Learning Goals
The main goal of the course, is to learn fundamental microprocessor performance issues and trade-offs, and practice the design and implementation of a RISC microprocessor.

Given the universality of computing today, it is important for all students to have a conceptual understanding of the internal workings of computer systems. The material is of course essential for those who will be involved in designing computer hardware or developing system software. In addition, application developers require basic knowledge of computer architecture in order to program these complex systems effectively.

Specifically, students will learn the advanced microprocessor design principles and evaluation methodologies of pipelining, fundamental computer design, instruction level parallelism, cache/memory hierarchy, I/O storage systems and clusters.

In addition, students will design and implement a RISC-like microprocessor as the final project in this class. The implementation will be done on FPGAs (Field Programmable Gate Arrays) where the design can be tested and validated.

Course web
http://arch.eece.maine.edu/ece473
The website is the primary source of information for the course, and students are expected to check it regularly.

Prerequisites
ECE 271 Microcomputer Architecture and Applications and ECE 275 Sequential Logic Systems.

Textbook
The Required text is Computer Organization and Design: The Hardware Software Interface: ARM Edition, by David A. Patterson, John L. Hennessy; Publisher: Morgan Kaufmann; 1 edition (May 6, 2016), ASIN: B01HI1DCRR

The optional reference books include:
Tentative Topics
Tentatively, we will cover the following topics.
1. Basic MIPS Processor datapath
2. Pipelining
3. Fundamental of computer design
4. Instruction set principles and examples
5. Instruction-level parallelism and its dynamic exploitation
6. Memory hierarchy design
7. Storage systems and clusters (if time permitted.)

Performance Indicators

• (a) Encoding and decoding binary instructions. Using the Amdal’s law to identify the performance bottleneck. Apply the principles of making the common case fast and favoring simplicity over regularity into processor design and implementation.

• (c) Design and implement a five-stage pipeline processor using VHDL/Verilog, CAD tools, and FPGA boards. The processors are required to pass binary programs, such as binary search.

• (d) Perform team-based course lab and project assignments. The teams often involve both students in computer engineering and electrical engineering.

• (e) Design the control unit of a state machine, including design the truth table, optimize the circuit using CAD tools, implement the design by using gate-level circuit, and test the design with various inputs.

• (g) Write project report and make oral course project presentation

• (j) Understanding the concept of green computing and the impacts of energy constraints on processor design.

• (k) Students use extensively VHDL/Verilog, CAD tools (Quartus II and espresso), and FPGA boards to complete the projects.

Homework and Lab Assignments
There will be around six homework assignments, six lab assignments, and one project assignment. In the project, you will be required to implement a 5-stage pipelined processor (group project, two members). The Lab uses state-of-the-art Altera FPGA boards, its corresponding CAD tool Quartus II, and Boolean minimization CAD tool espresso. The lab exposes students to hardware programming languages VHDL/Verilog.

For the team project, you must evaluate the members of your group (including yourself) based on the level of engagement of the group members in the project work. Place a number between one and five next to each student in your group:
• Score 5 (Best Rating): The group member was very engaged, participated in the implementa-
tion of the project, tried to understand the project, helped with the write-up, and contributed to the best of their ability.

• Score 1 (Worst Rating): The group member rarely showed up for the project work. The group would have functioned just as effectively without the group member.

The ratings you provide will be kept confidential. They will be considered (along with our own observations) in helping to determine how the instructor evaluation’s portion of the grade will be assigned.

Examinations.

There will be one in-class midterm exam and one final exam. Following is the tentative schedule for the exams.

Midterm exam : Thursday, October 13 (Tentative) (close book, close notes)
Final exam : Tuesday, December 13, 2:45-4:45pm, BW 131 (close book, close notes)

Grading Policy

Grading will be based on homework assignments, exams and project. The contribution of homeworks and exams towards your final grades is as follows.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Instructor Evaluation</td>
<td>5%</td>
</tr>
<tr>
<td>Homework</td>
<td>10%</td>
</tr>
<tr>
<td>Lab</td>
<td>20%</td>
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<tr>
<td>Project</td>
<td>30%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>15%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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</tbody>
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• Both homework and project assignments are due at the beginning of the class on the given due date. Late work is penalized 20% per day. Once solutions are published, late work cannot be accepted for credit.

• The electronic parts of all homework, labs and project need to be handed in through the department handin website (http://www.eece.maine.edu/hw/). Email attachment can NOT be accepted.

• The “Instructor Evaluation” will be based on your participation level in the class, and your perceived contribution to your lab group. You are expected to attend lectures and lab briefings, deliver an appropriate amount of harassment to the instructor during the lecture. All students are expected to start homework assignments early. A sure way to get a poor evaluation is to put off asking questions about homework or lab until close to the due date.

• Labs and project will be evaluated based on the accuracy and completeness of a brief write-up, and the lab-group performance in presenting and demonstrating the lab to the
Instructor and TA. All members of the lab/project group should be familiar with the assigned material at the time of the demonstration. Your grade will be based upon how well your entire group is prepared. Group members who are not present for a lab/project demonstration appointment will receive a 30% deduction for that lab/project grade.

Class/laboratory Attendance Attendance is required.

Makeup Exams No makeup exams.

Academic Honesty Statement Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University.

Students with disabilities statement: If you have a disability for which you may be requesting an accommodation, please contact Disabilities Services, 121 East Annex, 581-2319, as early as possible in the term.

Course Schedule Disclaimer (Disruption Clause) In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Sexual Violence Policy

Sexual Discrimination Reporting

The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, your teacher is required to report this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For confidential resources on campus: Counseling Center: 207-581-1392 or Cutler Health Center: at 207-581-4000.

For confidential resources off campus: Rape Response Services: 1-800-310-0000 or Spruce Run: 1-800-863-9909.

Other resources: The resources listed below can offer support but may have to report the incident to others who can help:

For support services on campus: Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911. Or see the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/