Faculty of Engineering

COURSE OUTLINE

ELEC 486/586 — Multiresolution Signal and Geometry Processing with C++
Summer 2017

Instructor:

Dr. Michael Adams
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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 30359), ELEC 586 A01 (CRN 30379), ELEC 586 A02 (CRN 30380)
Time/Location: Tuesdays, Wednesdays, and Fridays 11:30–12:20 in ECS 108

Tutorials:

Tutorial attendance is mandatory.

Section(s): ELEC 486 T01 (CRN 30360) and ELEC 586 T01 (CRN 30381)
Time/Location: Fridays 09:00–10:20 in ELW B326

Section(s): ELEC 486 T02 (CRN 31613) and ELEC 586 T02 (CRN 31614)
Time/Location: Fridays 14:00–15:20 in ELW B326

Description and Objectives:

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).

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 C++ standard library, OpenGL, GLUT, and CGAL
- use various software-development tools such as build tools (e.g., CMake) and version control systems (e.g., Git)
- 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

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. Software-development tools (e.g., compiler, linker, build tools, version control systems)
10. C++ programming language (e.g., classes, templates, generic programming) and standard library
11. Open Graphics Library (OpenGL) and OpenGL Utility Toolkit (GLUT)
12. Computational Geometry Algorithms Library (CGAL)

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 (Version 2013-09-26)*, 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 (Version 2015-02-03)*, University of Victoria, Victoria, BC, Canada, 2015, ISBN 978-1-55058-535-3 (paperback).
3. C++ Lecture Slides (Espresso book machine, print on demand; available from University Bookstore):

    M. D. Adams, *Lecture Slides for Programming in C++ (Version: 2017-02-24)*, University of Victoria, Victoria, BC, Canada, 2017, ISBN 978-1-55058-608-4 (paperback).

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).

Video Lectures:
Some of the course content is delivered in the form of video lectures. Information about this video-lecture content can be found on the course web site.

Other Important Documents Available from the 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. Video Lectures Handout and Video-Lecture Feedback Questionnaire (See section titled "Video Lectures")

4. Regular Assignment Handouts (See section titled "Regular Assignments")
5. Programming Assignment Handouts (See section titled "Programming Assignments")
6. Project Handout (See section titled "Project")

Importance of Email:

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

Lecture and Tutorial Attendance:

Students are required to attend all lectures and tutorials in the course. If a student is unable to attend a lecture/tutorial due to illness or some other reason, the student is solely responsible for any information missed (including any course-related announcements). Any student who does not attend lectures/tutorials regularly places themself at a **very serious disadvantage** in the course.

Assessment:

ELEC 486		ELEC 586	
10%	Regular Assignments†	10%	Regular Assignments†
35%	Programming Assignments†	35%	Programming Assignments†
5%	Participation¶	5%	Participation¶
50%	Final Exam‡	50%	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.

¶**Note:** Participation marks are awarded for the completion of video-lecture feedback questionnaires.

Percentage to Letter-Grade Conversion:

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate/Graduate Calendar. See http://web.uvic.ca/calendar2017-05/undergrad/info/regulations/grading.html and http://web.uvic.ca/calendar2017-05/grad/academic-regulations/grading.html.

Supplemental Exams:

There will be no supplemental examination for this course.

Note to Students (Regarding 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 Chair of the Department by email or the Chair's Secretary to set up an appointment.

Accommodation of Religious Observance:

See http://web.uvic.ca/calendar2017-05/general/policies.html.

Policy on Inclusivity and Diversity:

See http://web.uvic.ca/calendar2017-05/general/policies.html.

Standards of Professional Behaviour:

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

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult entry in current Undergraduate/Graduate Calendar

for the UVic policy on academic integrity. See http://web.uvic.ca/calendar2017-05/undergrad/info/regulations/academic-integrity.html and http://web.uvic.ca/calendar2017-05/grad/academic-regulations/academic-integrity.html.

Equality:

This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Resource Centre for Students with a Disability located in the Campus Services Building. The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.

Course Lecture Notes:

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are not to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

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.