0.11	0.00196	0.42503
0.12	0.00274	0.46395
0.13	0.00373	0.5029
0.14	0.00495	0.54199
0.15	0.00642	0.58113
0.16	0.00818	0.62033
0.17	0.01025	0.65962
0.18	0.01266	0.69899
0.19	0.01541	0.73844
0.20	0.01853	0.77798

FREQUENCY

ATTENUATION

PHASE

0.21	0.02204	0.81760
0.22	0.02594	0.85730
0.23	0.03024	0.89709
0.24	0.03495	0.93696
0.25	0.04004	0.97692
0.26	0.04552	1.01697
0.27	0.05137	1.05710
0.28	0.05757	1.09732
0.29	0.06408	1.13762
0.30	0.07088	1.17801
0.31	0.07792	1.21849
0.32	0.08516	1.25906
0.33	0.09255	1.29972
0.34	0.10002	1.34047
0.35	0.10752	1.38133
0.36	0.11496	1.42229
0.37	0.12229	1.46336
0.38	0.12943	1.50454
0.39	0.13629	1.54585
0.40	0.14280	-1.55430

FREQUENCY

ATTENUATION

PHASE

0.41	0.14888	-1.51272
0.42	0.15443	-1.47098
0.43	0.15938	-1.42907
0.44	0.16365	-1.38698
0.45	0.16716	-1.34469
0.46	0.16984	-1.30218
0.47	0.17162	-1.25944
0.48	0.17245	-1.21643
0.49	0.17226	-1.17315
0.50	0.17102	-1.12957
0.51	0.16870	-1.08566
0.52	0.16528	-1.04139
0.53	0.16076	-0.99674
0.54	0.15515	-0.95168
0.55	0.14848	-0.90618
0.56	0.14079	-0.86021
0.57	0.13217	-0.81373
0.58	0.12269	-0.76672
0.59	0.11247	-0.71914
0.60	0.10165	-0.67097

FREQUENCY	ATTENUATION	PHASE
0.61	0.09037	-0.62216
0.62	0.07883	-0.57270
0.63	0.06722	-0.52255
0.64	0.05576	-0.47168
0.65	0.04469	-0.42008
0.66	0.03427	-0.36771
0.67	0.02475	-0.31457
0.68	0.01642	-0.26063
0.69	0.00953	-0.20589
0.70	0.00434	-0.15033
0.71	0.00110	-0.09396
0.72	0.00002	-0.03677
0.73	0.00127	0.02124
0.74	0.00498	0.08005
0.75	0.01122	0.13965
0.76	0.01998	0.20005
0.77	0.03117	0.26123
0.78	0.04460	0.32318
0.79	0.06000	0.38591
0.80	0.07696	0.44942

FREQUENCY	ATTENUATION	PHASE
0.81	0.09497	0.51374
0.82	0.11343	0.57889
0.83	0.13159	0.64493
0.84	0.14863	0.71194
0.85	0.16364	0.78003
0.86	0.17564	0.84934
0.87	0.18364	0.92006
0.88	0.18665	0.99242
0.89	0.18381	1.06672
0.90	0.17442	1.14333
0.91	0.15812	1.22268
0.92	0.13505	1.30533
0.93	0.10614	1.39188
0.94	0.07346	1.48308
0.95	0.04065	-1.56184
0.96	0.01355	-1.45880
0.97	0.00084	-1.34849
0.98	0.01477	-1.23010
0.99	0.07152	-1.10310
1.00	0.19102	-0.96749

FREQUENCY	ATTENUATION	PHASE
1.01	0.39560	-0.82392
1.02	0.70709	-0.67411
1.03	1.14278	-0.52074
1.04	1.71126	-0.36719
1.05	2.41006	-0.21703
1.06	3.22632	-0.07342
1.07	4.13995	0.06135
1.08	5.12804	0.18599
1.09	6.16848	0.30012
1.10	7.24225	0.40403
1.11	8.33424	0.49840
1.12	9.43324	0.58411
1.13	10.53127	0.66211
1.14	11.62296	0.73330
1.15	12.70488	0.79851
1.16	13.77506	0.85847
1.17	14.83246	0.91383
1.18	15.87678	0.96515
1.19	16.90819	1.01291
1.20	17.92717	1.05751

FREQUENCY	ATTENUATION	PHASE
1.21	18.93441	1.09931
1.22	19.93074	1.13861
1.23	20.91707	1.17567
1.24	21.89437	1.21071
1.25	22.86363	1.24393
1.26	23.82586	1.27549
1.27	24.78209	1.30555
1.28	25.73333	1.33422
1.29	26.68063	1.36164
1.30	27.62503	1.38789
1.31	28.56759	1.41306
1.32	29.50939	1.43725
1.33	30.45152	1.46050
1.34	31.39515	1.48290
1.35	32.34146	1.50450
1.36	33.29171	1.52535
1.37	34.24724	1.54549
1.38	35.20946	1.56498
1.39	36.17992	-1.55775

1.40

37.16029

-1.53947

FREQUENCY

ATTENUATION

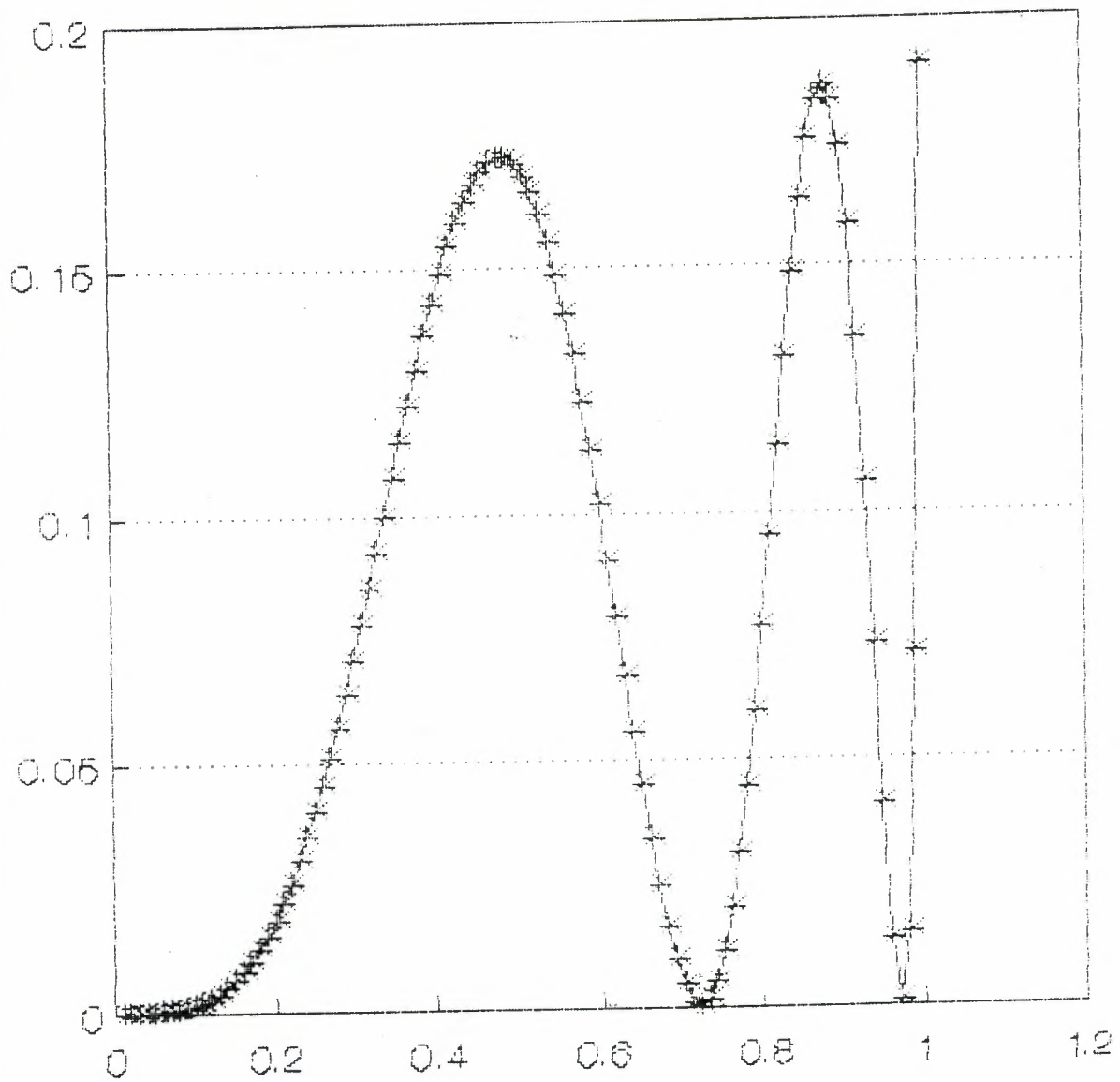
PHASE

1.41	38.15243	-1.52175
1.42	39.15839	-1.50454
1.43	40.18048	-1.48784
1.44	41.22134	-1.47160
1.45	42.28397	-1.45581
1.46	43.37187	-1.44044
1.47	44.48918	-1.42548
1.48	45.64079	-1.41091
1.49	46.83249	-1.39670
1.50	48.07204	-1.38284
1.51	49.36809	-1.36932
1.52	50.73249	-1.35613
1.53	52.18049	-1.34324
1.54	53.73269	-1.33065
1.55	55.41782	-1.31834
1.56	57.27777	-1.30631
1.57	59.37727	-1.29454
1.58	61.82422	-1.28302
1.59	64.81978	-1.27174
1.60	68.81148	-1.26070

DO YOU WANT TO CHANCE ANYTHING ? (Y OR N)
N

DO YOU WANT TO RUN AGAIN ?:(Y OR N)
N

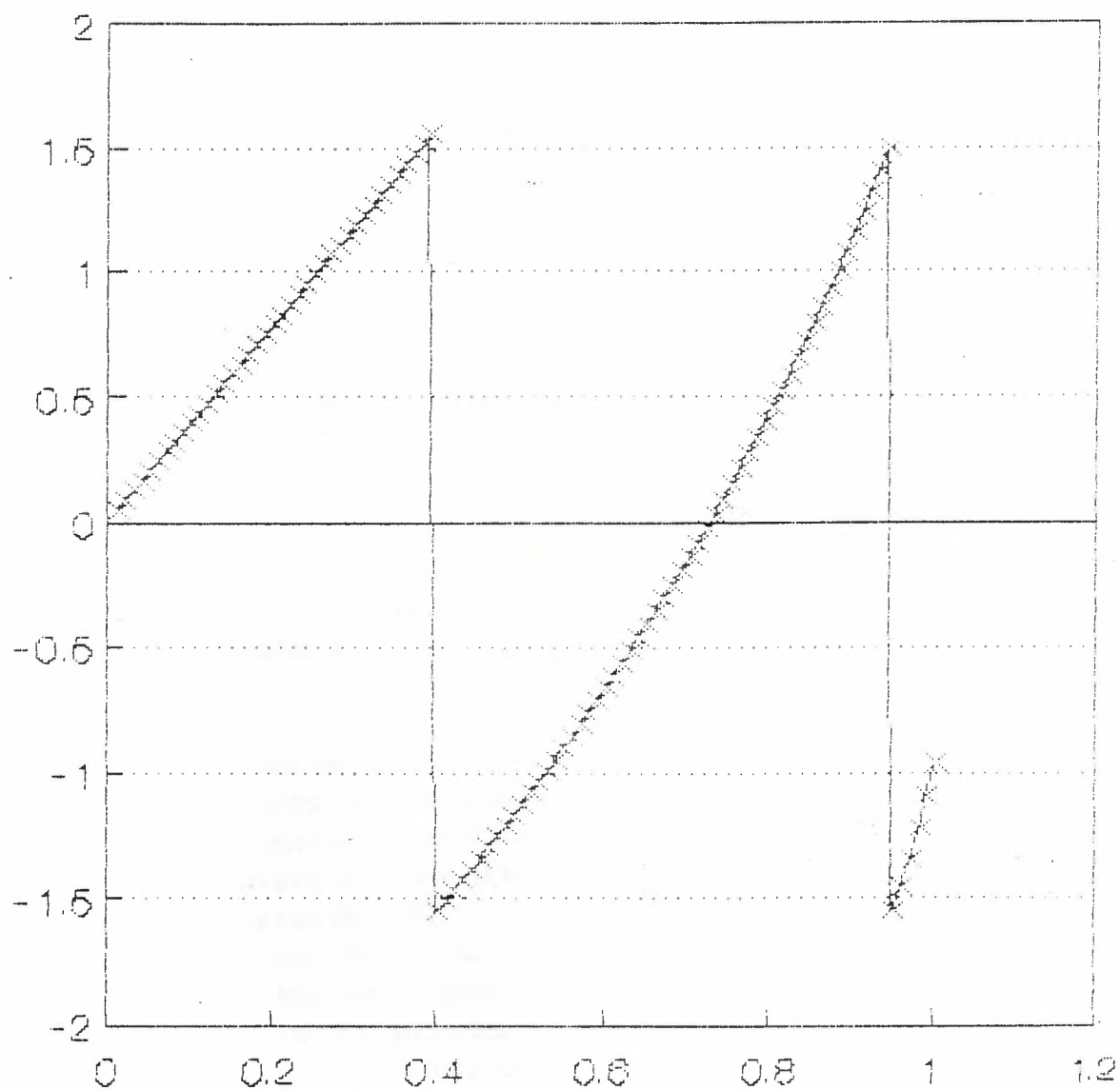
attenuation



frequency
Series 3

ATTENUATION CHARACTERISTIC OF THE SECOND EXAMPLE

phase



frequency

Series 6

PHASE CHARACTERISTIC OF THE SECOND EXAMPLE

2. 5 - Document of Written Computer Program

2.5.1 - Variables

A,A1,A2	indicters the value of the inductance.
C,C1,C2	indicates the value of capacitance.
Z	indicates the value of impedance or admittance of each branch with respect to frequencies.
KL	indicates the number of frequencies.
CODE	indicates the code of the configuration of each branch.
LMA	indicates the attenuation due to frequency.
TE	indicates the phase due to frequency.
CV	indicates the code of item which all calculations start from this point.
W1	indicates the frequency which all calculations start from this point.
W2	indicate the frequency which all calculations stop here.
W3	indicates the incrementation of the frequency range.
RL	indicates the value of load resistance.
RTH	indicates the value of input resistance.
G	indicates the $1/RL$.
E	indicates the real part of the continent.
S	indicates the imaginary part of the continent.
X	indicates the admittance of inductance's.
T	indicates the admittance of capacitance's.

2.5.2 - Ladder Network Analysis Program in Fortran 77

THIS PROGRAM IS WRITTEN IN FORTRAN LANGUAGE.

BY HASSAN AND WAHEED

THE SUPERVISOR IS MR. MAHIR DAD KHALDI.

THIS PROGRAM CALCULATES THE INSERTION LOSS AND
INSERTION PHASE CHARACTERISTICS OF A LADDER CIRCUITS.

COMPLEX Z(15,1000),X,ZA,ZB

COMPLEX VM, T, VL2(1000),H(15,1000),M(1000)

REAL RL, A, A1(1000), A2(1000),MA(1000),LMA(1000),AA,CA

REAL C,C1(1000),C2(1000),W,W1,W2,W3,TE(1000),RTH

CHARACTER CE*1,SE*2,CV*1,NAME*6,CF*1

INTEGER N, CODE(1000),K,KA,LD

PARAMETER (B=0,P=3.141592654,D=1)

X (W,A)= CMPLX(B,A*W)

T (W,C)= CMPLX(B,-1/(W*C))

WRITE(*,*)'DO YOU WANT TO KEEP THE RESULTS IN A FILE ?:(Y OR
N)

READ(*,33) CF

IF (CF.EQ.'Y'.OR.CF.EQ.'y') GOTO 4123

GOTO 4213

WRITE(*,*)'PLEASE ENTER THE NAME OF FILE'

READ(*,94)NAME

OPEN(D,FILE=NAME)

WRITE(*,9999)

WRITE(*,8) ' ,

WRITE(*,8) ' FORM OF THE FILTER WHICH WILL BE ANALYSED BY

,

WRITE(*,8) ' THIS PROGRAM MUST BE AS FOLLOWING CIRCUIT ,

WRITE(*,8) ' ,

WRITE(*,8) ' ,

WRITE(*,8) ' ————| Z1 |———| Z3 |———| |———>>>>| Z2n |———| ,

WRITE(*,8) ' ,

WRITE(*,8) ' $\frac{Z2}{\quad}$ $\frac{Z4}{\quad}$ $\frac{Z6}{\quad}$ $\frac{Z2n}{\quad}$,

WRITE(*,8) ' ,

WRITE(*,8) ' ,

WRITE(*,8) ' —————>>>>—————| ,

WRITE(*,8) ' ,

WRITE(*,8) ' ,

WRITE(*,8) ' THIS PROGRAM IS ,

WRITE(*,8) ' WRITTEN BY ,

WRITE(*,8) ' HASSAN AND WAHEED ,

WRITE(*,8) ' ,

WRITE(*,8) ' BY SUPERVISING OF ,

MR. MEHIR DAD KHALDI

```

WRITE(*,8)
WRITE(*,8)
WRITE(*,9999)
FORMAT(1X,79(' '))
FORMAT ( 1X , ' ', A63, 12X, ' ' )
PAUSE
FORMAT(23(/))
WRITE(*,88)
WRITE(D,*)'PLEASE ENTER THE VALUE OF INPUT RESISTANCE'
WRITE (*,*)'PLEASE ENTER THE VALUE OF INPUT RESISTANCE'
READ(*,*) RTH
WRITE(D,*)RTH
WRITE(D,*)'PLEASE ENTER THE VALUE OF THE LOAD RESISTANCE'
WRITE(*,*)'PLEASE ENTER THE VALUE OF THE LOAD RESISTANCE'
READ(*,*) RL
WRITE(D,*)RL
WRITE (D,*)'HOW MANY NODES ARE THERE ON FILTER CIRCUIT?'
WRITE(*,*)'HOW MANY NODES ARE THERE ON FILTER CIRCUIT?'
READ(*,*) N
WRITE (D,*)N
WRITE (*,*)'PLEASE ENTER THE FREQUENCY RANGE W1,W2,W3'
WRITE(*,*)'PLEASE ENTER THE FREQUENCY RANGE W1,W2,W3'
READ(*,*)W1,W2,W3
WRITE(D,*)W1,W2,W3
J=N*2

```

DO 10 I=1, J

```
WRITE(*,2222)
```

```
WRITE(*,222) '

```

```
WRITE(*,222) '

```

```
WRITE(*,222) '

```

```
WRITE(*,222) ' '
```

```
WRITE(*,222) '

```

WRITE(*,222)

```
WRITE(*,222)
```

```
WRITE( ,222)
WRITE(*,222)
```

```
WRITE( ,222)
WRITE(*,222)
```

WRITE(*.222)

```
WRITE(*,222)
```

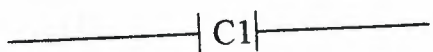
```
WRITE(*,222)
WRITE(*,222)
```

```
WRITE(*,222)
```

```
WRITE(' ',222)
WRITE(*,222)
```



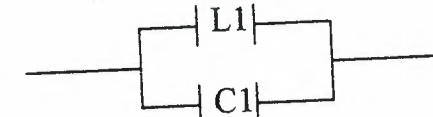
CODE :1



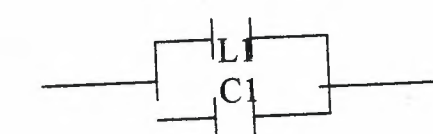
CODE :2



CODE :3



CODE :4

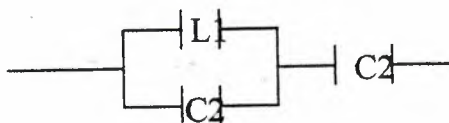


2 CODE:5

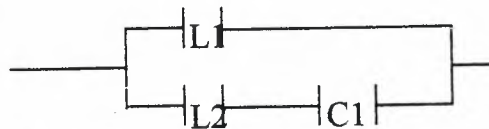

```

WRITE (*,222) '
WRITE (*,222) '
WRITE (*,222) '
WRITE (*,222) '
WRITE (*,222) '
WRITE (*,222) '
WRITE (*,222) '

```



CODE :6'



CODE :7

```

WRITE (D,*) 'PLEASE ENTER THE CONFIGURATION CODE '
WRITE (*,3333) 'PLEASE ENTER THE CONFIGURATION CODE

```

```

READ (*,*) CODE (I)

```

```

WRITE (D,*) CODE (I)

```

```

IF (CODE(I).NE.2) THEN

```

```

WRITE (D,*) 'PLEASE ENTER THE VALUE OF L1'

```

```

WRITE (*,*) 'PLEASE ENTER THE VALUE OF L1'

```

```

READ (*,*) A1(I)

```

```

WRITE (D,*) A1(I)

```

```

IF (CODE(I).EQ.5.OR.CODE(I).EQ.7) THEN

```

```

WRITE (D,*) 'PLEASE ENTER THE VALUE OF L2'

```

```

WRITE (*,*) 'PLEASE ENTER THE VALUE OF L2'

```

```

READ (*,*) A2(I)

```

```

WRITE (D,*) A2(I)

```

```

ELSE

```

```

ENDIF

```

```

ELSE

```

```

ENDIF

```

```

IF (CODE(I).NE.1) THEN

```

```

WRITE(D,*) 'PLEASE ENTER THE VALUE OF C1'

```

```

WRITE(*,*) 'PLEASE ENTER THE VALUE OF C1'

```

```

READ (*,*) C1(I)

```

```

IF (CODE(I).EQ.6) THEN

```

```

WRITE (D,*) 'PLEASE ENTER THE VALUE OF C2'

```

```

WRITE(*,*) 'PLEASE ENTER THE VALUE OF C2'

```

```

READ(*,*) C2(I)

```

```

ELSE

```

```

ENDIF

```

```

ELSE

```

```

ENDIF

```

```

CONTINUE

```

```

KL=(W2 - W1 + W3)/W3

```

```

DO 111 I = 1, J

```

```

E = MOD(I, 2)

```

```

THIS IF BLOCK CALCULATE THE VALUES OF ADMITTANCE OR
IMPEDANCE

```

```

W = W1

```

```

DO 101 L = 1, KL

```

```

IF (CODE(I).EQ.2) THEN

```



```

A=A1 ( I)
Z ( I,L ) = X ( W , A )
ELSE
IF ( CODE( I ).EQ.2) THEN
IF ( CODE( I ).EQ.0) THEN
Z(I,L) =(0,0)
GOTO 101
ELSE
C=C1( I )
Z( I,L) = X(W,A )+(T(W,C)
ELSE IF CODE( I ).EQ.3) THEN
A=A1(I)
C=C1(I)
ZA=(X(W,A)*T(W,C))
ZB=(X(W,A)+T(W,C))
Z(I,L)=ZA/ZB
ELSE
IF(CODE( I ) .EQ.5 )THEN
A=A1(I)
AA=A1(I)
C=C1(I)
ZA=(T(W,C)*X(W,A)
ZB=(X(W,C)+X(W,A))+X(W,AA)
Z(I,L)=ZA/ZB
ELSE
IF(CODE ( I ).EQ.6) THEN
A=A1(I)
C=C1(I)
CA0C2(I)
ZA=(X(W,A)*T(W,C))
ZB=(X(W,A)+T(W,C))+T(W,CA)
Z( I,L)0ZA/ZB
ELSE IF (CODE(I).EQ.7) THEN
A=A1(I)
AA=A2(I)
C=C1(I)
ZA=(X(W,A)*(X(W,AA)+T(W,C)))
ZB=(X(W,A)+(X(W,AA)+T(W,C)))
Z(I,L)0ZA/ZB
ENDIF
IF(E.EQ.O)Z(I,L)=1/Z( I , L)
W=W+W3
CONTINUE
CONTINUE
G=1/RL
DO 120 L=1 , KL

```

```

Z(1,L)=Z(1,L)+RTH
Z(J,L)=Z(J,L)+G
CONTINUE
THIS LOOP CALCULATES THE CONTINUANT OF LADDER CIRCUIT
DO 100 L=1,KL
H(J+2,L)=0
H(J+1,L)=1
DO 181 I=J,1,-1
H(I,L)=Z(I,L)*H(I+1,L)+H(I+2,L)
CONTINUE
CONTINUE
DO 102 L=1 KL
M(L) = H(1,L)*RL/(RL+RTH)
CONTINUE
DO 103 L=1 ,KL
E=REAL(M(L))
S=AIMAG(M(I))
MA(L)=SQRT(E*E+S*S)
IF(RL.EQ.RTH) THEN
LMA(L)=20*ALOG10(MA(L))
ELSE
LMA(L)=20*ALOG10(MA(L))+20*ALOG10((RTH+RL)/(2*SQRT(RTH*RL)))
)
ENDIF
IF(E.EQ.O) GOTO 159
TE(L)=ATAN (S/E)
GOTO 103 TE(L)=P/2
CONTINUE
FOLLOWING LOOP WRITES THE RESULT OF CALACULATIONS
W=W1
WRITE (D,99)
WRITE(*,99)
WRITE(D,99)
WRITE(*,99)
DO 40 L=1,KL
WRITE(*,9)W,LMA(L),TE(L)
WRITE(D,9)W,LMA(L),TE(L)
K =20
KA=MOD(L,K)
IF(KA.EQ.O.AND.L.NE.KL)THEN
WRITE( D,999)
WRITE(*,999)
PAUSE
IF(L.EQ.KL)GO TO 40
WRITE(D,99)
WRITE(*,99)

```

```

WRITE(D,199)
WRITE(*,199)
ENDIF
W=W+W3
CONTINUE
WRITE(D,999)
WRITE(*,999)
WHITE(D,333)'DO YOU WANT TO CHANGE ANYTHING?(Y OR N)'
WRITE(*,333)'DO YOU WANT TO CHANCGE ANYTHING?(Y OR N)';
READ(*,33)CV
WRITE(D,33)CV
IF(CV.EQ.'Y'.OR.CV.EQ.'y') THEN
W=W1
WRITE(D,2222)
WRITE(*,2222)
WRITE(D,222)'
WRITE(*,222)'
WRITE(D,222)'
WRITE(*,222)'
WRITE(D,222)'
WRITE(*,222)'
WRITE(D,222)'
WRITE(*,222)'
WRITE(D,222)'
WRITE(*,222)'
WRITE(D,222)'
WRITE(*,222)'
WRITE(D,2222)
WRITE(*,2222)
FORMAT(1X,79(' '))
FORMAT(1X,' ' ,A63,12X,' ');
WRITE(D,*)'
WRITE(*,*)'
WRITE(D,*)'INPUT THE NUMBER OF ITEM WHICH WILL BE
CHANCED'
WRITE(*,*)'INPUT THE NUMBER OF ITEM WHICH WILL BE
CHANCED'
READ(*,*)DE
WRITE(D,*)DE
IF(DE.EQ.2)THEN
WRITE(D,*)'PLEASE ENTER THE NEW INPUT RESISTANCE VALUE'
WRITE(*,*)'PLEASE ENTER THE NEW INPUT RESISTANCE VALUE'
READ(*,*)RTH
WRITE(D,*)RTH
GOTO 1999
ELSE IF(DE.EQ.3.)THEN

```

```

FREQUENCY RANGE :1
FREQUENCY RANGE :1
INPUT RESISTANCE :2
INPUT RESISTANCE :2
LOAD RESISTANCE :3
LOAD RESISTANCE :3
ELEMENT VALUE :4
ELEMENT VALUE :4

```

```

WRITE(D,*)'PLEASE ENTER THE NEW LOAD RESISTANCE VALUE'
WRITE(*,*)'PLEASE ENTER THE NEW LOAD RESISTANCE VALUE'
READ(*,*)RL
WRITE(D,*)RL
GO TO 1999
ELSE IF(DE.EQ.1) THEN
WRITE(D,*)'PLEASE ENTER THE NEW FREQUENCY RANGE
W1,W2,W3'
WRITE(*,*)'PLEASE ENTER THE NEW FREQUENCY RANGE
W1,W2,W3'
READ(*,*)W1,W2,W3
WRITE(D,*)W1,W2,W3
GOTO 1999
ELSE IF(DE.EQ.4) THEN
WRITE(D,*)'PLEASE ENTER THE BRANCH NUMBER'
WRITE(*,*)'PLEASE ENTER THE BRANCH NUMBER'
READ(*,*)I
WRITE(D,*)I
IF CODE(I).NE.2) THEN
WRITE(D,*) 'PLEASE ENTER THE VALUE OF L1'
WRITE(*,*) 'PLEASE ENTER THE VALUE OF L1'
READ(*,*)A1(I)
WRITE(D,*)A1(I)
IF (CODE)(I).EQ.5.OR.CODE(I).EQ.7) THEN
WRITE(D,*)'PLEASE ENTER THE VALUE OF L2'
WRITE(*,*)'PLEASE ENTER THE VALUE OF L2'
READ(*,*)A2(I)
WRITE(D,*)A2(I)
ELSE
ENDIF
ELSE
ENDIF
IF(CODE(I).NE.1) THEN
WRITE(D,*) 'PLEASE ENTER THE VALUE OF C1'
WRITE(*,*) 'PLEASE ENTER THE VALUE OF C1'
READ(*,*)C2(I)
ELSE
ENDIF
ELSE
ENDIF
GO TO 1999
ENDIF
ELSE
WRITE(D,333)'DO YOU WANT TO RUN AGAIN?:(Y OR N) '
WRITE(*,333)'DO YOU WANT TO RUN AGAIN?:(Y OR N) '
READ(*,33) CE

```



```

WRITE(D,*)CE
IF(CE.EQ.'Y'.OR.CE.EQ.'y') GOTO 4444
FORMAT(A2)
FORMAT(1X,'||',13X,F11.2,1X'||',4X,F11.5,12X,'||',4X,F11.5,12X,'||')
FORMAT(A6)
FORMAT(13X,'FREQUENCY',11X,'ATTENUATION',16X,'PAHSE')
FORMAT(1X,'f',25('='),'f',22('='),'f',27('='),'f')
FORMAT(1X,'L',25('='),'L',22('='),'L',27('='),'L')
FORMAT(1A)
FORMAT(3(/),A40)
FORMAT(1X,25(' '),A27,27(' '))
ENDIF
END

```

CONCLUSIONS AND DISCUSSIONS

Additional calculation subprograms are recommended . The calculations of the time delay , transfer functions of the ladder type network , all characteristics of any type networks are easily added to the written computer program.

Reactive element configurations which exists in the written computer program are enough ,if it is needed some new reactive element configuration can be added easily , also.

In the written program results are displayed as numeric form , but reading of numeric results are very difficult with respect too graphical results are sensitive than numeric results. Therefore a graphic subprogram have to added to the written computer program.

The reactive elements were considered as ideal in the written computer program. In practice there is no ideal circuit elements , so resistive part of the inductance and capacitance have to added to the calculations which were used in the written computer program.

There written computer program has some disadvantages and advantages.

These disadvantages are;

- 1- The maximum branch number 15. This is enough but in some application , the designed filter can have grater branch.
- 2- The results are displayed in numeric form.
- 3-The filename which the results stored in it must be new for every running . Otherwise , program stops.
- 4-The calculations are done for 1000 different frequencies . In some application , it can be needed more frequency values.
- 5- The circuit elements are considered ideal and calculations were done in this respect.

The advantages are ;

- 1- The network which will be analysed by written program is constructed easily.
- 2- The normalised or real values of the circuit elements are can be entered.
- 3- The maximum error can be at $1/1000$.
- 4- Calculation were done at high speed.

LIST OF REFERENCES

1- ALTIN, V. ' Engineering programming in Structured FORTRAN ' Istanbul , BOGAZICI UNIVERSITY 1990 , Publishing no :469

2-ARTUN , M.E , GUNGOR , I. , ' Fundamentals of Programing and Fortran v , ANKARA M.E.T.U 1983 , Publishing no :3

3-HASLER ,M. , NEIRYNCK , J. 'Electric Filters' , Dedham U.S.A , Artechhouse , INC . , 1986 , ISBN:0-89006-186-6

4- JOHNSON E.D. ' Introduction to The Filter Theory ' Newjersey U.S.A. Printice Hall , Inc . 1796 , ISBN : 0-13-483776-2

5-KORKMAZ , H. , KORKMAZ , B. 'Fortran Programlama dili ' Istanbul , Uzay Ofset , 1990 , Yayinci Kodu :0013

6-Muýt , T. , METZLER , W.A. , ' A Treatise on the Theory of the Determinants ' ,Dover Publications , INC . , 1960

7- RUSTON , H. BORDAGNA , J. , 'Electric Networks: Functions , Filters , Analysis ' , Newyork U.S.A Mc. GRAWHILL BOOK COMPANY,1996, ISBN:07-054343-7

8-TOKAD , Y. 'Foundations of Passive Electrical Network Syntesis ' Volume 1 , Ankara M.E.T.U. 1972 , Publication no :41