1. **Professor** : Haldun Hadimioglu  
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   http://cis.poly.edu/haldun

2. **Prerequisite** : CS613 Computer Architecture I. Operating systems, algorithms and compilers knowledge is recommended.

3. **Textbook** :  

   Publisher’s web site, [http://books.elsevier.com](http://books.elsevier.com), has a large amount of material. Students are strongly suggested that they study the web site material and print the appendices that will be used especially during the exams.

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

4. **Main Goals** : The course introduces parallelism techniques to improve computer performance and capacity:
   
i) **Advanced pipelining** techniques to improve the uniprocessor system performance by exploiting instruction-level parallelism (ILP) and loop-level parallelism of application programs.

   ii) **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 and shared-memory MIMD (multiple-instruction stream, multiple-data stream, multi-core) systems.

5. **Exams** : There will be a 135-minute midterm exam and a 135-minute final exam. Students will be allowed to use their own material, i.e. their books, notebooks and handouts during the exams: “open book” exams. Students are expected to solve exam questions as they are shown in past exam solutions and in class. This means showing work (showing intermediate steps given in past exam solutions and in class) is required to get full credits on a question. The reason is that not only the final answer of the question is important, but also the approach, the technique used to get the solution.

6. **Homework** : There will be six homework assignments. An assignment submitted late will not be accepted. Students are reminded about printing the appendices that are at the publisher web site. Again, showing work (intermediate steps) is required to get full/partial credits on a question. Although, the homework does not affect the term grade, it can help raise grades as explained below.

   Each homework assignment includes modified past exam questions and answers to help students understand chapters and solve homework problems. Students need to study them before they solve homework problems, not before exams. Also note that, these past exam questions are samples and do not give hints about exams this semester.
7. **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, having a good homework performance is important and it is taken into account when a student’s term grade is near a grade “border.” Also considered is student’s attendance record. If they are all good, the grade will be raised. Thus, students are strongly suggested that they fulfill the requirements of the course, i.e. the lectures and homework assignments.

8. **Office Hours**: The professor has an open-door policy that if he is not busy, students can ask question in his office at other times. If the door is closed, he might be teaching. If a student wants to see the professor absolutely, an appointment has to be made with the professor.

Students can use email for short non-emergency cases. An email message without student’s name and section will not be answered. Students will receive broadcast messages from the professor on utopia. Students are strongly requested they see the professor to ask questions, instead of sending email.

The class email list that the professor uses is created and maintained by the Information System (IS) department. If a student happens to not receive broadcast messages, s/he needs to go to the IS department : 337RH or contact it at (718) 260-3123 or help@poly.edu

9. **Material Coverage**: A number of chapters from the Hennessy book will be covered. Students will study other books and papers. They will be also given additional material in class. The tentative schedule is as follows:

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Day(s)</th>
<th>Subject and Textbooks Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sep 6</td>
<td>Introduction ; Computer layers ; Computational methods ; Flynn’s classification ; Dependency analysis ; CS613 pipeline overview ; (3.1, Appendix A)</td>
</tr>
<tr>
<td>2, 3, 4, 5</td>
<td>Sep 13, 20, 27, Oct 4</td>
<td>Algorithm complexity ; Popular scientific applications ; Levels of parallelism ; Instruction level parallelism (ILP) ; Speculative execution ; (3, 4, Appendix A)</td>
</tr>
<tr>
<td>6</td>
<td>Oct 11</td>
<td>Superscalar execution ; VLIW computation ; Current state of the art ; (3, 4, Appendix A)</td>
</tr>
<tr>
<td>6, 7</td>
<td>Oct 11, 18</td>
<td>Vector processors ; (Appendix G)</td>
</tr>
<tr>
<td>10</td>
<td>Nov 8</td>
<td>Midterm Exam ; Weeks 1 - 7</td>
</tr>
<tr>
<td>8, 9</td>
<td>Oct 25, Nov 1</td>
<td>Interconnection networks ; (8)</td>
</tr>
<tr>
<td>9</td>
<td>Nov 1</td>
<td>Parallel processing overview ; Parallelism issues ; PRAMs ; (6)</td>
</tr>
<tr>
<td>11</td>
<td>Nov 15</td>
<td>SIMD machines ; MIMD machine overview ; (6)</td>
</tr>
<tr>
<td>12</td>
<td>Nov 29</td>
<td>Cache coherency (6, Appendix I)</td>
</tr>
<tr>
<td>13</td>
<td>Dec 6</td>
<td>Shared Memory MIMD systems ; Synchronization ; Programming ; (6)</td>
</tr>
<tr>
<td>14</td>
<td>Dec 21</td>
<td>Final exam ; Weeks 1 - 13</td>
</tr>
</tbody>
</table>
10. The Theme of the Course:
i) CS613 introduces a uniprocessor computer with a pipelined CPU and a hierarchical memory of caches, physical and virtual memories.

ii) CS614 explores designs for higher computer performance and capacity through a more rigorous exploitation of parallelism. In CS614, 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. We will cover PRAMs which are theoretical systems to help understand practical parallel systems better. Then, we will discuss SIMD machines. Finally, we will cover shared-memory MIMD systems and the related topic of cache coherency (current multi-core systems are shared-memory MIMD systems).

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


13) “Scalable Shared-Memory Multiprocessing,” Daniel E. Lenoski and Wolf-Dietrich Weber, Morgan Kaufman,
1995.


18) Numerous research papers from journals and conference and workshop proceedings on computer architecture, parallel processing, supercomputing, operating systems, algorithms, programming languages and compilers.

12. Reminder :

a) A reason for a low grade on CS614 is missing classes. Even if one gets the notes, they may not be helpful. On average, during each lecture more than 100 pages from the textbook will be covered. Attending the lecture will help students focus on the pages better. Also, someone taking the notes may not write down all the verbal comments and suggestions made by the professor.

b) 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 on the student provided by the academic department and the Student Development 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. That is, 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 will not be given a make-up exam. The weight of the midterm exam exam will be calculated at the discretion of the professor.

c) For a course, the semester is over when the final exam is over. Students will not be 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.

d) Students are strongly recommended that they not make assumptions and decisions on the course without asking the professor: exams, lectures, the homework and attendance.

e) Students are advised that they be cautious about web sites used when they gather information related to the course. Many web sites contain erroneous material and are not reliable. Students can contact the professor for web site links. They can also access web sites of academic people who specialize in the area of CS614.