

**UVic**

Department of Electrical and Computer Engineering



ELEC 486/586
Multiresolution Signal and Geometry Processing with Software Applications (in C++)
Course Outline (Summer 2014)

Instructor:

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Course Web Site:

Home Page: <http://www.ece.uvic.ca/~mdadams/courses/wavelets>
Username: wavelets
Password: as announced during lectures

Office Hours:

As announced during the lectures and posted on the course web site.

Lectures:

Sections: ELEC 486 A01 (CRN 30320), ELEC 486 A02 (CRN 30321), ELEC 586 A01 (CRN 30332)
Time/Location: Tuesdays, Wednesdays, and Fridays 10:30–11:20 in ECS 130

Tutorials:

Sections: ELEC 486 T01 (CRN 30322) and ELEC 586 T01
Time/Location: Wednesdays 13:30–15:00 in ELW B215
Tutorial attendance is mandatory.

Description:

This course provides an introduction to multiresolution signal and geometry processing, including filter banks, wavelets, and subdivision. Some applications of multiresolution processing are also explored in detail. Students are given the opportunity to implement various methods in software using the C++ programming language. Since no prior knowledge of C++ is assumed, the C++ programming language is introduced in detail, along with several libraries, including the Open Graphics Library (OpenGL), OpenGL Utility Toolkit (GLUT), and Computational Geometry Algorithms Library (CGAL).

Topics:

1. Fundamentals of multirate signal processing
2. Multirate filter banks and transmultiplexers
3. Classical wavelet systems
4. Geometry processing preliminaries
5. Subdivision surfaces
6. Subdivision wavelet systems
7. Applications in signal processing (e.g., signal compression, noise reduction, communication systems)
8. Applications in geometry processing (e.g., computer graphics, rendering, mesh compression)
9. C++ programming language (e.g., classes, templates, generic programming) and standard library
10. Open Graphics Library (OpenGL) and OpenGL Utility Toolkit (GLUT)
11. Computational Geometry Algorithms Library (CGAL)

Learning Outcomes:

Upon completion of the course, students should be able to:

- demonstrate a core competency in C++ by writing programs in this language that: 1) make use of language features including classes and templates; and 2) utilize libraries such as the standard C++ library, OpenGL, GLUT, and CGAL
- use a source-level debugger (such as the GNU Debugger or Data Display Debugger) in order to find bugs in code
- use the Make utility to build (i.e., compile and link) a program
- explain the importance of software and programming in the context of engineering
- identify several applications of multiresolution signal and geometry processing
- demonstrate an understanding of the basic mathematics underlying multiresolution signal and geometry processing through its use in problem solving
- characterize the behavior of downsampling and upsampling in the time domain, frequency domain, and z domain; and explain the phenomena of aliasing and imaging
- implement (in software) various types of multirate systems (such as decimators, interpolators, sampling-rate converters, filter banks, and transmultiplexers) in a computationally-efficient manner using polyphase techniques
- analyze filter banks and transmultiplexers in order to determine some of their properties (e.g., alias/crosstalk free, PR)
- state the definition of a polygon mesh and describe several data structures for representing polygon meshes, explaining the advantages and disadvantages of each
- implement (in software) several subdivision schemes for polygon meshes

Required Texts/Materials:

The following references are required for the course:

1. Textbook (Espresso book machine, print on demand; available from University Bookstore):
M. D. Adams, *Multiresolution Signal and Geometry Processing*, University of Victoria, Victoria, BC, Canada, 2013, ISBN 978-1-55058-507-0 (paperback).
2. Textbook Lecture Slides (Espresso book machine, print on demand; available from University Bookstore):
M. D. Adams, *Lecture Slides for Multiresolution Signal and Geometry Processing*, University of Victoria, Victoria, BC, Canada, 2013, ISBN 978-1-55058-521-6 (paperback).
3. C++ Lecture Slides (coursepack; available from University Bookstore):
M. D. Adams, *The C++ Programming Language*, University Bookstore, 2014.

Optional Texts/Materials:

Since the required textbook does not contain any material on the C++ programming language (and the lecture slides on C++ are not intended to be a complete reference on the language), the following book is very highly recommended as a reference on C++:

B. Stroustrup, *The C++ Programming Language, Fourth Edition*, Addison-Wesley, Upper Saddle River, NJ, USA, 2013, ISBN 978-0-321-56384-2 (paperback). On Amazon: <http://www.amazon.ca/dp/0321563840>.

(The fourth edition of this book is the most recent edition at the time of this writing.) It is important to note that older editions of this book do not have coverage of C++11 features. So, if you do obtain a copy of this book, be sure to obtain the fourth edition. This book is available from the University Bookstore as well as many online book retailers (e.g., Amazon).

Assessment:

ELEC 486	ELEC 586
20% Regular Assignments [†]	20% Regular Assignments [†]
30% Programming Assignments [†]	30% Programming Assignments [†]
50% Final Exam [‡]	20% Final Exam [‡]
	30% Project [§]

ELEC 486 and ELEC 586: Course-Materials Bug-Bounty Program Bonus*: 2% (of course mark)

***Note:** See the handout titled “Course-Materials Bug-Bounty Program” for more details.

[†]**Note:** The submission deadlines for (regular and programming) assignments will be posted on the course web site. The assignments are to be done independently by each student. With respect to the programming

assignments, the instructor reserves the right to, at any time, question a student regarding any aspect of their software in order to ensure that the software is the student's own work. Furthermore, the instructor reserves the right to use plagiarism-detection software in the review and grading of student work.

‡**Note:** All exams are closed book. Calculators are not permitted in exams.

§**Note:** See the handout titled "Project" for more details.

Importance of Email:

Important course announcements are often sent to students via email. Therefore, students are responsible for checking their email regularly.

Other Important Documents Available from Course Web Site:

1. Course-Materials Bug-Bounty Program Handout (See section titled "Course-Materials Bug-Bounty Program")
2. Course-Materials Errata Handout (See section titled "Course-Materials Bug-Bounty Program")
3. Project Handout (See section titled "Project")

Percentage to Letter-Grade Conversion:

The final grade obtained in the course will be based on the following percentage to letter-grade conversion:

Percentage Grade x	Letter Grade	Percentage Grade x	Letter Grade
$90 \leq x \leq 100$	A+	$65 \leq x < 70$	C+
$85 \leq x < 90$	A	$60 \leq x < 65$	C
$80 \leq x < 85$	A-	$50 \leq x < 60$	D
$77 \leq x < 80$	B+	$35 \leq x < 50$	E [†]
$73 \leq x < 77$	B	$0 \leq x < 35$	F [‡]
$70 \leq x < 73$	B-		

[†]Fail, conditional supplemental exam (for undergraduate courses only).

[‡]Fail, no supplemental exam.

Supplemental Exams:

For regulations regarding supplemental exams, see:

<http://web.uvic.ca/calendar2014/FACS/UnIn/UARe/USEx.html>.

Handling Concerns About Course:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the ECE Chair by email or the ECE Chair's secretary to set up an appointment.

Accommodation of Religious Observance:

See <http://web.uvic.ca/calendar2014/GI/GUPo.html>.

Policy on Inclusivity and Diversity:

See <http://web.uvic.ca/calendar2014/GI/GUPo.html>.

Standards of Professional Behaviour:

You are advised to read the Faculty of Engineering document "Standards for Professional Behaviour" at <http://www.uvic.ca/engineering/assets/docs/professional-behaviour.pdf> which contains important information regarding conduct in courses, in labs and in the general use of facilities.

Cheating, plagiarism, and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult <http://web.uvic.ca/calendar2014/FACS/UnIn/UARe/PoAcI.html> for the UVic policy on academic integrity.

Plagiarism Detection Tools:

Plagiarism detection software may be used to aid the instructor and/or teaching assistants in the review and grading of some or all student work.