CE211-L Circuit Analysis Lab

Kickoff Report

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Classroom Environment Controller (CEC)

CE211 – Circuit Analysis | Project-Based Learning

1. Introduction

This project aims to design and implement a *Classroom Environment Controller (CEC)* — an automatic system that adjusts lighting, fan speed, and noise alerts inside a classroom based on real-time environmental conditions.
The controller consists of three subsystems:

1. **Automatic Light Controller:**
   Uses a light sensor (LDR) to detect ambient brightness and turn the classroom light ON or OFF depending on whether the room is dark or sufficiently illuminated.
2. **Temperature-Based Fan Controller:**
   Uses a temperature sensor (LM35 or thermistor) to adjust fan speed. The fan should operate at low, medium, or high speed depending on the room temperature.
3. **Noise Detector:**
   Uses a microphone sensor and signal conditioning circuits to detect excessive noise levels and trigger an alert indicator.

The entire system will be built using **analog circuits and basic devices**, including voltage dividers, comparators, op-amps, RC filters, transistors/MOSFETs, and driver circuits—ensuring that the design stays fully within the CE211 syllabus.

The objective is to demonstrate practical applications of core circuit analysis concepts (KCL, KVL, Op-amp analysis, Thevenin equivalents, RC time constants) while creating a system with real-world relevance.

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2. Equipment and Tools to Be Utilized

Hardware Components

- Op-amps (LM358 / LM324)
- Light-dependent resistor (LDR)
- Temperature sensor (LM35 or NTC thermistor)
- Electret microphone with preamplifier
- Comparator circuits (op-amp based)
- 555 Timer (optional for PWM fan control)
- Transistors / MOSFETs (IRLZ44N or similar)
- Relays or transistor drivers
- LEDs, resistors, capacitors, potentiometers
- Breadboard and jumper wires
- 12V DC fan
- 12V LED lamp / DC light
- DC power supply (5V, 12V)

Software Tools

- **LTSpice / Multisim** for circuit simulation
- **Microsoft Word/LaTeX** for documentation
- **Multimeters & Oscilloscope (if available)** for testing and calibration

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3. Expected Outcome

At the completion of the project, the group is expected to produce:

Functional Prototype

A working breadboard prototype demonstrating:

- Automatic switching of classroom light with correct threshold behavior and hysteresis
- Temperature-based fan control with at least 3 distinct speed levels
- Noise detection system that activates an alert (LED/buzzer) when sound exceeds a threshold

Technical Artifacts

- Complete circuit schematic (analog components, op-amps, RC networks, drivers)
- Simulation results (waveforms, comparator thresholds, RC responses)
- Calibration data for light, temperature, and noise thresholds
- Short technical report describing the design, theory, and implementation
- Project demonstration during evaluation

Learning Outcomes

- Application of KCL/KVL and nodal analysis in circuit design
- Understanding of analog signal conditioning
- Designing comparators with hysteresis
- Using Thevenin equivalents for sensor analysis
- Interfacing sensors with driver circuits
- Practical hands-on circuit debugging

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4. References

1. Boylestad, R. & Nashelsky, L. *Electronic Devices & Circuit Theory*. 11th Ed.
2. Sedra, A. & Smith, K. *Microelectronic Circuits*.
3. LM35 Temperature Sensor Datasheet – Texas Instruments.

4. LM358 / LM324 Operational Amplifier Datasheets.

5. 555 Timer IC Datasheet – STMicroelectronics.

6. Lab Manuals

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5. Timeline

Week	Milestone
Week 1	Finalize project design, block diagram, and component selection. Begin basic simulations for light and temperature sensor circuits.
Week 2	Complete detailed simulation of all three subsystems (light comparator, temperature comparator, noise preamp). Select component values.
Week 3	Hardware prototyping on breadboard. Test each subsystem individually (light → fan → noise). Perform calibration.
Week 4	Integrate all subsystems. Final testing, troubleshooting, and demonstration preparation. Submit report and complete final evaluation.