# ELECTRIC PIANO

## ELECTRICAL CIRCUIT LAB EE1200 FINAL PROJECT

**TEAM MEMBERS:** Ameen Aazam - EE23BTECH11006 , Praful Kesavadas - EE23BTECH11049, Nimal Sreekumar - EE23BTECH11044, Venkata Chanakya - EE23BTECH11048, Faisal Imtiyaz - EE23BTECH11019

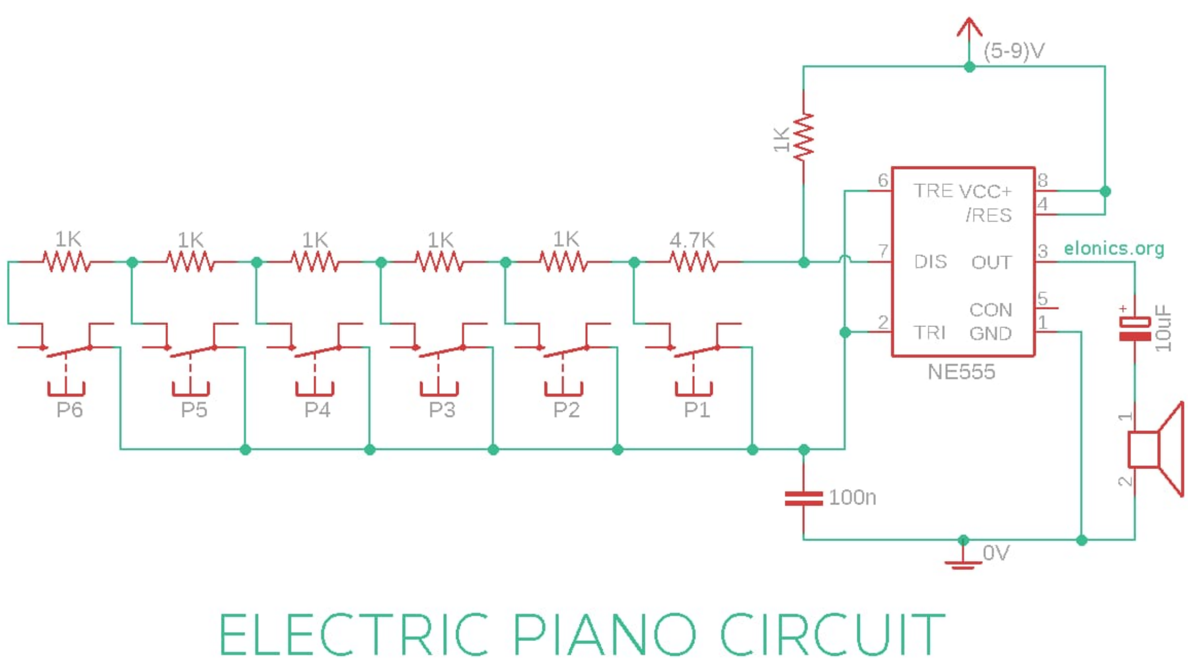
## I. AIM:

The aim of this group project is to analyze and evaluate the functionality, design, and performance of an electric piano, exploring its key features, sound quality, and overall user experience in a basic level. Through a systematic examination, the project aims to gain insights into the technological advancements and musical capabilities of modern electric pianos, contributing to a deeper understanding of their role in contemporary music production and performance.

## II. MATERIALS USED:

1) 555 Timer IC
2) 8 Ohm Speaker
3) Breadboard
4) 6 x Momentary Push Button Switches
5) Capacitors: 100nF, 10uF
6) Resistors: 6 x 1K, 4.7K
7) Few Breadboard Connectors
8) (5-9)V Power Supply

## III. CIRCUIT DIAGRAM:



# IV. Theory:

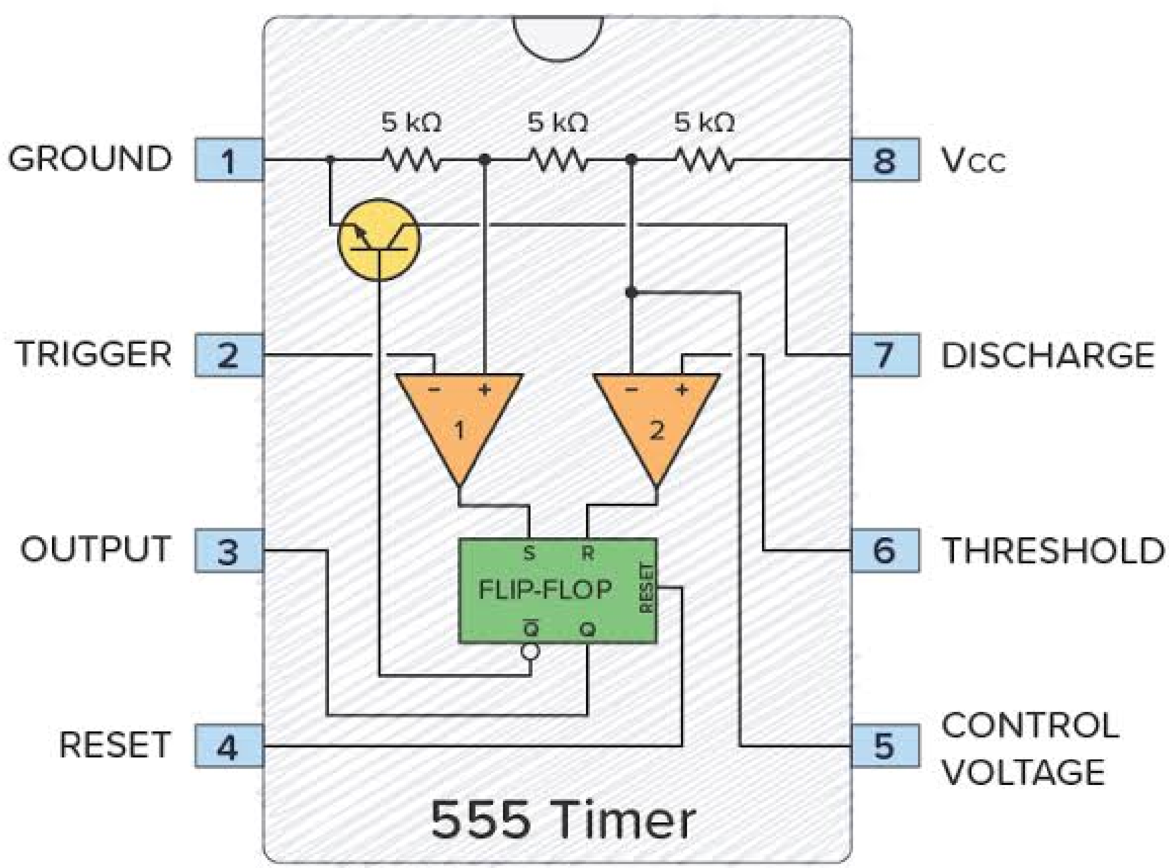
### A. IC 555 timer:

The integrated circuit (IC) 555 timer in the electric piano circuit is a widely-used timer chip.It can function as an oscillator, timer, or pulse width modulator (PWM) . In this circuit, the 555 timer is used as an oscillator.

### B. Astable mode:

In the circuit, the IC runs in astable mode. In astable mode, the 555 timer operates as a free-running oscillator, continuously generating a square wave output signal. This mode is characterized by the absence of a stable state; hence, the term ”astable.” The frequency and duty cycle of the square wave output can be adjusted by external components connected to the timer.
By adjusting the external components connected to the timer, such as resistors and capacitors, the frequency of the square waves can be varied to produce various pitches corresponding to different keys on the piano. Additionally, the square wave output from the 555 timer is further processed and amplified to drive a speaker or audio output device, creating the audible sound of the electric piano.

### C. IC Circuit:



### *D. Pins and internal parts of the IC:*

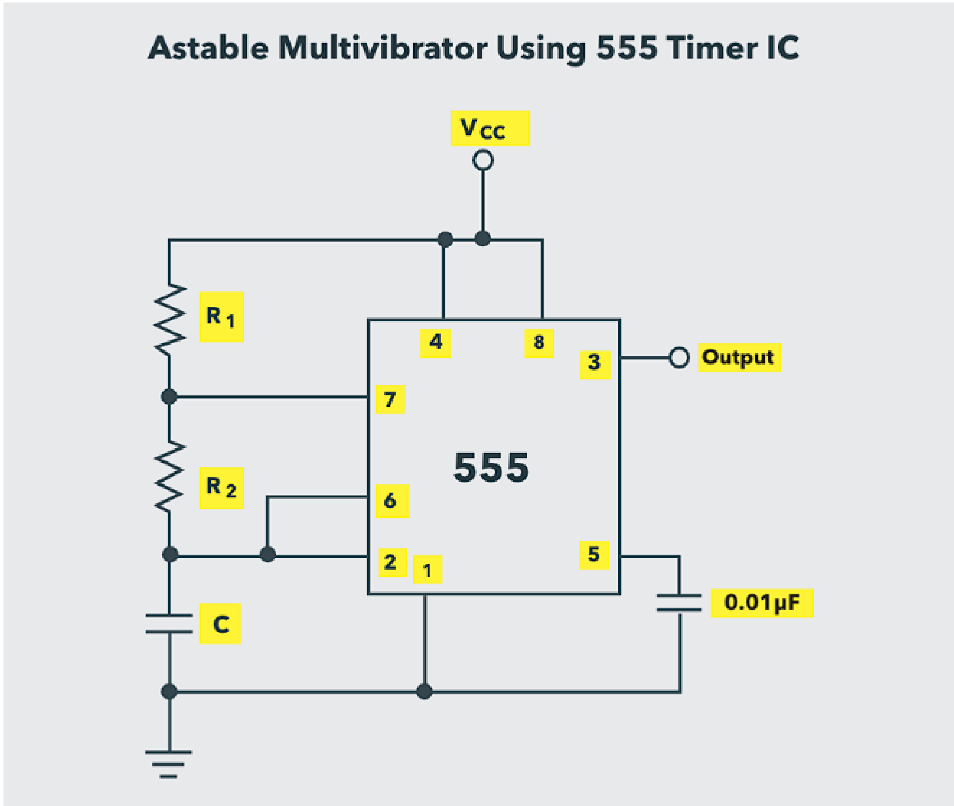
1) Pin 1: This pin is the ground connection for the IC. It needs to be connected to the negative rail of the power supply circuit.
2) Pin 2: This pin is responsible for initiating the timing cycle when its voltage falls below one-third of the supply voltage (Vcc). When the voltage at the Trigger pin drops below this threshold, it triggers the internal flip-flop, causing the output to change state (e.g., from low to high). The Trigger pin controls the timing of the output waveform.
3) Pin 3: This is the output pin of the 555 timer. In astable mode, it generates a continuous square wave at the frequency determined by the external resistors and capacitor connected to the timer. This output signal is what drives the speaker in the circuit.
4) Pin 4: This pin is used to reset the output of the 555 timer to a low state. A negative-going pulse applied to this pin forces the output to low, regardless of the timing cycle. In this circuit, it is tied to ground (high state) to avoid unintended resets.
5) Pin 5: This pin provides access to a voltage point inside the 555 timer that is normally two-thirds of the supply voltage (VDD). It isn't typically used in astable mode but can be used in other modes to affect the timing cycle.
6) Pin 6: This pin is responsible for ending the timing cycle when its voltage exceeds two-thirds of the supply voltage (Vcc). When the voltage at the Threshold pin rises above this threshold, it resets the internal flip-flop, causing the output to change state again (e.g., from high to low).The Threshold pin determines the duration of the output waveform.
7) Pin 7: This pin is an open-collector output, meaning it can only pull the voltage down. It's used to discharge the timing capacitor during the cycle. In astable mode, it's typically connected to an external resistor that discharges the capacitor when the output goes low.
8) Pin 8(VCC): This is the power supply pin of the 555 timer. It needs to be connected to the positive rail of the power supply circuit, typically between 5V and 15V.

**Special connection made in the circuit:**

In the circuit diagram given above, we are able to observe some common connections made, namely pins 4,8 and 2,6.

1) Pins 4 and 8: By connecting pin 4 (reset) to VCC (positive supply voltage), you are essentially keeping the reset pin in a high-voltage state. This disables the reset function and ensures that the timing cycle of the 555 timer isn't interrupted unexpectedly.
2) Pins 2 and 6: When both the Trigger (Pin 2) and Threshold (Pin 6) pins of a 555 timer are connected together, it essentially creates a bistable mode of operation. In this configuration, the 555 timer acts as a basic flip-flop, where it toggles its output state each time it receives a trigger signal (a falling edge at the connected pins).
   Connecting Pin 2 and Pin 6 together means that both pins are monitoring the same voltage level. When this voltage level drops below one-third of the supply voltage (Vcc), it triggers the 555 timer, causing its output to switch states. Then, when the voltage level rises above two-thirds of Vcc, it resets the timer, toggling the output back to its original state.

   The below figure is a saw tooth wave generator which is given input to the pin 5 of IC in piano, which is used for producing a range of frequency when a switch is pressed.




## V. Calculation:

The formula for calculating the frequency of the output sound/tone:

$$\text{Frequency (f) } = 1.44/((R1 + 2 * R2) \times C1)$$

In the circuit we made, the value of R1 is 1K and C1 is 100n. After replacing these values in the above formula, we have:

$$\text{Frequency (f) } = 1.44/((1000 + 2 * R2) \times 10^{-7})$$

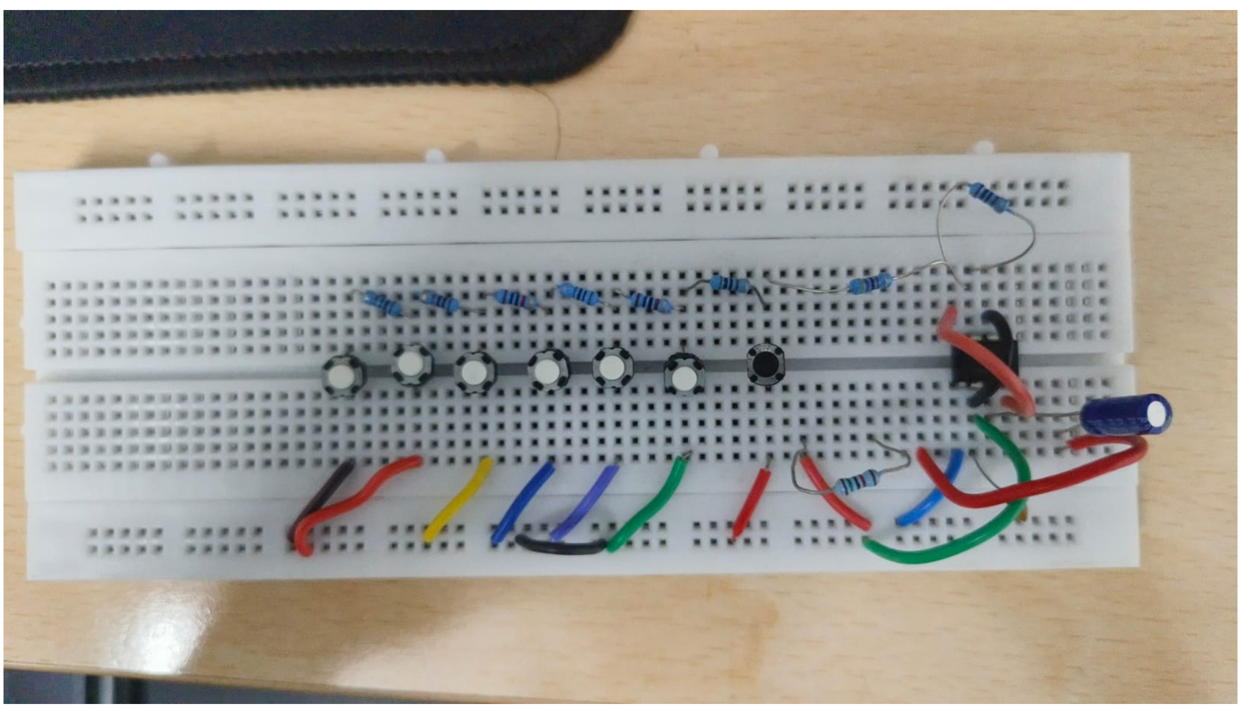
We can also rearrange the formula to calculate the value of the resistor we need to use for any frequency required:

$$\text{Resistance (R2) } = ((1.44 \times 107)/f) - 500$$

## VI. Procedure:

1) Prepare the Breadboard: Position the breadboard on a stable surface.
2) Power Supply Rails: Using jumper wires, connect one long row of the breadboard to the positive rail of the power supply. Similarly, connect another long row on the opposite side of the breadboard to the negative rail of the power supply. These rows will serve as your common ground (negative) and power (positive) rails.

3) 555 Timer: Place the 555 timer IC onto the breadboard, ensuring its pins line up with the available holes. Refer to the pinout diagram for the 555 timer to identify the pin functions.
4) Connect a jumper wire from pin 1 (GND) of the 555 timer to the negative power supply rail on the breadboard.
5) Connect a jumper wire from pin 8 (VCC) of the 555 timer to the positive power supply rail on the breadboard.
6) Pins 2 (Trigger) and 6 (Threshold) might be connected with a jumper wire in this circuit. You can implement this connection now or wait until later if the purpose is unclear based on the circuit variation.
7) Insert the 10uF electrolytic capacitor onto the breadboard. Note that electrolytic capacitors have a positive and negative side. The positive leg of the capacitor (usually marked with a longer lead or a "+" symbol) should be connected to pin 6 (Threshold) of the 555 timer.
8) Connect a jumper wire from the negative leg of the capacitor to the negative power supply rail on the breadboard.
9) Connect the 1K ohm as shown in the diagram between 4 or 8 and 7.
10) Select five $1K\Omega$ resistors. Connect one leg of each resistor to different empty holes on the same row where the previous $1K\Omega$ resistor is connected (pin 6 connection). Connect the other legs of all these resistors using another jumper wire. Finally, connect this combined wire to the negative power supply rail on the breadboard.
11) For each desired piano key, take a momentary push-button switch. Connect one leg of the switch to the positive power supply rail on the breadboard. Connect the other leg of the switch to an empty hole on the breadboard.
12) For each push-button, connect a jumper wire from the empty hole where the switch connects (from step 9) to another empty hole on the breadboard.
13) Finally connect the 2nd pin of the multivibrator to the 5th pin of the piano circuit. Making sure that both have common supply input and common ground.



## VII. Observation:

It was observed that the output signal generated by the IC is a square wave. Also changing the values of resistors resulted in different range of tones(frequencies).
In conclusion, this document provided a comprehensive breakdown of the electric piano circuit. It explained the function of each component and how they work together to generate sound. We explored the role of the 555 timer in astable mode and how the circuit configuration determines the frequency of the output square wave. Finally, a step-by-step procedure for building the circuit was presented, outlining the connections for essential components.

## VIII. Precautions:

1) Ensure you're using a power supply with the recommended voltage range for the 555 timer (typically 5V-9V DC). Using a higher voltage can damage the IC.
2) Pay attention to the ratings of the resistors and capacitors you use. Make sure they can handle the expected voltage and current in the circuit.
3) Breadboards are excellent for prototyping circuits, but they can introduce loose connections over time. Be gentle when manipulating the circuit to avoid accidental disconnections.

**Bibliography:**https://elonics.org/electric-piano-circuit-using-555-ic/