BHARATI VIDYAPEETH COLLEGE OF ENGINEERING, NAVI MUMBAI

A Report on

SAWTOOTH WAVEFORM GENERATOR

for

Mini Project 1-A (REV- 2019 ‘C’ Scheme) of Second Year, (SE Sem-IV)

in

Electronics & Telecommunication Engineering

By

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UNIVERSITY OF MUMBAI
AY 2023-2024

CERTIFICATE

This is to certify that the project entitled Automatic Door Opening/Closing System is a bonafide work of

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submitted to the University of Mumbai in partial fulfillment of the requirement for the award of **Mini Project 1-A (REV- 2019 ‘C’ Scheme) of Second Year, (SE Sem-IV)** in **Electronics & Telecommunication Engineering** as laid down by **University of Mumbai** during academic year **2023-24.**

(______________________) (______________________)

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Name of the guide	**Head of Department**	**Principal**

ACKNOWLEDGEMENT

I would like to express my sincere gratitude towards **Prof. M.M. Bhule sir** for the help, guidance and encouragement, he provided during the Mini Project work. This work would have not been possible without his valuable time, patience and motivation. I thank him for making my stint thoroughly pleasant and enriching. I take the privilege to express my sincere thanks to our head of the department Dr. P.A.Kharade and Principal Dr.Sandhya D.Jadhav for providing the encouragement and much support throughout my work.

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ABSTRACT

A simple sawtooth generator with electronic control of the frequency and the amplitude, was presented. The circuit was build around the 555 timer and had used a grounded capacitor and two operational transconductance amplifiers to achieve current control of the amplitude and the frequency of the sawtooth waveform. Since the sawtooth was taken from the capacitor, then any load resistance connected across the capacitors would take its current from the charging current of the capacitor. This resulted in distorting the sawtooth output voltage.

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CHAPTER 1

INTRODUCTION

Sawtooth and pulse generators find numerous applications in many diverse fields, for example,in instrumentation, measurement and control. In most of the existing sawtooth generators, agrounded capacitor is charged at a pre-specified rate using a constant-current source, andthen rapidly discharged through a transistor switch [1–5]. However, while electronic controlof the frequency is available in some of the circuits, none of the available circuits can simul-taneously provide electronic control of the frequency and the amplitude. The purpose of thisarticle is therefore to present asimple sawtooth generator with electronic control of the frequency and the amplitude

CHAPTER 2

LITERATURE REVIEW

1. Design Techniques: Literature reviews may discuss different design techniques for sawtooth generators, including analog and digital implementations. Analog sawtooth generators often use operational amplifiers, transistors, and passive components, while digital implementations may utilize microcontrollers, programmable logic devices, or field-programmable gate arrays (FPGAs).

2. Performance Evaluation: Reviews typically evaluate the performance characteristics of sawtooth generators, such as frequency range, linearity, stability, and waveform distortion. These evaluations are crucial for understanding the suitability of sawtooth generators for specific applications.

3. Applications: Sawtooth generators find applications in various fields such as signal processing, instrumentation, communication systems, and function generation. Literature reviews may provide insights into these diverse applications and discuss the requirements and challenges associated with each application domain.

4. Comparative Analysis: Comparing sawtooth generators with other waveform generators, such as sine, square, or triangle wave generators, can help researchers and designers understand the advantages and limitations of each waveform type in different scenarios. Literature reviews may analyze the comparative performance, complexity, and implementation considerations of sawtooth generators versus other waveforms.

5. Noise and Distortion Analysis: Sawtooth generators are susceptible to noise and distortion, which can degrade waveform quality and introduce errors in applications. Literature reviews may explore noise sources, distortion mechanisms, and techniques for minimizing these effects in sawtooth generator circuits.

CHAPTER 3

PROBLEM DEFINATION

1. Objective: The primary objective of the sawtooth waveform generator is to produce a waveform with a linearly increasing voltage (or current) followed by a rapid return to the starting voltage (or current), resembling the teeth of a saw. This objective defines the desired output waveform characteristics.

2. Specifications: The problem definition should include specific requirements for the sawtooth waveform, such as frequency range, amplitude, duty cycle, rise/fall time, linearity, and precision. These specifications are essential for ensuring that the generated waveform meets the desired performance criteria.

3. Constraints: Various constraints may influence the design or implementation of the sawtooth waveform generator. These constraints could include limitations on power supply voltage, available components, size, cost, temperature range, and environmental conditions. Additionally, there may be constraints related to noise levels, distortion, and stability requirements.

4. Applications: Understanding the intended applications of the sawtooth waveform generator is crucial for defining the problem accurately. Different applications may have specific requirements or performance criteria that need to be met by the generator. For example, sawtooth waveforms are commonly used in signal processing, instrumentation, waveform synthesis, and synchronization applications.

5. Performance Metrics: The problem definition should specify the performance metrics used to evaluate the effectiveness of the sawtooth waveform generator. These metrics may include parameters such as waveform linearity, frequency accuracy, amplitude stability, distortion levels, jitter, and noise performance. Clear performance metrics help in assessing the quality and suitability of the generated waveform for its intended applications.

CHAPTER 4
PRINCIPLE AND WORKING

Principle of Operation:

The principle of generating a sawtooth waveform involves creating a voltage (or current) that increases linearly over time until it reaches a certain level, at which point it rapidly resets to its starting value and begins the linear increase again. This process repeats cyclically to produce the characteristic sawtooth waveform.

Analog Sawtooth Generator:

An analog sawtooth waveform generator typically consists of a charging circuit and a reset circuit. The charging circuit charges a capacitor linearly over time using a constant current source or a voltage ramp. Once the voltage across the capacitor reaches a certain threshold or maximum value, the reset circuit triggers, discharging the capacitor rapidly and returning it to its initial voltage. This cycle repeats to generate the sawtooth waveform.

Digital Sawtooth Generator:

In digital systems, a sawtooth waveform can be generated using algorithms and digital signal processing techniques. One common approach is to use a digital counter that increments at a constant rate. The output of the counter is then processed to produce a digital representation of the sawtooth waveform. This digital representation can be converted to an analog signal using digital-to-analog converters (DACs) for applications requiring analog waveforms.

Working:

01. Initialization: The sawtooth waveform generator is initialized, setting initial conditions such as the starting voltage (or current) and the maximum voltage (or current) reached before resetting.

2. Charging Phase: During this phase, the voltage (or current) across the capacitor (in analog circuits) or the counter value (in digital circuits) increases linearly over time. This is typically achieved using a charging circuit or a counting mechanism with a constant increment.

3. Reset Phase: Once the voltage (or counter value) reaches a certain threshold or maximum level, the reset phase is triggered. In analog circuits, this involves discharging the capacitor rapidly using a reset circuit. In digital systems, the counter value is reset to its initial value.

4. Repeat: After the reset phase, the cycle repeats, starting again from the initial voltage (or current) and continuing to increase linearly until the maximum level is reached, followed by rapid reset

4.

CHAPTER 5

COMPONENTS TOOLS TO BE USED

Matlab is a high level programming language and interactive e-nvironment for numericalisation and programming its widely used in various field such as engineering and economy for task like data analysis development and model simulator compressive set of build in function documentation. Matlab provides a compressor set of a building function tool boxes and the graphical tools to facility the complex mathematics communication and data analysis stars it's known for its easy use extensive documentation other strong community support additional leave my life offers integration with other programming language in the tools making it was a tile for platform for research and development

5.

CHAPTER 6
IMPLEMENTATION

To implement a sawtooth waveform generator in MATLAB, you can use either analog circuit simulation techniques or digital signal processing algorithms. Here, I'll provide an example of how to generate a sawtooth waveform digitally using MATLAB:

```matlab
% Parameters
Fs = 1000;        % Sampling frequency (Hz)
T = 1;            % Duration of the waveform (seconds)
f = 10;           % Frequency of the sawtooth waveform (Hz)

% Time vector
t = 0:1/Fs:T-1/Fs;

% Generate the sawtooth waveform
sawtooth_waveform = sawtooth(2*pi*f*t);

% Plot the waveform
plot(t, sawtooth_waveform);
title('Sawtooth Waveform');
xlabel('Time (s)');
ylabel('Amplitude');
grid on;
```

This MATLAB code generates a sawtooth waveform with a frequency of 10 Hz and a duration of 1 second sampled at 1000 Hz. The `sawtooth` function is used to generate the waveform, and then it's plotted using `plot`.

6.

CHAPTER 7

RESULT AND CONCLUSION

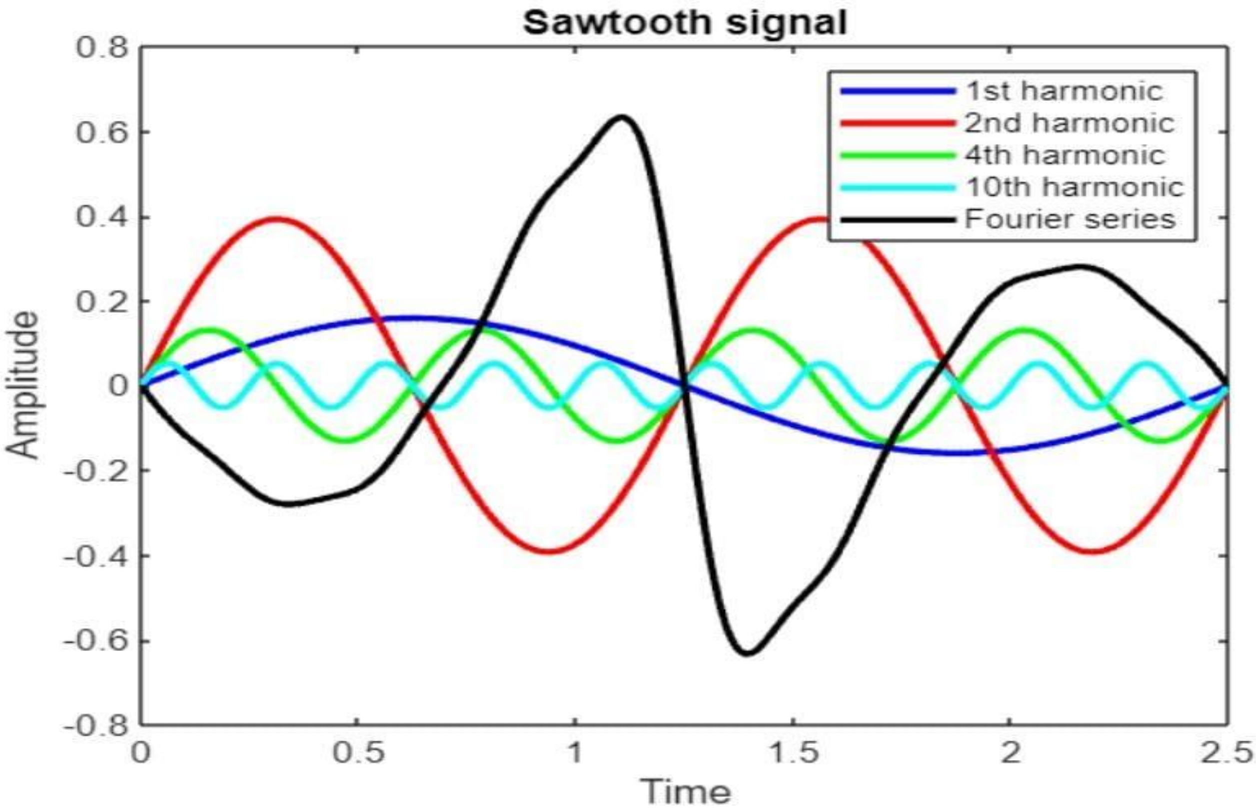

Fig 0.1 Sawtooth signal

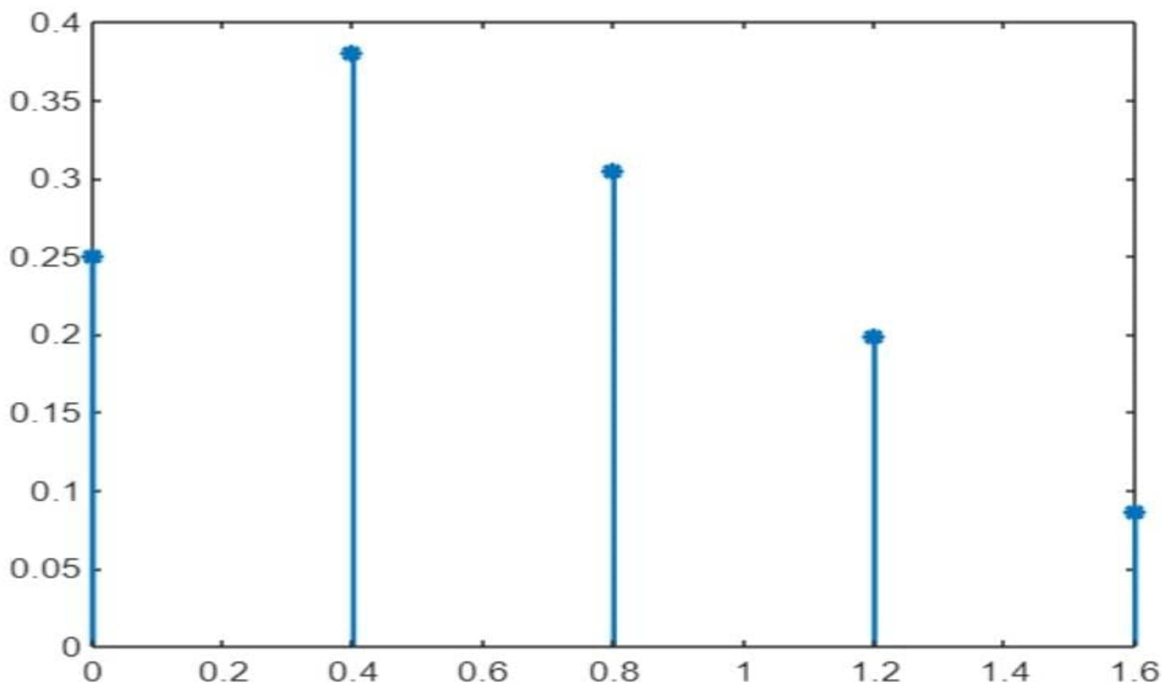

Fig 0.2 **7.**

CONCLUSION

In this mini project using my knowledge of signals and system i have created a sawtooth waveform series representation, Fourier means any signal can be represented in the terms of sine and cosine. Fourier series is a way of mathematical

CHAPTER 8
FUTURE SCOPE

The future scope of sawtooth waveform generators lies in several directions, driven by advancements in technology, evolving application requirements, and emerging research trends. Here are some potential future directions:

1. Integration with Emerging Technologies: Sawtooth waveform generators may integrate with emerging technologies such as internet of things (IoT), edge computing, and wireless communication systems. Integration with these technologies could enable new applications in areas such as sensor networks, smart grids, and industrial automation.

2. High-Frequency Operation: There may be a growing demand for sawtooth waveform generators capable of operating at higher frequencies. High-frequency sawtooth generators could find applications in fields such as high-speed data communication, radar systems, and advanced signal processing.

3. Advanced Control and Synchronization: Sawtooth waveform generators may incorporate advanced control algorithms and synchronization techniques to meet the requirements of precision timing, synchronization, and phase-locking applications. This could involve the integration of phase-locked loop (PLL) circuits, digital phase control, and adaptive control techniques.

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CHAPTER 9

REFERENCE

1. "The Art of Electronics" by Paul Horowitz and Winfield Hill - Provides comprehensive coverage of electronic circuits and includes sections on waveform generation techniques.

2.- "Analog Circuit Design: A Tutorial Guide to Applications and Solutions" by Bob Dobkin and Jim Williams - Offers practical insights into analog circuit design, including waveform generation.

3. - Journal of Analog Integrated Circuits and Signal Processing

4. Websites of academic institutions and research organizations may offer publications, theses, and technical reports related to waveform generation and analog circuit design.