PROJECT ABSTRACT

Theremin Musical Instrument using Heterodyne Oscillators and Audio Amplifier

A contactless musical instrument built from two RF heterodyne oscillators, pitch and volume antennas, and an LM386 audio amplifier — delivered built-to-order with working prototype, circuit documentation, calibration procedure, report, PPT and viva kit.

01. Introduction / Background

The theremin, invented in 1920, is the only musical instrument played without physical contact: the player's hands move in electromagnetic fields near two antennas, and hand position sets the pitch and the volume. Underneath the musical novelty it is a textbook heterodyne system — two radio-frequency oscillators are mixed, and their difference (beat) frequency is the audible note. Students of analog electronics meet LC oscillators, mixers and the heterodyne principle as equations and simulation waveforms, and the commercial theremin kits that exist arrive as finished boxes that hide the circuitry. This project makes the principle tangible: the instrument is built from discrete stages on a homemade Veroboard-style PCB, so every block — oscillator, mixer, volume control, audio amplifier — is visible, measurable and explainable.

02. Problem Statement

Oscillator and mixer theory is abstract until a student tunes a real circuit and hears the result. Simulation waveforms do not drift, do not pick up hand capacitance, and do not need trimming — so the calibration skill that separates a hobbyist from an engineer is never practised. The project addresses this by requiring the student to build two RF oscillators near 440 kHz, null their beat with a trimmer, and play a real instrument whose pitch responds to hand capacitance. The gap it fills is hands-on heterodyne design: tank-circuit capacitance, beat-frequency generation, RF stability and supply decoupling — all demonstrated on a working, playable prototype.

03. Objectives

- Build two transistor LC oscillators (Colpitts-type) near 440 kHz: a fixed reference and a variable pitch oscillator with the pitch antenna in its tank circuit.
- Mix the two oscillator outputs to produce an audio-frequency beat note equal to their frequency difference.
- Implement a volume-antenna stage that converts hand distance into a varying audio level.
- Amplify the beat signal with an LM386 power-amplifier stage driving an 8-ohm speaker.
- Provide a trimmer-based null calibration so the beat can be set with the hand far from the pitch antenna, with a documented buyer-run procedure.
- Power the RF stages from a filtered, decoupled 12 V DC supply for stable pitch.
- Deliver the complete student kit: prototype, circuit docs, report, PPT and viva Q&A.;

04. Proposed Methodology

The system is developed in four stages. (1) RF oscillators: two Colpitts-type transistor oscillators are built on a Veroboard-style PCB to run near 440 kHz; the variable oscillator's tank circuit includes the copper-rod pitch antenna, and the fixed reference oscillator includes a trimmer for calibration. (2) Mixing: a diode mixer stage combines the two RF outputs; a low-pass section retains the difference (beat) frequency in the audio band. (3) Volume and amplification: the volume antenna feeds a control stage that gates the audio path by hand distance, and the LM386 stage with gain/volume controls drives the 8-ohm speaker. (4) Power and calibration: a 12 V adapter with LC/RC filtering and per-stage decoupling supplies the board; labeled test points at each stage let the student observe waveforms on an oscilloscope while trimming the null and checking pitch tracking.

05. System Architecture / Working

With the hand held far from the pitch antenna, the reference oscillator's trimmer is adjusted until its frequency matches the variable oscillator — the mixer output (beat) drops to near zero, the null point. Bringing the hand toward the pitch antenna adds body capacitance to the tank, pulling the variable oscillator's frequency down; the mixer then outputs the difference frequency, which rises and falls as the audible pitch. The volume antenna's circuit converts the other hand's distance into a control level that gates the audio path — hand close quiets the note, hand withdrawn lets it sing. The beat signal passes through the volume stage into the LM386 amplifier for clean drive of the speaker. The filtered 12 V supply with stage decoupling keeps both RF oscillators stable so pitch does not drift with mains ripple or loading changes during play.

06. Hardware / Software Requirements

- Discrete transistor LC oscillators (Colpitts-type), two units near 440 kHz design
- Diode mixer / beat-frequency stage with audio low-pass section
- LM386 audio power-amplifier stage with gain and volume controls
- Copper-rod pitch and volume antennas, hand-bent, grounded mounting
- 8-ohm speaker (0.5 W class, expected)
- 12 V DC adapter with LC/RC supply filtering and per-stage decoupling
- Veroboard-style hand-built PCB, trimmer potentiometer, test points
- Oscilloscope/DSO and digital multimeter for calibration (buyer-run)
- Soldering tools and enclosure hardware

07. Expected Outcomes

- A working, playable theremin prototype whose pitch and volume respond to hand position.
- A documented trimmer null calibration and pitch-tracking check performed by the student.
- Observable waveforms at every stage (reference, variable oscillator, mixer output) for the viva demonstration.

- A complete report, PPT and viva Q&A; covering LC oscillators, heterodyne mixing, capacitive sensing and audio amplification.

08. Applications

- Teaching LC oscillator design, heterodyne mixing and beat-frequency generation in analog-electronics laboratories.
- Demonstrating capacitive sensing and contactless human interfacing.
- Student final-year projects in Electronics, E&TC; and Electrical programs.
- Science-exhibition and open-day demonstrations of RF principles.

09. Future Scope

- Pitch linearization network for more uniform note spacing across the hand zone.
- Octave-shift switch or preset tone control on the audio stage.
- Digital tuner display showing the beat frequency during calibration.
- MIDI/CV output interface for driving synthesizers (optional extension).