# Course Overview

**Course**  
ECE 452 - Design Advances in Computer Architecture (3 credits)

**Instructor**  
Dr. Bipin Rajendran  
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**Text Books**  
The following reading materials based on Synthesis Lectures that are available online for NJIT users for free will be used as text material. Also relevant papers published in top-tier conferences will be provided in the class.


**Course Description**  
Overview of recent advances and topics of current active research in Computer Architecture. Includes: new computing paradigms such as brain inspired non-von Neumann architectures; stochastic computing; hybrid memory systems and other architectures leveraging emerging memory technologies; systolic array systems; new interconnect architectures including NoCs; GPU-accelerated computing etc.

**Prerequisite**  
ECE 451

**Specific course learning outcomes (CLO)**  
The student will be able to

1. Understand basic principles of non-Von Neumann computer architecture, and explain differences with Von Neumann architecture based on examples and design of brain-inspired systems
2. Understand and utilize the basic principles of stochastic computing architecture to analyze trade-offs with deterministic systems; design hardware modules and evaluate performance;
3. Quantitatively evaluate and compare design of hybrid memory systems that are based on emerging memory technologies with conventional memory hierarchy;
4. Understand and outline high level aspects of emerging topics such quantum computing, systolic array architectures, NoC design and General Purpose GPU programming paradigms.
5. Read critically and analyze papers published in top-tier computer architecture conferences and journals.
Relevant student outcomes (ABET criterion 3)

(a) an ability to apply knowledge of mathematics, science, and engineering (CLO 1, 2, 3, 4)
(b) an ability to design and conduct experiments, as well as to analyze and interpret data (CLO 2, 3)
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (CLO 2, 3, 4)
(g) an ability to communicate effectively (CLO 5)
(i) a recognition of the need for, and an ability to engage in life-long learning (CLO 1, 2, 3, 4)
(j) a knowledge of contemporary issues (CLO 1, 2, 3, 4)
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (CLO 3, 4).

Computer assisted design and course specific software

MATLAB, VHDL

Tentative Course Schedule

Week 1: Von Neumann vs Non Von Neumann
Week 2-3: Principles of Brain-inspired Computing
Week 4-5: Brain-inspired chip Architecture
Week 6-7: Stochastic Computing principles & Architecture
Week 8: Conventional Memory & Storage Hierarchy
Week 9: Emerging Memory technologies
Week 10: Hybrid Memory architectures
Week 11: Systolic array architecture and examples
Week 12: Quantum computing principles arch
Week 13: Networks on chip - design and architectures
Week 14: GPU architectures & acceleration

Grading

Final letter grade will be based on the following tentative curve:
Homework + Quizzes & Class Participation - 20%
Programming assignments/mini-projects - 25%
Midterm Exam - 25%
Final Exam - 30%

Honor Code

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