SNS COLLEGE OF TECHNOLOGY

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23EET104 / ANALOG ELECTRONICS CIRCUITS
I YEAR / II SEMESTER

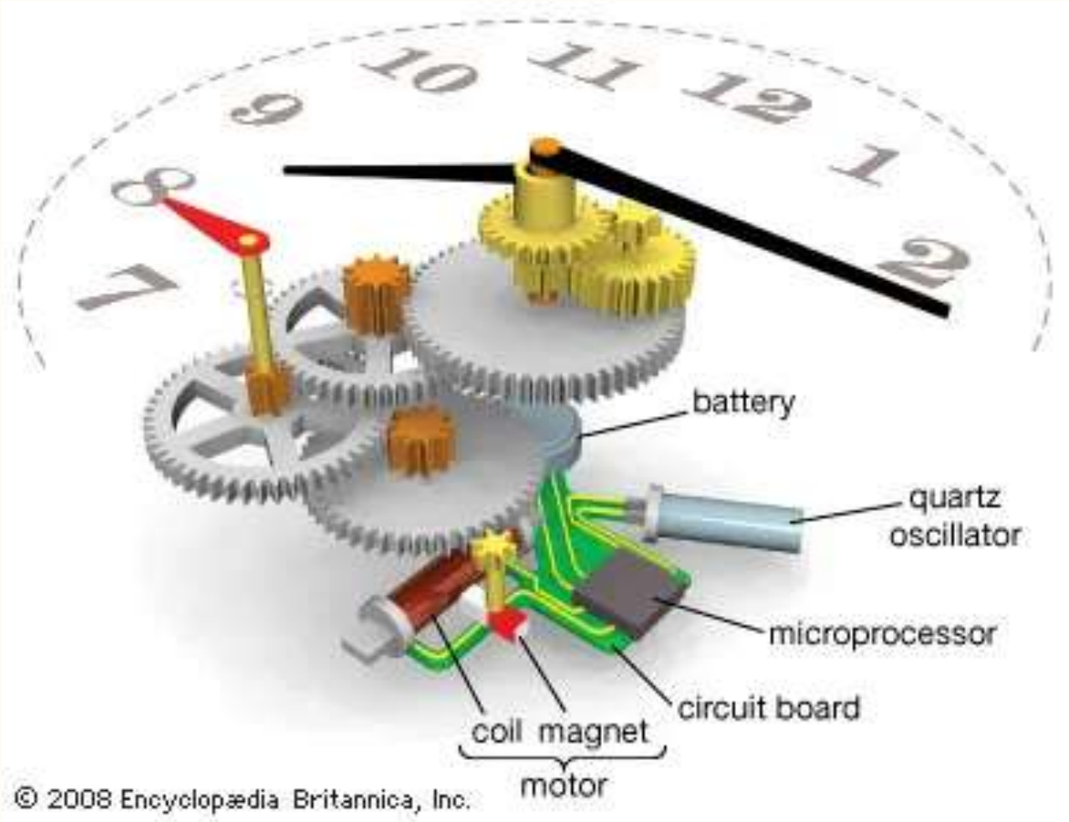
UNIT-V: FEEDBACK AMPLIFIER AND OSCILLATOR

CRYSTAL OSCILLATOR

Understanding Crystal Oscillators

This presentation explores crystal oscillators, vital for stable frequencies in electronics. We cover principles, circuits, advantages, types, and applications.

by Senthil Kumar R.



What is a Crystal Oscillator?

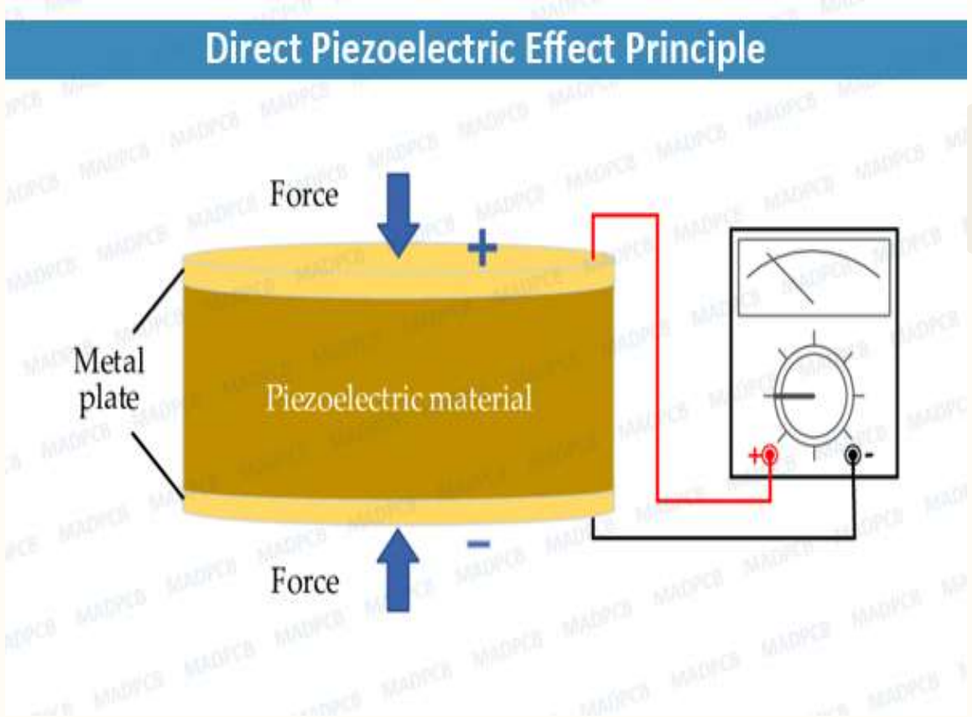
Definition

A **crystal oscillator** uses a **piezoelectric crystal** for frequency generation.

Key Features

- Stable and precise frequency
- Long-term reliability
- Common in clocks, microcontrollers, comm devices

Piezoelectric Effect



Voltage Application

Voltage causes crystal to mechanically vibrate at resonant frequency.

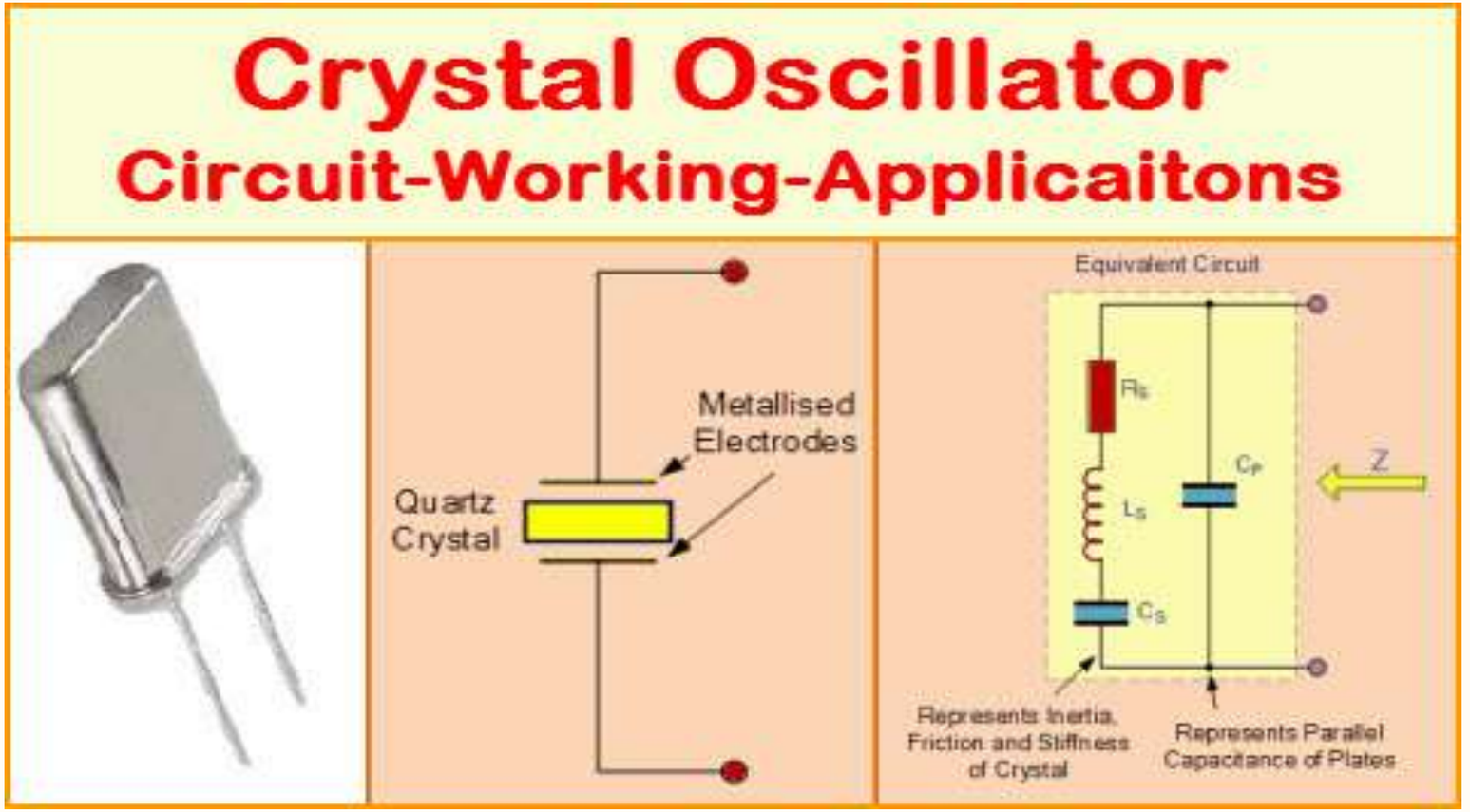
Mechanical Stress

Mechanical stress generates electric charge in crystal.

High Q Resonance

Crystal acts like a high-Q tuned LC circuit.

Equivalent Circuit of a Crystal

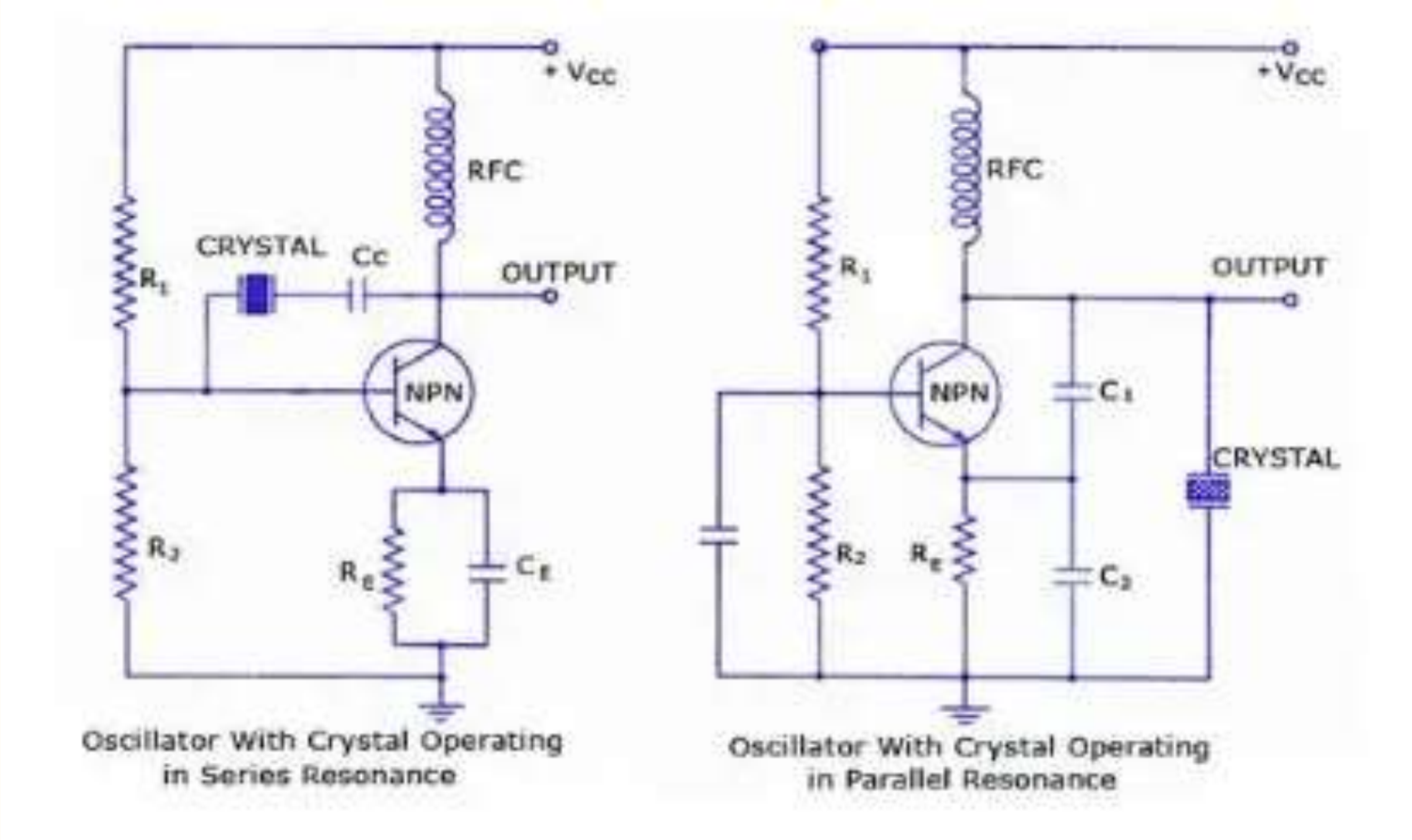


Represents the crystal's electrical behavior as a series RLC circuit in parallel with capacitance C_0.

Crystal Oscillator Circuit

Key Components

- Crystal (XTAL)
- Capacitors and resistors
- Transistor or logic inverter
- Feedback network



Principle of Operation

A crystal oscillator uses a piezoelectric crystal, like quartz, to generate a stable and precise electrical signal at a specific frequency.

This is achieved by applying voltage to the crystal, causing it to vibrate at its natural resonant frequency, which is then converted into an electrical signal.

The crystal's vibrations are sustained by a feedback loop that amplifies and feeds back the signal to the crystal, sustains oscillation.

1

Mechanical Vibration

Crystal vibrates when excited by AC voltage.

2

Resonance

Acts as sharp frequency resonator.

3

Feedback Loop

Maintains continuous oscillation signal.

4

Amplification

Amplifier boosts and filters output signal.

Frequency Stability

High Q-Factor

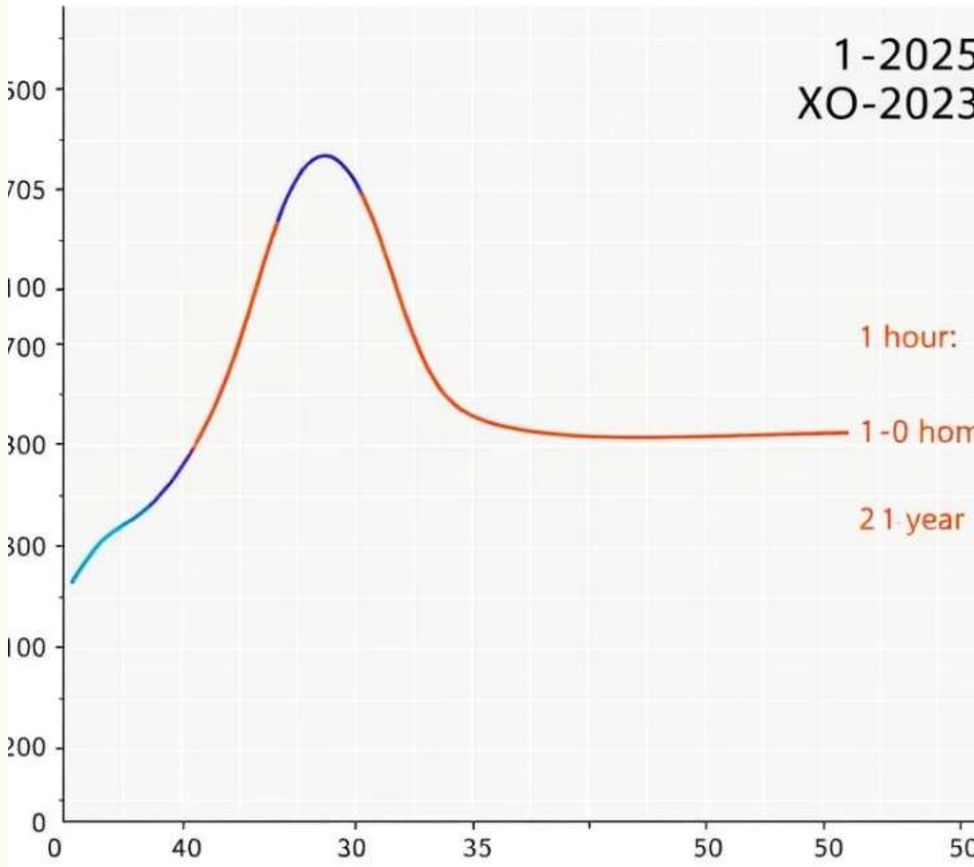
Ensures low signal loss and sharp resonance.

Temperature Sensitivity

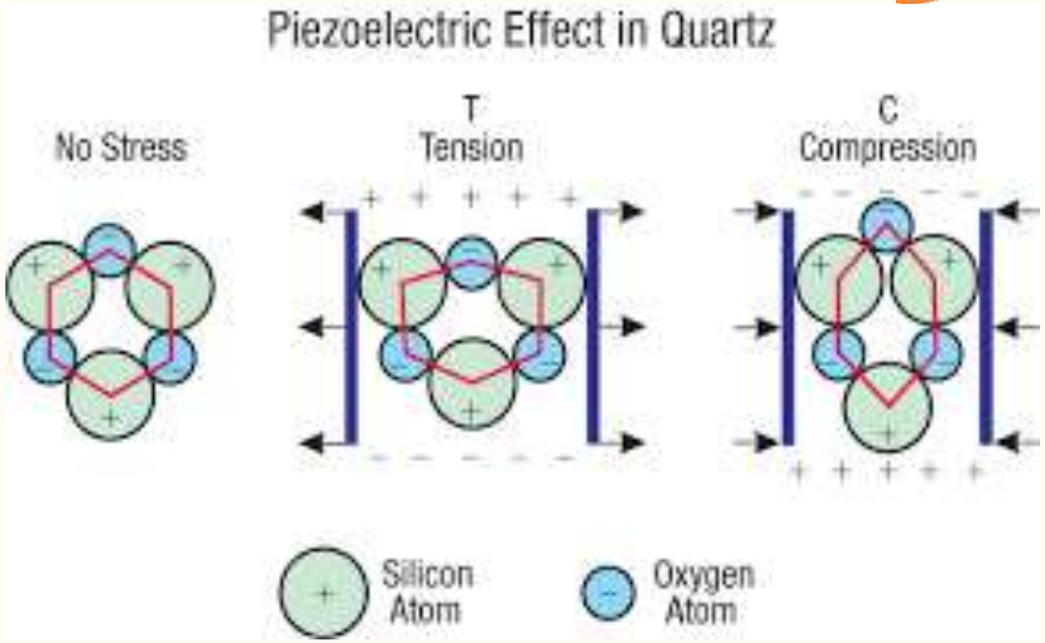
Low drift with temperature changes.

Aging Effects

Minimal frequency shift over years.



Advantages and Disadvantages



Advantages

- High frequency accuracy
- Very low phase noise
- Long-term stability

Disadvantages

- Fixed frequency, limited tuning
- Mechanical shock sensitive
- Higher cost than RC/LC oscillators

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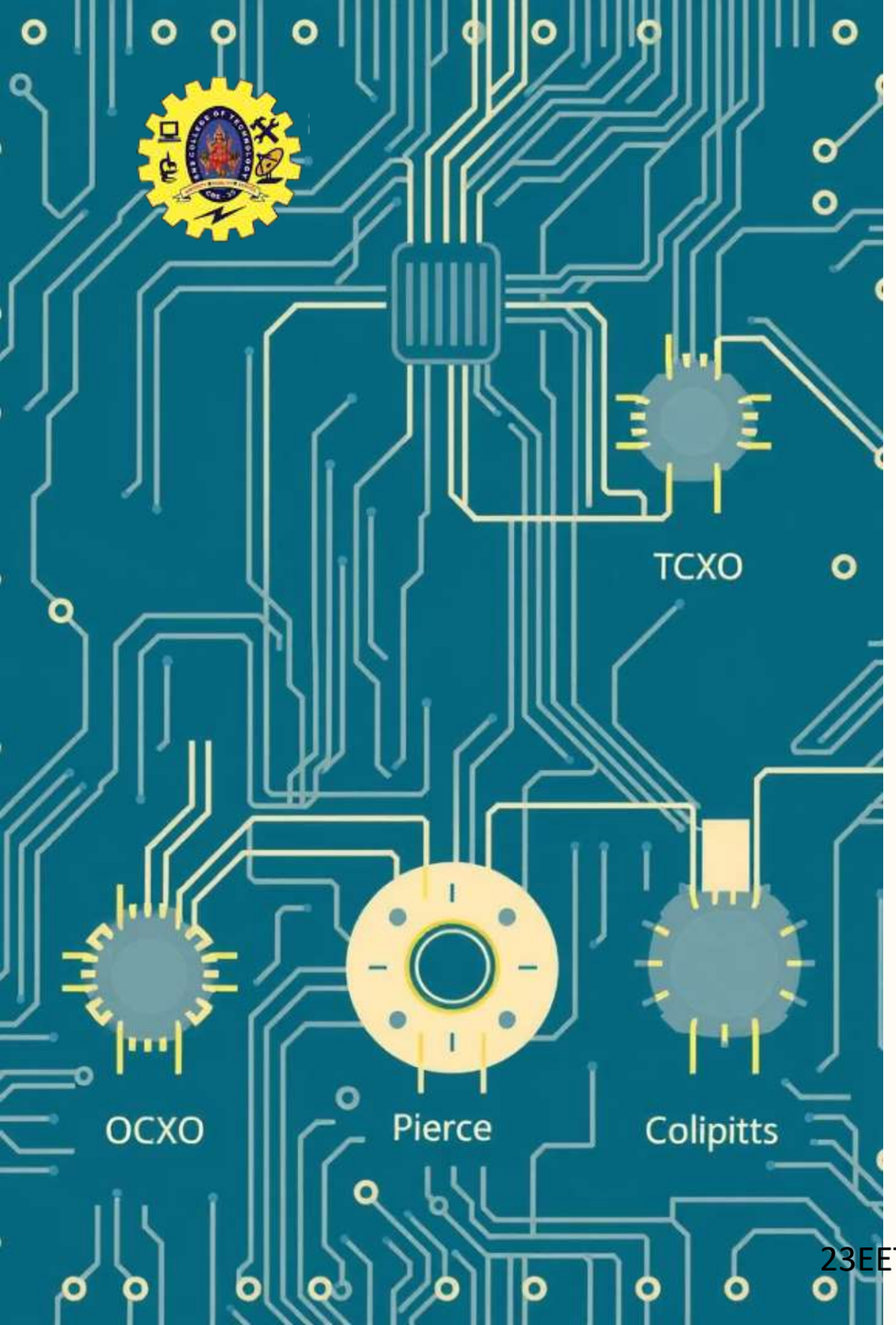
Applications of Crystal Oscillators

Watches & Clocks

Microcontrollers

Communication Systems

GPS Devices



Types and Conclusion

1. **Pierce Oscillator**
   Simple, popular design using inverter and crystal.
2. **Colpitts Oscillator**
   Uses capacitive voltage divider and crystal.
3. **Butler Oscillator**
   Stable oscillator with feedback from crystal.
4. **OCXO & TCXO**
   Temperature compensated and oven-controlled for ultra stability.

Crystal oscillators deliver precise, stable frequencies vital to modern electronics.