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ECE 451: Advanced Computer Architecture

Shaahin Angizi

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**Helen and John C. Hartmann Department of Electrical and Computer Engineering
New Jersey Institute of Technology**

ECE 451: Advanced Computer Architecture (3 credits, 3 contact hours)

Instructor:	Shaahin Angizi, email: shaahin.angizi@njit.edu, Tel.: 973-596-3516
Text books:	John L. Hennessy and David A. Patterson, <i>Computer Architecture: A Quantitative Approach</i> , ISBN: 012383872X. Morris Mano, <i>Computer System Architecture</i> , ISBN: 0131755633 David A. Patterson and John L. Hennessy, <i>Computer Organization & Design, The Hardware/Software interface</i> , ISBN: 0123747503
Catalog Description:	This course focuses on advanced concepts in computer systems design, and the interaction between hardware and software components at various levels (i.e., hardware/software codesign). It introduces common performance measures and tradeoffs used by hardware and software designers to facilitate comparative analysis. The main topics are: Technology challenges, Pipelining, Multicore architecture, Advanced memory technologies, Introduction to parallel computing, Conventional architecture for AI acceleration, Analog neuromorphic computing architecture, and Digital in-memory computing.
Prerequisite:	Computer Organization and Architecture (ECE 353)
Specific course learning outcomes (CLO):	The student will be able to: <ol style="list-style-type: none">1. Understand the technology challenges and tradeoffs between device/circuit/architecture parameters and interaction between hardware and software components;2. Understand and utilize the common performance measures used by hardware and software designers to facilitate comparative analysis;3. Design basic instruction pipeline and quantitatively evaluate and compare the multicore processor designs and memory hierarchy;4. Understand volatile and non-volatile memory design techniques;5. Understand the basics of AI/ML and performance measures used by AI accelerator architectures;6. Understand how architecture-level simulators work, and choose and present one simulator at the class
Student Outcomes:	1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (CLOs 1, 2,3,5)

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (CLOs 4,5)
3. an ability to communicate effectively with a range of audiences (CLO 6)
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (CLO 6)
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (CLOs 2,3,5)

Course Schedule:

Topic	Weeks
Technology Challenges, Power & Memory Wall	1,2
Von-Neumann Model & Pipelining	3,4
Multicore Systems	5
Volatile Main Memory	6
Main Memory in Multicore Systems	7
Non-volatile Memories	8,9
Domain-Specific Architectures & Parallel Processing	10,11
In-Memory Computing	12,13
Project Presentation	14

Grading Policy: HomeWorks, Quizzes, and Critical Reviews: 30%
 Research Project: 30% (15% Report +15% Presentation)
 Exams: 40% (20% Midterm + 20% Final)

Updates and Assignments to be distributed via NJIT Canvas

Office hours, recitations, and group studies: Two-hour-a-week after class office hours or with by appointment

Honor Code: The NJIT Honor Code will be upheld; any violations will be brought to the immediate attention of the Dean of Students

Office ECE Bldg., Room 325

Prepared by: S. Angizi