William Paterson University of New Jersey
Department of Computer Science
College of Science and Health
Course Outline

1. TITLE OF COURSE AND COURSE NUMBER:
   Computer Architecture, CS441 Credits: 3

2. DESCRIPTION OF THE COURSE: An introduction to the architecture of digital computer systems. Topics include arithmetic for computers, performance measurements, levels of computer description, instructions and instruction set architectures, data-path and pipelining, memory and I/O organization, and multiprocessors.

3. COURSE PREREQUISITES: CS341 with a grade of C- or better and CS345

4. COURSE OBJECTIVES:

   To learn the nature and characteristics of modern computer systems.

   To learn how system performance can be enhanced through various ways from instruction to processor level.

   To become familiar with typical modern computer architectures.

   To understand hardware technology on computer organization.

   To learn the computer organization and architecture from the software standpoint.

   To be aware of the current development and the trends of the field.

5. STUDENT LEARNING OUTCOMES:

   Upon completion of the course, students will be able to:

   a) Recognize the nature and characteristics of modern computer system.
   b) Identify computer architecture, organization and hardware.
   c) Recognize the importance of performance measuring.
   d) Understand the design principles of major components of computer.
   e) Recognize the improvement of computer performance at various aspects and various levels in a computer.
   f) Identify the new trends and technologies of computer architecture and organization.
   g) Recognize the computer architecture and organization from the software standpoint.

h) Use some simulation and profiling tools.

Assessment of the above learning outcomes is through exams, surveys, and projects. Through classroom discussions, and various homework, term papers, team lab projects, and other assignments, the course also reinforce the students learning outcomes of the university:

a) Effectively express themselves in written and oral form. Measure: exams and projects.
b) Demonstrate ability to think critically. Measure: exams and projects.
c) Locate and use information. Measure: projects.
d) Demonstrate ability to integrate knowledge and ideas in a coherent and meaningful manner. Measure: exams and projects.
e) Work effectively with others. Measure: projects.

6. TOPICAL OUTLINE OF THE COURSE CONTENT:

Topic 1: Introduction to computer architecture.
- a) Levels of abstraction
- b) Instruction Set Architecture
- c) Computer architecture, computer organization and computer hardware.
- d) A Brief History: From early electromechanical computer to contemporary computers from the function and structure standpoint.

Topic 2: The Role of Performance:
- a) Measuring performance
- b) Popular performance metrics
- c) Benchmarks: choosing programs to evaluate performance

Topic 3: Arithmetic for computers:
- a) Carry lookahead adder.
- b) Arithmetic of multiplication and division, Booth algorithm.

Topic 4: Instruction set architectures:
- a) Stack, accumulator, register-memory, and register-register architectures.
- b) Reduced Instruction Set Computers (RISC) and Complex Instruction Set Computers (CISC) architectures.

Topic 5: Processors:
- a) Datapath and control.
- b) Simple and multi-cycle implementations.

Topic 6: Enhancing Performance with Pipelining
- a) A pipelined data-path
- b) Pipelined control
- c) Data hazards and related issues

d) Control hazards and related issues
e) Performance of pipelined systems

Topic 7: Exploiting Memory Hierarchy
a) The basics of caches
b) Measuring and improving cache performance
c) Virtual memory

Topic 8: Interfacing Processors and Peripherals
a) I/O performance measures
b) Programmed I/O
c) Interrupt-driven I/O
d) Direct memory access
e) I/O channel and processors and interfacing to operating systems

Topic 9: Parallel Processors
a) SIMD computers: Single instruction stream, multiple data streams
b) MIMD computers: Multiple instruction stream, multiple data streams
c) Programming MIMD
d) Future trends for parallel processors

7. GUIDELINES/SUGGESTIONS FOR TEACHING METHODS AND STUDENT LEARNING ACTIVITIES:
a) Classroom lectures, discussions, and problem-solving sessions.
b) Homework and pre-exam reviews.

8. GUIDELINES/SUGGESTIONS FOR METHODS OF STUDENT ASSESSMENT (OUTCOMES):
a) Periodic examinations, quizzes, and the final examination
b) Software and/or hardware projects at instructor's discretion
c) Term papers.

9. SUGGESTED READINGS, TEXTS, OBJECTS OF STUDY:

"Computer Organization and Design: the Hardware/Software Interface", D. Patterson and J. Hennessy, 3rd edition (w/CD), 2004, Morgan Kaufmann.

10. BIBLIOGRAPHY OF SUPPORTIVE TEXTS AND OTHER MATERIALS:

"Computer Organization and Architecture: Designing for Performance", 7th edition, William Stallings, 2006, Prentice Hall.

"Essentials of Computer Architecture", Douglas E. Comer, 2004, Prentice Hall.

"Computer Systems Design and Architecture", 2nd edition, V. Heuring, and H. Jordan, 2004, Prentice Hall.

"The Essentials of Computer Organization and Architecture", L. Null, 2003, Jones and Bartlett.

"Computer Architecture: A Quantitative Approach", J. Hennessy and D. . Patterson, 3rd edition, 2002, Morgan Kaufmann.

"Computer Architecture and Organization", 3rd edition, J.P. Hayes, 2002, McGraw-Hill.

"Schaum's Outline of Computer Architecture", 1st edition, N. Carter, 2002, McGraw-Hill.

"Advanced PC Architecture", W. Buchanan and A. Wilson, 2001, Addison Wesley.

"Computer Systems Organization and Architecture", J. D. Carpinelli, 2001, Addison Wesley.

"Principles of Computer Architecture", M. Murdocca and V. Heuring, 2000, Prentice Hall.

"Computer Architecture: Concepts and Evolution", G.A. Blaauw and F.P. Brooks, 1997, Addison Wesley.

"Computer Architecture: Single and Parallel Systems", Mehdi R. Zargham, 1996, Prentice Hall.

"Computer System Architecture", 3rd edition, M. Morris Mano, 1992, Prentice Hall.

Periodicals and journals:
COMPUTER, a monthly journal published by IEEE Computer Society
MICRO, a monthly journal published by IEEE Computer Society

11. PREPARER'S NAME AND DATE: Dr. E. Hu

12. ORIGINAL DEPARTMENTAL APPROVAL DATE: Spring, 1996

13. REVISERS' NAME AND DATE: Drs. E. Hu and B. Su on Spring 2005 and previously in Spring 2000.

14. DEPARTMENTAL REVISION APPROVAL DATE: Spring 2005