🎹 Toy Piano - Module Project III

Welcome to the **Toy Piano** project repository!

This project was developed by Group 15 for the Department of Electrical-Electronics Engineering at **Sivas Science and Technology University**.

Our goal was to design and implement a simple yet functional "Toy Piano" capable of generating distinct musical tones using analog circuitry and signal processing concepts.

👥 Project Team (Group 15)

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📖 Project Overview

In this project, we designed a circuit to generate musical notes (Do, Re, Mi, Fa, Sol, La, Si, Do) within one octave. The core of the system is a **555 Timer IC** configured in **Astable Multivibrator** mode.

Key Features:

- **Tone Generation:** Square-wave signal generation using a 555 Timer.
- **Frequency Control:** A resistor ladder network controlled by push buttons to change the oscillation frequency (musical notes).
- **Amplification:** A Class B Push-Pull (Complementary Symmetry) amplifier (using TIP31/TIP32 transistors) to drive the speaker.
- **Simulation:** Validated using **Proteus** (for circuit logic) and **MATLAB** (for signal analysis).

🛠️ Circuit Design & Theory

1. The Oscillator (555 Timer)

We used the standard astable frequency formula:

$$f = \frac{1.44}{(R_1 + 2R_2) \cdot C}$$

- **C:** 100nF (constant)
- **R1:** 1kΩ (constant)
- **R2:** Variable resistance determined by the button pressed.

2. Frequency Table & Error Rates

We calculated the theoretical values vs. the measured values. Here is a summary of our results:

Button	Note	Theoretical Freq (Hz)	Measured Freq (Hz)	Error (%)
1	Fa 5	698	685.7	1.83%
2	Mi 5	659	644.0	2.31%
3	Re 5	587	571.0	2.78%
4	Do 5	523	511.0	2.34%
5	La 4	440	444.0	0.91%
6	G# 4	415	419.0	0.89%
7	F# 4	370	369.0	0.27%
8	Mi 4	330	328.0	0.49%

3. Amplification

Since the 555 timer cannot drive an 8Ω speaker directly with high quality, we implemented a **Push-Pull Amplifier** stage to act as a current buffer, ensuring the speaker operates safely.

💻 Simulations

MATLAB Analysis

We modeled the discrete-time signal and compared the oscilloscope measurements with theoretical waves. You can run the analysis using the file: `toy_piano_analysis.m`

Proteus Circuit

The circuit schematic includes:

- Button array for note selection.
- Resistor ladder.

- 555 Timer IC.
- Push-pull amplifier stage.
- Speaker (modeled as RL load).

(Screenshots of the simulations can be found in the `docs/` folder or the project report).

🚀 How to Run

1. **MATLAB:** Open `toy_piano_analysis.m` in MATLAB and run it to see the waveform plots and frequency calculations.
2. **Proteus:** Load the `.pdsprj` file (if available) to simulate the live circuit.
3. **Real Life:** Assemble the circuit on a breadboard using the component values listed in the report.

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