Instructor
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Calendar Description

Topics in the engineering area of multimedia systems with particular emphasis on the theory, design features, performance, complexity analysis, optimization and application of multimedia engineering technologies. Topics include sound/audio, image and video characterization, compression, source entropy and hybrid coding, transform coding, wavelet-based coding, motion estimation, JPEG coding, digital video coding, MPEG-1/2 coding, content-based processing, and MPEG-7, New Video Coding Standard H264 and H265.

Learning Objectives

Multimedia systems are an integral part of our modern lives providing unprecedented opportunities to connect, convey and distribute information. Our ubiquitous dependence on such systems have made multimedia technologies, networks, assets and services essential to our society’s health, safety, security and economic well-being. The objective of this course is to provide an introduction to signal compression technologies which is the power engine that enables multimedia systems. Topics include image, speech and video compression methodologies and principles.

Lectures

Monday, 5:00-6:00 pm (Toronto time)
Wednesday, 5:00-6:00 pm (Toronto time)
Thursday, 5:00-6:00 pm (Toronto time)
First class: Monday, January 11, 2021

Office Hours: Wednesdays, 6:10 pm to 7:30 pm (Toronto time)

All lectures and office hours will be delivered online, synchronously with Quercus BBCollaborate.
**Discussion Board:** We will use Piazza for the class discussion board. Please post your course related questions to Piazza. Others may have the same question and will benefit from the response if it is available to everyone. Information on how to use Piazza will be provided soon.

**Labs**

Labs commence on **Friday, January 22, 2021.** (Fridays 4:00-6:00 pm, online).

**Midterms**

Two midterm exams will be given, 5:00-6:00 pm during class time with tentative dates, Thursdays Feb. 11 and March 11, 2021.

**Marking Scheme**

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<tr>
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<tbody>
<tr>
<td>Final Exam</td>
<td>40%</td>
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<tr>
<td>Midterms (2)</td>
<td>40%</td>
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<td></td>
<td>(20% each)</td>
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<tr>
<td>Lab(s)</td>
<td>20%</td>
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<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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**Course Outline**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Chapter(s)</th>
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<tbody>
<tr>
<td>Introduction to Multimedia (Optional)</td>
<td>1</td>
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<tr>
<td>Graphics/Image Data Types</td>
<td>3.1</td>
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<tr>
<td>Colour in Image and Video</td>
<td>4</td>
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<tr>
<td>Distortion Measures</td>
<td>8.2</td>
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<td>Quantization</td>
<td>8.4</td>
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<td>Transform Coding (Lossy) - DCT, KLT</td>
<td>8.5</td>
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<td>Information Theory/Lossless Coding</td>
<td>7.1-7.4, 7.6</td>
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<td>Predictive Coding (Lossless)</td>
<td>6.3</td>
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<td>JPEG Standard</td>
<td>9.1</td>
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<td>Wavelet Transform</td>
<td>8.6</td>
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<td>Wavelet Based Coding (EZW)</td>
<td>8.8-8.9</td>
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<td>JPEG2000 Standard</td>
<td>9.2</td>
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<td>Video Compression/Motion Estimation</td>
<td>10.1-10.4</td>
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<td>MPEG-1/2 Standards</td>
<td>11.1-11.3</td>
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<tr>
<td>MPEG-4/H.264 Standards</td>
<td>12.1-12.2, 12.5</td>
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Vocoders (Speech Compression) 13.3
MPEG Audio Compression 14.1-14.2

Special Topics (Time Permitting):
- H264, H265 Video standards
- Digital Camera Image Processing
- MPEG-7 (Content Description)

References

Textbook (Required)
Fundamentals of Multimedia, Second edition
ZeNian Li, Mark S. Drew, Jiangchuan Liu

Additional References (Optional)

Introduction to Data Compression (3rd Edition)
K. Sayood

Multimedia Signals and Systems
Mrinal Kr. Mandal

Color Image Processing and Applications
K.N. Plataniotis, A.N. Venetsanopoulos
Springer Verlag, ISBN 3-540-66953-1, August 2000

Digital Video Processing
A. Murat Tekalp
Prentice-Hall, 1995

IEEE Signal Processing Magazine: Transform Coding (Special Issue)
IEEE, September 2001

IEEE Signal Processing Magazine: Immersed in Multimedia (Special Issue)
IEEE, January 1999

Design and Implementation of Next Generation Video Coding Systems (H.265/HEVC) Tutorial
Vivienne Sze (sze@mit.edu) Madhukar Budagavi (m.budagavi@samsung.com) ISCAS Tutorial 2014
Lab details

All the labs will be conducted online through BBCollaborate. Lab submissions will be created on Quercus. MATLAB programming is required.

Submissions:

Lab 0 – Pre-lab will need to be submitted before the start of Lab 1 i.e., the first lab for this course. • On Quercus, we will create the submission for all the labs/quizzes that can be done any time before the Lab 0 end time.

Lab work is to be done individually. Discussion of problems with your classmates is acceptable, but you must write all your code yourself. Plagiarism will not be tolerated and dealt with as per departmental and university policy. All lab submissions must be submitted in a single Zip file. The Zip file must contain:

• Working code without errors for the lab task
• Screenshots demonstrating all the results (Without these you will not receive any credit for the lab)
• Explanation of the results in a short note. (Without these you will not receive any credit for the lab)
• All times posted on Quercus refer to Toronto Local time. • Quercus allows for unlimited submissions until the deadline. If you have to update anything, please do so before the deadline.

Sessions

• Lab sessions will be hosted on BBCollaborate.
• TA will be available during the lab time to answer any questions you have
• There will be 4 quizzes in total during lab time. Lab quizzes will emphasize a fundamental understanding of the lab material (not programming). There is one quiz for each lab, held during the last 30 minutes of week 2 for each lab. Each quiz will count 20/100 of the corresponding lab mark.

Lab Topics

Lab 0: Prelab preparation

Lab 1: Colour Image Processing

Lab 2: DCT Transform and Coding
Lab 3: Wavelet Transform and Coding
Lab 4: Motion Estimation and Video Coding

Schedule: Fridays, 4:00 to 6:00 pm

<table>
<thead>
<tr>
<th>Lab</th>
<th>Week 1</th>
<th>Week 2</th>
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<tbody>
<tr>
<td>Lab 0</td>
<td>Jan. 22</td>
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<tr>
<td>Lab 1</td>
<td>Jan. 29</td>
<td>Feb. 5</td>
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<td>Week 2</td>
<td>Feb. 12</td>
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<td>Lab 2</td>
<td>Feb. 12</td>
<td>Feb. 26</td>
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<td></td>
<td>Week 1</td>
<td>March 5</td>
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<td>Week 2</td>
<td>March 12</td>
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<tr>
<td>Lab 3</td>
<td>March 19</td>
<td>March 26</td>
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<tr>
<td>Lab 4</td>
<td>March 5</td>
<td>March 12</td>
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Other Course Policies

- All tests and examinations for this course are open-book. Everyone taking the course is expected to attend all lab sessions. The lab period will be devoted to discussing concepts and implementation issues. Students are expected to attend lab sessions prepared, and to answer related questions.

- Usage of the course webpage will be limited to people taking the course. This means that in order for students to download relevant labs and course material from the course website, they MUST register.
• Remarking Policy: remarking requests may be made up to **one week** after an item is returned. Only under special circumstances will remarking be considered after this time limit.

**Notice of video recording and sharing (Download permissible re-use prohibited)**

At times during this course, some interactions including your participation, may be recorded on video and will be available to students in the course for viewing remotely and after each session. Course videos and materials belong to the instructors, the University, and/or other source depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

**Academic Integrity policies**


**Land Acknowledgement**

I (we) wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

**Statements**

- **Syllabus Statements on Inclusivity, Accommodations & Mental Health Support**
- **Inclusivity Statement:**
- All students and faculty at the University of Toronto have a right to learn, work and create in a welcoming, respectful, inclusive and safe environment. In this class we are all responsible for our language, action and interactions. Discriminatory comments or actions of any kind will not be permitted. This includes but is not limited to acts of racism, sexism, Islamophobia, anti-Semitism, homophobia, transphobia, and ableism. As a class we will work together to create an inclusive learning environment and support each other’s learning.
If you experience or witness any form of discrimination, please reach out to the Engineering Equity Diversity & Inclusion Action Group online, an academic advisor, a U of T Equity Office, or any U of T Engineering faculty or staff member that you feel comfortable approaching.

Accommodations:

If you have a learning need requiring an accommodation the University of Toronto recommends that students immediately register at Accessibility Services at www.studentlife.utoronto.ca/as.

- Location: 4th floor of 455 Spadina Avenue, Suite 400
- Voice: 416-978-8060
- Fax: 416-978-5729
- Email: accessibility.services@utoronto.ca

The University of Toronto supports accommodations of students with special learning needs, which may be associated with learning disabilities, mobility impairments, functional/fine motor disabilities, acquired brain injuries, blindness and low vision, chronic health conditions, addictions, deafness and hearing loss, psychiatric disabilities, communication disorders and/or temporary disabilities, such as fractures and severe sprains, recovery from an operation, serious infections or pregnancy complications.

Mental Health:

As a university student, you may experience a range of health and/or mental health issues that may result in significant barriers to achieving your personal and academic goals. The University of Toronto offers a wide range of free and confidential services and programs that may be able to assist you. We encourage you to seek out these resources early and often.

- Health & Wellness Resources: undergrad.engineering.utoronto.ca/advising-and-wellness/health-wellness/
- U of T Health & Wellness Website: studentlife.utoronto.ca/hwc
- If, at some point during the year, you find yourself feeling distressed and in need of more immediate support, visit the Feeling Distressed Webpage: www.studentlife.utoronto.ca/feeling-distressed, for more campus resources.
- Off campus, immediate help is available 24/7 through Good2Talk, a post-secondary student helpline at 1-866-925-5454.
- All students in the Faculty of Engineering have an Academic Advisor who can advise on academic and personal matters. You can find your department’s Academic Advisor here: uoft.me/engadvising