1. Professor: Haldun Hadimioglu

2. Course format: Lecture Section: 1185

3. Prerequisite: CS 6133 Computer Architecture I.
   ➔ Students who took CS 2214 at NYU-Poly can take the course

   ➔ Course handout files are at the course web site

5. CS6143 is a course on advanced pipelining and parallel processing, with focus on parallel algorithms!

6. Textbooks:
      ➔ Publisher’s web site, http://books.elsevier.com has a large amount of material, including Appendices D through L of the textbook. Students are strongly suggested that they study the web site material and print the appendices that will be used especially during the exams.
      ✩ Students are reminded about printing the appendices!

Also, Students will also read other books and papers, especially on multi-core, parallel random access machine (PRAM) and single-instruction stream, multiple-data stream (SIMD) machines.

7. Homework:
There will be six homework assignments. An assignment submitted late will not be accepted. Students are reminded about studying the solutions provided by the textbook.

➔ Students will form teams by the third week of the semester. The homework will be submitted by teams.

➔ Students who do homework are faster at solving problems. Showing work (intermediate steps) is required to get full/partial credits on a question. Although, the homework will not affect the term grade, it can help raise grades as explained below.
Homework assignments have modified past exam questions and answers to help learn chapters and solve homework problems. Students need to study them before they solve homework problems, not before exams. Note that, these past exam questions are samples and do not give hints about exams this semester.

8. Exams:
There will be a 150-minute midterm exam and a 150-minute final exam.

- Showing work (showing intermediate steps) is required to get full credits on a question. That is, both the final answer and the steps to get it, the approach, are important.
  - These steps are given in class and past exam solutions. Therefore, students are expected to solve exam questions as such. Showing the approach also helps students acquire and improve their documentation skills, critical for the technical world.
  - In order to facilitate this, the exams are open book exams: students can use their own material, i.e. their books, notebooks and handouts during the exams. Note that once the exam starts there is no sharing.
  - Students must prepare for the exams as if they are closed book exams!

9. Term Grade:
The term grade is based on the weights of the exams:

- 40% Midterm Exam
- 60% Final Exam

- The homework does not affect the term grade directly but it is taken into account when a student’s term grade is near a grade “border.” Also, taken into account is student’s attendance record. If they are good, the grade is raised. Finally, the professor may change the term grade computation. Thus, students are strongly suggested that they fulfill the requirements of the course, i.e. lectures and homework assignments.

10. Office Hours:
The professor has an open-door policy that if he is not busy, students can ask questions in his office. If the door is closed, he might be teaching or at a meeting. If a student wants to see the professor at a certain time, he/she makes an appointment with the professor.

- Students can use email. But, they are strongly suggested that they see the professor to ask questions, instead of sending email. If email is sent, a Polytechnic email address must be used and student’s name and section must be included. Broadcast messages will be sent to class to make announcements. Note that grades are not given out to students via email or telephone. Students need to see the professor to learn their grades.

11. Material Coverage:
Chapters from Hennessy and Jordan books will be covered. Also, students will study other books and papers. They will be also given additional material in class. The tentative schedule is as follows:
12. References:

Students are suggested that they study recent computer architecture and parallel processing books since the field advances fast. **Using the web to gather information is strongly discouraged!**

The following references are recommended with respect to their relevance to the course and the textbooks:

g) *Programing Many-Core Chips*, A. Vajda, Springer Verlag, 2011.
h) *Computer Architecture: From Microprocessors to Supercomputers*, B. Parhami, Oxford Uni-

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<tr>
<th>Day(s)</th>
<th>Subject</th>
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<tbody>
<tr>
<td>Jan 29</td>
<td>Introduction ; Computer layers ; Computational methods ; Popular scientific applications ; MIPS FP instructions ; CS613 Integer pipeline ; (Chp 1 ; Appendix A, B, C) ; (Chp 1)</td>
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<tr>
<td>Jan 29, Feb 5, 12, 19, 26</td>
<td>MIPS FP pipeline ; Advanced pipelining ; Speculative execution, superscalar execution, VLIW computation ; (Chp 2, 3 ; Appendix A, B, C, H) ; (Chp 7)</td>
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<td>Feb 26, Mar 5</td>
<td>Vector processors ; (Chp 4 ; Appendix A, B, C, G)</td>
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<td>Mar 26</td>
<td>Midterm Exam ; Lectures on Jan 29 - Mar 5 ; HW : 1 - 3</td>
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<td>Mar 5, 12, Apr 2</td>
<td>Flynn’s classification ; Interconnection networks ; (Chp 5 ; Appendix F, I) ; (Chp 1, 4, 6)</td>
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<td>Apr 2, 9, 16</td>
<td>Parallel processing overview ; Dependency analysis ; Levels of parallelism ; Parallelism issues ; Algorithm complexity ; PRAMs ; (Chp 3, 5 ; Appendix I) ; (Chp 2, 4, 7)</td>
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<td>Apr 16, 23</td>
<td>MIMD machine overview ; Shared-memory MIMD systems ; Cache coherency ; Shared Memory MIMD systems ; Synchronization ; Programming ; (Chp 3, 5 ; Appendix I) ; (Chp 2, 4, 7, 8, 9, 10)</td>
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<td>Apr 30</td>
<td>Distributed Memory MIMD systems ; SIMD machines ; (Chp. 3, 5 ; Appendix I) ; (Chp 2, 4, 5, 7, 8, 9, 10)</td>
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<td>May 7</td>
<td>Current parallel processing system issues ; (Chp 3, 5 ; Appendix I) ; (Chp 2, 4, 5, 7, 8, 9, 10)</td>
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<td>May 14</td>
<td>Final exam ; All lectures : Jan 29 - May 7 ; HW : 1 - 6</td>
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13. The Theme of the Course:
i) CS6133 introduces a uniprocessor computer with an integer pipelined CPU and a hierarchical memory of caches, physical and virtual memories.

ii) CS6143 explores designs for higher computer performance and higher capacity through a more rigorous exploitation of parallelism. In CS6143, parallelism on several layers of computers is targeted. The layers we will target are the computational method, algorithm, high-level language, architecture and microarchitecture.

iii) The first half of the semester is on low-level parallelism, including the instruction-level parallelism, ILP, and loop-level parallelism, that are on the architecture and microarchitecture layers. These two forms of parallelisms have been extensively exploited in the form of dynamic pipelining, superscalar execution, vector processing and VLIW (EPIC used by the Intel Itanium is a version of VLIW).

iv) The second half of the semester is on parallel processing, especially massively parallel processing, i.e. SIMD and MIMD computers. We will start with interconnection networks used in SIMD and MIMD computers. Then, we will cover PRAMs which are theoretical systems to help understand real parallel systems better. We will then discuss SIMD machines. We will continue with shared-memory MIMD systems and the related topic of cache coherency (current multi-core systems are shared-memory MIMD systems). This is followed by distributed memory MIMD systems. We will discuss their properties and why today’s fastest supercomputers are distributed memory MIMD systems.
Finally, we will sum up the semester by studying current conference and workshop papers that outline issues for now and future for parallel processing systems.

14. Reminders about the course:

Students are required to read the web pages whose links are provided with at the course web site:

1) NYU-Poly Code of Conduct web page: http://engineering.nyu.edu/academics/code-of-conduct

2) NYU-Poly Life page web page with links to Health+Wellness, Campus Safety, Students Resources and other: http://engineering.nyu.edu/life. In addition, keep the following in mind:

a) Always keep contact with the professor and discuss your personal matters in professor’s office.

b) A successful course experience: To enjoy the course as much as possible and be ready for the follow up courses, students need to be committed to the course:

- Attending classes and doing the work are needed.
- Lectures are dependent on each other.
- Study the notes, books, handouts. But, just reading does not mean studying! Also, do the homework!

C) Students must realize that every action they take has consequences. They also should not make assumptions and decisions on the course (the exams, lectures, the homework and attendance) without asking the professor. An assumption that is often made by students is that every course is the same. This is not the case!

d) A reason for a low grade is missing classes. Even if one gets the notes, it does not help. This is because:

- The notes taken from the board may not be correct.
- Someone taking the notes may not write down all the verbal comments and suggestions made by the professor.
- Attending classes forms better memory because of visual (seeing the writing on the board), audio (listening to the professor) and tactile (writing down the notes) inputs.
- During lectures, the professor refers to earlier lectures (past topics, comments, suggestions, etc.) which refreshes students’ memory and further reinforces their knowledge.

Overall, students learn and remember more. Finally, since their memory is fresh, students save time when they study for exams.

e) Missing an exam is not a minor case. A careful assessment is made to excuse a student or to grant an incomplete to a student. The professor makes the decision. The decision is made also based on the information by the student’s academic department and the Student Affairs Office.

One of the requirements to excuse a student is that at the time the student is not able to take the exam, he/she be in good standing in class, i.e. has good attendance, a good homework performance and a good exam performance: The professor wants to see that the student has been committed to the course and learning the material has been his/her main objective.

A student who is excused from a midterm exam is not given a make-up exam. The weight of the midterm exam is distributed to the other exams at the discretion of the professor. The make-up exam for the final exam will be harder than the one given to the whole class.

If a student experiences any problem, including health/personal problems, he/she must immediately contact Judith Simonsen who is the director of the Student Development Office: jsimonse@poly.edu. Her number is (718) 260-3046. Her office number is LC 240C.

f) For a course, the semester is over when the final exam is over. Students are not given extra work, a project, a make-up exam or any other kind of special treatment to raise their grade during or after the semester.
g) Some students do not know/follow NYU-Poly and CS2204 rules and regulations nor seek advice from Polytechnic staff. Students are strongly suggested that they speak with the professor, the TAs, the major advisor, the personnel of the Student Affairs Office, and the Counseling Center.

15. Professor’s message:

- Focus on learning and thinking!
- More importantly, focus on motivating yourself to learn more and think more!
- Knowledge is not finite!
  - As a student, you will use your motivation to learn and think to learn more of each topic!
  - Students consider the learning and thinking style shown on the left not the one on the right:

    | Learning, thinking and motivating yourself? WHY? |
    |-----------------------------------------------|
    | Motivation | Learn | Success = Graduate, work, be healthy, be happy = Enjoy life |
    |            | Think |                        |
    | Learn     | Trial & error | Failure |
    | Joy       | Discover | Think |
    | Knowledge is not finite & the world is not predictable |

    | Learn | Memorize |
    | Memorize | Success | Learn |
    | Past exams, handouts, etc. |
    | No thinking, no discovery & no joy |
    | Knowledge is finite & the world is predictable |

- Students are suggested that they read the following book that describes the cycle on the left above:

16. Benefitting from the course for the years before and after graduation:

- Industry and academia look for graduates who can solve problems, are systems oriented and creative
  - In order to accomplish those you need to have
    - Analytical skills, synthesis skills and team work skills
    - For these three skills, you will need to develop critical thinking and personal skills for which you need to do the following
  - Learning is your target!
  - You interact with people to work on a problem, to exchange ideas, to help, etc.!
- After graduation, the most common way you will be judged is how you write
  - Concentrate on documentation!
  - Homework and exams help you practice writing: Students show work, not just the final answer
- Students understand and satisfy the goal of the course:
  - Acquiring skills to be systems oriented and a problem solver as well as acquiring the necessary course content which is parallelism:
  - CS6143 introduces parallelism techniques to improve computer performance and capacity:
    - Advanced pipelining: techniques to improve the uniprocessor system performance by exploiting instruction-level parallelism (ILP) and loop-level parallelism of application programs.
    - Parallel processing: techniques to improve the performance and capacity, by utilizing multiple processors or processing elements to exploit loop-level and higher-levels of parallelism: thread-level, task-level and process-level parallelisms. The focus will be on PRAM, SIMD (single-instruction stream, multiple-data stream) and MIMD (multiple-instruction stream, multiple-data stream, multi-core) systems.