1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Shawki Areibi, Ph.D., P.Eng.
Office: THRN 2335, ext. 53819
Email: sareibi@uoguelph.ca
Personal Web Page: http://www.uoguelph.ca/~sareibi
Course Web Page: http://islab.soe.uoguelph.ca/sareibi/TEACHING_dr/ENG6600_PDA_html_dr/eng6600-pda.html
Office hours: Thursdays: 2:00 - 3:00 PM

1.2 Lab Technician

Info Tech Manager: Joel Best
Office: RICH 3501, ext. 54234
Email: jbest@uoguelph.ca

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*6600 Course Webpage site. You are responsible for checking the site regularly.

2.2 Required Resources


2.3 Recommended Resources


2.4 Additional Resources

1. Lecture Information: All the lecture notes are posted on the web page (week #1-#12).

2. Project Information: The handouts for the projects are within the project section. All types of resources regarding tutorials, links to web pages can be found in this section.

3. Assignments: Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.

4. Exams: Some finals of previous years are posted as samples of exams. The solutions are also posted for your convenience.

5. Miscellaneous Information: Other information related to Electronic Design Automation is also posted on the web page.

2.5 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. It is your responsibility to check the course website regularly. As per university regulations, all students are required to check their “uoguelph.ca” e-mail account regularly: e-mail is the official route of communication between the University and its students.

3 ASSESSMENT

3.1 Dates and Distribution

1. Paper Review: 5%
   Week 11, in the Lecture

2. Assignments: 15%
   See Section 5.3 for due dates

3. Project: 30%
   See Section 5.5 for due dates

4. Final Exam: 50%
   Week 13, (Time TBA), (Room TBA)
3.2 Course Grading Policies

**Missed Assessments:** When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration: https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2082.shtml

**Accommodation of Religious Obligations:** If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations: https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2116.shtml

**Drop Date:** The last date to drop one-semester courses, without academic penalty, is 40th day of classes. Two-semester courses must be dropped by the last day of the add period in the second semester. Refer to the Graduate Calendar for the schedule of dates: https://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-f10.shtml

**Passing Grade:** In order to pass the course, you must pass the final exam. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the project write-up portion of the course to count towards the final grade. Students must obtain a grade of 65% or higher overall to pass the course.

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4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

*This course serves as a graduate introduction into VLSI Electronic Design Automation. This course focuses on the layout problem that plays an important role in the design process of current architectures. The primary focus is on the algorithms for designing tools. The measure of the quality of a given solution to the circuit layout problem is the efficiency with which the circuit can be laid according to the formal rules dictated by the VLSI technology. Topics include: Front End Tools (Synthesis), Back End Tools (Partitioning, Floorplanning, Placement, Routing, Timing).*

**Prerequisite(s) (Required Skills):**

1. Basic knowledge of optimization (e.g., Linear Programming).
2. Basic knowledge of data structures and algorithm complexity analysis.
3. Basic knowledge of programming languages (i.e C, C++) is essential.
4. Basic knowledge in Digital Design and VLSI design fabrication.

4.2 Course Aims

Integrated Circuit technology has evolved in the 1960’s from the integration of a few transistors (Small Scale Integration) to the integration of millions of transistors (Very Large Scale Integration) chips currently in use. Physical design is the process of determining the physical location of active devices and interconnecting them inside the boundary of a VLSI chip. This course deals mainly with algorithms and optimization techniques for ASIC and FPGA systems. In this course, we investigate the state-of-the-art in VLSI Physical Design Automation and the main factors driving it. Initially, we review the basic concepts of the VLSI Design process.
Both the front end tool and back end tool required to map components on the IC will be discussed. Specific algorithms for partitioning, placement, floorplanning, routing of chips will be examined with emphasis on limitations and future research opportunities.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Understand the relationships between design automation algorithms and various constraints posed by VLSI fabrication and design technology.
2. Learn critical performance related parameters and their importance in design automation tools.
3. Understand the different underlying problems within circuit layout such as partitioning, floorplanning, placement and routing.
4. Develop state-of-the-art tools and algorithms for VLSI physical level design.
5. Tackle large complex designs and understand related performance issues in the design of VLSI systems.

4.4 Instructor’s Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Course Web Page but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

4.5 Students’ Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

4.6 Relationships with other Courses

ENGG*6600 will teach you plenty about electronic design automation, its specification, design and implementation. More importantly however, is that it teaches you how various algorithms operate and interact. The emphasis is on essential and fundamental techniques, ranging from hyper-graph partition and circuit placement to timing closure. Here are courses related to ENGG*6600:

**ENGG*6520, VLSI Digital Systems Design:**
This course will introduce the principles of VLSI MOSFET digital design from a circuit and system perspective. Advanced topics include: power issues related to each level of design abstraction; voltage and frequency scaling; power to speed trade-offs; ASIC digital design flow; Verilog integration, ASIC case studies.

**ENGG*6510, Analog Integrated Circuit Design:**
In this course, operating principles and design techniques of analog integrated circuits are introduced with emphasis on device and system modeling. These circuits include analog and switched-capacitor filters, data converters, amplifiers, oscillators, modulators, circuits for communications, sensor readout channels, and circuits for integrated memories.
5 Teaching and Learning Activities

5.1 Timetable

Lectures:
- Wednesday 11:30 AM - 1:00 PM RICH 2531 S. Areibi
- Friday 11:30 AM - 1:00 PM RICH 2531 S. Areibi

5.2 Lecture Schedule

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Lecture Topics</th>
<th>References</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>VLSI Design Flow/Styles, Tech Road-map</td>
<td>Chapter 1</td>
<td>1</td>
</tr>
<tr>
<td>3-4</td>
<td>Graph Theory and Optimization Techniques</td>
<td>Lecture Notes</td>
<td>1,2,3</td>
</tr>
<tr>
<td>5-6</td>
<td>Two Level and Multi Level Logic Synthesis</td>
<td>Lecture Notes</td>
<td>5</td>
</tr>
<tr>
<td>7-8</td>
<td>High Level Synthesis</td>
<td>Lecture Notes</td>
<td>5</td>
</tr>
<tr>
<td>9-10</td>
<td>Circuit Partitioning</td>
<td>Chapter 2</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td>11-12</td>
<td>Floorplanning</td>
<td>Chapter 3</td>
<td>2,3,5</td>
</tr>
<tr>
<td>13-14</td>
<td>Global Placement (Analytic Placement)</td>
<td>Chapter 4</td>
<td>3,4,5</td>
</tr>
<tr>
<td>15-16</td>
<td>Detailed Placement</td>
<td>Chapter 4</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td>17-18</td>
<td>Global Routing</td>
<td>Chapter 5</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td>19-20</td>
<td>Detail Routing</td>
<td>Chapter 6</td>
<td>4,5</td>
</tr>
<tr>
<td>21-22</td>
<td>Specialized Routing (Clock and Power)</td>
<td>Chapter 7</td>
<td>4,5</td>
</tr>
<tr>
<td>23-24</td>
<td>Timing Closure</td>
<td>Chapter 8</td>
<td>4,5</td>
</tr>
</tbody>
</table>

5.3 Assignments

There will be 4 assignments throughout the term. Solve all problems and hand it in during the lecture.

<table>
<thead>
<tr>
<th>Item</th>
<th>Handed In</th>
<th>Due Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assign #1</td>
<td>(Week #1)</td>
<td>Week #4</td>
<td>Logic Synthesis</td>
</tr>
<tr>
<td>Assign #2</td>
<td>(Week #4)</td>
<td>Week #6</td>
<td>Circuit Partitioning</td>
</tr>
<tr>
<td>Assign #3</td>
<td>(Week #6)</td>
<td>Week #8</td>
<td>Circuit Placement</td>
</tr>
<tr>
<td>Assign #4</td>
<td>(Week #8)</td>
<td>Week #10</td>
<td>Global/Detailed Routing</td>
</tr>
</tbody>
</table>

5.4 Paper Review

Besides the assignments, each student is assigned a conference or journal article to read. The student must prepare a brief (about 30-45 minutes) oral description of the article, its objectives, methods, results and contributions to present to the class. A two page summary (detailed) giving the citation and the material in the oral presentation must be written and a copy is distributed to each class member. The articles are selected so that they pertain to current or very recent classroom material. Several topics and related literature are found on the course web-page. Here are some general points to consider when reading about a particular study:

- What is the general purpose of the article, whom it is intended for, and why is the topic important.
- What are the main results.
- Indicate the technique used and the experimental methodology followed. Was the analysis sufficient?
• What do you think is the main contribution of the article? How is work unique? Who might benefit from the results? Practitioners, researchers, managers, etc?

• What are the weaknesses and strengths of the work? How might it have been improved? What are your recommendations for future work in this area.

The following are some conferences and journals that you can get articles from:

• ACM/IEEE Conference on VLSI Physical Design Automation (ISPD).

• ACM Transactions on CAD.

• IEEE Transaction on Computer Aided Design.

• International Conference on Computer Aided Design.

• Design Automation Conference.

5.5 Research Project

Each of you will select a topic related to VLSI Physical Design Automation. You should conduct an in-depth study covering the problem to be solved and its origins, developments, and current status. This will involve extensive research; your findings should be documented in a report with the basic references cited. Background reading should include several articles. In writing your report you should think about what you have read, and provide your personal opinions about the presentation and usefulness of the work. Sample projects could be found on the course web-page. Below are the deadlines set for the project:

<table>
<thead>
<tr>
<th>Item</th>
<th>Due Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideas for Project</td>
<td>Week #4</td>
<td>One Page listing of possible projects</td>
</tr>
<tr>
<td>Initial Proposal</td>
<td>Week #5</td>
<td>Two pages defining the topic</td>
</tr>
<tr>
<td>Interim Report #1</td>
<td>Week #7</td>
<td>Progress Report, more details</td>
</tr>
<tr>
<td>Interim Report #2</td>
<td>Week #9</td>
<td>Preliminary Results</td>
</tr>
<tr>
<td>Presentation</td>
<td>Week #12</td>
<td>PPT Presentation (20 Minutes)</td>
</tr>
<tr>
<td>Final Report</td>
<td>Week #13</td>
<td>Complete report with results and code</td>
</tr>
</tbody>
</table>

5.6 Other Important Dates

1. **First Class**: Wednesday September 9th 2015,

2. **Thanks Giving Holiday**: Monday, 12th October 2015,

3. **Drop Date**: Friday, November 6th, 2015.

4. **Last Class**: Friday, December 4th, 2015.

6 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.
7 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community - faculty, staff, and students - to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offenses from occurring. University of Guelph students have the responsibility of abiding by the University’s policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

The Academic Misconduct Policy is detailed in the Graduate Calendar:
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2386.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in the Program Guide:
http://www.uoguelph.ca/engineering/Engineering_Program_Guides.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

8 Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community’s shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible

9 Recording of Materials

Presentations which are made in relation to course work-including lectures-cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

10 Resources

The Graduate Calendar is the source of information about the University of Guelph’s procedures, policies and regulations which apply to graduate programs: http://www.uoguelph.ca/registrar/calendars/graduate/current