Experiment 1

Oscilloscope and Function Generator Operation

OBJECTIVES:

- To study about Function Generator.
- To study about Analog Oscilloscope and observe basic waveforms on CRO

EQUIPMENT REQUIRED:

- Function Generator
- Probes for Oscilloscope and Function Generator
- Cathode Ray Oscilloscope

INTRODUCTION:

The world of electronics is a realm of infinite possibilities, where currents and voltages dance to the tune of scientific exploration and technological innovation. At the heart of this intricate dance lies two indispensable tools: the oscilloscope and the function generator. These instruments are the maestros of the electronic symphony, allowing engineers, scientists, and hobbyists to visualize and manipulate electrical signals with precision and finesse.

An oscilloscope, often referred to as an "oscillograph" or simply a "scope," is a device that plays the role of a visual interpreter in the world of electronics. It provides a real-time display of electrical waveforms, enabling users to analyze the behavior of signals with precision. By faithfully rendering voltage over time on its screen, the oscilloscope transforms abstract electrical phenomena into tangible, comprehensible graphs. This graphical representation opens a window into the inner workings of circuits, revealing details that would otherwise remain hidden. Oscilloscopes are essential tools for diagnosing problems, debugging circuits, and verifying the performance of electronic devices.

On the other hand, the function generator is a versatile device that complements the oscilloscope's capabilities. While the oscilloscope observes and records electrical signals, the function generator creates them. Function generators are skilled composers that produce a wide range of waveforms, from simple sine waves to complex, custom-designed signals. These waveforms serve as input signals for circuits and devices under test, allowing engineers to simulate real-world scenarios and study the responses of their creations. Function generators are indispensable for designing, testing, and calibrating electronic circuits and systems.

OSCILLOSCOPE:

An oscilloscope is easily the most useful instrument available for testing circuits because it allows you to *see* the signals at different points in the circuit. The best way of investigating an electronic system is to monitor signals at the input and output of each system block, checking that each block is operating as expected and is correctly linked to the next. With a little practice, you will be able to find and correct faults quickly and accurately.

The function of an oscilloscope is extremely simple: it draws a *V*/*t* graph, a graph of voltage against time, voltage on the vertical or Y-axis, and time on the horizontal or X-axis. The simple graph of Oscilloscope tells us many things about the signal such as:

- The time and voltage values of a signal
- The frequency of an oscillating signal
- The “moving parts” of a circuit represented by the signal
- The frequency with which a particular portion of the signal is occurring relative to other portions
- Whether or not a malfunctioning component is distorting the signal
- How much of a signal is direct current (DC) or alternating current (AC)
- How much of the signal is noise and whether the noise is changing with time

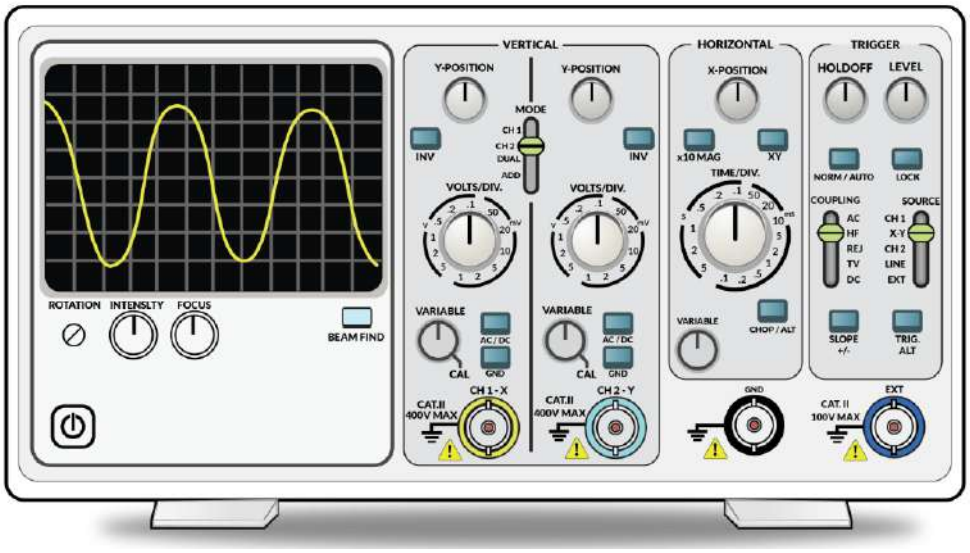


Figure 5: Cathode Ray Oscilloscope

Display Group:

This group is used to display and adjust the signal for optimal viewing. It consists of the **display screen**, the **intensity-control** knob, the **beam-find** button, the **focus-control** knob, and the **power switch**.

The **display screen** is laid out in a 8 by 10 centimeter grid. The oscilloscope draws a ‘trace’ or graph by moving an electron beam across the phosphor coating on the inside of the cathode-ray tube (CRT). The excited phosphorous glows for a short period of time, thereby tracing the path of the beam.

The **intensity-control knob** is used to adjust the brightness of the trace. The level should be set to the user's preference; however, increasing the intensity beyond a certain point will make the trace "fuzzy." The intensity level should never be increased past the point where the trace has sharply defined edges.

The **beam-find button** allows the user to locate the electron beam anytime it's off-screen. Push the beam find button to temporarily reduce the vertical and horizontal deflection voltages so that the beam always appears within the 8 by 10 centimeter screen.

The **focus-control knob** adjusts the electron beam for optimal trace resolution.

Vertical Group:

This group is used to adjust the vertical components (Y-axis) and the vertical position of the signal. This group consists of the **vertical-position knobs, channel-selector switch, volts-per-division selector knobs, input-coupling switch**, the **channel-mode-selector switch, the channel-2-invert switch**, and the **BNC connectors**. Because the oscilloscope available in the lab is a two channel oscilloscope, there is one set of switches for each channel.

- The vertical-position controls are used to vertically move the trace of one channel or the other.
- The channel-selector switch, labeled 'CH1/BOTH/CH2', selects which channels are displayed on the screen.
- The volts-per-division-selector knob sets the vertical scale for each channel's trace.
- Since a 10X probe is used in this lab, all readings should be made from the '10X' box on the knob.
- Each channel can have a different vertical scale.
- A division is one "block" on the screen.
- Each tick mark is one-fifth (0.2) of a division.
- This knob is marked in both volts and millivolts.
- The input-coupling switch, labeled 'AC/GND/DC', selects the coupling mode of that channel's display. AC means that only the alternating portion of the signal is displayed. DC will display both the alternating portion of the signal, plus any DC component. GND shows the 0 V reference level.
- The trace-separation knob is used in conjunction with the horizontal-magnification controls, to be discussed later.
- The channel-mode-selector switch, labeled 'ADD/ALT/CHOP', is activated only when BOTH is selected on the channel-selector switch. ADD graphically adds the Channel 1 signal to the Channel 2 signal. If the channel-2-invert switch ('NORMAL/INVERT') is set to INVERT, then ADD will in fact subtract the Channel 2 signal from the Channel 1 signal. ALT traces one channel, then the next. CHOP works like ALT, but jumps back and forth between the two channels during a single trace.

Horizontal Control Group:

The Horizontal Control Group consists of the **coarse and fine position** knobs, **the horizontal magnification** switch, the **seconds-per-division-selector** knob, and the **magnification-scale-selector** switch.

- The **coarse** and **fine-position-knobs** allow the horizontal movement of the traces in a rough manner and in a precise manner, respectively. These are used to position the traces in a manner that makes measurement both more convenient and more precise.

The **horizontal-magnification switch ('X1/ALT/MAG')** selects the regular (X1) and/or a horizontally magnified trace.

- The **trace separation knob** in the Vertical-Control Group allows for the vertical separation of the X1 trace from the magnified trace when ALT is selected.

- If ALT or MAG is selected, then the magnification-scale-selector switch ('5X/10X/50X') is activated.

The seconds-per-division knob sets the time base (horizontal) scale. It is marked in seconds, milliseconds, and microseconds. Note: There is only one horizontal scale for both channels.

Trigger Group:

In order to display a signal, the oscilloscope must be able to 'lock' onto that signal; the function of the triggering controls is to do just that. Triggering can be a complicated topic, and is beyond the scope of this lab. For more details, the student is referred to the Tektronix manual. The trigger group is made up of the **trigger level** knob, the **rising/falling edge** switch, the **trigger mode** switch, the **holdoff** knob, the **trigger source** switches, and the **trigger coupling** switch.

- The **trigger-level knob** sets the voltage level at which the oscilloscope will 'trigger'. If a signal is 'running' -- that is, not stable -- the trigger level may be too high or too low for the oscilloscope to recognize the signal. Often you can lock in a running signal by rotating this knob to the left and to the right. This adjustment provides a mechanism for ignoring small (low voltage) signals that are well below the level of the signal you ar interested in. This knob is not indexed.
- The **rising/falling-edge** switch selects whether the oscilloscope will trigger on the positive (rising) or negative (falling) edge of the signal.
- The **trigger-mode** switch will normally be set to AUTO, but sometimes it is necessary to use NORM. Other settings are not relevant to this lab.
- The **holdoff** knob affects the delay associated with triggering. The student should consult the manual if more information is desired.
- The **trigger-source** switches select which signal the oscilloscope will attempt to lock onto. Possible choices include CH1, CH2, VERT MODE, or EXTERNAL. Selecting CH1 or CH2 will make the oscilloscope attempt to trigger on those channels. If no input is available on that channel, there may be problems when attempting to view both channels simultaneously. For this reason, it is recommended that this switch be left on VERT MODE, which provides an automatic trigger on either CH1 or CH2.
- The **trigger-coupling** switch is another more complicated feature which will not be discussed here. This switch should typically be set to AC

Setting Up / Calibrating an Oscilloscope for Nominal Operation:

First disconnect all input cables to your oscilloscope except the rear power cable.

Control	Settings	Notes
INPUTS	DISCONNECTED	
POWER	ON	Led Light is ON
INTENS(ITY)	MID-RANGE	
FOCUS	MID-RANGE	
Y-POS(ITION)	MID-RANGE	(both knobs: A and B channels)

X-POS(ITION)	MID-RANGE	
VAR(IABLE)	CAL	(fully clockwise) All 3 knobs
HOLD OFF	MIN(IMUM)	(fully clockwise)
TRIG(GER) LEVEL	MID-RANGE	
LOCK	OFF	

Function Generator:

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. Most function generators allow the user to choose the shape of the output from a small number of options.

- Square wave - The signal goes directly from high to low voltage.
- Sine wave - The signal curves like a sinusoid from high to low voltage.
- Triangle wave - The signal goes from high to low voltage at a fixed rate.

The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal. The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground. The frequency control of a function generator controls the rate at which output signal oscillates.



Figure 6: Digital Function Generator

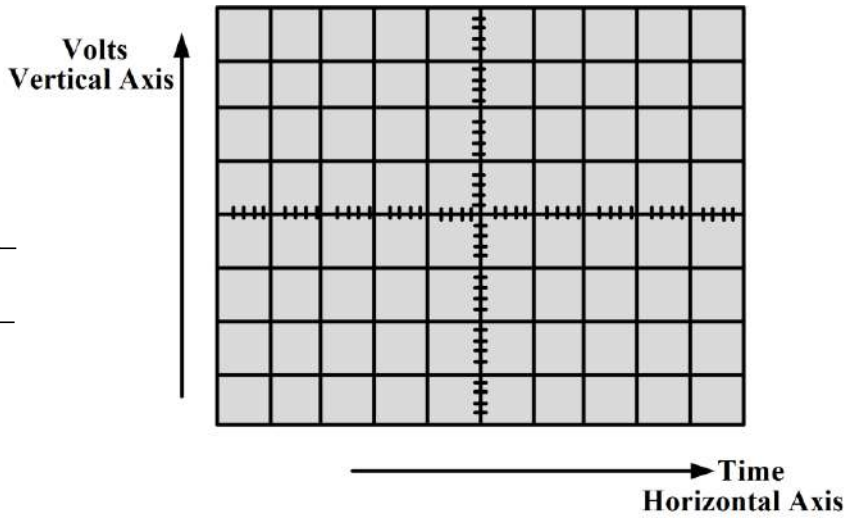
Readings and Exercises:

Task 1:

Calibrate the Cathode Ray Oscilloscope as per the procedure mentioned in the details before. Sketch the Waveform in the Graph given below:

Volts/Div : _____

Time/Div:_____



Task 2:

Construct Sine Wave of $5V_{p-p}$ and 2 KHz and connect oscilloscope with function generator as per the procedure mentioned in the details before. Sketch the Waveform in the Graph given below:

Vm = _____

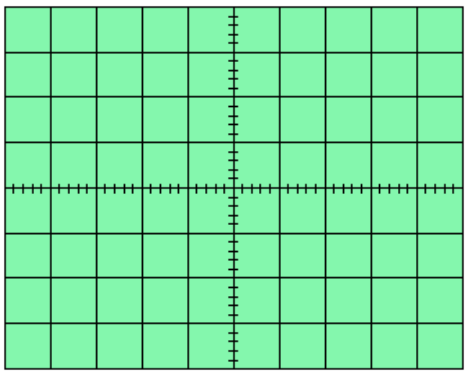
V/div = _____

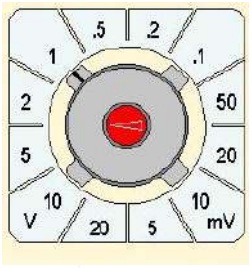
Div (vertically)= _____

T/div= _____

Div (Horizontally)=_____

Frequency= _____





Vertical sensitivity Sv
Volts/div or m Volts/div

Exercise:

Q.1: Define a term Calibration? Briefly describe the procedure for calibration of an Oscilloscope

Lab Exercise and Summary

Summary should cover Introduction, Procedure, Data Analysis and Evaluation.

Student's Signature: _____ **Date: _____**

LABORATORY SKILLS ASSESSMENT (Psychomotor)

Total Marks: 100

Criteria (Max Marks)	Level 1 0% ≤ S < 50%	Level 2 50% ≤ S< 70%	Level 3 70% ≤ S< 90%	Level 4 90%≤ S ≤100%	Score (S)
Procedural Awareness (20)	Selects inappropriate skills and/or strategies required by the task.	Selects and applies appropriate skills and/or strategies required by the task with major errors.	Selects and applies the appropriate strategies and/or skills specific to the task without significant errors.	Selects and applies appropriate strategies and/or skills specific to the task without any error.	
Practical Implementation (30)	Makes major critical errors in applying procedural knowledge related to Oscilloscope and Function Generator Operation	Makes numerous critical errors in applying procedural knowledge related to Oscilloscope and Function Generator Operation	Makes some non-critical errors in applying procedural knowledge related to Oscilloscope and Function Generator Operation	Applies the procedural knowledge in optimized ways related to Oscilloscope and Function Generator Operation	
Participation to Achieve Group Goals (10)	Shows little commitment to achieve group goals and fails to perform assigned roles.	Demonstrates commitment to achieve group goals, but has difficulty in performing assigned roles.	Demonstrates commitment to achieve group goals and carries out assigned roles effectively.	Actively helps to identify, achieve group goals and works effectively to meet them in all roles assumed.	
Interpersonal Skills in Group Work (10)	Rarely interacts positively within a group, even with prompting.	Interacts with other group members if prompted.	Interacts with all group members spontaneously.	Interacts positively with all group members and encourages such interaction in others.	
Use of Tool/Equipment (20)	Uses tools, equipment and materials with limited competence.	Uses tools, equipment and materials with some competence.	Uses tools, equipment and materials with considerable competence.	Uses tools, equipment and materials with a high degree of competence.	
Safety (10)	Requires constant reminders to follow safety procedures.	Requires some reminders to follow safety procedures.	Follows safety procedures with only minimal reminders.	Routinely follows safety procedures.	
				Marks Obtained	

Instructor Name: _____ **Sign: _____**

LABORATORY SKILLS ASSESSMENT (Affective)

Total Marks: 40

Criteria (Max. Marks)	Level 1 0% ≤ S < 50%	Level 2 50% ≤ S < 70%	Level 3 70% ≤ S < 90%	Level 4 90% ≤ S ≤ 100%	Score
Introduction (5)	Very little background information provided or information is incorrect	Introduction is brief with some minor mistakes	Introduction is nearly complete, missing some minor points	Introduction complete and well-written; provides all necessary background principles for the experiment	
Procedure (5)	Many stages of the procedure are not entered on the lab report.	Many stages of the procedure are entered on the lab report.	The procedure could be more efficiently designed but most stages of the procedure are entered on the lab report.	The procedure is well designed and all stages of the procedure are entered on the lab report.	
Data Record (10)	Data is brief and missing significant pieces of information.	Data provides some significant information and has few critical mistakes.	Data is almost complete but has some minor mistakes.	Data is complete and relevant. Tables with units are provided. Graphs are labeled. All questions are answered correctly.	
Data Analysis (10)	Data is presented in very unclear manner.	Data is presented in ways that are not clear enough.	Data is presented in ways that can be understood and interpreted.	Data is presented in ways that best facilitate understanding and interpretation.	
Report Quality (10)	Report contains many errors.	Report is somewhat organized with some spelling or grammatical errors.	Report is well organized and cohesive but contains some grammatical errors.	Report is well organized and cohesive and contains no grammatical errors. Presentation seems polished.	
				Marks Obtained	

LABORATORY SKILLS ASSESSMENT (Cognitive)

Total Marks: 10

(If any) **Marks Obtained**	

Instructor's Signature: _____ **Date: _____**