JEPPIAAR
ENGINEERING COLLEGE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Faculty Name: RANJITHKUMAR J
Course Title: CEC370 – Low Power IC Design
Academic Year: 2023 - 24
Semester/Year: VI / III
Type: Application-Oriented Learning

Objective

To enable students to design energy-efficient Integrated Circuits (ICs) using modern low-power design techniques in simulation platforms, analyze power consumption, and optimize for performance and area trade-offs.

Design Parameters

- Supply voltage scaling
- Threshold voltage control
- Clock gating techniques
- Power gating
- Leakage reduction strategies
- Dynamic voltage and frequency scaling (DVFS)

Simulation Tools and Implementation Platforms

1. Cadence Virtuoso / LTSpice / Xilinx Vivado
2. ModelSim / Synopsys VCS
3. Power analysis using PrimeTime PX / XPower Analyzer
4. SPICE simulations
5. Python/MATLAB for Data Visualization (Power vs Performance)

Innovative Activities

1. Subsystem-Level Design Challenge

Design a digital system block (e.g., 4-bit ALU or SRAM cell) with low-power optimization using clock gating and logic-level power reduction.

2. Real-Time Power Profiling

Simulate a design under dynamic workloads and analyze energy consumption using power analysis tools.

3. Low Power Design using FinFET / Advanced CMOS Nodes

Students explore advanced node characteristics and compare performance vs power trade-offs.

4. IoT Device Power Management Mini-Project

Develop a model for an IoT device (sensor + controller) and demonstrate battery life estimation under different duty cycles and power-saving modes

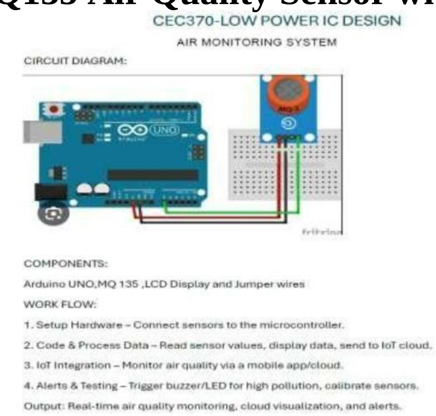
Working

1. Circuit design is simulated for functional correctness.
2. Apply low power techniques (e.g., DVFS, MTCMOS).
3. Measure power metrics (dynamic, static) and optimize.
4. Compare baseline and optimized designs.

Tools Used

- Cadence Virtuoso
- Synopsys Tools (DC, VCS, PT PX)
- Xilinx Vivado
- SPICE (LTSpice, HSPICE)
- Python/MATLAB for plotting and analysis
- Multisim / Proteus (optional)

MQ135 Air Quality Sensor with Arduino UNO



Practical Code:

```
int mq135Pin = A0; // MQ135 connected to Analog Pin A0
int airQualityValue;

void setup() {
  Serial.begin(9600); // Start Serial communication
```

```
  pinMode(mq135Pin, INPUT); // Set A0 as input
  Serial.println("MQ135 Air Quality Monitoring System Started");
}

void loop() {
  airQualityValue = analogRead(mq135Pin); // Read analog value from MQ135
  Serial.print("Air Quality (Analog Value): ");
  Serial.println(airQualityValue);

  delay(1000); // Wait for 1 second before next reading
}
```

Practical Considerations

- Trade-off analysis: Power vs. Speed vs. Area
- Technology scaling impacts
- Thermal considerations in SoC design
- Battery life prediction models for mobile applications

Applications

- Mobile SoCs
- Battery-powered medical devices
- Smart IoT sensors
- Wearable electronics
- Data center server chips

Conclusion

Students gain hands-on exposure to modern low power techniques, using industry tools to simulate and analyze the efficiency of IC designs. This promotes a practical understanding of power-aware computing and circuit design optimization.

CO & PO Mapping

Course Outcome (CO)	Program Outcome (PO)
Apply low power design strategies	**PO1 – Engineering Knowledge**
Analyze power-performance tradeoffs	**PO2 – Problem Analysis**
Use modern EDA tools for simulation	**PO5 – Modern Tool Usage**
Engage in design of energy-efficient circuits	**PO12 – Life Long Learning**

Outcome of the Activity

The integration of low-power circuit design with real-world applications such as air quality monitoring empowers students with essential skills in modern embedded systems. Through hands-on experimentation, critical analysis, and the use of industry-standard tools, learners gain a deep understanding of energy-efficient electronics. This approach not only strengthens their technical foundation but also cultivates innovation, interdisciplinary thinking, and problem-solving abilities. Ultimately, such experiential learning significantly enhances students’ employability, research capabilities, and readiness to contribute to sustainable technology solutions in the evolving global landscape.