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Lab Manual:

Network Analysis and Scientific Computing Laboratory
(AEEC08)

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Contents

INTRODUCTION

Introduction

This course is intended to enhance the learning experience of the student in topics encountered in Network Analysis Course AEEC05.In this lab, students are expected to develop the practical skills required to do the experiments and gain experience in using the basic measuring devices used in Computer Science Engineering. Students also learn to interpret the experimental results in terms of the concepts introduced in the Engineering Physics course.How the student performs in the lab depends on his/her preparation and participation. Each student must participate in all aspectsof the lab to ensure a thorough understanding of the equipment and concepts. The student, Faculty teachingthe lab course, Laboratory In-charge and faculty coordinator all have certain responsibilities towards successful completion of the lab's goals and objectives.

Student Responsibilities

The student is expected tocome prepared for each lab.Lab preparation includes understanding the labexperiment from the lab manual and reading the related textbook material.

Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner.

Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results.

Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment.They are also responsible for keeping a professional and accurate record of the labexperiments in the files provided.

Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each labprior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the same semester as AEEC05, but receives a separate grade. Students are required to have completed both AHSB04,AHSB14 and AEE002 with minimum passing grade or better grade in each.

Course Goals and Objectives

The Network Analysis and SCientific Computing Laboratory course is designed as a foundation course to provide the student with the knowledge to understand the basic concepts in Networks which have lot of applications in the field of Engineering.

The experiments are designed to complement the concepts introduced in AEEC05. In addition, the student should learn how to record experimental results effectively and present these results in a written report.

More explicitly, the class objectives are:

1. To gain proficiency in the use of common measuring instruments.
2. To enhance understanding of theoretical concepts including:
3. To develop communication skills through:
   - Verbal interchanges with the Faculty and other students.
   - Preparation of succinct but complete laboratory reports.
   - Maintenance of laboratory worksheets aspermanent, written descriptions of procedures, analysis and results.
4. To compare theoretical predictions with experimental results and to determine the source of any apparent errors.

Instrument Protection Rules

Data Recording and Reports

The Laboratory Worksheets

The Laboratory Files/Reports

LAB-1 ORIENTATION

1.1 Introduction

In the first experiment period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor.

1.2 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

1.3 Prelab Preparation:

Read the introduction and procedure of the experiment of respective experiments which are given this manual.

1.4 Equipment needed

Lab manual

1.5 Procedure

1. During the first laboratory period, the faculty coordinator will provide the students with a general idea of what is expected from them in this course. Each student will receive a copy of the syllabus, stating the faculty coordinator's contact information. In addition, the faculty coordinator will review the safety concepts of the course.

2. During this period, the faculty coordinator will briefly review the equipment which will be used throughout the semester. The location of instruments, equipment, and components will be indicated. The guidelines for instrument use will be reviewed.

1.6 Further Probing Experiments

Questions pertaining to this lab must be answered at the end of laboratory report.

LAB-2 INTRODUCTION TO MATLAB

2.1 Introduction

This experiment focuses to check the symbols, tool kits and connections related to electrical circuits in MATLAB.

2.2 Objective

By the end of this experiment, the students should be able to check the symbols, tool kits and connections related to electrical circuits in MATLAB.

2.3 Prelab Preparation:

Read online information from Google that describes about MATLAB software.

2.4 Equipment needed

MATLAB Software

2.5 Background

MATLAB integrates mathematical computing, visualization, and a powerful language to provide a flexible environment for technical computing.
MATLAB includes tools for:
Data acquisition
Data analysis and exploration
Visualization and image processing
Algorithm prototyping and development
Modeling and simulation
Programming and application development
Run demos in the following categories to see MATLAB

Introduction of Toolbox:
Toolboxes are specialized collections of M-files (MATLAB language programs) built specifically for solving particular classes of problems. Our toolboxes represent the efforts of some of the world's top researchers in fields such as controls, signal processing, system identification, and others. The following toolboxes have demos to browse through. Try these demos to see which toolboxes might be appropriate for the work you do. Note that this is a comprehensive list of toolboxes. 6 Your particular installation of Math Works products will likely include only some of these products.
Introduction of Simulink:

Simulink is a tool for modeling, analyzing, and simulating physical and mathematical systems, including those with nonlinear elements and those that make use of continuous and discrete time. As an extension of MATLAB, Simulink adds many features specific to dynamic systems while retaining all of general-purpose functionality of MATLAB. Run demos in the following categories to see Simulink in action.

2.6 Procedure

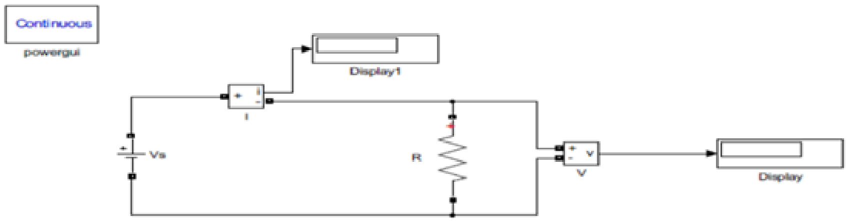


Figure – 1.3 Verification of Ohm's Law

1. On the MATLAB home tab click Simulink Option.
2. Click the blank model template, the Simulink Editor opens.
3. From the Simulink tap, select save ¿ save as. In the file name text box, enter the name of your model. Click on Library browser in the Simulink Left pane. Browse Resistors, Power GUI, Current measurement, Voltage measurements, Display.
4. Click and Drag the models to the blocks to the Simulink block Diagram.
5. Connect the Circuit as per the Circuit Diagram.
6. Click save
7. Click Run on Target and see the results in the display.

S. No.	Voltage (V)	Current (mA)

2.7 Expected Graph

2.8 Result

2.9 VIVA Questions

1. What is MATLAB?

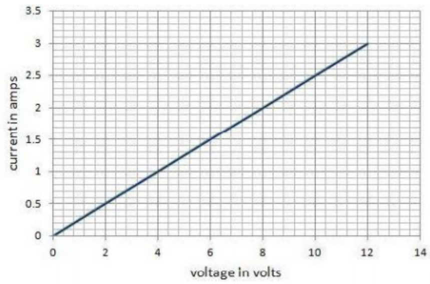


Figure – 1.2 Verification of Ohm's Law Graph

2. What is workspace window in MTALAB?
3. What is Simulink?
4. What is GUI environment?

LAB-3 TRANSIENT RESPONSE OF SERIES RL, RC AND RLC CIRCUITS

3.1 Introduction

This experiment focuses on to plot the time varying characteristics of series RL,RC and RLC circuits using MATLAB.

3.2 Objective

By the end of this experiment, the student should be able to plot the time varying characteristics of series RL,RC and RLC circuits using MATLAB.

3.3 Prelab Preparation:

Read the material in the textbook that describes time response of series RL, RC and RLC circuits.

3.4 Equipment needed

MATLAB software

3.5 Background

The transient response is the fluctuation in current and voltage in a circuit (after the application of a step voltage or current) before it settles down to its steady state. This lab will focus on simulation of series RL (resistor-inductor), RC (resistor-capacitor), and RLC (resistor inductor-capacitor) circuits to demonstrate transient analysis.
Transient Response of Circuit Elements:
A. Resistors: As has been studied before, the application of a voltage V to a resistor (with resistance R ohms), results in a current I, according to the formula: $I = V/R$ The current response to voltage change is instantaneous; a resistor has no transient response.
B. Inductors: A change in voltage across an inductor (with inductance L Henrys) does not result in an instantaneous change in the current through it. The i-v relationship is described with the equation: $v=L\, di/dt$ This relationship implies that the voltage across an inductor approaches zero as the current in the circuit reaches a steady value. This means that in a DC circuit, an inductor will eventually act like a short circuit.
C. Capacitors: The transient response of a capacitor is such that it resists instantaneous change in the voltage across it. Its i-v relationship is described by: $i=C\, dv/dt$ This implies that as the voltage across the capacitor reaches a steady value, the current through it approaches zero. In other words, a capacitor eventually acts like an open circuit in a DC circuit. Series

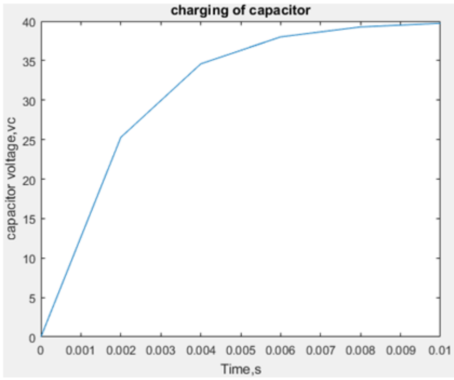


Figure 3.1: Charging of Capacitor.

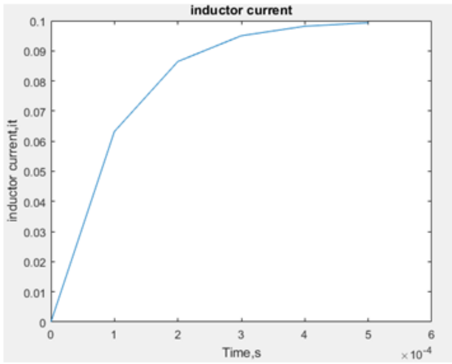


Figure 3.2: Inductor Current

Combinations of Circuit Elements: Solving the circuits involves the solution of first and second order differential equations.

3.6 Program

Series RC Circuit:

clc;
c=10e-6; r=200; tau=c*r; t=0:0.002:0.01; vc=40*(1-exp(-t/tau)); plot(t,vc); xlabel('Time,s'),ylabel('capacit
voltage,vc') title('charging of capacitor')

Series RL Circuit:

clc
l=0.01; r=100; tau=l/r; t=0:100e-6:500e-6; it=0.1*(1-exp(-t/tau)); plot(t,it); xlabel('Time,s'),ylabel('induct
current,it') title('inductor current')

Series RLC Circuit:

clc
L=8; c=2; r=4; w0=1/sqrt(L*c); for t=1:21; it=125*t*exp(-w0*t); IT(:,t)=it end t=0:20 plot(t,IT); xlabel('Time,s'),ylabel('current,I(T)') title('current response')

3.7 Result

3.8 VIVA Questions

1. Define transient response

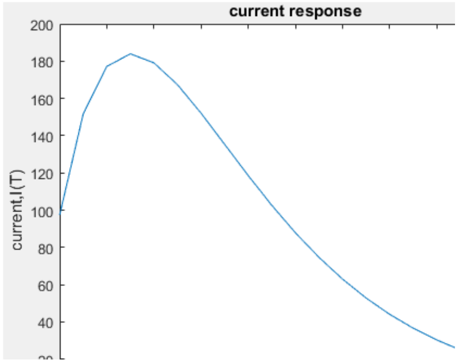


Figure 3.3: Current Response

2. Define steady state response.
3. If XL is greater than XC then the nature of the circuit is ————-.
4. If XL is less than XC then the nature of the circuit is ————-.
5. Application of series RLC circuits
6. Application of parallel RLC circuits

LAB-4 TRANSIENT RESPONSE OF PARALLEL RL, RC AND RLC CIRCUITS.

4.1 Introduction

This experiment focuses to plot the time varying characteristics of parallel RL,RC and RLC circuits using MATLAB.

4.2 Objective

By the end of this experiment, the student should be able to plot the time varying characteristics of parallel RL,RC and RLC circuits using MATLAB.

4.3 Prelab

Read the material in the textbook that describes time response of parallel RL, RC and RLC circuits.

4.4 Equipment needed

MATLAB software

4.5 Background

Depending on the circuit constants (or), , and , the natural response of a parallel circuit may be overdamped, critically damped or underdamped. In this section we will derive the total response of a parallel circuit which is excited by a DC source using the following example. For the circuit of Figure has been opened for a long time. If the switch opens at t = 0, find the voltage v(t).

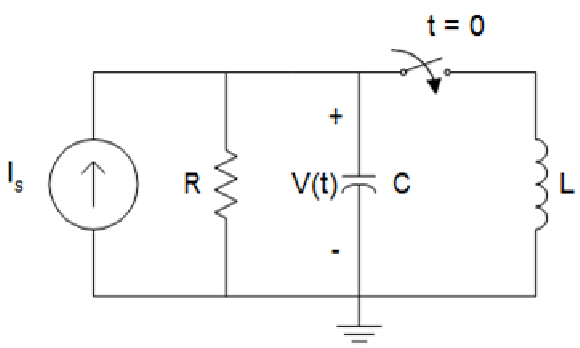


Figure 4.1: Parallel RLC Circuit

$$I_S = \frac{v(t)}{R} + C\frac{dv(t)}{dt} + \frac{1}{L}\int_0^t v(\tau)d\tau + i_L(0)$$

Taking the Laplace transform of the above expression, we get

$$\frac{I_S}{s} = \frac{V(s)}{R} + C[sV(s) - V_C(0)] + \frac{V(s)}{sL} + \frac{i_L(0)}{s}$$

Simplifying the above expression, we get

For $I_S = 2\text{A},\ C = 50\mu\ \text{F},\ R = 10\Omega,\ L = 1/32\ \text{H},\ V(s)$ becomes

$$V(s) = \frac{40000 + 20s}{s^2 + 2000s + 64*10^4}$$

$$V(s) = \frac{40000 + 20s}{(s+1600)(s+400)} = \frac{A}{(s+1600)} + \frac{B}{(s+400)}$$

$$A = \lim_{s \to -1600} V(s)(s+1600) = -6.67$$

$$B = \lim_{s \to -400} V(s)(s+400) = 26.67$$

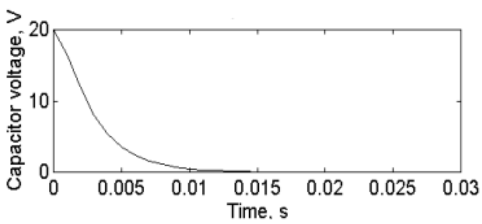
$$v(t) = -6.67e^{-1600t} + 26.67e^{-400t}$$

Assume that R = 10 ohms, L = 1/32 H, C = 50 microfarads and IS = 2 A. At t ¡ 0, the voltage across the capacitor is vC (0) = (2)(10) = 20 V In addition, the current flowing through the inductor iL (0) = 0 At t ¿ 0, the switch closes and all the four elements of Figure remain in parallel. Using KCL, we get

4.6 Procedure

clc

t2 =0:1e-3:30e-3; vt = -6.667*exp(-1600*t2) + 26.667*exp(-400*t2); plot(t2,vt) xlabel('Time, s'), ylabel('Capacitor voltage, V')



4.7 Result

4.8 VIVA Questions

1. Define transient response
2. Define steady state response.
3. If XL is greater than XC then the nature of the circuit is ———–.
4. If XL is less than XC then the nature of the circuit is ———–.
5. Application of series RLC circuits
6. Application of parallel RLC circuits

LAB-5 TRANSFER FUNCTION OF ELECTRICAL CIRCUIT

5.1 Introduction

This experiment focuses to determine the Transfer function of electrical circuit using MATLAB circuit.

5.2 Objective

By the end of this experiment, the student should be able to determine the Transfer function of electrical circuit using MATLAB circuit.

5.3 Prelab Preparation:

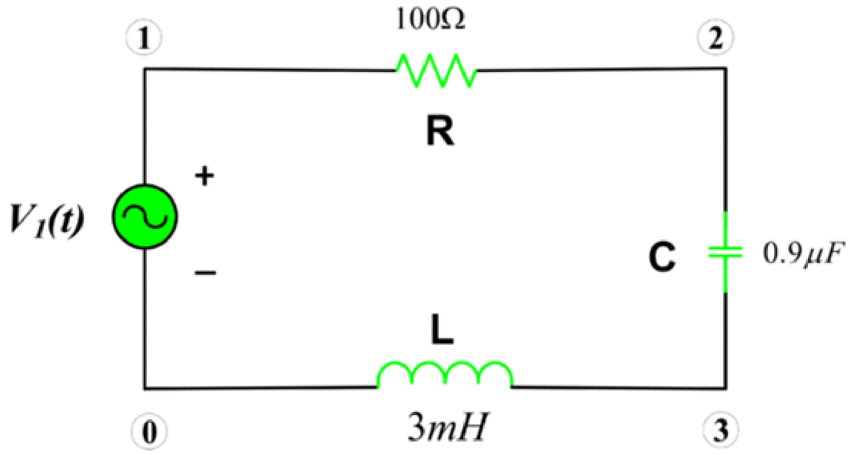
Read the material in the textbook that describes about determination of the Transfer function of electrical circuit.

5.4 Equipment needed

MATLAB Software

5.5 Background

Plot the magnitude and the phase response of the voltage transfer function of series RLC circuit for frequencies from 10 Hz to 100kHz.:



$$v_1(t) = 10\cos(30 * 10^3 t + \pi / 4)$$

Here, we will compute the phase and the magnitude of the voltage transfer function Vo/V1 for frequencies ranging from 10 Hz to 100 kHz. The transfer function can be determined by the following relation:

$$H(f) = \frac{V_o}{V_1} = \frac{Z_C}{Z_C + Z_L + R}$$

A transfer function is simply a ratio between input and output.

Whereas:

$$Z_C = \frac{1}{j\omega C}$$
$$Z_L = j\omega L$$

Now, let's compute the transfer function using Matlab:

5.6 Procedure

5.7 Expected Graph

5.8 Result

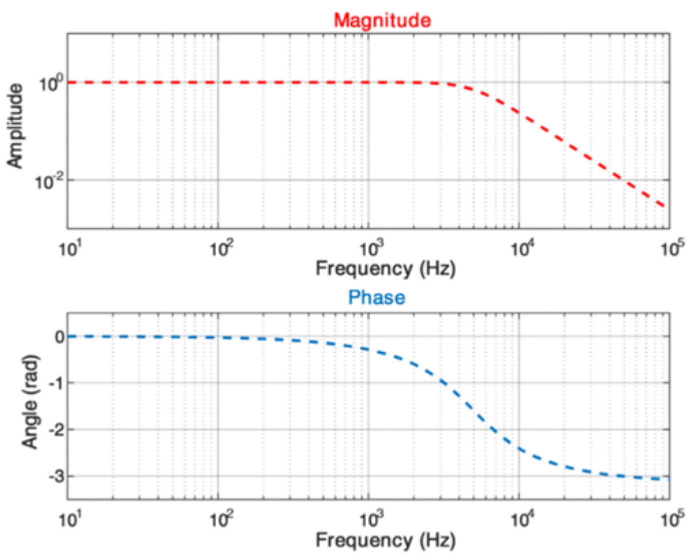
5.9 VIVA Questions

1. Define transfer function.
2. Write transfer function of RLC Circuit.
3. What are the uses of transfer functions for electrical circuits.
4. Define R, L, C Parameters.
5. Why do we need transfer function in Network Analysis
6. What are the properties of transfer functions.
7. Application of series RLC circuits
8. What is the significance of transfer function.

```
%Transfer Function Calculation for an AC Circuit
clear all;close all;clc
%% Circuit Parameters
R= 30; % Resistance (30 Ohm)
L= 0.7e-3; % Inductance (0.7 mH)
C= 1.5e-6; % Capacitance (1.5 microfarad)
% Please see "help logspace" in order to understand how does logspa
f= logspace(1,5); % Frequency range between 10 Hz and 100 kHz
omega= 2*pi.*f; % Angular Frequency
ZC= 1./(j.*omega.*C); % Capacitive Reactance
ZL= j.*omega.*L; % Inductive Reactance
Hf=ZC./(ZC+ZL+R); % Transfer Function (V0/V1)
%% Plot the phase and the magnitude response of a transfer function
%Magnitude Plot
subplot(211)
%loglog(...) is the same as PLOT(...), except logarithmic scales ar
loglog(f,abs(Hf))
title('Magnitude')
xlabel('Frequency (Hz)')
ylabel('Amplitude')
% Please see "help axis" in order to understand how does axis work.
axis([10 1e5 1e-3 10]) % Manual axis adjustment

%Phase Plot
subplot(212)
%semilogx(...) is the same as PLOT(...), except a logarithmic (base
semilogx(f,angle(Hf))
title('Phase')
xlabel('Frequency (Hz)')
ylabel('Angle (rad)')
axis([10 1e5 -3.5 0.5]) % Manual axis adjustment
```

RLC Circuit Transfer Function Frequency Response:



LAB-6 TRANSIENT RESPONSE OF RLC CIRCUIT

6.1 Introduction

This experiment focuses to verify the frequency characteristics of Low pass and High pass filters.

6.2 Objective

By the end of this experiment, the student should be able to verify the frequency characteristics of Low pass and High pass filters.

6.3 Prelab Preparation:

Read the material in the textbook that describes about Low pass and High pass filters.

6.4 Equipment needed

MATLAB Software

6.5 Background

Active low pass filter with amplification: **Active High pass filter with amplification:**

6.6 Procedure

MATLAB code for Low pass filter : clc; f=0:1:10^6; $r1 = 10000; rf = 1000; r = 15900; c = 0.01*10^-6; af = (1+rf/r1); fc = 1/(2*pi*r*c); a = f/fc; acl_lp = af./sqrt(1+a.*a)semilogx(acl_lp)xlabel('freque$
$)ylabel('gain >')title('frequencyresponseoflowpassfilter')grid$

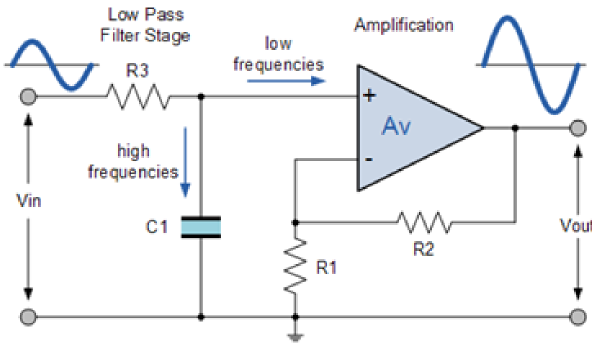
MATLAB code for High pass filter : clc; f=[0:1:10^6]; $r1 = 10000; rf = 1000; r = 15900; c = 0.01*10^(-6); af = (1+rf/r1); fc = 1/(2*pi*r*c); a = f/fc; acl_lp = af.*a./sqrt(1+a.*a); semilogx(acl_lp)xlabel('frequency >')ylabel('gain >')title('frequencyresponseofhighpassfilter')grid$

6.7 Model Graph

6.8 Result

6.9 VIVA Questions

1. What is high pass filter?
2. What is low pass filter?



The frequency response of the circuit will be the same as that for the passive RC filter, except that the amplitude of the output is increased by the pass band gain, A_F of the amplifier. For a non-inverting amplifier circuit, the magnitude of the voltage gain for the filter is given as a function of the feedback resistor (R_2) divided by its corresponding input resistor (R_1) value and is given as:

$$\text{DC gain} = \left(1 + \frac{R_2}{R_1}\right)$$

Therefore, the gain of an active low pass filter as a function of frequency will be:

Gain of a first-order low pass filter

$$Voltage\ Gain, (Av) = \frac{Vout}{Vin} = \frac{A_F}{\sqrt{1 + \left(\frac{f}{fc}\right)^2}}$$

Where:

A_F = the pass band gain of the filter, (1 + R2/R1)

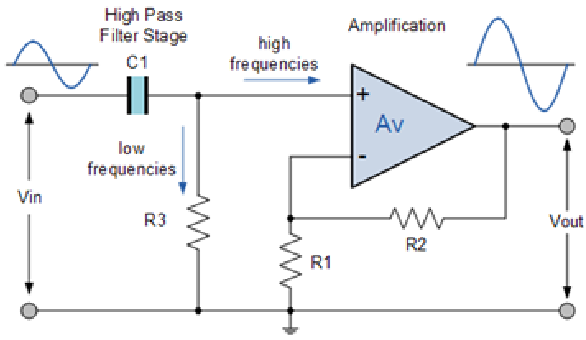
f = the frequency of the input signal in Hertz, (Hz)

fc = the cut-off frequency in Hertz, (Hz)

3. What is expression for cut of frequency for line pass or high pass filter?
4. What is frequency response curve?
5. When does cut of frequency occur?
6. What does high pass filter generally comprise of?
7. Theregion between pass band and stop band is called?
8. The rate of change of amplitude with frequency in a filter is?

Thus, the operation of a low pass active filter can be verified from the frequency gain equation above as:

1. At very low frequencies, $f < fc$ $\quad \frac{Vout}{Vin} \cong A_F$
2. At the cut-off frequency, $f = fc$ $\quad \frac{Vout}{Vin} = \frac{A_F}{\sqrt{2}} = 0.707\,A_F$
3. At very high frequencies, $f > fc$ $\quad \frac{Vout}{Vin} < A_F$



This *first-order high pass filter*, consists simply of a passive filter followed by a non-inverting amplifier. The frequency response of the circuit is the same as that of the passive filter, except that the amplitude of the signal is increased by the gain of the amplifier.

For a non-inverting amplifier circuit, the magnitude of the voltage gain for the filter is given as a function of the feedback resistor (R2) divided by its corresponding input resistor (R1) value and is given as:

Gain for an Active High Pass Filter

$$\text{Voltage Gain, }(Av) = \frac{Vout}{Vin} = \frac{A_F\left(\frac{f}{fc}\right)}{\sqrt{1+\left(\frac{f}{fc}\right)^2}}$$

Where:

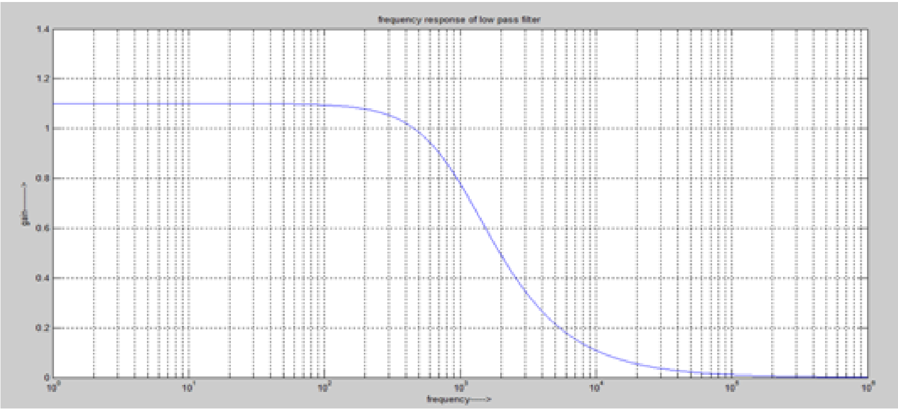
A_F = the Pass band Gain of the filter, (1 + R2/R1)

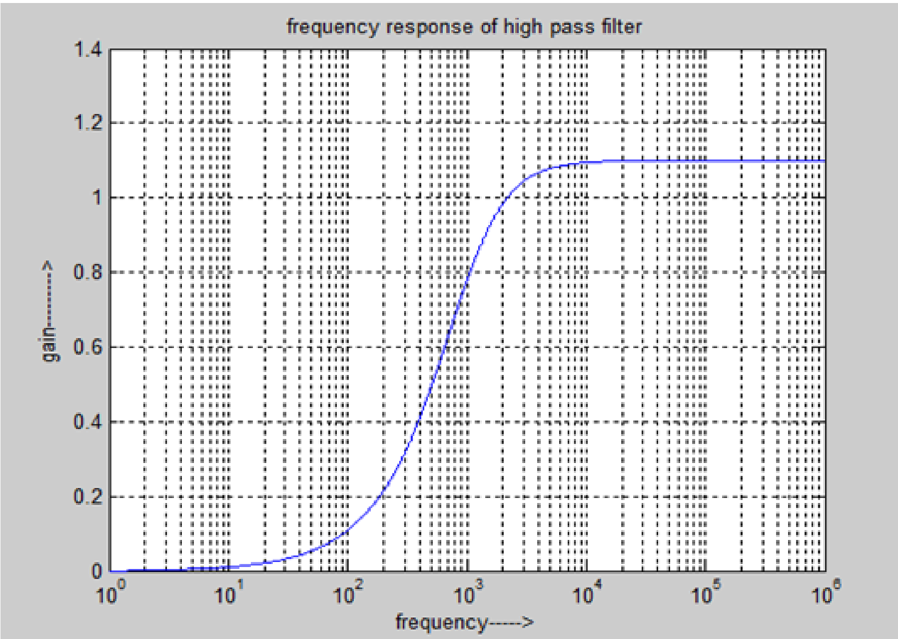
f = the Frequency of the Input Signal in Hertz, (Hz)

fc = the Cut-off Frequency in Hertz, (Hz)

Just like the low pass filter, the operation of a high pass active filter can be verified from the frequency gain equation above as:

1. At very low frequencies, $f < fc$ $\qquad \dfrac{Vout}{Vin} < A_F$
2. At the cut-off frequency, $f = fc$ $\qquad \dfrac{Vout}{Vin} = \dfrac{A_F}{\sqrt{2}} = 0.707\,A_F$
3. At very high frequencies, $f > fc$ $\qquad \dfrac{Vout}{Vin} \cong A_F$





LAB-7 GENERATION OF THREE PHASE WAVEFORM

7.1 Introduction

This experiment focuses to generate three phase AC waveform for different phase differences and phase sequesnces using MATLAB.

7.2 Objective

By the end of this experiment, the student should be able to generate three phase AC waveform for different phase differences and phase sequesnces using MATLAB.

7.3 Prelab Preparation:

Read the material in the textbook that describes about three phase waveform.

7.4 Equipment needed

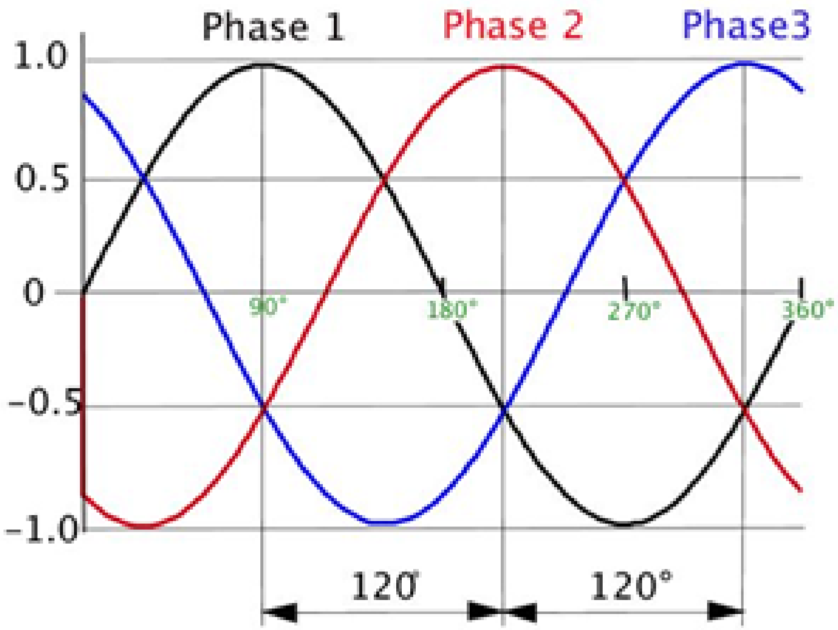
MATLAB software

7.5 Background

Electrical Waveforms are basically visual representations of the variation of a voltage or current over time. All electrical waveforms include the following three common characteristics:
Period: This is the length of time in seconds that the waveform takes to repeat itself from start to finish. This value can also be called the Periodic Time, (T) of the waveform for sine waves, or the Pulse Width for square waves.
Frequency: This is the number of times the waveform repeats itself within a one second time period. Frequency is the reciprocal of the time period, ($f = 1/T$) with the standard unit of frequency being the Hertz, (Hz).
Amplitude: This is the magnitude or intensity of the signal waveform measured in volts or amps.
Three-phase power provides three alternating currents, with three separate electric services. Each leg of alternating current reaches a maximum voltage, only separated by 1/3 of the time in a full cycle. ... In a three-phase power supply, it requires four wires, namely one neutral wire and three-conductor wires.

Three-phase power is a three-wire ac power circuit with each phase ac signal 120 electrical degrees apart. Residential homes are usually served by a single-phase power supply, while commercial and industrial facilities usually use a three-phase supply. ... Single-phase systems can be derived from three-phase systems.

A three-phase circuit provides greater power density than a one-phase circuit at the same amperage, keeping wiring size and costs lower. In addition, three-phase power makes it easier to balance loads, minimizing harmonic currents and the need for large neutral wires.



7.6 Procedure

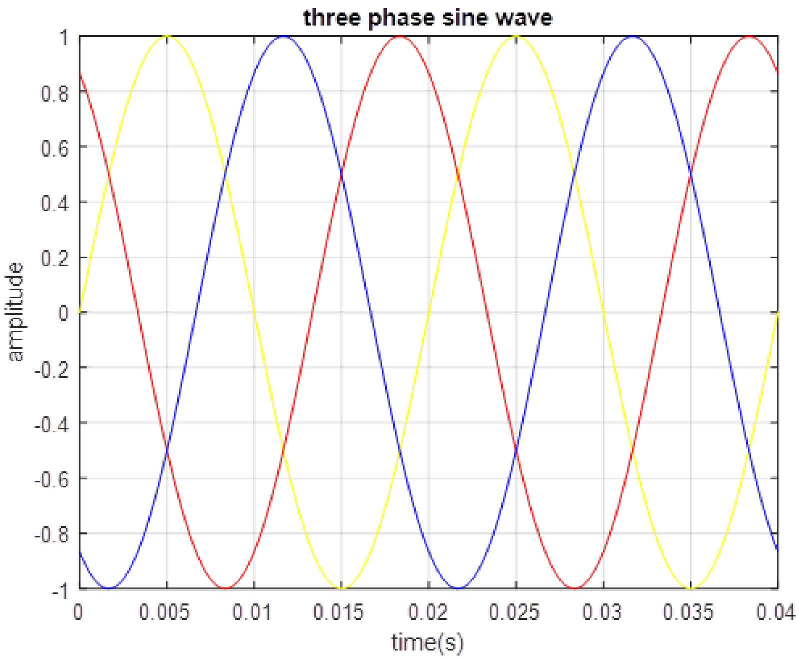
MATLAB code: clc clear all t=0:0.002:0.04; y=sin(2*pi*50*t); plot(t,y,'y') hold on t1=0:0.002:0.04; y1=sin(2*pi*50*t+2*pi/3); plot(t1,y1,'r') hold on t2=0:0.002:0.04; y2=sin(2*pi*50*t-2*pi/3); plot(t2,y2,'b') grid; xlabel('time(s)'); ylabel('amplitude'); title('three phase sine wave');

7.7 Expected Graph

7.8 VIVA

1. What is Electrical Waveform
2. What is phase difference in AC circuit?
3. Name some basic AC waveform
4. What is the duration of one cycle known as?
5. Write the basic formula for three phase system.
6. A polyphase system is generated by——-
7. In a three phase AC circuit, the sum of all three generated voltages is

Applicationsofthreephasewaveform


three phase sine wave
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
amplitude
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
time(s)

LAB-8 SOLVING DIFFERENTIAL EQUATION

8.1 Introduction

obtain the solution of differential equation representing electric network using MATLAB.

8.2 Objective

By the end of this experiment, the student should be able to obtain the solution of differential equation representing electric network using MATLAB.

8.3 Prelab Preparation:

Read the material in the textbook that describes about the electrical network differential equations.

8.4 Equipment needed

MATLAB software.

8.5 Background

In mathematics, the derivative of a function of a real variable measures the sensitivity to change of the function value with respect to a change in its argument.
Derivatives are absolutely everywhere in electrical engineering and applications. For example, the relationship between current and voltage in a capacitor is a derivative:

8.6 Procedure

From the above figure we can write i = ir + ic

i=V/R+C dV / dt

dQ/dt=(C*V-q)/(R*C);

We can solve the differential equation using MATLAB Command. We will solve this equation for two cases:
(i) When 12 V battery is connected
(ii) When Battery is not coonected

"Ohm's Law" for a capacitor

$$i = C \frac{dv}{dt}$$

Where,

i = Instantaneous current through the capacitor

C = Capacitance in Farads

$\frac{dv}{dt}$ = Instantaneous rate of voltage change (volts per second)

"Ohm's Law" for an inductor

$$v = L \frac{di}{dt}$$

Where,

v = Instantaneous voltage across the inductor

L = Inductance in Henrys

$\frac{di}{dt}$ = Instantaneous rate of current change (amps per second)

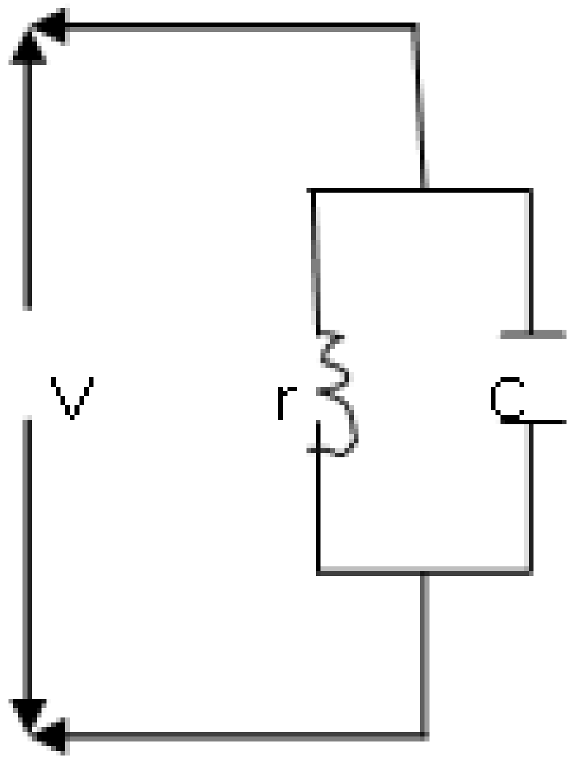
8.7 Procedure

MATLAB code: function RC1()

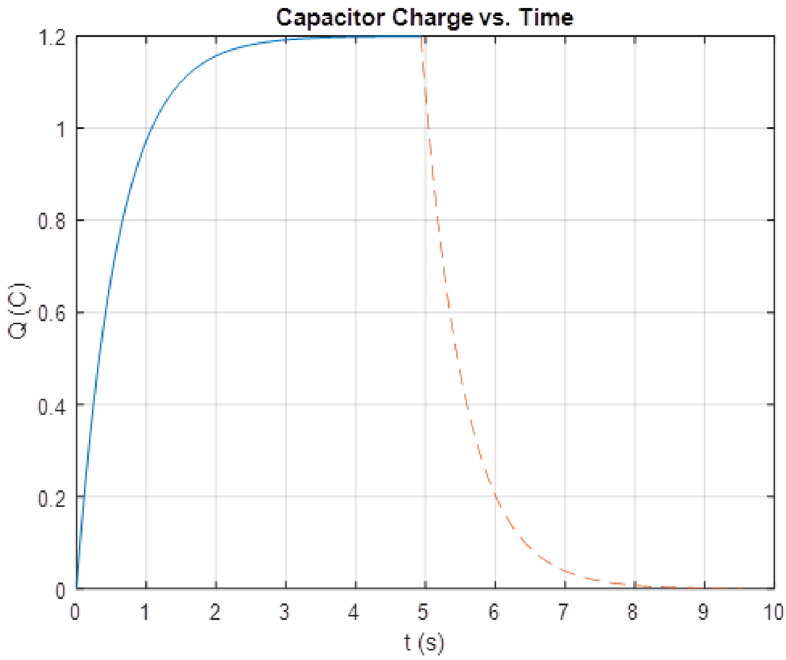
```
C=.1 R=6 V=12; q0=0; t0=0;
[time1,Q1]=ode45(@(t,q) diffeq(t,q,C,R,V),[t0 10000],q0,odeset('RelTol',0.00001));
for j=1:length(Q1)-1 dQ1=Q1(j+1)-Q1(j); if abs(dQ1)¡=0.0001 index=j; break; end end
q1=Q1(index); t1=time1(index); V1=0; [time2,Q2]=ode45(@(t,q) diffeq(t,q,C,R,V1),[t1 10],q1,odeset('RelT
for j=1:length(Q2)-1 dQ2=Q2(j+1)-Q2(j); if abs(dQ2)¡=0.0001 plot_end = j; break; endend
plot(time1(1:index),Q1(1:index),'-',time2(1:plot_end), Q2(1 : plot_end),' −−'); title('CapacitorChargevs.Tim
function dQdt=diffeq( ,q,C,R,V) dQdt=(C*V-q)/(R*C); end
```

8.8 VIVA

1. What is Electrical Network?
2. What is the significance of differentiation?
3. Give two examples of electrical network where we can find differential equation.
4. Give two examples where we can find differential equation application apart from electrical network.



5. What is charging current of capacitor?
6. Mention the KCL for a RC Circuit.
7. Mention the KVL for a RL Circuit.
8. What is the command in MATLAB for derivative?



Capacitor Charge vs. Time
Q (C)
t (s)
0
0.2
0.4
0.6
0.8
1
1.2
0
1
2
3
4
5
6
7
8
9
10

LAB-9 THREE PHASE MEASUREMENTS

9.1 Introduction

This experiment focuses to determine the electrical quantities of three phase waveform using MATLAB.

9.2 Objective

By the end of this experiment, the student should be able to determine the electrical quantities of three phase waveform using MATLAB.

9.3 Prelab Preparation:

Read the material in the textbook that describes about the three phase system quantities.

9.4 Equipment needed

MATLAB software.

9.5 Background

Overview of Three Phase Circuits

The three-phase circuit is composed of a three-phase system of voltages connected to a three-phase load configuration. If the voltages have the same magnitude and frequency and each voltage is 120° out of phase with the other voltages, the voltages are said to be balanced. In addition, if the loads are configured in a way that the resulting currents are balanced, then the result is a balanced three-phase circuit [1-5].

In a three-phase circuit, the voltages are connected to the corresponding loads by lines a, b and c. This results in three voltages (Y-connection), $\tilde{V}_{an}$, $\tilde{V}_{bn}$, and $\tilde{V}_{cn}$. The notations a, b, and c represent the three phases and n represents the neutral. Equation 1 shows the formula for the three voltages.

$$\begin{aligned}\tilde{V}_{an} &= V_p\angle 0^\circ \\ \tilde{V}_{bn} &= V_p\angle -120^\circ \\ \tilde{V}_{cn} &= V_p\angle +120^\circ\end{aligned} \qquad (1)$$

where V_p is the phase voltage. With balanced three-phase systems it is important to note that

$$\tilde{V}_{an} + \tilde{V}_{bn} + \tilde{V}_{cn} = 0 \qquad (2)$$

When connecting the source of the three phase generator and the load, there are two types of connections, a *wye* (Y) and a *delta* (Δ) connection. Because the source and the load can each be connected in two different ways, there exists four different configurations for balanced three-phase circuits, Y-Y, Y-Δ, Δ-Y, and Δ-Δ. These various circuits are discussed in the following sections.

Y-Y Connection

A balanced Y-Y connection is shown in Figure 1.

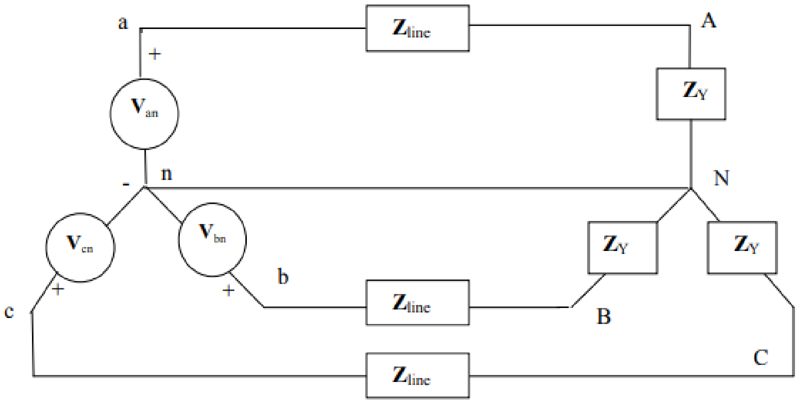


Fig. 1 Y-Y Connection

Using (1) for phase voltages, the line voltages can be calculated using KVL to obtain the following equations.

$$\tilde{V}_{ab} = \sqrt{3} * V_p \angle 30^\circ$$
$$\tilde{V}_{bc} = \sqrt{3} * V_p \angle -90^\circ \qquad (3)$$
$$\tilde{V}_{ca} = \sqrt{3} * V_p \angle -210^\circ$$

The line currents can be calculated by

$$\tilde{I}_a = \frac{\tilde{V}_{an}}{\tilde{Z}_Y} \qquad (4)$$

The neutral current can then be calculated by

$$\tilde{I}_n = \tilde{I}_a + \tilde{I}_b + \tilde{I}_c = 0 \qquad (5)$$

It is also important to note that in a Y-Y connection, the current in the line connecting the source to the load is the same as the phase current that is flowing through Z_Y.

9.6 Procedure

MATLAB code: clc

v=110; van=v*(cos (0)+i*sin (0)); vbn=v*(cos (2*pi/3)-i*sin (2*pi/3)); vcn=v*(cos (2*pi/3)+i*sin (2*pi/3)); vtotal=van+vbn+vcn zline=5-i*2;zl=10+i*8; ia=van/(zline+zl) ib=vbn/(zline+zl) ic=vcn/(zline+zl) in=ia+ib+ic vadropline=ia*zline vbdropline=ib*zline vcdropline=ic*zline vadropload=ia*zl vbdropload=ib*zl vcdropload=ic*zl s= 3*van*ia

1. What is a three-phase system.

2. How line voltages and phase voltages are related in wye-connected system?

3. How line currents and phase currents are related in delta-connected system?

4. What are the expressions for active, reactive and apparent power expressions for 3-phase system?

Power Calculations

The single phase power equations can be applied to each phase of a Y- or a Δ-connected three phase load. The real, reactive, and apparent powers supplied to a balanced three phase load in phase quantities are given by:

$$P = 3V_p I_p \cos\theta$$
$$Q = 3V_p I_p \sin\theta$$
$$S = 3V_p I_p$$

Also, it is possible to express the power in a balanced three phase load in terms of line quantities. The following equations are applicable regardless the connection:

$$P = \sqrt{3}\,V_L I_L \cos\theta$$
$$Q = \sqrt{3}\,V_L I_L \sin\theta$$
$$S = \sqrt{3}\,V_L I_L$$

5. What is balanced system?
6. What is an unbalanced system?
7. are different configurations for balanced 3-phase circuit?

LAB-10 VIRTUAL INSTRUMENTS (VI) USING LabVIEW

10.1 Introduction

Editing and Building a VI, Creating a VI.

10.2 Objective

By the end of this experiment the student should be able to build a VI and edit a VI.

10.3 Prelab Preparation:

Read the online material from Google that describes about Labview software.

10.4 Equipment needed

Labview software.

10.5 Background

LabVIEW programs are called virtual instruments, or VIs, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. Lab VIEW contains a comprehensive set of tools for acquiring, analyzing, displaying, and storing data, as well as tools to help you troubleshoot code you write.
In LabVIEW, you build a user interface, or front panel, with controls and indicators. Controls are knobs, push buttons, dials, and other input mechanisms. Indicators are graphs, LEDs, and other output displays. After you build the front panel, you add code using VIs and structures to control the front panel objects. The block diagram contains this code. You can use Lab VIEW to communicate with hardware such as data acquisition, vision, and motion control devices, as well as GPIB, PXI, VXI, RS232, and RS485 instruments.
virtual instrument: A virtual instrument (VI) is a program in the graphical programming language G. Virtual instrument front panels often have a user interface similar to physical instruments. G also has built-in functions that are similar to VIs, but do not have front panels or block diagrams as VIs do.

10.6 Procedure

CREATING A VI

1. Open new VI by selecting File» New, select New VI from the Lab VIEW dialog box. Then you can see block diagram panel and front panel.

2. Then right click on the block diagram panel and select adder block from functions¿¿numeric. Then select and drag it to the block diagram panel.

3. Copy paste the adder block as we need four inputs for the average of four numbers

4. Then right click on the adder block and create a control, which displays the input in the front panel. Likewise create controls for the four inputs.

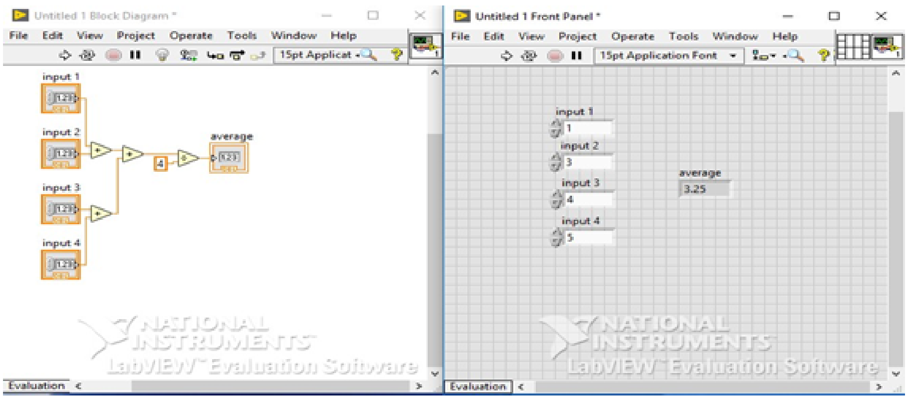
5. Then copy paste another adder block and connect the outputs of first two adder blocks to it.

6. Then right click on the block diagram panel and select divider block from functions¿¿numeric. Select the divider block and drag it to block diagram panel.

7. And connect the output of 3rd adder block to 1st input and create a constant to second input by right clicking on divider block and give its value as 4.

8. Go to front panel and label every block as shownin figure, and give the values for input blocks.

9. Run the VI. Save the VI as 'AVG' from file menu.



CREATING A SUB VI

(To use a VI as a sub VI, you must create an icon to represent it on the block diagram of another VI, and a connector pane to which you can connect inputs and outputs. Lab VIEW provides several tools with which you can create or edit an icon for your VI's.)

1. Open AVG.vi from file menu.

2. From the front panel, pop up on the icon in the top right corner and select Edit Icon. You also can double click on the icon to invoke the icon editor.

3. Erase the default icon. With the Select tool, which appears as a dotted rectangle, click and drag over the section you want to delete. You also can double click on the shaded rectangle in the tool box to erase the icon.

4. Create the text with the Text tool. To change the font, double-click on the Text tool. Your icon should look similar to the following illustration.

5. Close the Icon Editor by clicking on OK. The new icon appears in the icon pane.

6. Define the connector terminal pattern by popping up in the icon pane on the front panel and choosing Show Connector.

7. Assign the terminals to inputs and output.
   a. Click on the top terminal in the connector. The cursor automatically changes to the Wiring tool, and the terminal turns black.
   b. Click on the input 1 block. The selected terminal changes to a color consistent with the data type of the control/indicator selected. Likewise do to all the inputs and outputs.

8. Save the VI by choosing File» Save.

9. Close the VI by choosing File» Close.

EDITING AND RUNNING VI

1. Open a new VI by selecting File» New.

2. Then right click on the block diagram and select already existing VI from functions¿¿select VI.

3. Then select AVG.VI from the folder and drag it to the block diagram panel.

4. Then copy paste two times. Then right click and select multiply and divide block from functions¿¿numeric.

5. Then wire the blocks as shown in the diagram

6. Create controls to inputs and indicators to outputs as shown.

7. Save the VI from file¿¿save.

10.7 VIVA

1. What is expansion of LabVIEW?

2. What is VI?

3. What is front panel?

4. What is block diagram?

5. What do you mean by controls and indicators?
6. How do you create a sub VI?
7. How do you use functions from function pallete.
8. What are various color coding for data types?
9. What is sequence of executing LabVIEW program?

LAB-11 GENERATION OF COMMON WAVEFORMS USING LAB VIEW

11.1 Introduction

This experiment focuses to perform signal generation and display of wave form, minimum and maximum values of waveform and modulation.

11.2 Objective

By the end of this experiment the student should be able to perform signal generation and display of wave form, minimum and maximum values of waveform and modulation.

11.3 Prelab Preparation:

Read the material in the textbook that describes about the common waveforms.

11.4 Equipment needed

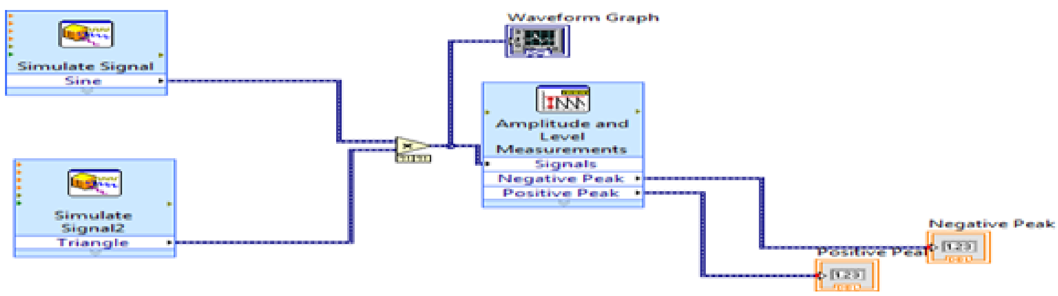
Labview software.

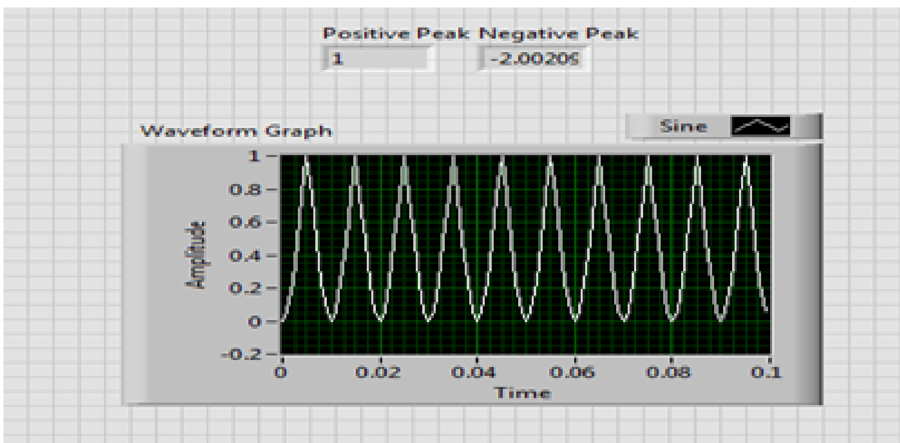
11.5 Background

In the analog world, a signal frequency is measured in Hz or cycles per second. But the digital system often uses a digital frequency, which is the ratio between the analog frequency and the sampling frequency:
Digital frequency = analog frequency / sampling frequency
This digital frequency is known as the normalized frequency. Its units are cycles/sample. Some of the Signal Generation VIs use an input frequency control, f, that is assumed to use normalized frequency units of cycles per sample. When you use a VI that requires the normalized frequency as an input, you must convert your frequency units to the normalized units of cycles/sample. You must use these normalized units with the following VIs.
sine wave
square wave
saw tooth wave
Triangle Wave
Arbitrary Wave
Chirp Pattern
If you are used to working in frequency units of cycles, you can convert cycles to cycles/sample by dividing cycles by the number of samples generated.

11.6 Procedure

1. Open a new VI. You can open a blank VI by selecting File» New VI.
2. Then you will see front panel and block diagram panel.
3. Right click on block diagram panel and add simulate signal blocks and copy paste another simulate signal block.
4. Add a multiplier to the block diagram panel to perform modulation.
5. Add the amplitude level measurement block by right clicking on the block diagram panel to measure the positive negative peaks of a waveform.
6. Create indicators to the positive and negative peaks.
7. Place a waveform graph block in the front panel to show the modulation graph and common waveform graph.
8. By double clicking on the simulate signal block change the wave forms to display different waveforms.
9. Wire the blocks as shown in block diagram panel.





11.7 Result

11.8 VIVA

(a) How many types of waveforms can be generated in labVIEW?

(b) How are indicators created in labVIEW?
(c) How many types of waveform blocks available in labVIEW.
(d) Why is amplitude and level block used?
(e) What is meant by modulation of signals?
(f) What is the function of simulate signal block.
(g) How are positive and negative peak displayed in front panel.

LAB-12 FREQUENCY MEASURMENT USING LabVIEW

12.1 Introduction

This experiment focuses to measure frequency using Lissajous figures in LabVIEW.

12.2 Objective

By the end of this experiment, the student should be able to measure frequency using Lissajous figures in LabVIEW.

12.3 Prelab Preparation:

Read the material in the textbook about frequency measurements.

12.4 Equipment needed

Labview software.

12.5 Background

A Lissajous figure is produced by taking two sine waves (one with known frequency and the other whose frequency has to be measured) displaying them on an XY graph.Lissajous patterns are displayed by LabVIEW which may be used for accurate measurement of frequency.

12.6 Procedure

(a) Open new blank VI from file¿¿ new VI, then you will get two panels named block diagram panel and front panel.

(b) Right click on the blank space on the front panel. Then you will get control palette. Click on the XY Graph icon to select the Express XY Graph object and drag it onto the Front Panel workspace.

(c) Right-click in the Controls palette and place two Numeric Control objects to the left of the XY Graph object in the Front Panel workspace.

(d) Select the Block Diagram workspace to activate the Functions palette, Right-click in the Functions palette and move the cursor over the Input icon to open the Input sub palette.

(e) Click on the Simulate Sig icon to select the Simulate Signal object and drag it onto the block diagram panel and copy paste it for another simulate signal block.

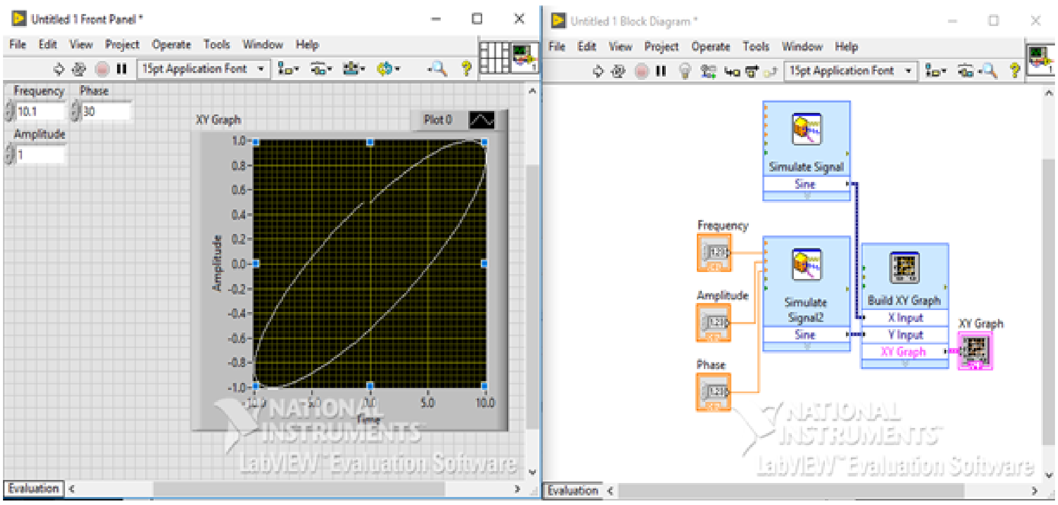
(f) Then connect the blocks in the block diagram panel with the wires, delete the bad wires if needed.

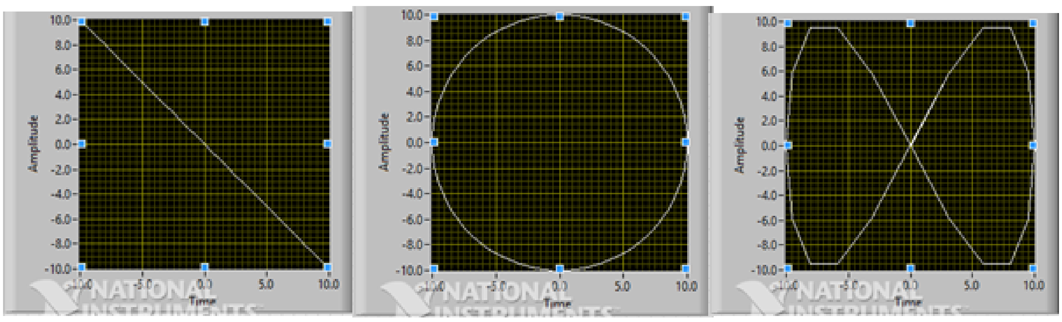
(g) A number of conclusions can be drawn from the above block diagram when sinusoidal voltages of same frequencies are applied.
(i) A straight-line result when the two voltages are equal and are either in phase with each other or 180 degrees out of phase with each other.
(ii) An ellipse appears when magnitude of two signals are equal and has phase difference of either 30 deg or 330 deg and 150 deg or220 deg.
(iii) A circle is thus formed only when magnitude of two signals are equal and has phase difference of either 90 deg or 270 deg.

(h) The Lissajous pattern for other frequencies also can be drawn, when the voltages are equal and the frequency ratios are (2:1), (3:1), (4:1), (1:2), (1:3) and so on.

(i) Use Save All in the File menu of either workspace to save your work.

(j) Run VI.





12.7 Result

12.8 VIVA

(a) How to measure phase angle from Lissajous figures.

(b) How to measure frequency from Lissajous figures.

(c) If two signals are having same frequency what is the pattern of Lissajous figure.

(d) If phase angle difference between two waves is 0 or 360 degrees then what is Lissajous pattern.

(e) How to get the Lissajous pattern.

(f) If phase angle difference between two waves is 90 or 270 degrees then what is Lissajous pattern.

(g) If two ac voltages are perfectly in phase with each other then what is pattern of Lissajous figures.

(h) When you get the circle pattern of Lissajous figure.

LAB-13 STRUCTURES USING LAB VIEW

13.1 Introduction

This experiment focuses Using FOR loop, WHILE loop, Charts and Arrays, Graphs and analysis VI s.

13.2 Objective

By the end of this experiment, the student should be able to Using FOR loop, WHILE loop, Charts and Arrays, Graphs and analysis VI s.

13.3 Prelab Preparation:

Read the material in the textbook that describes about FOR loop, WHILE loop, Charts and Arrays, Graphs.

13.4 Equipment needed

Labview software.

13.5 Background

A structure is a program control element. Structures control the flow of data in a VI. G has five structures: the While Loop, the For Loop, the Case structure, the Sequence structure, and the Formula Node.
While loop:A while loop is a control flow statement you use to execute a block of the sub diagram code repeatedly until a given Boolean condition is met. First, you execute the code within the sub diagram, and then the conditional terminal is evaluated. Unlike a for loop, a while loop does not have a set iteration count; thus, a while loop executes indefinitely if the condition never occurs.
For loop: A for loop is a control flow statement you use to execute a block of the sub diagram code a set number of times, but a while loop stops executing the sub diagram only if the value at the conditional terminal exists.
Charts:A chart is a numeric plotting indicator which is updated with new data periodically. You can find two types of charts in the Controls» Graph palette: waveform chart and intensity chart. You can customize charts to match your data display requirements or to display more information. Features available for charts include: a scrollbar, a legend, a palette, a digital display, and representation of scales with respect to time.

Array: An array is a collection of data elements that are all the same type. An array has one or more dimensions and up to 231 − 1 elements per dimension, memory permitting. You access each array element through its index. The index is in the range 0 to n − 1, where n is the number of elements in the array.

Graph:A graph is a two-dimensional display of one or more data arrays called plots. There are three types of graphs in the Controls» Graphpalette:

- XY graph
- Waveform graph
- Intensity graph

The difference between a graph and a chart is that a graph plots data as a block, whereas a chart plots data point by point, or array by array.

13.6 Procedure

While loop:

(a) Open a new VI. You can open a blank VI by selecting File» New VI.

(b) Then you can see block diagram panel and front panel.

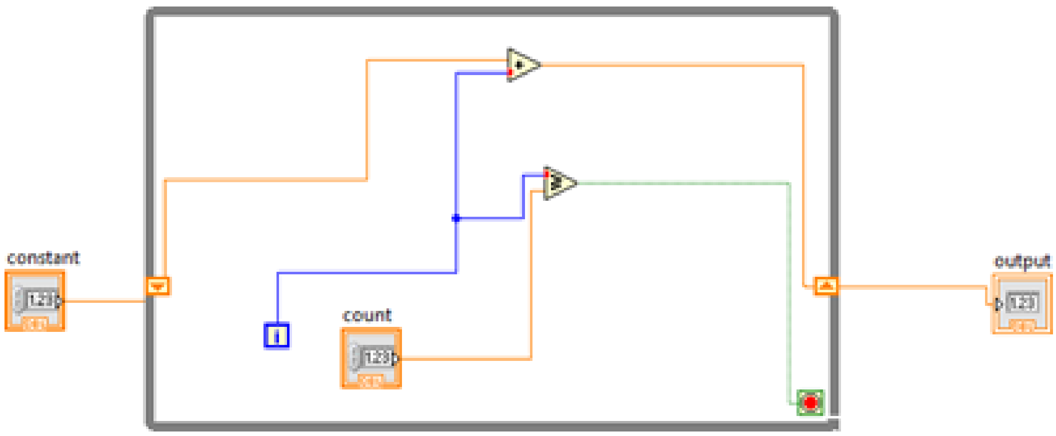
(c) Right click on block diagram panel and select while loop from structures¿¿ while loop and drag it to the block diagram panel.

(d) Select adder and greater than or equal to blocks from numeric block and drag it to block diagram panel.

(e) Go to front panel and two controls and an indicator by right clicking on the front panel selecting from numeric block and label them as constant, output and count.

(f) Wire the blocks as shown in block diagram.

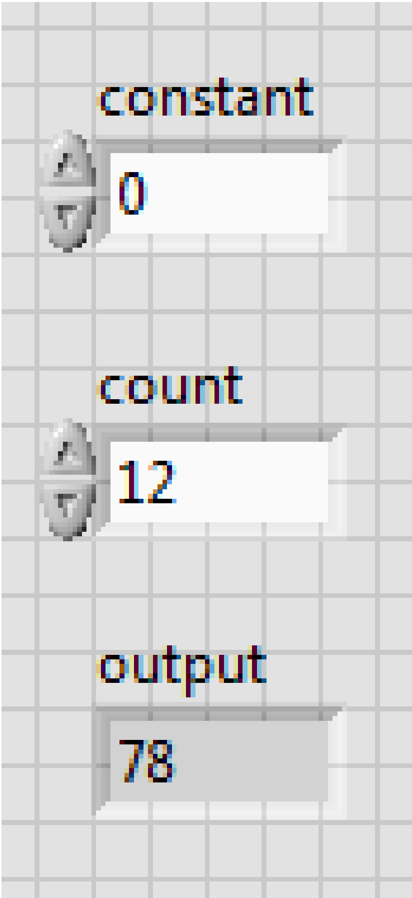
(g) Give the value to count and run the VI.



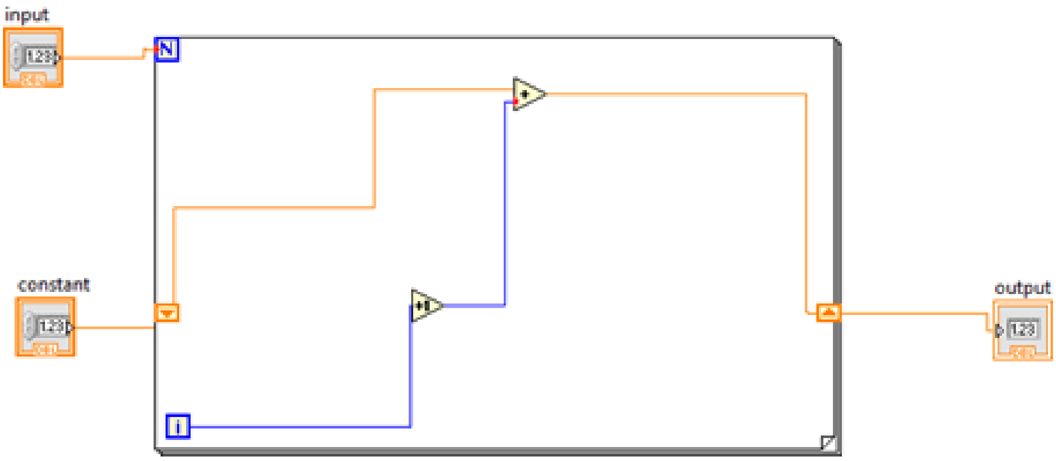
Using For loop:

(a) Open a new VI. You can open a blank VI by selecting File» New VI.

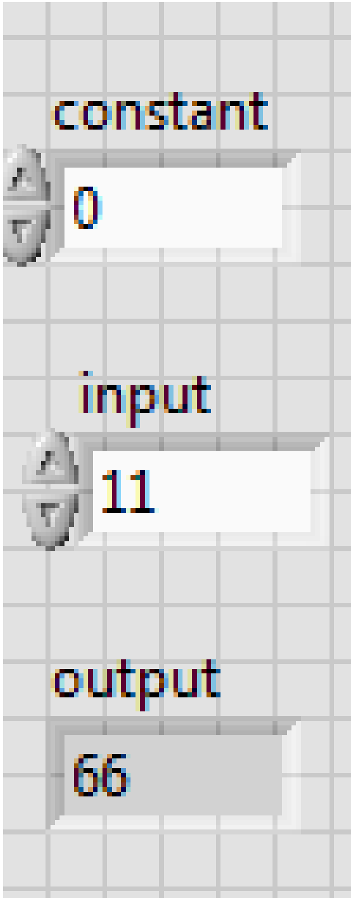
(b) Then you can see block diagram panel and front panel.



(c) Right click on the block diagram panel and select for loop from structures ¿¿ for loop and drag it to block diagram panel.
(d) Select adder and increment blocks from numeric block and drag it to the block diagram panel.
(e) Go to front panel and add two controllers and one indicator and label them as constant, input, output.
(f) Wire the blocks as shown in block diagram.
(g) Give the value to input in front panel and run the VI.



Using Array:



(a) Open a new VI. You can open a blank VI by selecting File» New VI.

(b) Then you will see front panel and block diagram panel.

(c) Got to front panel and right click and select array from array block.

(d) Right click in the array block and add numeric control to it, follow the same for 5 array blocks.

(e) Then for one array block give size as 2D by right clicking on the array block and selecting properties and then size column, this is used for appending mode.

(f) Then go to block diagram panel and add build array block by right clicking on block diagram panel and then selecting array block.

(g) For the first build array block right click and select concatenate mode and the other automatically becomes appending mode.

(h) Wire the blocks as shown in block diagram.

(i) Give values to input arrays and run the VI.

Using Charts and Waveform:

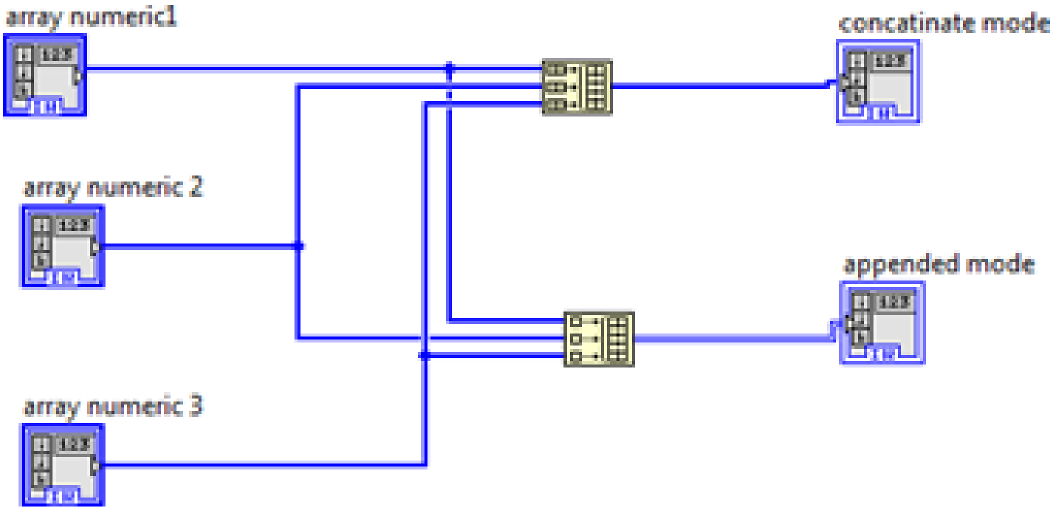
(a) Open a new VI. You can open a blank VI by selecting File» New VI.

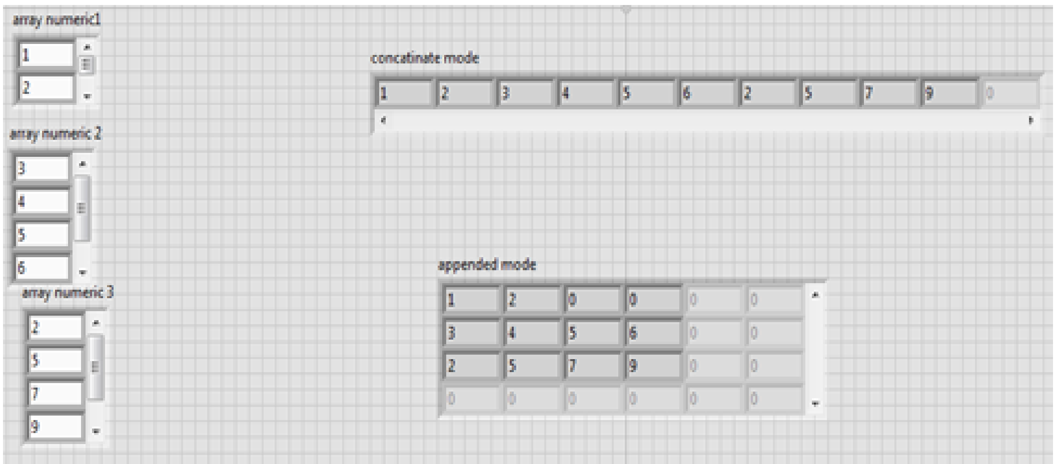
(b) Then you will see the block diagram panel and front panel.

(c) Right click on the block diagram panel and select the for loop block from structure block.

(d) Add the formula node block and timer block in to the for loop block.

(e) Create constants for timer block.





(f) Go to front panel and add waveform graph and waveform chart by right clicking on front panel.

(g) Wire the blocks as shown in block diagram panel.

(h) Run the VI.

Analysis:

(a) Open a new VI. You can open a blank VI by selecting File» New VI.

(b) Then you will see block diagram panel and front panel.

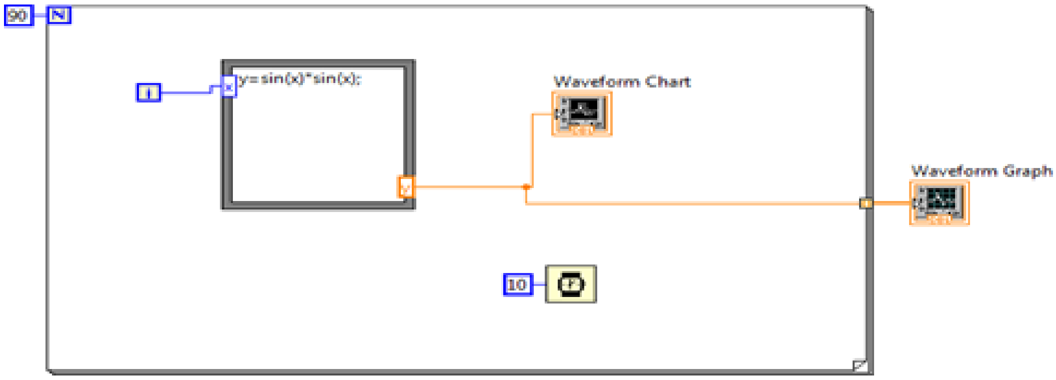
(c) Right click on block diagram panel and add simulate signal from express block.

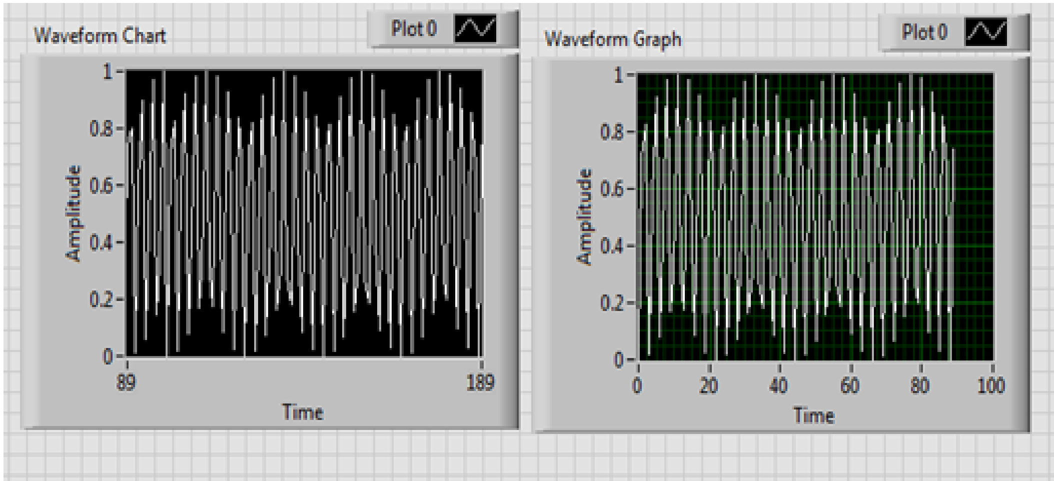
(d) Copy another simulate signal block.

(e) Add spectral measurement from signal analysis block and also add multiplier to block diagram panel.

(f) Add waveform graph to front panel by right clicking on front panel.

(g) Wire the blocks as shown in block diagram panel.





13.7 Result

13.8 VIVA

(a) What are the structures available in lab view?

(b) How are arrays represented in lab view?

(c) What are the various analysis blocks available in lab VIEW?

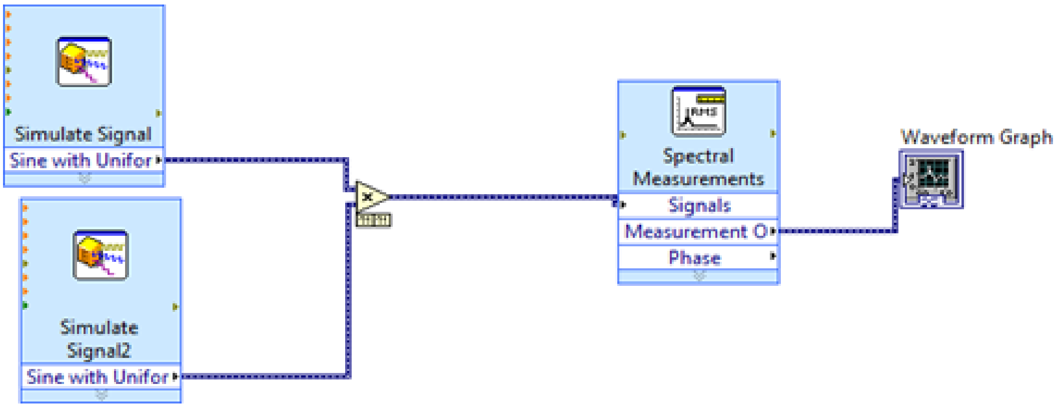
(d) What is difference between charts and graphs?

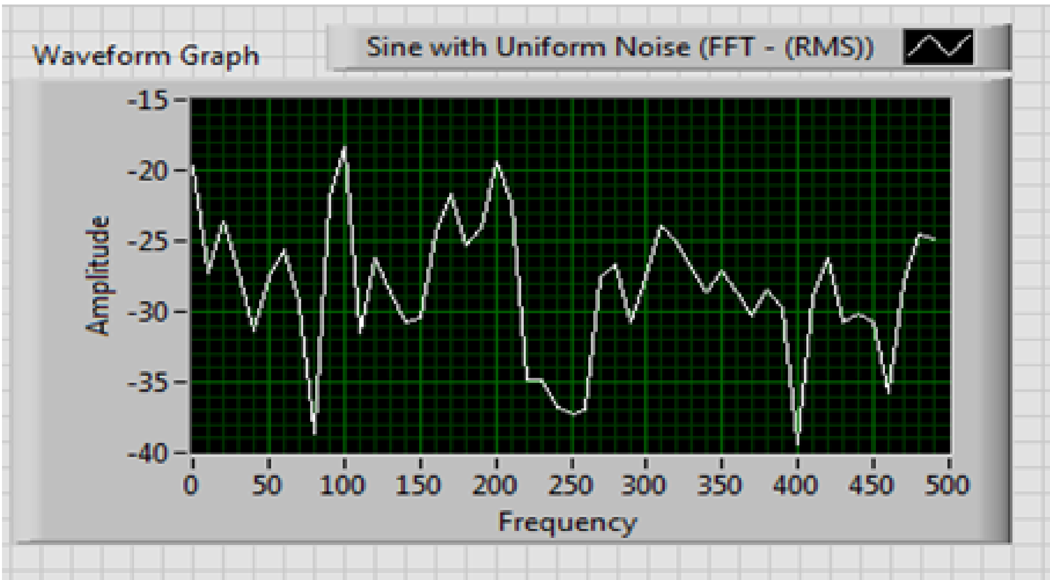
(e) Explain in detail use of for loop.

(f) Explain in detail use of while loop.

(g) Explain in detail the use of charts and graphs.

(h) Explain use of analysis block.


Simulate Signal
Sine with Unifor
Simulate Signal2
Sine with Unifor
Spectral Measurements
Signals
Measurement O
Phase
Waveform Graph


Waveform Graph
Sine with Uniform Noise (FFT - (RMS))
Amplitude
-15
-20
-25
-30
-35
-40
0
50
100
150
200
250
300
350
400
450
500
Frequency

LAB-14 SENSOR CIRCUIT AND PROXIMITY SENSOR USING LAB VIEW

14.1 Introduction

This experiment focuses to design the electric and electronic circuit of sensor and to measure the speed of the machine with proximity sensor in LAB View.

14.2 Objective

By the end of this experiment, the student should be able to design the electric and electronic circuit of sensor and to measure the speed of the machine with proximity sensor in LAB View.

14.3 Prelab Preparation:

Read the material in the textbook that describes about sensor circuit and proximity sensor.

14.4 Equipment needed

Labview software.

14.5 Background

Sensor Circuit:

(a) Open a new VI. You can open a blank VI by selecting File» New VI.

(b) Then you will see front panel and block diagram panel.

(c) Right click on Front panel, Control block will open in that block go to numeric block and select the horizontal pointer slide and drag it on Front panel and give the properties for Horizontal pointer.

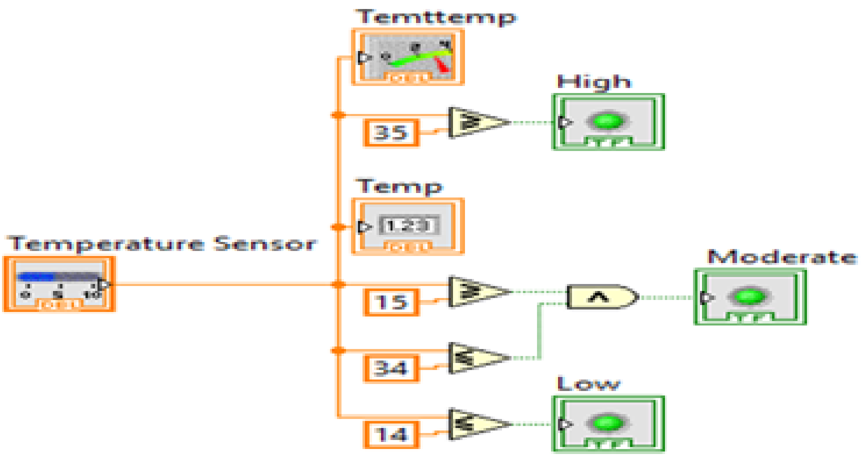
(d) In the same way again select the Numeric indicator in numeric block and click on in and drag it on front panel and again select the meter and drag on its front panel.

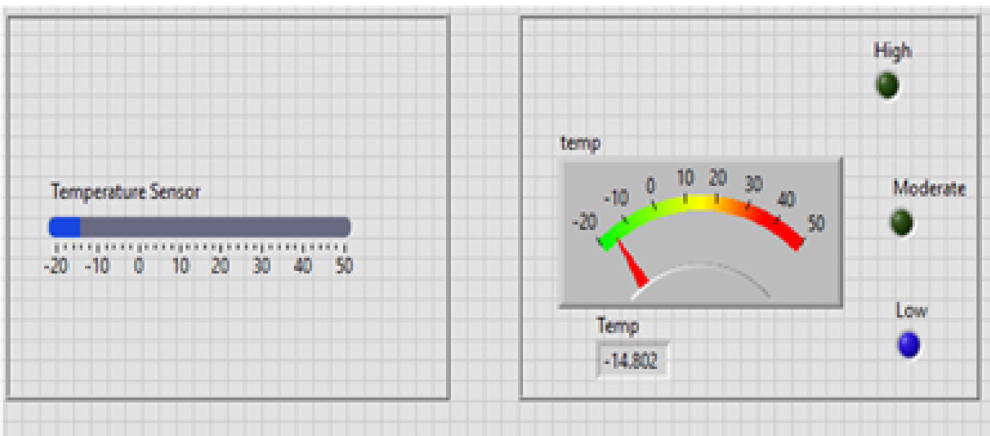
(e) Right click on Front panel, Control block will open in that block click on Boolean block in that block we select LED bulbs and drag on its front panel, we add another two bulbs for high, moderate, low.

(f) Now give the ranges and properties of three LED bulbs in Front panel.

(g) Now open the block diagram as per circuit diagram add some blocks like comparison indicators, constants, And operators and all these are connected in as per circuit diagram.

(h) Save it and Run VI.





Proximity Sensor:

14.6 Result

14.7 VIVA

(a) What is a sensor?

(b) What is the difference between electric and electronic circuit of sensor.

(c) What are the different ways to measure speed of the machine?

(d) Write about proximity sensor.

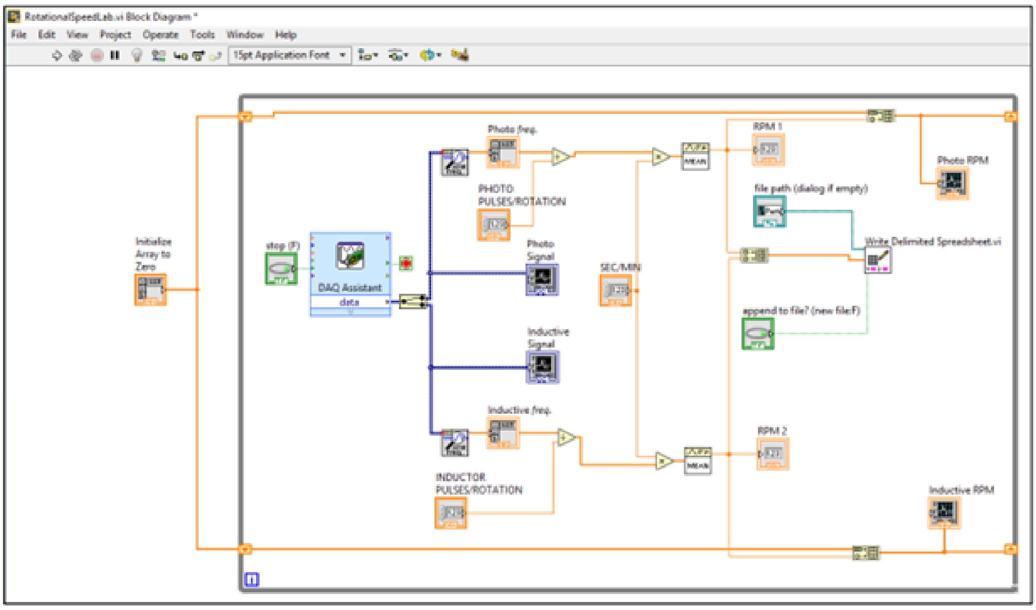


Figure 3. Sample Labview Diagram