Balochistan University of Engineering & Technology, Khuzdar

Department of Electrical Engineering

PRACTICAL WORK BOOK

For Academic Session 2011

NETWORK ANALYSIS

Code No: EE-214

For

Class Second Year Electrical

Name: ________________________________

Roll Number: ________________________________

Batch: ________________________________

Department: ________________________________

Year: ________________________________

CONTENTS

EXPERIMENT NO: 01

OBJECT: To Obtain the Admittance Parameters for the network given below, Using MATLAB 7.0

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: Admittance parameters or Y-parameters (the elements of an admittance matrix or Y-matrix) are properties used in electrical engineering, electronic engineering and communication systems engineering describe the electrical behavior of linear electrical networks.

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \qquad Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$
$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} \qquad Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

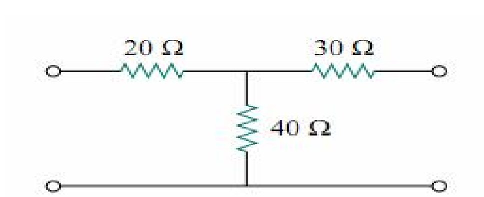
TABLE 18.1 Conversion of two-port parameters.

	z		y		h		g		T		t	
z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	z_{21}	z_{22}	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	g_{11}	g_{12}	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	g_{21}	g_{22}	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$-\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	A	B	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$-\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	C	D	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	a	b
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	c	d

$\Delta_z = z_{11}z_{22} - z_{12}z_{21}$, $\Delta_h = h_{11}h_{22} - h_{12}h_{21}$, $\Delta_T = AD - BC$

$\Delta_y = y_{11}y_{22} - y_{12}y_{21}$, $\Delta_g = g_{11}g_{22} - g_{12}g_{21}$, $\Delta_t = ad - bc$

PROCEDURE:



- First Calculate the Z-Parameters of the Circuit
- So the Z- Parameter of the Circuit is:

$$[\mathbf{z}] = \begin{bmatrix} 60\ \Omega & 40\ \Omega \\ 40\ \Omega & 70\ \Omega \end{bmatrix}$$

- Open MATLAB Command Window
- Type the function as

```
>> z = [60 40; 40 70]
z =
   60    40
   40    70
>> y = z2y(z)
y =

   0.0269   -0.0154
  -0.0154    0.0231
>>
```

OBSERVATION: Get the print out from the main editor of MATLAB for minimum two conversions.

RESULT: You should be able to understand the conversion of Impedance Parameter into Admittance Parameters.

EXERCISE:

Calculate the Y-Parameters and Print out from MATLAB, the Z- Parameters are as

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$$

EXPERIMENT NO: 02

OBJECT: To Obtain the Hybrid Parameters for the network given below, Using MATLAB 7.0

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The z and y parameters of a two-port network do not always exist. So there is a need for developing another set of parameters. The h parameter or the hybrid parameters of a transistor helps us to analyse the amplifying action of transistor for small signal .it is necessary for practical purposes.

$$\boxed{\begin{aligned} \mathbf{V}_1 &= \mathbf{h}_{11}\mathbf{I}_1 + \mathbf{h}_{12}\mathbf{V}_2 \\ \mathbf{I}_2 &= \mathbf{h}_{21}\mathbf{I}_1 + \mathbf{h}_{22}\mathbf{V}_2 \end{aligned}}$$

$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} \mathbf{h}_{11} & \mathbf{h}_{12} \\ \mathbf{h}_{21} & \mathbf{h}_{22} \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{V}_2 \end{bmatrix} = [\mathbf{h}] \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{V}_2 \end{bmatrix}$$

$$\boxed{\begin{aligned} \mathbf{h}_{11} &= \left.\frac{\mathbf{V}_1}{\mathbf{I}_1}\right|_{\mathbf{V}_2=0}, \qquad & \mathbf{h}_{12} &= \left.\frac{\mathbf{V}_1}{\mathbf{V}_2}\right|_{\mathbf{I}_1=0} \\ \mathbf{h}_{21} &= \left.\frac{\mathbf{I}_2}{\mathbf{I}_1}\right|_{\mathbf{V}_2=0}, \qquad & \mathbf{h}_{22} &= \left.\frac{\mathbf{I}_2}{\mathbf{V}_2}\right|_{\mathbf{I}_1=0} \end{aligned}}$$

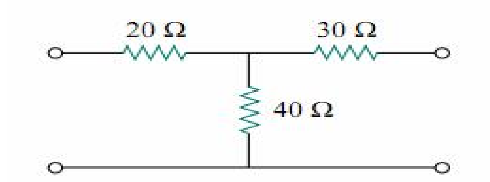
TABLE 18.1 Conversion of two-port parameters.

	z		y		h		g		T		t	
z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	z_{21}	z_{22}	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	g_{11}	g_{12}	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	g_{21}	g_{22}	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$-\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	A	B	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$-\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	C	D	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	a	b
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	c	d

$\Delta_z = z_{11}z_{22} - z_{12}z_{21}$, $\Delta_h = h_{11}h_{22} - h_{12}h_{21}$, $\Delta_T = AD - BC$

$\Delta_y = y_{11}y_{22} - y_{12}y_{21}$, $\Delta_g = g_{11}g_{22} - g_{12}g_{21}$, $\Delta_t = ad - bc$

PROCEDURE:



- First Calculate the Z-Parameters of the Circuit
- So the Z- Parameter of the Circuit is:

$$[\mathbf{z}] = \begin{bmatrix} 60\ \Omega & 40\ \Omega \\ 40\ \Omega & 70\ \Omega \end{bmatrix}$$

- Open MATLAB Command Window
- Type the function as

```
>> z = [60 40; 40 70]
z =
    60    40
    40    70
>> h=z2h(z)

h =

   37.1429    0.5714
   -0.5714    0.0143
```

RESULT: You should be able to understand the conversion of Impedance Parameter into Admittance Parameters.

EXERCISE:

Calculate the Hybrid -Parameters and Print out from MATLAB Command Window, the Z- Parameters are as

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$$

EXPERIMENT NO: 03

OBJECT: To Obtain the Inverse Hybrid Parameters for the network given below, Using MATLAB 7.0

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: A set of parameters closely related to the h parameters are the g parameters or inverse hybrid parameters. These are used to describe the terminal currents and voltages as.

$$\boxed{\begin{aligned} I_1 &= g_{11}V_1 + g_{12}I_2 \\ V_2 &= g_{21}V_1 + g_{22}I_2 \end{aligned}}$$

$$\begin{bmatrix} I_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = [g] \begin{bmatrix} V_1 \\ I_2 \end{bmatrix}$$

$$\boxed{\begin{aligned} g_{11} &= \left.\frac{I_1}{V_1}\right|_{I_2=0}, \qquad g_{12} = \left.\frac{I_1}{I_2}\right|_{V_1=0} \\ g_{21} &= \left.\frac{V_2}{V_1}\right|_{I_2=0}, \qquad g_{22} = \left.\frac{V_2}{I_2}\right|_{V_1=0} \end{aligned}}$$

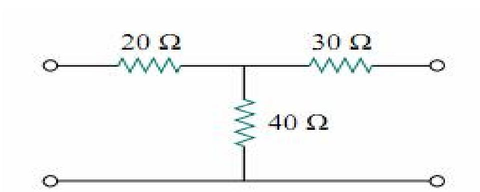
TABLE 18.1 Conversion of two-port parameters.

	z		y		h		g		T		t	
z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	z_{21}	z_{22}	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	g_{11}	g_{12}	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	g_{21}	g_{22}	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$-\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	A	B	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$-\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	C	D	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	a	b
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	c	d

$\Delta_z = z_{11}z_{22} - z_{12}z_{21}$, $\Delta_h = h_{11}h_{22} - h_{12}h_{21}$, $\Delta_T = AD - BC$

$\Delta_y = y_{11}y_{22} - y_{12}y_{21}$, $\Delta_g = g_{11}g_{22} - g_{12}g_{21}$, $\Delta_t = ad - bc$

PROCEDURE:



- First Calculate the Z-Parameters of the Circuit
- So the Z- Parameter of the Circuit is:

$$[\mathbf{z}] = \begin{bmatrix} 60\ \Omega & 40\ \Omega \\ 40\ \Omega & 70\ \Omega \end{bmatrix}$$

- Open MATLAB Command Window
- Type the function as

```
>> z = [60 40; 40 70]
z =
   60    40
   40    70
>> h=z2h(z)

h =


  37.1429    0.5714
  -0.5714    0.0143
>> ih = inv(h)
```

```
ih =

   0.0167   -0.6667
   0.6667   43.3333
```

RESULT: You should be able to understand the conversion of Impedance Parameter into Inverse Hybrid Parameters.

EXERCISE:

Calculate the Inverse Hybrid -Parameters and Print out from MATLAB Command Window, the Z-Parameters are as

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$$

EXPERIMENT NO: 04

OBJECT: To Obtain the Transmission Parameters for the network given below, Using MATLAB 7.0

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: Since there are no restrictions on which terminal voltages and currents should be considered independent and which should be dependent variables, we expect to be able to generate many sets of parameters. Another set of parameters relates the variables at the input port to those at the output port.

$$\boxed{\begin{aligned} \mathbf{V}_1 &= \mathbf{A}\mathbf{V}_2 - \mathbf{B}\mathbf{I}_2 \\ \mathbf{I}_1 &= \mathbf{C}\mathbf{V}_2 - \mathbf{D}\mathbf{I}_2 \end{aligned}}$$

$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{I}_1 \end{bmatrix} = \begin{bmatrix} \mathbf{A} & \mathbf{B} \\ \mathbf{C} & \mathbf{D} \end{bmatrix} \begin{bmatrix} \mathbf{V}_2 \\ -\mathbf{I}_2 \end{bmatrix} = [\mathbf{T}] \begin{bmatrix} \mathbf{V}_2 \\ -\mathbf{I}_2 \end{bmatrix}$$

$$\boxed{\begin{aligned} \mathbf{A} &= \left.\frac{\mathbf{V}_1}{\mathbf{V}_2}\right|_{\mathbf{I}_2=0}, \qquad & \mathbf{B} &= -\left.\frac{\mathbf{V}_1}{\mathbf{I}_2}\right|_{\mathbf{V}_2=0} \\ \mathbf{C} &= \left.\frac{\mathbf{I}_1}{\mathbf{V}_2}\right|_{\mathbf{I}_2=0}, \qquad & \mathbf{D} &= -\left.\frac{\mathbf{I}_1}{\mathbf{I}_2}\right|_{\mathbf{V}_2=0} \end{aligned}}$$

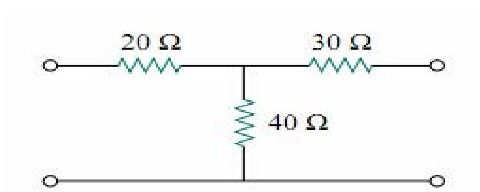
TABLE 18.1 Conversion of two-port parameters.

	z		y		h		g		T		t	
z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	z_{21}	z_{22}	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	g_{11}	g_{12}	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	g_{21}	g_{22}	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$-\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	A	B	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$-\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	C	D	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	a	b
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	c	d

$\Delta_z = z_{11}z_{22} - z_{12}z_{21}$, $\Delta_h = h_{11}h_{22} - h_{12}h_{21}$, $\Delta_T = AD - BC$

$\Delta_y = y_{11}y_{22} - y_{12}y_{21}$, $\Delta_g = g_{11}g_{22} - g_{12}g_{21}$, $\Delta_t = ad - bc$

PROCEDURE:



- First Calculate the Z-Parameters of the Circuit
- So the Z- Parameter of the Circuit is:

$$[\mathbf{z}] = \begin{bmatrix} 60\ \Omega & 40\ \Omega \\ 40\ \Omega & 70\ \Omega \end{bmatrix}$$

- Open MATLAB Command Window
- Type the function as

```
>> z = [60 40; 40 70]
z =
   60    40
   40    70
>> abcd = z2abcd(z)

abcd =

   1.5000   65.0000
   0.0250    1.7500
```

>> **RESULT:** You should be able to understand the conversion of Impedance Parameter into Transmission Parameters.

EXERCISE:

Calculate the Transmission Parameters and Print out from MATLAB Command Window, the Z-Parameters are as

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$$

EXPERIMENT NO: 05

OBJECT: To Obtain the Inverse Transmission Parameters for the network given below, Using MATLAB 7.0

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: Our last set of parameters may be defined by expressing the variables at the output port in terms of the variables at the input port is the Inverse Transmission Parameters

$$\boxed{\begin{aligned} \mathbf{V}_2 &= \mathbf{a}\mathbf{V}_1 - \mathbf{b}\mathbf{I}_1 \\ \mathbf{I}_2 &= \mathbf{c}\mathbf{V}_1 - \mathbf{d}\mathbf{I}_1 \end{aligned}}$$

$$\begin{bmatrix} \mathbf{V}_2 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} \mathbf{a} & \mathbf{b} \\ \mathbf{c} & \mathbf{d} \end{bmatrix} \begin{bmatrix} \mathbf{V}_1 \\ -\mathbf{I}_1 \end{bmatrix} = [\mathbf{t}] \begin{bmatrix} \mathbf{V}_1 \\ -\mathbf{I}_1 \end{bmatrix}$$

$$\boxed{\begin{aligned} \mathbf{a} &= \left.\frac{\mathbf{V}_2}{\mathbf{V}_1}\right|_{\mathbf{I}_1=0}, \qquad & \mathbf{b} &= -\left.\frac{\mathbf{V}_2}{\mathbf{I}_1}\right|_{\mathbf{V}_1=0} \\ \mathbf{c} &= \left.\frac{\mathbf{I}_2}{\mathbf{V}_1}\right|_{\mathbf{I}_1=0}, \qquad & \mathbf{d} &= -\left.\frac{\mathbf{I}_2}{\mathbf{I}_1}\right|_{\mathbf{V}_1=0} \end{aligned}}$$

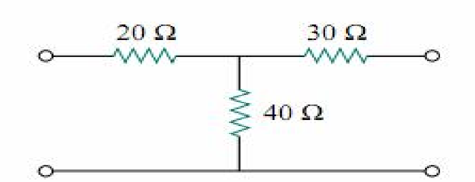
TABLE 18.1 Conversion of two-port parameters.

	z		**y**		**h**		**g**		**T**		**t**	
z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	z_{21}	z_{22}	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	g_{11}	g_{12}	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	g_{21}	g_{22}	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$-\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	A	B	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$-\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	C	D	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	a	b
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	c	d

$\Delta_z = z_{11}z_{22} - z_{12}z_{21}$, $\Delta_h = h_{11}h_{22} - h_{12}h_{21}$, $\Delta_T = AD - BC$

$\Delta_y = y_{11}y_{22} - y_{12}y_{21}$, $\Delta_g = g_{11}g_{22} - g_{12}g_{21}$, $\Delta_t = ad - bc$

PROCEDURE:



- First Calculate the Z-Parameters of the Circuit
- So the Z- Parameter of the Circuit is:

$$[\mathbf{z}] = \begin{bmatrix} 60\ \Omega & 40\ \Omega \\ 40\ \Omega & 70\ \Omega \end{bmatrix}$$

- Open MATLAB Command Window
- Type the function as

```
>> z = [60 40; 40 70]
z =
   60    40
   40    70
>> abcd = z2abcd(z)

abcd =

   1.5000   65.0000
   0.0250    1.7500
>> iabcd=inv(abcd)
```

```
iabcd =

    1.7500  -65.0000
   -0.0250    1.5000

>>
```

>> **RESULT:** You should be able to understand the conversion of Impedance Parameter into Inverse Transmission Parameters.

EXERCISE:

Calculate the Inverse Transmission Parameters and Print out from MATLAB Command Window, the Z-Parameters are as

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$$

EXPERIMENT NO: 06

OBJECT: To Obtain the Laplace Transform of the following functions, Using MATLAB 7.0

1) f(t) = 1
2) f(t) = t
3) f(t) = t^5
4) f(t) = e^{5t}
5) f(t) = e^{-5t}
6) f(t) = e^{kt}
7) f(t) = e^{-kt}
8) f = -1.25+3.5*t*exp(-2*t)+1.25*exp(-2*t)

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The Laplace transform is often interpreted as a transformation from the time-domain, in which inputs and outputs are functions of time, to the frequency-domain, where the same inputs and outputs are functions of complex angular frequency, in radians per unit time.

$$F(s) = \mathcal{L}\left\{f(t)\right\} = \int_0^\infty e^{-st} f(t)\, dt.$$

The parameter s is a complex number:

$s = \sigma + i\omega$, with real numbers σ and ω.

Function y(t)	Transform Y(s)	s
1	1/s	s>0
t	1/s^2	s>0
t^n, n=integer	n!/s^(n+1)	s>0
exp(at), a=constant	1/(s-a)	s>a
cos(bt), b=constant	s/(s^2+b^2)	s>0
sin(bt), b=constant	b/(s^2+b^2)	s>0
exp(at)cos(bt)	(s-a)/[(s-a)^2+b^2]	s>a
exp(at)sin(bt)	b/[(s-a)^2+b^2]	s>a

PROCEDURE:

- Open MATLAB Command Window
- Type the function as in Tabular Form

FUNCTION	MATLAB COMMAND	OUTPUT IN MATLAB
f(t) = 1	>> syms t; >> f=t^0; >> laplace(f)	ans = 1/s
f(t) = t	>> syms t; f = t^1; laplace(f)	ans = 1/s^2
$f(t) = t^5$	>> syms t; f = t^5; laplace(f)	ans = 120/s^6
$f(t) = e^{5t}$	>> syms t; f = exp(5*t); laplace(f)	ans = 1/(s-5)
$f(t) = e^{-5t}$	>> syms t; f = exp(-5*t); laplace(f)	ans = 1/(s+5)
$f(t) = e^{kt}$	>> syms k,t; f = exp(k*t); laplace(f)	ans = 1/(s-k)
$f(t) = e^{-kt}$	>> syms k,t; f = exp(-k*t); laplace(f)	ans = 1/(s+k)
f=-1.25+3.5*t*exp(-2*t)+1.25*exp(-2*t);	syms t s f=-1.25+3.5*t*exp(-2*t)+1.25*exp(-2*t); F=laplace(f,t,s) OR >> simplify(F) OR >> pretty(ans)	F = -5/4/s+7/2/(s+2)^2+5/4/(s+2) OR ans = (s-5)/s/(s+2)^2 OR s - 5 ---------- 2 s (s + 2)
f(t) = cos(2*t)	>> syms t f=cos(2*t) laplace(f)	s/(s^2+4)

f(t) = cos(wt)	>> syms t w f=cos(w*t) laplace(f)	s/(s^2+w^2)
f(t) = sin(pt)	>> syms p t f=sin(p*t) laplace(f)	p/(s^2+p^2)
f(t) = sin(4t)	>> syms p t f=sin(4*t) laplace(f)	4/(s^2+16)

>> **RESULT:** You should be able to understand the conversion of Laplace Transform from Time Domain into S-Domain.

EXERCISE:

Compute the following Laplace Functions and Print out from MATLAB Command Window

(1)	f(t)	=	50	(2)	f(t)	=	t^{12}	(3)	f(t)	=	e^{13t}
(4)	f(t)	=	e^{-10t}	(5)	f(t)	=	e^{pt}	(6)	f(t)	=	e^{-rt}
(7)	f(t)	=	cos(6*t)	(8)	f(t)	=	cos(k*t)	(9)	f(t)	=	sin(3*t)

EXPERIMENT NO: 07

OBJECT: To Obtain the Laplace Inverse Transform of the following functions, Using MATLAB 7.0

9) f = 1/s
10) f = 1/s^2
11) f = 120/s^6
12) f = 1/(s-5)
13) f = 1/(s+5)
6) f = s/(s^2+4)
7) f = 4/(s^2+16)

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The Laplace Inverse transform is often interpreted as a transformation from the frequency (s-domain) domain to the time domain.

$$\mathcal{L}^{-1} G(s) = g(t)$$

S-Domain ***F*(*s*)**	Time Domain ***f*(*t*)**
$\frac{1}{s}$ $\quad s > 0$	1
$\frac{1}{s^2}$ $\quad s > 0$	t
$\frac{n!}{s^{n+1}}$ $\quad s > 0$	t^n (n, a positive integer)
$\frac{1}{s-a}$ $\quad s > a$	e^{at}
$\frac{\omega}{s^2+\omega^2}$ $\quad s > 0$	$\sin \omega t$
$\frac{s}{s^2+\omega^2}$ $\quad s > 0$	$\cos \omega t$

PROCEDURE:

- Open MATLAB Command Window
- Type the function as in Tabular Form

FUNCTION	MATLAB COMMAND	OUTPUT IN MATLAB
f = 1/s	>> syms s f = 1/s; ilaplace(f)	ans = 1
f = 1/s^2	>> syms s f = 1/s^2; ilaplace(f)	ans = t
f = 120/s^6	>> syms s f=120/s^6; ilaplace(f)	ans = t^5

f = 1/(s-5)	>> syms s f= 1/(s-5); ilaplace(f)	ans = exp(5*t)
f = 1/(s+5)	>> syms t; >> syms s f = 1/(s+5); ilaplace(f)	ans = exp(-5*t)
f = s/(s^2+4)	>> syms s f = s/(s^2+4); ilaplace(f)	ans = cos(2*t)
f =4/(s^2+16)	>> syms s f=4/(s^2+16) ilaplace(f)	ans = sin(4*t)

RESULT: You should be able to understand the conversion of Inverse Laplace Transform from Frequency Domain into Time Domain.

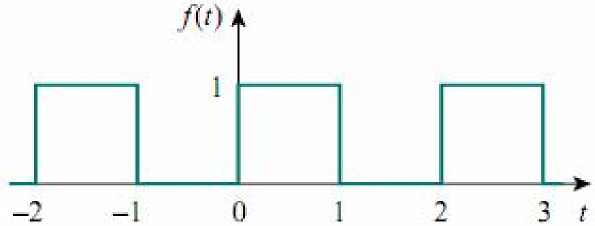
EXERCISE:

Compute the following Laplace Functions and Print out from MATLAB Command Window

(1) f(s) = 50/s (2) f(s) = 6/s^4 (3) f(s) = 1/(s-7)
(4) f(s) = 1/(s+12) (5) f(s) = s/(s^2 +9) (6) f(s) = 5/(s^2+25)

EXPERIMENT NO: 08

OBJECT: To Compute the Fourier series of the square wave, using MATLAB 7.0



$$f(t) = \frac{1}{2} + \frac{2}{\pi}\sin \pi t + \frac{2}{3\pi}\sin 3\pi t + \frac{2}{5\pi}\sin 5\pi t + \cdots$$

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The Fourier series of a periodic function f (t) is a representation that resolves f (t) into a dc component and an AC component comprising an infinite series of harmonic sinusoids.

$$\boxed{f(t) = f(t + nT)}$$

$$f(t) = a_0 + a_1 \cos \omega_0 t + b_1 \sin \omega_0 t + a_2 \cos 2\omega_0 t + b_2 \sin 2\omega_0 t + a_3 \cos 3\omega_0 t + b_3 \sin 3\omega_0 t + \cdots$$

$$\boxed{f(t) = \underbrace{a_0}_{\text{dc}} + \underbrace{\sum_{n=1}^{\infty}(a_n \cos n\omega_0 t + b_n \sin n\omega_0 t)}_{\text{ac}}}$$

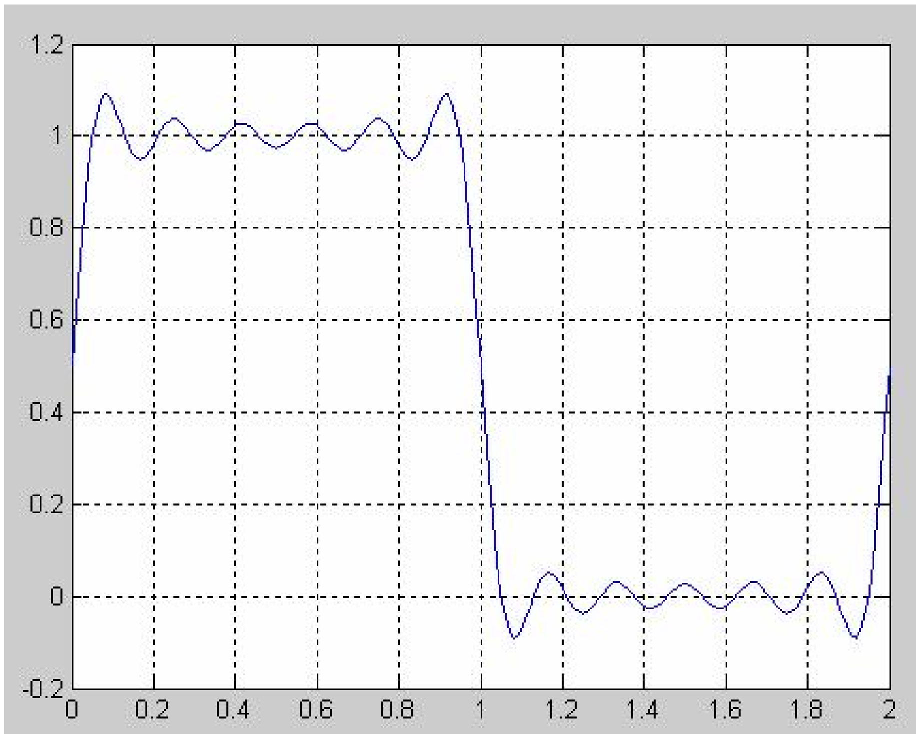
PROCEDURE:

$$f(t) = \frac{1}{2} + \frac{2}{\pi}\sin \pi t + \frac{2}{3\pi}\sin 3\pi t + \frac{2}{5\pi}\sin 5\pi t + \cdots$$

- Open MATLAB Command Window
- Type the function as

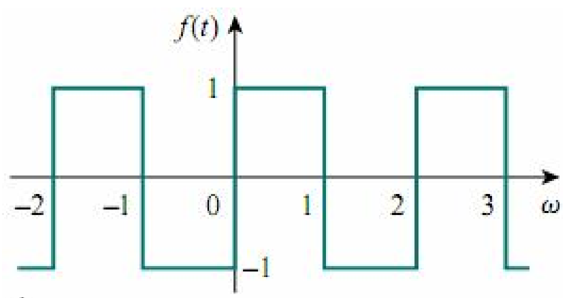
```
T =2;                      %   Period of the Square wave
t = 0:0.01:2;              %   spacing between periods
a=1/2;                     %   DC component a0
b=(2/pi)*sin(pi*t);        %   First Odd Harmonic
```

```
c=(2/(3*pi))*sin(3*pi*t);       %  Second Odd Harmonic
d=(2/(5*pi))*sin(5*pi*t);       %  Third Odd Harmonic
e=(2/(7*pi))*sin(7*pi*t);       %  Fourth Odd Harmonic
f=(2/(9*pi))*sin(9*pi*t);       %  Fifth Odd Harmonic
g=(2/(11*pi))*sin(11*pi*t);     %  Sixth Odd Harmonic
s=(a+b+c+d+e+f+g);              %  summation of dc and all harmonics in fourier series
plot(t,s)                       %  Draw t and sum of components
grid                            %  Show lines in graphs
```



RESULT: You should be able to compute the Fourier series with the help of Matlab 7.

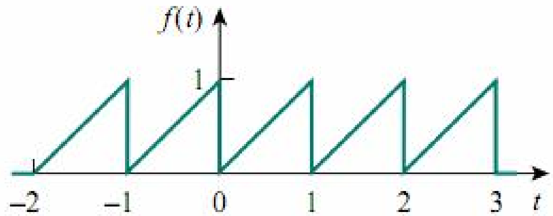
EXERCISE: Compute the Fourier series of the square wave, using MATLAB 7.0



$$f(t) = \frac{4}{\pi} \sum_{k=1}^{\infty} \frac{1}{n} \sin n\pi t, n = 2k - 1.$$

EXPERIMENT NO: 09

OBJECT: To Compute the Fourier series of the sawtooth waveform, using MATLAB 7.0



$$f(t) = \frac{1}{2} - \frac{1}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\sin 2\pi n t.$$

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The Fourier series of a periodic function f (t) is a representation that resolves f (t) into a dc component and an AC component comprising an infinite series of harmonic sinusoids.

$$\boxed{f(t) = f(t + nT)}$$

$$f(t) = a_0 + a_1 \cos\omega_0 t + b_1 \sin\omega_0 t + a_2 \cos 2\omega_0 t + b_2 \sin 2\omega_0 t + a_3 \cos 3\omega_0 t + b_3 \sin 3\omega_0 t + \cdots$$

$$\boxed{f(t) = \underbrace{a_0}_{\text{dc}} + \underbrace{\sum_{n=1}^{\infty}(a_n \cos n\omega_0 t + b_n \sin n\omega_0 t)}_{\text{ac}}}$$

PROCEDURE:

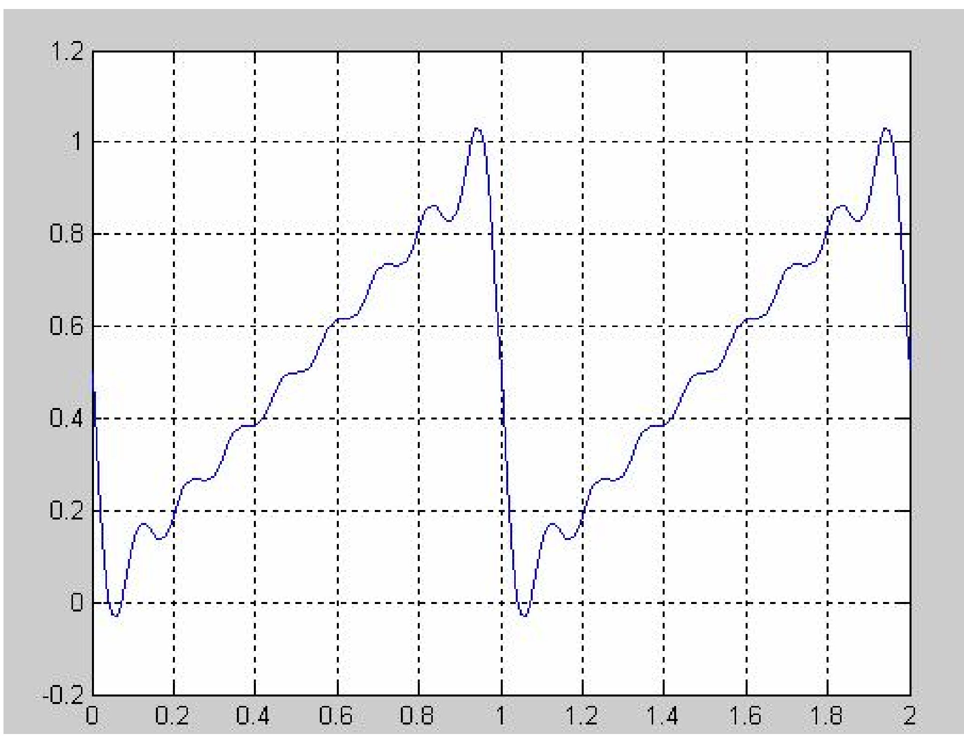
$$f(t) = \frac{1}{2} - \frac{1}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\sin 2\pi n t.$$

$f(t) = \frac{1}{2} - \frac{1}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\sin 2\pi n t.$	
f(t) =(1/2)-(1/pi)*((1/1)*(sin2*1*pi*t)) =(1/2)-(1/pi)*(sin2*pi*t)	n = 1
f(t) =(1/2)-(1/pi)*((1/2)*(sin2*2*pi*t)) =(1/2)-(1/pi)*((1/2)*(sin4*pi*t))	n = 2

f(t) =(1/2)-(1/pi)*((1/3)*(sin2*3*pi*t)) =(1/2)-(1/pi)*((1/3)*(sin6*pi*t))	n = 3
f(t) =(1/2)-(1/pi)*((1/4)*(sin2*4*pi*t)) =(1/2)-(1/pi)*((1/4)*(sin8*pi*t))	n = 4

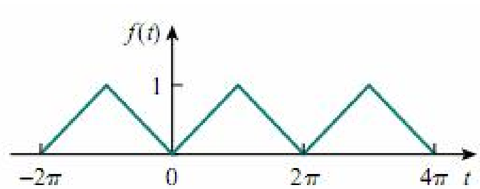
- Open MATLAB Command Window
- Type the function as

```
T =1;
t = 0:0.01:2;
a=1/2;
b=(1/pi)*sin(2*pi*t);
c=(1/(2*pi))*sin(4*pi*t);
d=(1/(3*pi))*sin(6*pi*t);
e=(1/(4*pi))*sin(8*pi*t);
f=(1/(5*pi))*sin(10*pi*t);
g=(1/(6*pi))*sin(12*pi*t);
h=(1/(7*pi))*sin(14*pi*t);
i=(1/(8*pi))*sin(16*pi*t);
s=(a)-(b+c+d+e+f+g+h+i);
plot(t,s)
grid
```



RESULT: You should be able to compute the Fourier series with the help of Matlab 7.

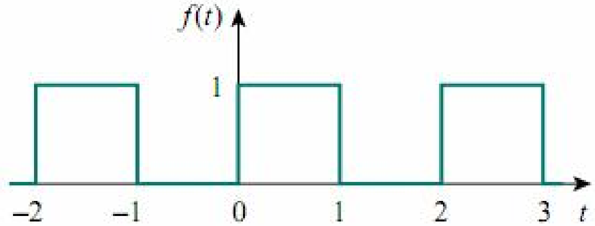
EXERCISE: Compute the Fourier series of function f(t), using MATLAB 7.0



$$f(t) = \frac{1}{2} - \frac{4}{\pi^2} \sum_{k=1}^{\infty} \frac{1}{n^2} \cos nt, \; n = 2k - 1.$$

EXPERIMENT NO: 10

OBJECT: To Obtain the Amplitude Spectrum of the Given Fourier series, using MATLAB 7.0



$$f(t) = \frac{1}{2} + \frac{2}{\pi}\sin \pi t + \frac{2}{3\pi}\sin 3\pi t + \frac{2}{5\pi}\sin 5\pi t + \cdots$$

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The plot of the Amplitude A_n of the harmonics versus Frequency nw_0 is called the Amplitude Spectrum of f (t).

$$\boxed{A_n = \sqrt{a_n^2 + b_n^2},}$$

$$f(t) = a_0 + \sum_{n=1}^{\infty}(a_n \cos n\omega_0 t + b_n \sin n\omega_0 t)$$

$$f(t) = \begin{cases} 1, & 0 < t < 1 \\ 0, & 1 < t < 2 \end{cases}$$

and $f(t) = f(t+T)$. Since $T = 2$, $\omega_0 = 2\pi/T = \pi$. Thus,

$$a_0 = \frac{1}{T}\int_0^T f(t)\,dt = \frac{1}{2}\left[\int_0^1 1\,dt + \int_1^2 0\,dt\right] = \frac{1}{2}t\Big|_0^1 = \frac{1}{2}$$

$$a_n = \frac{2}{T}\int_0^T f(t)\cos n\omega_0 t\,dt = \frac{2}{2}\left[\int_0^1 1\cos n\pi t\,dt + \int_1^2 0\cos n\pi t\,dt\right] = \frac{1}{n\pi}\sin n\pi t\Big|_0^1 = \frac{1}{n\pi}\sin n\pi = 0$$

$$b_n = \frac{2}{T}\int_0^T f(t)\sin n\omega_0 t\,dt \quad = \frac{2}{2}\left[\int_0^1 1\sin n\pi t\,dt + \int_1^2 0\sin n\pi t\,dt\right] \quad = -\frac{1}{n\pi}\cos n\pi t\Big|_0^1$$

$$= -\frac{1}{n\pi}(\cos n\pi - 1), \qquad \cos n\pi = (-1)^n$$

$$b_n = \frac{1}{n\pi}[1-(-1)^n] = \begin{cases} \dfrac{2}{n\pi}, & n = \text{odd} \\ 0, & n = \text{even} \end{cases}$$

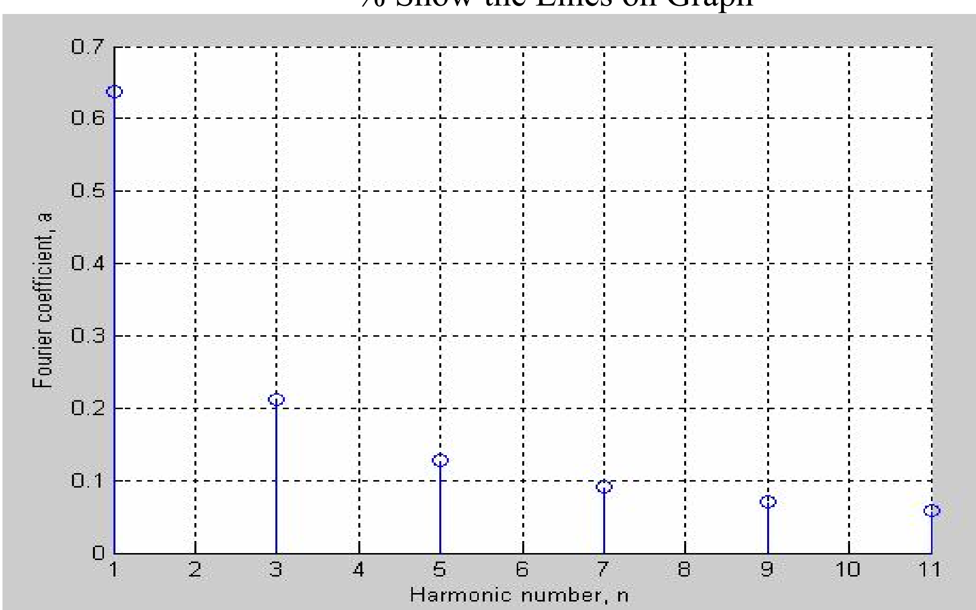
PROCEDURE:

$$f(t) = \frac{1}{2} + \frac{2}{\pi}\sin \pi t + \frac{2}{3\pi}\sin 3\pi t + \frac{2}{5\pi}\sin 5\pi t + \cdots$$

$$A_n = \sqrt{a_n^2 + b_n^2} = |b_n| = \begin{cases} \dfrac{2}{n\pi}, & n = \text{odd} \\ 0, & n = \text{even} \end{cases}$$

- Open MATLAB Command Window
- Type the function as

```
close all;                          % close any existing graphics windows
clear all;                          % clear any existing data from memory
A = 1;                              % amplitude of square wave
n = 1:2:12;                         % odd harmonic numbers generated
a = 2./(n*pi);                      % amplitudes of odd (sine)harmonics  of F.S.
stem(n,a);                          % plot as line spectrum
xlabel('Harmonic number, n');       % Name on X-Axis
ylabel('Fourier coefficient, a');   % Name on Y-Axis
grid                                % Show the Lines on Graph
```



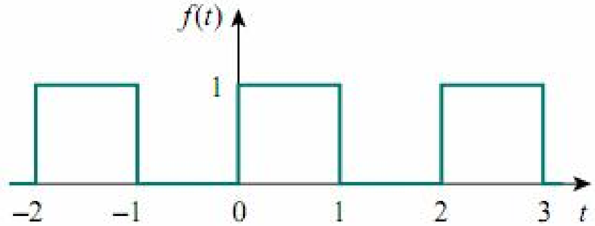
RESULT: You should be able to compute the Amplitude Spectrum of Fourier series with the help of Matlab 7.

EXERCISE: You given some values and find the Amplitude spectrum and check whether it is Odd Amplitude Spectrum or Even Amplitude Spectrum

```
A = 1;
n = 0:2:12;
a = 1./(n*pi);
```

EXPERIMENT NO: 11

OBJECT: To Obtain the Phase Spectrum of the Given Fourier series, using MATLAB 7.0



$$f(t) = \frac{1}{2} + \frac{2}{\pi}\sin \pi t + \frac{2}{3\pi}\sin 3\pi t + \frac{2}{5\pi}\sin 5\pi t + \cdots$$

EQUIPMENT: IBM PC/Compatible PC, MATLAB Software

THEORY: The plot of the Phase ϕ_n of the harmonics versus frequency nw_0 is called the Phase Spectrum of f (t).

$$\phi_n = -\tan^{-1}\frac{b_n}{a_n}$$

$$a_n = \frac{2}{T}\int_0^T f(t)\cos n\omega_0 t\,dt = \frac{2}{2}\left[\int_0^1 1\cos n\pi t\,dt + \int_1^2 0\cos n\pi t\,dt\right] = \frac{1}{n\pi}\sin n\pi t\Big|_0^1 = \frac{1}{n\pi}\sin n\pi = 0$$

$$b_n = \frac{2}{T}\int_0^T f(t)\sin n\omega_0 t\,dt = \frac{2}{2}\left[\int_0^1 1\sin n\pi t\,dt + \int_1^2 0\sin n\pi t\,dt\right] = -\frac{1}{n\pi}\cos n\pi t\Big|_0^1$$

$$= -\frac{1}{n\pi}(\cos n\pi - 1), \qquad \cos n\pi = (-1)^n$$

$$b_n = \frac{1}{n\pi}[1 - (-1)^n] = \begin{cases} \dfrac{2}{n\pi}, & n = \text{odd} \\ 0, & n = \text{even} \end{cases}$$

$$\phi_n = -\tan^{-1}\frac{b_n}{a_n} = \begin{cases} -90^\circ, & n = \text{odd} \\ 0, & n = \text{even} \end{cases}$$

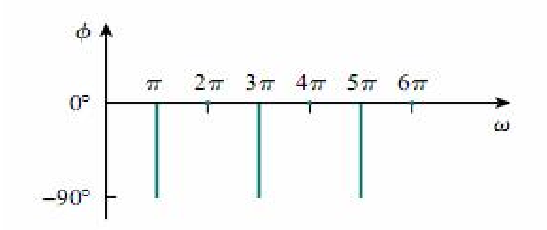


Fig: Phase Spectrum of Series

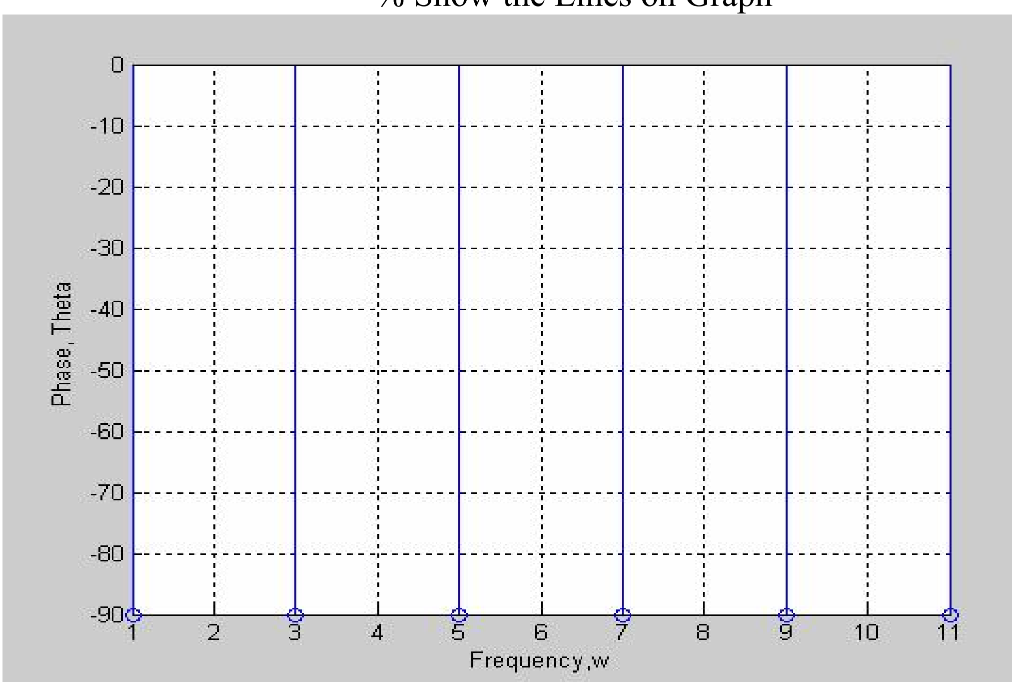
PROCEDURE:

$$f(t) = \frac{1}{2} + \frac{2}{\pi}\sin \pi t + \frac{2}{3\pi}\sin 3\pi t + \frac{2}{5\pi}\sin 5\pi t + \cdots$$

$$\phi_n = -\tan^{-1}\frac{b_n}{a_n} = \begin{cases} -90^\circ, & n = \text{odd} \\ 0, & n = \text{even} \end{cases}$$

- Open MATLAB Command Window
- Type the function as

```
close all;                  % close any existing graphics windows
clear all;                  % clear any existing data from memory
n = 1:2:12;                 % odd harmonic numbers generated
theta =  -atan(n/0);        % angle of odd harmonics of F.S.
theta1=(theta)*(180/pi)     % angle convert from radian to degrees
stem(n,theta1);             % plot as line spectrum
xlabel('Frequency,w');      % Name on X-Axis
ylabel('Phase, Theta ');    % Name on Y-Axis
grid                        % Show the Lines on Graph
```



RESULT: You should be able to compute the Frequency Spectrum of Fourier series with the help of Matlab 7.

EXERCISE: The Phase Spectrum is given to you, so write the code for this phase spectrum.