Analysis and Design Projects in Computer System Architecture

Overview

Students will work in groups to **analyze or design a project related to computer system architecture**, focusing on innovative ideas or practical applications. This activity encourages critical thinking, collaboration, and practical application of theoretical concepts.

Instructions for Students

1. Project Scope

Choose one of the following project types:

- **Analysis**: Investigate an existing architecture, its features, limitations, and possible improvements.
- **Design**: Create and present a novel architecture or modification addressing specific problems in computing.

2. Topics to Choose From

1. **Processor Architecture**: Analyze and compare RISC vs. CISC processors. Design a simplified CPU model with specified features.
2. **Memory Hierarchy**: Study cache, virtual memory, and RAM. Propose enhancements for improving memory performance.
3. **Input/Output (I/O) Systems**: Investigate DMA or interrupt mechanisms and suggest improvements for real-time applications.
4. **Parallel Computing**: Analyze the architecture of GPUs and design a simple multiprocessor system for a specific task.
5. **Emerging Trends**: Analyze architectures like quantum computing or neuromorphic computing. Design a hypothetical system integrating these technologies.
6. **Energy-Efficient Computing**: Study power-efficient architectures and propose a design for a sustainable computing system.

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3. Deliverables

1. **Group Presentation**

- **Duration**: 10–12 minutes per group.
- **Content**:
  - Introduction to the topic.
  - Project analysis/design, supported by diagrams, simulations, or demonstrations.
  - Conclusion and potential future work.

2. **Written Report**
   - Format: APA style, 3–5 pages.
   - Content:
     - Executive summary.
     - Technical details of the analysis or design.
     - References and citations.
3. **Illustrations or Simulations**
   - Use tools like Logisim, Microsoft PowerPoint, or any relevant software to create diagrams or simulate designs.

Assessment Criteria

Criterion	Description	Weight
Depth of Research	Depth of analysis or innovation in design	30%
Clarity and Organization	Well-structured presentation and clear explanation	20%
Technical Accuracy	Accuracy of information and technical correctness	25%
Creativity and Innovation	Novelty in approach or solution	15%
Visuals and Presentation	Use of effective visuals, diagrams, or simulations	10%

Timeline

1. **Nov. 18-23**: Submit a brief proposal.
2. **Nov. 25-30**: Conduct research or begin design.
3. **Dec. 2-7**: Draft the presentation and report.
4. **Dec. 9-14**: Submit the report and present in class.

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	MARTINEZ, MIKKA JAIRRAH MACALAWA
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	CASIL, DAVID ANGELO CRUZ
	COPINO, JOSH YRIELLE SENGCO
	GESULGON, RAMON CEDRIC MAMANGON
	JARINA, KRISTEL ROSE MECENARIO
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6	ALVAREZ, VIRON EDSON MILAG
	GRISOLA, JOEMI
	LAPUZ, JENNISE RIFEN NARSOLIS
	LLACUNA, JOHN VEL CABANAS
	NAVARETTE, NATHANIEL AÑONUEVO
	SANCHEZ, JOHN CARLO MADDUMA
	VILLANUEVA, MARITHEI HERRERA

Illustrative Example: Project Presentation

Topic: Designing a Low-Power CPU Architecture for IoT Devices

Slide 1: Title Slide

- **Title**: Designing a Low-Power CPU Architecture for IoT
- **Team Members**: Names

Slide 2: Problem Statement

- **Visual**: Diagram showing IoT growth and power consumption challenges.
- **Content**: “IoT devices require CPUs that balance performance and energy efficiency. Traditional CPUs are not optimized for these constraints.”

Slide 3: Proposed Design

- **Visual**: Simplified block diagram of a CPU with specialized low-power components.
- **Content**:
    - Use of ARM Cortex-M architecture.
    - Optimizations: Reduced clock speed, sleep modes, simplified instruction set.

Slide 4: Evaluation

- **Visual**: Chart comparing power consumption between traditional and proposed designs.
- **Content**: “The proposed design achieves a 30% reduction in energy consumption while maintaining task performance.”

Expected Outcomes

By completing this activity, students will:

- Gain a deeper understanding of computer system architecture concepts.
- Develop research, design, and presentation skills.
- Work collaboratively to solve real-world computing challenges.

Tools and Resources

1. **Software**: Logisim
2. **References**:
    - Textbooks on Computer System Architecture.
    - Research papers and technical documentation.

Sample Proposal

Topic: Energy-Efficient Processor Architecture for IoT Devices

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1. Project Title

"Designing a Low-Power CPU Architecture for Internet of Things (IoT) Applications"

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2. Group Members

1. [Student Name 1]
2. [Student Name 2]
3. [Student Name 3]
4. [Student Name 4]
5. [Student Name 5]

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3. Project Objective

The objective of this project is to design an energy-efficient processor architecture tailored for IoT devices. IoT systems often operate on constrained power sources, such as batteries, making power efficiency a critical requirement. Our proposed design will focus on reducing power consumption while maintaining sufficient computational capabilities for IoT applications like smart sensors, home automation, and wearable devices.

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4. Scope of the Project

1. **Literature Review**:
    - Explore existing low-power CPU designs, such as ARM Cortex-M processors.
    - Analyze power-saving techniques like clock gating, dynamic voltage scaling, and sleep modes.
2. **Proposed Design Features**:
    - Simplified instruction set for reduced processing overhead.
    - Integration of power-saving modes for idle states.
    - Optimized architecture to balance computation and energy use.
3. **Implementation Plan**:
    - Create a block diagram of the proposed CPU architecture.
    - Simulate the design using Logisim to evaluate its functionality.
4. **Evaluation Metrics**:
    - Power consumption: Measure energy usage during simulated operations.
    - Performance: Compare speed and efficiency against standard designs.

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5. Expected Deliverables

1. **Technical Report**:
    - A detailed analysis of energy-efficient processor architecture and the proposed design.
    - Discussion of challenges and future scalability.
2. **Simulation Results**:
    - A working simulation demonstrating the CPU's functionality and energy efficiency.
3. **Presentation**:
    - Visual slides illustrating the design process, architecture, and evaluation outcomes.

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6. Timeline

Week	Task
Nov. 18-23	Conduct literature review and finalize design requirements.
Nov. 25-30	Create the initial CPU block diagram and begin simulation setup.
Dec. 2-7	Test and refine the simulation model; draft technical report.
Dec. 9-14	Finalize report, prepare presentation slides, and present the project.

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7. References

1. D. Patterson and J. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*.
2. ARM Holdings, *Technical Overview of ARM Cortex-M Processors*.
3. Research articles on energy-efficient processor designs from IEEE Xplore.

Submitted by:
[Group Name or Number]
Date:
[Submission Date]