WATERLOO | ENGINEERING

ECE 224: Embedded Microprocessor Systems
Course Syllabus
Fall 2021

Course Description

This course examines the design and implementation of embedded microprocessor systems from both hardware and software design perspectives. Bus architectures and bus interfaces are examined in detail. Synchronization and timing considerations are presented. Error detection and error correction are briefly introduced.

ECE 224: Embedded Microprocessor Systems

LAB, LEC, TUT 0.50 Course ID: 013172

Microprocessor system architecture, bus systems, memory systems, peripherals, parallel interfaces, serial interfaces, analog interfaces, data transfer, synchronization, error detection/correction, testing and debugging.

Prerequisites: (ECE 124, ECE 222; Level at least 2B Computer Engineering or 2B Electrical Engineering) or (ECE 124, ECE 222; Level at least 3A Software Engineering).

Antirequisites: MTE 325

Territorial Acknowledgement

The University of Waterloo acknowledges that much of our work takes place on the traditional territory of the Neutral, Anishinaabeg, and Haudenosaunee peoples. The main campus of the University of Waterloo is situated on the Haldimand Tract, the land promised to the Six Nations that includes ten kilometers on each side of the Grand River. Our active work toward reconciliation takes place across our campuses through research, learning, teaching, and community building, and is centralized within our Indigenous Initiatives Office.

More information on the Haldimand Treaty of 1784 can be found online. To learn more about the purpose of territorial acknowledgements, please refer to the CAUT Guide to Acknowledging Traditional Territory (PDF).

CONTENTS

Course Schedule

In this course, lectures will be delivered asynchronously using a combination of short videos and narrated PowerPoint slides that will serve as micro lectures on a topic relevant to the course material. Tutorials will be conducted synchronously using a combination of in-person and remote delivery. The remotely delivered tutorial sessions will be recorded for the benefit of students who cannot attend their scheduled sessions. The traditional labs have been replaced with two activities. The first activity is a design project that consists of researching and analyzing analog-to-digital converters for a design problem. The second activity is a lab tools tutorial that consists of watching a video on embedded system design and answering quiz questions. Should conditions allow, students registered for blended lab sessions may have an opportunity to complete an in-person lab exercise in lieu of completing the lab tools tutorial. Office hours will be held once per week to provide a second point of contact with students.

Lecture Schedule

Lecture videos will be added to LEARN as they become available. All lecture videos will be provided on LEARN by the end of the last day of classes on Tuesday, December 7th.

Scheduling Notes

The University of Waterloo Calendar of Events and Academic Deadlines, the schedule of classes, and the Department of Electrical and Computer Engineering provides the following scheduling notes:

1. Classes start on Wednesday, September 8th.
2. Monday, October 11th is the Thanksgiving Day holiday.
3. Reading Week starts Saturday, October 9th and runs until Sunday, October 17th.
4. Classes end on Tuesday, December 7th.
5. Wednesday, December 8th is a pre-examination study day.
6. Final examinations begin on Thursday, December 9th.
7. Final examinations end on Thursday, December 23rd.
8. Unofficial grades begin to appear in Quest on Friday, December 24th.
9. Standings and official grades are available in Quest on Thursday, January 20th.

Contact Information

Piazza is the most effective way to ask questions about the course. If you have a question about the course, other students will likely have the same question. By posting your question on Piazza, the question and its answer will be accessible to all students. If you do not yet have access to Piazza, you may signup using the following link:

http://piazza.com/uwaterloo.ca/fall2021/ece224

The access code for the course is 1219. Please do not share this access code with anyone.

If you need to contact the course instructor directly for more personal matters, please send an email to your course instructor's address with a subject line of "ECE 224 Course Question".

Course Instructor

Students may book an online appointment to speak with the course instructor about any aspect of the course. All questions regarding course topics, course materials, deadlines, and grading should be directed to the course instructor. Regularly scheduled office hours for meeting with students will be announced on Piazza. An appointment is not needed during regularly scheduled office hours.

Instructor	Campus Phone	E-mail Address
William (Bill) Bishop	(519) 888-4567 ext. 43712	wdbishop@uwaterloo.ca

My campus phone has recently been converted to a Skype for Business phone. If you are unable to reach me by phone, please leave a message and I will try to respond as soon as I can. Alternatively, you may e-mail me or post your question to Piazza.

Lab Instructor

A lab instructor has not been assigned for this course offering. Students may contact the course instructor to inquire about the lab studies, to discuss concerns about the conduct of teaching assistants, or to discuss concerns about the conduct of fellow students.

Teaching Assistants

Students may book an online appointment with the teaching assistant to discuss questions on course content. Appointments may be booked by contacting the teaching assistant via e-mail.

Teaching Assistant	E-mail Address
Pragnya Chebolu	pchebolu@uwaterloo.ca
Rabiul Islam	r25islam@uwaterloo.ca
Reza Kohandani	rkohanda@uwaterloo.ca

Key Learning Outcomes

The table below lists the key learning outcomes for this course. On successful completion of this course, a student should be able to do the following:

	Key Learning Outcome
1	Identify system realities (such as noise, jitter, metastability, and transmission line effects) and select suitable approaches for managing these realities in an embedded computer system.
2	Compare and critically assess design tradeoffs in an embedded computer system.
3	Analyze the effects of synchronization mechanisms on the operational characteristics of an embedded computer system.
4	Design hardware and software components to reliably connect devices to an embedded computer system.

Attendance and Participation

Students are expected to complete all activities. If you are unable to attend a scheduled tutorial, a recording of the remotely delivered tutorial will be made available on LEARN for you.

If you anticipate missing a deliverable deadline or an exam for a non-medical reason, you should contact your course instructor as soon as you are aware of the issue. Given sufficient notice, alternate arrangements may be possible. Alternate arrangements are rare and subject to the discretion of the course instructor.

In Case of Illness

The university has recently updated its guidance on how illnesses should be reported during the Fall term. If the procedures for reporting illnesses change, notification will be provided on Piazza. Quest provides a mechanism for self-reporting illnesses. It is my understanding that submission of a verification of illness form is not required this term.

If you exhibit the symptoms of COVID-19, you should self-isolate and get tested for COVID-19 at a location approved for symptomatic testing. If you subsequently test positive for COVID-19, you must report the positive test to Health Services.

In the absence of further clarification from the Faculty of Engineering, it is recommended that students who require academic accommodation for any illness e-mail the instructor as soon as possible for guidance. Students will not be required to provide any details of the illness to their instructor.

Topic Sequence

Lecture and tutorial topics have been scheduled to maximize learning and to ensure adequate preparation for course deliverables. The course instructor may deviate from the schedule to spend more time where needed by students.

Lecture Topics

The table below provides an estimate of the lecture hours for each topic as well as an overview of the content of each topic. You will find more detailed descriptions of each topic at the start of each section of the lecture notes.

Lecture Topic	Estimated Hours	Description
Course Introduction	1	An introduction to the teaching team, course expectations, deliverables, marking scheme, and a very brief introduction to interfacing concepts.
Embedded Systems	1	A review of the fundamentals of embedded systems and the terminology associated with embedded systems.
Interfacing Software, Introduction to Synchronization, and Device Drivers	1	A review of embedded software design concepts and synchronization concepts.
Synchronization, Data Generation and Data Transfer	2	A model for analyzing synchronization behaviour and performance and examples of synchronization analysis.
Computer Structure	4	A review of processor structure, instruction execution, clock signals, control signals, and bus interfacing.
Parallel Interfacing	3	A detailed examination of the design of parallel interfaces. This includes an examination of the role of the interface in matching bus timing and signaling characteristics with a device's timing and signaling characteristics.
Error Detection and Correction	2	An introduction to error detection and error correction including a discussion of error types, differences in detection and correction, and one example of an error correcting code (the Hamming code).
Serial Interfacing	6	An introduction to serial communication interfacing. This includes a comparison of asynchronous communication techniques and synchronous techniques as well as the protocols for serial communication.
Analog Interfacing	6	An introduction to digital-to-analog interfacing, analog-to-digital interfacing, and sample-and-hold circuitry. This includes a discussion of static and dynamic errors.
Buses - Data Transfer	3	A comparison of the functional behaviour and timing behaviour of synchronous, asynchronous, partially interlocked asynchronous, semi-synchronous, and split cycle bus systems. This section of the notes deals exclusively with the transfer of data.
Buses - Arbitration	3	A detailed examination of alternatives for bus arbitration including a discussion of the operation and characteristics of daisy chained and non-daisy chained bus arbitration techniques.
Direct Memory Access (DMA)	2	A brief examination of direct memory access including a discussion of hardware design implications, software implications, and system performance.
Grounding, Shielding, and Transmission Lines	2	An introduction to some of the real-world considerations that affect signal integrity when designing high-speed digital systems.

Tutorial Topics

In this course, the weekly tutorial sessions will typically be conducted by the course instructor. The sessions are designed to offer additional insight into the course material. Each session will focus on a topic, assignment, or design project. Solutions to sample problems will be presented but no new course topics will be introduced. Students will have an opportunity to ask for help on course material. The table below provides a summary of the tutorial topics scheduled to be covered. This schedule is subject to change based on the perceived needs of the students.

Tutorial Dates	Tutorial Topic
Wednesday, September 8th to Tuesday, September 14th	Welcome to the Course / Review of Digital Logic
Wednesday, September 15th to Tuesday, September 21st	Synchronization Techniques
Wednesday, September 22nd to Tuesday, September 28th	Output Drivers and I/O Transfers
Wednesday, September 29th to Tuesday, October 5th	Computer Design Fundamentals
Wednesday, October 6th to Tuesday, October 19th	Parallel Interfacing
Wednesday, October 20th to Tuesday, October 26th	Error Detection and Correction
Wednesday, October 27th to Tuesday, November 2nd	Serial Interfacing
Wednesday, November 3rd to Tuesday, November 9th	Mini Design Project
Wednesday, November 10th to Tuesday, November 16th	Data Conversion
Wednesday, November 17th to Tuesday, November 23rd	Buses – Data Transfer
Wednesday, November 24th to Tuesday, November 30th	Buses – Arbitration
Wednesday, December 1st to Tuesday, December 7th	Buses – DMA

Course Resources

The most significant course resources available on LEARN are listed below:

- The LEARN calendar provides reminders of important dates for the course. Students are encouraged to refer to this calendar regularly.
- The Introduction module provides links to the Faculty of Engineering Course Responsibilities website, the course syllabus, and presentations on promoting student wellness.
- The Lectures module provides links to the micro lectures for the course. These videos will be added as the course progresses. Students may be required to complete viewing of one set of micro lectures to gain access to the next set of micro lectures in the series.
- The Labs module provides links to all materials required for completion of the lab tools tutorial.
- The Tutorials module provides links to the supporting materials for the tutorial sessions.
- The Assignments module provides links to problem sets for the purpose of assessing your knowledge of the course material. Solutions to these problem sets will also be made available.
- The Examinations module provides links to previous exams and their solutions. You may use these exams to assess your preparation for the quizzes and exams in the course.
- The Design Project module provides links to the description of the design project and the template files for completion of the design project.
- Piazza will be used as the official discussion forum for questions on lectures, tutorials, labs, assignments, and exams. Piazza will be monitored by the teaching team.

Recommended Textbook

There is no recommended textbook for this course.

Other References of Potential Interest

W. Bishop, R. Gorbet, C. Hulls, and W. Loucks, *Lecture Notes – ECE 224: Embedded Microprocessor Systems*, Lecture Notes, University of Waterloo, Fall 2019.

C. Hamacher, Z. Vranesic, S. Zaky, and N. Manjikian, *Computer Organization and Embedded Systems*, Sixth Edition, McGraw-Hill Education, 2011.

Z. Vranesic and S. Zaky, *Microcomputer Structures*, Saunders College Publishing, 1989.

Course Deliverables

The course deliverables consist of a lab tools tutorial, a design project, weekly quizzes, and a final assessment.

Lab Tools Tutorial

Students studying remotely will be asked to watch a 1 hour lab tools tutorial video and then complete a quiz on the design of embedded systems. The lab tools tutorial video will be made available on LEARN on Wednesday, September 22nd at 9:00 am. The lab quiz will become available on LEARN immediately after viewing the video.

In the lab tools tutorial, students will be introduced to the design of a system-on-a-programmable chip (SOPC) using the Intel Quartus Prime tools. Students will observe the acts of designing, building, and testing a 32 bit microprocessor system based on the Nios II processor core. Following the completion of the tutorial video, students will gain access to the Lab Quiz where they will be asked questions on the proper use of the Intel Quartus Prime tools. Students will have one attempt to complete the quiz successfully.

Should conditions allow, students registered in the blended lab sessions will be provided with an opportunity to complete an in-person lab tools tutorial in the course lab room under the supervision of the course instructor. Students in the blended lab sessions will be given the option of signing up for an in-person lab tools tutorial session or completing the lab tools tutorial video and the lab quiz. The lab tools tutorial sessions require approximately 3 hours to complete. More information on the availability of in-person lab tools tutorial sessions will be provided by September 22nd.

Grading

The lab quiz provided on LEARN will be used to determine the lab tools tutorial grade for students that complete the lab tools tutorial video and the lab quiz. Upon the submission of the quiz, students will receive a lab tools tutorial grade out of 10 marks. Students in blended lab sessions that signup and complete the in-person lab tools tutorial option will be awarded a grade out of 10 marks for participation.

Design Project

Students participating in teams of four assigned by the course instructor will be asked to complete a design project (DP) that encourages students to conduct research into data converters and critically assess the usefulness of the devices for an embedded system application. The purpose of this project is to provide students with experience tackling an open-ended design problem in preparation for their 4th year design project. To complete the project, students must submit two reports. The Selection Report (SR) proposes four data converters to be considered for use in the embedded system design. Each team member is responsible for researching data converters online and proposing one of the four data converters in the report. The Recommendation Report (RR) recommends the best data converter for the application from the four described in the Selection Report. Additional details on the design project will be provided on LEARN once the topic of analog interfacing has been presented in the micro lectures.

Grading

Grading rubrics will be provided on LEARN for both the Selection Report (SR) and the Recommendation Report (RR). Each report will be assigned a grade out of 10. In total, the mini design project is worth 20% of your final grade in this course.

Late Policy

If you submit either report more than 3 days late, penalties will apply. The late penalty is 20% of the deliverable's maximum value per late day. Reported illnesses and other accommodations will be taken into consideration, if appropriate.

Weekly Quizzes

Starting in the 2nd week of the term, a weekly quiz will be placed on LEARN to assess student progress through the course material. The quizzes will appear every Wednesday at 9:00 am and end the same day at 10:00 pm. There will be 11 quizzes with the first one appearing on Wednesday, September 15th and the last one appearing on Wednesday, December 1st. Each quiz will be graded out of 5. The top 10 quiz grades will be used to compute the grade for the Weekly Quizzes.

A missed quiz will be assigned a grade of 0 unless accommodation has been arranged.

Final Assessment

The final assessment will consist of a set of open-ended design questions. Submissions will be marked to produce a grade out of 20 for the final assessment. The final assessment will go online at 9:00 am on Friday, December 10th and remain online until Friday, December 17th @ 10:00 pm. It is expected that the final assessment will require no more than 2.5 hours to complete.

Collaboration on the final assessment is not permitted. Students may refer to the online course materials posted on LEARN and Piazza. Students may not use other online resources unless expressly permitted. File-sharing services such as chegg.com, coursehero.com, and stackexchange.com are strictly prohibited. You may not discuss the assessment directly or indirectly with any person except the course instructor. All students are expected to behave with integrity.

Missing the Final Assessment

Missing the final assessment due to a reported illness will result in an assigned grade of INC (Incomplete). The grade of INC (Incomplete) must be resolved by the completion of the final assessment within 4 months of the end of the course. If the final assessment is not completed, a grade of 0 will be assigned to the final assessment for the purpose of computing a final grade.

Due Dates

Course Deliverable	Due Date
Lab Tools Tutorial (LTT) (Approximately 3 Hours)	Wednesday, November 3rd @ 10:00 pm
Design Project - Selection Report (SR) (Approximately 10 Hours)	Wednesday, November 17th @ 10:00 pm
Design Project - Recommendation Report (RR) (Approximately 10 Hours)	Wednesday, December 1st @ 10:00 pm
Weekly Quizzes (Approximately 1 Hour Each)	Wednesdays @ 10:00 pm
Final Assessment (Approximately 2.5 Hours)	Friday, December 17th @ 10:00 pm

Note for Students Repeating the Course

This offering of the course uses substantially different assessment techniques from previous offerings of this course. For this reason, repeating students are expected to complete all course deliverables as if they were taking the course for the first time. The following material provides further clarification:

Do I have to do the lab tools tutorial and the design project again?

- *Yes, repeating students are expected to participate fully in the course.*

Can I reuse material from previous submissions?

- *Yes, but you must ensure the following:*

1. If you intend to reuse material from previous submissions, full disclosure is required. The previous submission must be clearly referenced (previous course, term, and partner(s) during that previous term as well as the mark received). You should also clearly indicate what has changed from your previous submissions.

2. You will need to get permission from your previous partner(s) to share their intellectual property with your new partner.

3. You will need to disclose to your new partner that you are reusing previously submitted work.

4. Although you may use the previous work (with reference), you will be expected to update the work and correct deficiencies. Your new work should reflect your added understanding of the material.

If you have any other questions related to repeating the course, please e-mail your course instructor.

Overall Grade Calculation

Your overall grade will be computed using the following deliverable weights:

Course Deliverable	Deliverable Weight
Lab Tools Tutorial	10%
Design Project	20%
Weekly Quizzes	50%
Final Assessment	20%

The instructor reserves the right to use alternative grading schemes in special circumstances. For example, if an accommodation is necessary, an alternative grading scheme may be used to fairly assess an individual student.

University Expectations and Policies

The following statements represent university expectations and policies with respect to academic integrity, grievances, discipline, student appeals, and academic accommodations. If you would like more clarification, please contact your course instructor directly.

Academic Integrity

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check the Office of Academic Integrity for more information.

Turnitin.com

Text matching software may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

Grievance

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline

A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. Check the Office of Academic Integrity for more information. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals

A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

Note for Students with Disabilities

AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each term.

Counselling Services

Counselling Services offers a variety of confidential services to University of Waterloo students. Counselling Services is located on the 2nd floor of Needles Hall North (the new addition to Needles Hall). The phone number to book an appointment for Counselling Services is (519) 888-4567 ext. 32655.

Counselling Services is currently providing services by phone and video on Mondays from 8:30 am to 7:30 pm and on Tuesday to Friday from 8:30 am to 4:30 pm. For those in need of counselling outside of these working hours, students are encouraged to take advantage of the following resources:

- **Good2Talk**: A free confidential help line for post-secondary students 1 (866) 925-5454
- **Grand River Hospital**: Offering 24/7 emergency care for all emergencies including mental health emergencies (519) 749-4300 ext. 6880
- **Here 24/7**: Waterloo Region's Mental Health and Crisis Services team 1 (844) 437-3247
- **UW Police Services**: Offering 24/7 assistance for all on-campus emergencies (519) 888-4567 ext. 22222

Intellectual Property

Students should be aware that this course contains the intellectual property of their instructor, TAs, and/or the University of Waterloo. Intellectual property includes items such as:

- *Lecture content, spoken and written (and any audio/video recording thereof);*
- *Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides);*
- *Questions or solution sets from various types of assessments (e.g., assignments, quizzes, labs, exams); and*
- *Work protected by copyright (e.g., any work authored by the instructor or TAs or used by the instructor or TAs with permission of the copyright owner).*

Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TAs, and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

Permission from an instructor, TAs, or the University of Waterloo is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. Doing so without permission is considered a violation of intellectual property rights.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know.

Coronavirus Information

For the latest updates on COVID-19 within the university community, refer to the COVID-19 Information website. This resource is maintained by the University of Waterloo to provide updated information on COVID-19 and its impact upon the university community. All members of the university community are expected to abide by the guidance provided on this website.

In-Person Activity Expectations

The following expectations apply to all students during in-person activities:

- Students shall not attend class if they are ill, have been in close contact with someone who is ill, or have travelled outside of Canada within the past 14 days.
- Wearing of a face-covering/mask is a requirement in common use areas on campus and must be worn in the classroom/lab.
    - As such, no food is allowed to be consumed during the class. Beverages are allowed if a straw is used or if the mask is lowered only for a brief period.
    - When a student asks or answers a question it may be difficult for them to be heard if they are asking from the back of large classrooms while wearing a mask. A student may briefly lower their mask to ask/answer the question and then the mask must be replaced.
- Students are expected to practice frequent hand hygiene (handwashing with soap and water or use of hand sanitizer) before coming to class.
- Students are permitted to sit where they wish.

Fair Contingencies for Emergency Remote Teaching

To provide contingency for unforeseen circumstances, the instructor reserves the right to modify course topics and/or assessments and/or weight and/or deadlines with due notice to students. In the event of further challenges, the instructor will work with the Department/Faculty to find reasonable and fair solutions that respect rights and workloads of students, staff, and faculty.

Cancellation of In-Person Activities

Should it become necessary to cancel in-person activities for any reason, a note will be posted to Piazza to notify all students.

If in-person activities are cancelled, all activities will proceed remotely until in-person activities are able to safely resume. Given that remote delivery is not constrained by physical distancing considerations and classroom sizes, all in-person tutorial sessions will be consolidated into a single remotely delivered tutorial session per week. These tutorial sessions will be recorded for viewing by students whose schedule does not allow synchronous attendance.

Compassionate Consideration

If you are facing challenges that are affecting more than one course, please contact your Associate Chair or Director of your program. They will review your case and coordinate a reasonable and fair plan in consultation with the appropriate individuals (e.g., Instructors, Department Undergraduate Studies Committee, Chair, AccessAbility Services, Counselling Services, Registrar's Office, etc.).

Wellness Support and Contact Information

We all need a support system. We encourage you to seek out mental health supports when they are needed. Please reach out to Campus Wellness and Counselling Services. We understand that these circumstances can be troubling, and you may need to speak with someone for emotional support. Good2Talk is a post-secondary student helpline based in Ontario, Canada that is available to all students including outside Ontario. MATES is a one-to-one student peer support program offered by the Waterloo Undergraduate Student Association in consultation with Campus Wellness. MATES provides support to students who are hoping to build social skills or are experiencing personal or academic concerns or low-level mental health and wellness difficulties.

Remote Teaching and Learning: Student Notice of Recording

Activities for this course involve recording, in partial fulfillment of the course learning outcomes. You will receive notification of recording via at least one of the following mechanisms: within the Learning Management System (LEARN), a message from your course instructor, course syllabus/website, or other means. Some technologies may also provide a recording indicator. Images, audio, text/chat messaging that have been recorded may be used and/or made available by the University to students enrolled in ECE 224: Embedded Microprocessor Systems for the purpose of learning and review. Recordings will be managed according to the University records classification scheme, WatClass, and will be securely destroyed when no longer needed by the University. Your personal information is protected in accordance with the Freedom of Information and Protection of Privacy Act, as well as University policies and guidelines and may be subject to disclosure where required by law.

The University will use reasonable means to protect the security and confidentiality of the recorded information but cannot provide a guarantee of such due to factors beyond the University's control, such as recordings being forwarded, copied, intercepted, circulated, disclosed, or stored without the University's knowledge or permission, or the introduction of malware into computer system which could potentially damage or disrupt the computer, networks, and security settings. The University is not responsible for connectivity/technical difficulties or loss of data associated with your hardware, software or Internet connection.

By engaging in course activities that involve recording, you are consenting to the use of your appearance, image, text/chat messaging, and voice and/or likeness in the manner and under the conditions specified herein. In the case of a live stream event, if you choose not to have your image or audio recorded, you may disable the audio and video functionality (see: Student privacy during live events). Instructions to participate using a pseudonym instead of your real name are included where the feature exists; however, you must disclose the pseudonym to your instructor in advance in order to facilitate class participation. If you choose not to be recorded, this notice serves as confirmation of your understanding that you will be expected to view the recording once it is made available and ask questions in the discussion forum on the material presented.

You are not permitted to disclose the link to/URL of an event or an event session recording or copies of recording to anyone, for any reason. Recordings are available only to authorized individuals who have been directly provided the above instructions/link for their use. Recordings for personal use, required to facilitate your learning and preparation of personal course/lecture notes, should not be shared with others without the permission of the instructor or event coordinator. Review the University's guidelines for faculty, staff and students entering relationships with external organizations offering access to course materials for more information on your obligations with respect to keeping copies of course materials. For more information about accessibility, connect with AccessAbility Services.

UNIVERSITY OF WATERLOO

Technology questions should be directed to learnhelp@uwaterloo.ca. General questions about information and privacy at the University, should be directed to fippa@uwaterloo.ca.