

**ELE 455 / 555**  
**Computer System Architecture**

**Section 1 – Review and Foundations**

**Class 1 – Introduction**

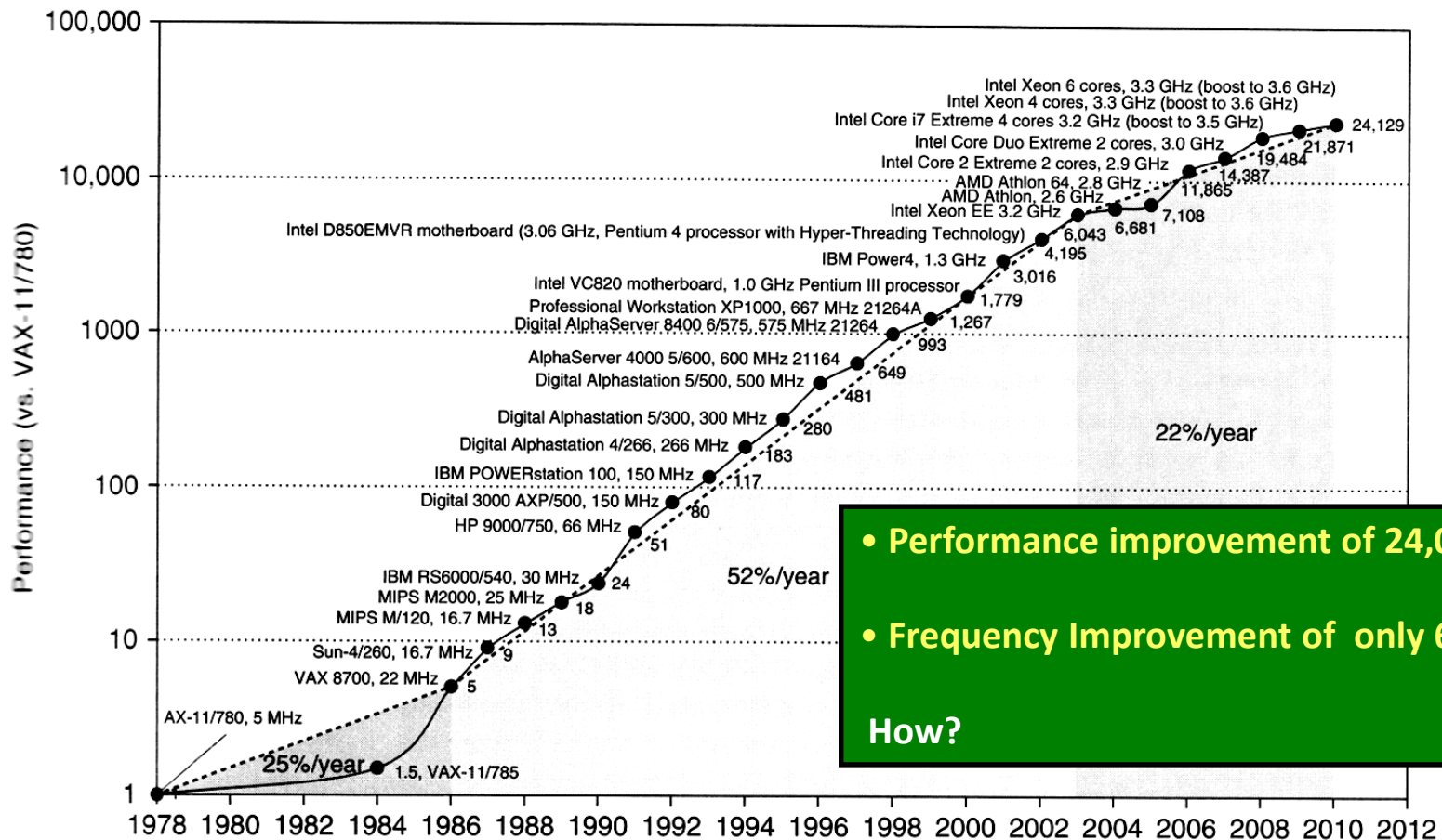
# Introduction

- **Dr. Johnson**
- I enjoyed a thirty year career in the high technology industry spanning the military, industrial, commercial and consumer markets. I have been involved in basic and applied research, product development, engineering management, and business management. I have designed or been responsible for the design of over 250 integrated circuits and was responsible for as much as \$4B of integrated circuits on an annual basis. I worked directly for Motorola, Harris Corporation, IBM and RCA and indirectly with nearly every major semiconductor company around the world.
- **Major Programs and Projects**
  - Motorola: Phones, tablets, set-top boxes, police/fire radios, Iridium
  - [AMRAAM](#) - Advance Medium Range Air-to-Air Missile
  - [BAT](#) - Brilliant Anti-Tank Munitions System
  - 100s of smaller programs
- **General Technology Expertise**
  - Integrated Circuit (IC) Design
  - IC Process Technology
  - Computer System Architecture
  - Wireless System Architecture
- **IC Specific Technology Expertise**
  - Bipolar (JI & DI), NMOS, CMOS, BiCMOS
  - Analog, Mixed Signal, Digital (IIL, TTL, ECL, NMOS, CMOS)
  - Low Power, Sub-threshold
  - Sampled Data (switched capacitor)
  - Radiation Hardened
  - Low Temperature (77K)
  - RF, IF, Baseband, Power Management
  - Microcontrollers, Microprocessors, Multi-Processors, DSP, FPGA
- **Odds and Ends (Misc things I've done over the years)**
  - Research at Oak Ridge National Laboratory
  - Particle Detector design at [Rutherford-Appleton Laboratories](#)
  - LINAC / Gamma Radiation work at [White Sands Missile Range](#)
  - Unix system administrator
  - Co-developed a switched capacitor simulator
  - Developed a thermal fusing simulator

# Introduction

## CMOS Technology Trends

- Processor Performance



- Performance improvement of 24,000 X
- Frequency Improvement of only 660 X

**How?**

Source: Computer Architecture, Hennessy and Patterson, 2012 Elsevier Inc





# Introduction

## Syllabus

- ELE 455/555 - NIU Course Description
  - Register transfer and micro-operation, basic computer organization and design; central processing unit; micro-programmed control; pipeline and vector processing; computer arithmetic; input/output organization, and memory organization.
  - Lecture/discussion two periods per week
- Prerequisites:
  - ELE 250 is the official prerequisite but an understanding of assembly and C programming is helpful.

# Introduction

## Syllabus

- Additional Course Information
  - This is a dual level course
  - ELE555 students will have additional HW and test questions
- Primary Goal
  - This course will introduce students to the inner workings of the core elements of modern day microprocessors. Successful participants will understand the architectural and performance drivers, function, and design of each of these core elements.

# Introduction

## Syllabus

- Course Outline
  - The lecture/discussion portion of the course will consist of four major sections:
    - Review and Foundations
    - The Processor
    - Memory
    - Parallel Processing



# Introduction

## Syllabus

- Mechanics
  - Class Details:
    - Room - EB 209
    - Days - Tuesdays and Thursdays
    - Time - 11:00 – 12:15



# Introduction

## Syllabus

- Learning Outcomes and Objectives

**Learning Outcomes and Objectives:**

A student who successfully fulfills the course requirements will have demonstrated:

- the ability to identify / compare / contrast key processor architecture features  
ABET Outcomes [a,b,c,e,g,i,j,k]
- the ability to analyze and design a processor data path  
ABET Outcomes [a,b,c,e,g,i,j,k]
- the ability to analyze and design processor control logic  
ABET Outcomes [a,b,c,e,g,i,j,k]
- the ability to analyze and design a memory hierarchy  
ABET Outcomes [a,b,c,e,g,i,j,k]
- the ability to analyze and design parallel processing architectures  
ABET Outcomes [a,b,c,e,g,i,j,k]

# Introduction

## Syllabus

- Instructors
  - Class: Dr. Johnson
    - EB 350
    - [tjohnson11@niu.edu](mailto:tjohnson11@niu.edu)
      - preferred method of contact
      - (prepend all email subjects with ELE455 - subject...)
    - Website – <http://www.ceet.niu.edu/faculty/tjohnson>
    - Office phone - (815) 753-9967
    - Office hours: T/TH 1:00 – 2:00, W 9-11, 1-3
  - TA: N/A

# Introduction

## Syllabus

- Resources
  - Text book
    - Computer Organization and Design, The Hardware/Software Interface 5<sup>th</sup> ed.  
By: Patterson and Hennessy  
ISBN: 978-0-12-407726
  - Class website:
    - <http://www.ceet.niu.edu/faculty/tjohnson>
    - Notes, Handouts and readings will be available on the website

# Introduction

## Syllabus

- Support outside of class
- If you are struggling it is **ALWAYS** better to ask for help early since concepts build upon each other. In addition, office hours will be more crowded prior to the test and you may not get the kind of time needed to clarify your understanding.



# Introduction

## Syllabus

- **Americans with Disabilities Statement & Non-Discrimination Statement:**
  - NIU abides by Section 504 of the Rehabilitation Act of 1973 which mandates reasonable accommodations be provided for qualified students with disabilities. The NIU Center for Access-Ability Resources (CAAR), located on the 4th floor of the University Health Service (815.753.1303) is the designated office on campus to provide services and accommodations to students with diagnosed disabilities. You need to provide documentation of your disability to CAAR if you seek accommodations in this course.
  - Your success as a student is of utmost importance to me. If you have a disability or any other special circumstance that may have some impact on your work in this class, and for which you may require special accommodations, please contact me early in the semester so that accommodations can be made in a timely manner.

# Introduction

## Syllabus

- Class Notes / Additional Reading
  - I will make every attempt to put the class notes and additional readings on the web page two weeks in advance of the lecture but worse case these will be available one week in advance of class.
  - It is critical that you read these over before class. They are not intended to include all the class material but will jump start the learning process. In addition, all the material in the notes may not be covered in class – but you are still responsible for it.
  - *See the notes on Effective Learning Concepts.*

# Introduction

## Syllabus

- HW Assignments
  - The web page will be used for scheduling and distributing assignments.
  - Due to the nature of the material, assignments will be handed-in in hard copy form.
  - Blackboard will be used for grades and announcements
  - All assignments will be due at the beginning of the class on the assigned day.
  - No late assignments accepted
- Tests
  - The first three tests will be administered during normal class hours. The fourth test will be administered at the university assigned final time/location.

# Introduction

## Syllabus

- Class Attendance
- This is a Sr/Grad level course and will move pretty quickly. While you may be able to learn the material on your own, if you fail to attend class you will not:
  - be exposed to the subtlety of the concepts
  - learn the details “between the lines”
  - know what points I consider important
  - learn from the questions of other students
  - get the benefit of the doubt on any borderline decisions



# Introduction

## Syllabus

- In Class Behavior
  - You are young professionals and I expect you to act accordingly. Disruptive behavior of any kind will be referred to the appropriate administrative office.
  - I expect your focus in class to be on the course material. Cell phones, MP3 players, laptops, tablets, ... are not allowed in my class. If you must use one of these devices you are welcome to leave the room.
    - Research shows that taking notes on a laptop or tablet is less effective than taking them long-hand, so please do not ask for an exception.
  - No video or audio recording is allowed in class. Failure to follow this rule will be treated as academic dishonesty and dealt with accordingly.

# Introduction

## Syllabus

- Professionalism and Academic Honesty

***A professional does not take credit for the work of someone else.***

- A major component of your education is learning how to learn and perform. Now is the time you must develop the discipline, mindset, and ethics to contribute in the technical society. I can assure you; those who claim the work of others in the workplace are dealt with rather harshly. They may not even know they are being penalized, but those around them will make sure justice is served.
- **Any** documented case of “cheating” will result in a **FAILING GRADE** for the course as well as possible disciplinary action. All cases of academic dishonesty will be reported to the ELE Chair as well as to the Dean of Students.

# Introduction

## Syllabus

- Examples of Cheating include **(but are not limited to)** the following:
  - Testing
    - copying the work of another student (past or present) during a test
    - providing test information to students who have not yet taken it
    - obtaining information about a test prior to taking it
    - having someone else take a test for you
    - bringing “cheat sheets” in any form with you to a test
    - using a cell phone or other electronic device during a test
  - Homework
    - modifying a graded lab or homework paper and submitting it for reevaluation
    - turning in work that was done by someone else
    - using another student’s (past or present) homework files
    - posting solutions to homework problems or lab experiments

# Introduction

## Syllabus

- Collaboration
  - Working collaboratively on homework assignments is allowed and encouraged. **The work you turn in however must be your own.** If you short circuit this process and let someone else do the work for you, you will be cheating yourself.
  - This will be obvious when you do well on homework and fail the tests.



# Introduction

## Syllabus

- Participation

- Participation in class is valuable to the student, the instructor, and others in the class.
- Students must learn to ask questions when they don't understand, provide input where they believe it adds to the discussion, and become comfortable speaking in various settings. An engineer who is not able to provide appropriate input in a meeting or group discussion is a waste of a seat.
- Most instructors know their course material very well. The key to conveying that information is constant feedback. The pace, approach and content can usually be modified to enhance the student's learning process, IF, the students provide feedback. Where the opportunity to change the lesson has passed, consider your feedback as a form of "paying it forward" to future students.
- When someone asks a question there are almost always others with a similar question. In some cases the question or answer may clarify the concept for a student who thought they understood but now realize they did not.
- Participation will not be officially graded. I reserve the right to use participation as the "borderline" determining factor as outlined in the *Grading* section.

# Introduction

## Syllabus

- Grading
  - Your “overall score” will be calculated based on the following weights:
    - Participation <1% only used on borderline cases
    - Homework 40% 10 sets at 4% each
    - Tests 60% 4 tests at 15% each

# Introduction

## Syllabus

- Grading
  - On each HW and Test you will receive a “raw score”. This will reflect your un-weighted performance. Your “raw score” will be shifted with respect to the **upper percentile** of the class to obtain a “weighted score”. It is these weighted scores that will be used in your “overall score” calculation. ELE455 and ELE555 will be weighted separately.
  - For example, if the top student has an raw score of 93%, everyone’s raw score will be multiplied by 1.075 ( $1.00/0.93$ ) to obtain their corresponding weighted score.

# Introduction

## Syllabus

- Grading
  - For the final grade, equal-width cutoffs will be applied based on a cutoff width of 10 (i.e., the nominal cutoffs for A-B-C-D will be 90-80-70-60, respectively).
  - Letter grades in the upper 33% of each range will have a “+” designation, and those that fall in the lower 33% of each range will have a “-” designation.
  - Subject to the official university limits (No A+, C-, D+ or D-)
  - A “borderline” is officially defined as an “overall score” within 0.5% of a cutoff when the final grade calculation is performed. Before course grades are assigned, the instructor will carefully examine all such cases and determine if the next higher grade is warranted.



# Introduction

## Syllabus

- Grading
  - Individual homework assignments, labs and tests will be graded and returned to the student. These grades are unofficial.
  - The official grades will be kept in Blackboard and updated on a regular basis.
  - Any errors in grading must be brought to the attention of the instructor within one week of posting to Blackboard.
  - Blackboard will contain the raw and weighted score for each assessment, and the current overall score.

# Introduction

## Syllabus

As an engineer you most likely consider yourself a scientist also. A critical piece of being a scientist is believing in the scientific method and not ignoring the results. Here are some key learning and learning behavior results.

- Multi-tasking reduces competency in each task undertaken
- <5% of the population can multi-task and the odds are high that you are not one of them
- Repetition is a key factor in long term retention
- Your brain tosses out anything it thinks is irrelevant each night – review material the same day to help make it relevant to your brain
- Sleep is not an option – it is critical to learning (7 hours min – no exceptions)
- Connect new concepts to concepts you already know
- Taking notes by hand increases understanding – not true for typing
- Study as you go and review in the days before the test – then sleep the night before
- Hear – Do – Teach      Teaching others solidifies learning
- Cramming has no long term learning value
- Cramming works for a few hours – if you do it – do it the morning of the test

# Introduction

## Syllabus

- 7 things to make you a better learner
  1. Make connections. Use analogies or mnemonic devices to build upon your existing knowledge. Not only do these help you remember – but the act of creating these helps you learn.
  2. Never read anything without a purpose and stop once you have accomplished it.
  3. When you read – stop after every major section or chapter and write down a few key notes. Review the summary within 24hrs to help transition it from short term to long term memory.
  4. 20-30 min maximum at any task – then take a short stretch break (30-60sec) and get the blood flowing – review what you have been doing in your mind.
  5. 2 hours total without a long break (10 - 15 minutes). Do something that stimulates other parts of your brain – music, exercise, food – when you return – review your short notes from earlier.
  6. Plan your time – keep a record – modify your schedule accordingly – Stress reduces learning and being overloaded with no time left is very stressful.
  7. Ask – when you don't get it, and have tried a few times - ASK



# Introduction

## Syllabus

- **Course Calendar**

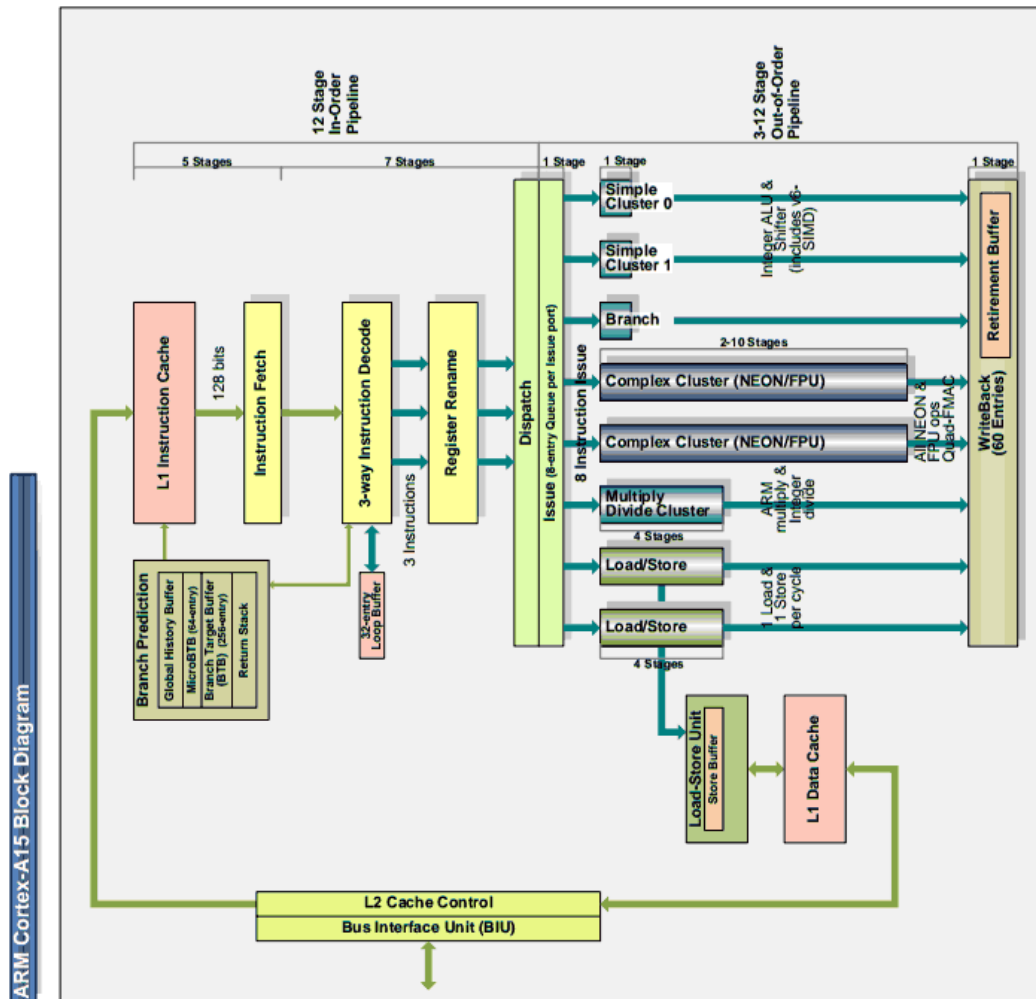
*SUBJECT TO CHANGE – depending on overall class progress and any unforeseen natural phenomena.*

- **1/19 – 2/9**      **Review and Foundations**
- 1/26      HW 1 due
- 2/2      HW 2 due
- 2/9      HW 3 due
- 2/16      *Test 1*
- **2/11 – 3/8**      **The Processor**
- 2/25      HW 4 due
- 3/8      HW 5 due
- 3/10      *Test 2*
- **3/22 – 4/12**      **Memory**
- 3/29      HW 6 due
- 4/5      HW 7 due
- 4/12      HW 8 due
- 4/19      *Test 3*
- **4/14 – 5/5**      **Parallel Processing**
- 4/26      HW 9 due
- 5/5      HW 10 due
- Final day/time      *Test 4*



# ELE 455/555

## Semester Preview



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# ELE 455/555

## Semester Preview

