School of Electrical Engineering and Telecommunications

Term 2, 2021
Course Outline

ELEC4622
Multimedia Signal Processing

COURSE STAFF

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Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC4622 in the subject line; otherwise they will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

COURSE SUMMARY

Contact Hours

The course consists of 3 hours of lectures, and a 3-hour laboratory session every week. The laboratory session will be divided flexibly between a tutorial and a computer laboratory. To help you get up to speed as quickly as possible in the 3 term model, there are four additional 1-hour lectures scheduled in the first 4 weeks.
NB: In the new UNSW timetable, **Week 6** cannot be used to deliver lectures, but can be used to provide supervised laboratories to help you with your projects.

	Day	Time	Location	Weeks
Lectures	Wednesdays	9am - 12noon	Microsoft Teams meeting online	W1-W5, W7-W10
Extra Lecture	Thursday	2pm - 3pm	Microsoft Teams meeting online	W1-W4 W5: Midterm Test
Labs	Slot 1: Fridays Slot 2: Fridays	12noon - 3pm 3pm - 6pm	EE108 EE108 and Online	W1,3,5,6,8,10 W1,3,5,6,8,10
Tutorials	Slot 1: Fridays Slot 2: Fridays	1pm - 3pm 4pm - 6pm	Microsoft Teams meeting online	W2,4,7,9 W2,4,7,9

Context and Aims

This course provides a broad introduction to multimedia signal processing. The major emphases of the course are:
1. Extension and application of one-dimensional signal processing concepts into multiple dimensions (2 dimensions for images and 3 dimensions for video);
2. Practical implementation of signal processing algorithms in software, using real programming environments (particularly C/C++) as opposed to Matlab;

3. Understanding, estimating and enhancing specific multimedia features of shape, orientation, texture, colour and motion.
4. Understanding multi-media formats and representation schemes.

Assumed Prior Knowledge

Students taking this course should have previously taken at least an introductory subject in one-dimensional signal processing, and have at least some computer programming skills.

Assessment for ELEC4622

- Final exam: 60%
- Midterm test (Week 5, Thursday 2-3pm): 10%
- Three laboratory projects (assessed in Labs in Weeks 5, 8 and 10):
  30% (+ possible bonus marks)

The final mark for the subject is $B + \left(1 - \frac{B}{100}\right) \cdot (E + Q + L)$, where B, E, Q and L are the bonus, exam, quiz and laboratory marks mentioned above.

Course schedule (tentative)

Week	Tut / Lab	Lecture Topic(s)
W1 *3h Wed + 1h Thu*	Lab	Continuous and discrete LSI systems + review of native programming in C + memory organization and management + multi-dimensional filtering
W2 *3h Wed + 1h Thu*	Tut (2nd 2 hours only)	Imaging systems, aliasing, resampling and intro to multi-dimensional filter design
W3 *3h Wed + 1h Thu*	Lab	Multi-dimensional filter design, correlation and Discrete Fourier Transforms in multiple resolutions
W4 *3h Wed + 1h Thu*	Tut (2nd 2 hours only)	Multi-resolution processing and transforms
W5 *3h Wed + 1h Thu*	Lab (Proj-1 due)	Shape and morphological processing Midterm Test is on Thursday 2pm-3pm
W6 *no lecture*	Lab is open and staffed	
W7 *3h Wed*	Tut (2nd 2 hours only)	Segmentation and image feature analysis
W8 *3h Wed*	Lab (Proj-2 due)	Colour processing, conversion and analysis
W9 *3h Wed*	Tut (2nd 2 hours only)	Motion and optical flow
W10 *3h Wed*	Lab (Proj-3 due)	Introduction to media compression

COVID19 - Important Health Related Notice

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate**. We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed.

If you are required to self-isolate and/or need emotional or financial support, please contact the Nucleus: Student Hub. If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for special consideration through the Special Consideration portal. To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this form.

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the Safe Return to Campus guide for students for more information on safe practices.

COURSE DETAILS

Credits

This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a 4th year professional elective course in the School of Electrical Engineering and Telecommunications.

Pre-requisites and Assumed Knowledge

The pre-requisite for this course is ELEC3104, Digital Signal Processing. Postgraduate students taking this course should have previously taken at least an introductory subject in one-dimensional signal processing. It is further assumed that all students undertaking this course have at least some familiarity with C programming.

Learning outcomes

At the successful completion of the course the student should:
1. Be familiar with multimedia signal representations, acquisition, file formats and standards;
2. Be comfortable with Fourier transforms, power spectra, convolution and other signal processing concepts for multi-dimensional signals;
3. Be able to design filters and other algorithms to enhance and extract important features from multimedia signals;
4. Be confident in implementing multimedia signal processing algorithms in both Matlab and C/C++.

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in **Appendix A**. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in **Appendix B**). This course also addresses the Engineers Australia (National Accreditation Body) Stage I Competency Standards as outlined in **Appendix C**.

Syllabus

Signal acquisition, sampling and interpolation for signals in 1, 2 and 3 dimensions. Digital representation of multimedia signals, including representations for colour. Fourier transforms, power spectra and convolution in multiple dimensions. Segmentation and image feature analysis. Introduction to shape, geometry and motion processing techniques. Colour processing, conversion and analysis. Compression technologies and standards for image and video signals. Software and hardware techniques for representing and processing multimedia signals.

TEACHING STRATEGIES

Rationale behind this course's approach to learning and teaching

- Signal processing is an important branch of Electrical Engineering, which is foundational to multimedia processing and telecommunications. The initial mathematical framework for signal processing is introduced in earlier courses in signals and systems and the third year signal processing course ELEC3104. However, many students find that they do not feel confident enough to implement real signal processing algorithms to solve practical problems. In view of this, the present professional elective has been deliberately designed to have a strong emphasis on practical implementation.

- Multimedia signal processing is highly intensive in terms of computational and memory resources. As a result, most practical work in this area involves programming in a native language (typically C or C++), sometimes in tandem with the development of dedicated hardware (FPGA's initially). In view of this, the practical aspects of this course emphasize native implementation and resource management methodologies.

- The course covers significant fundamental material of a theoretical nature. In order to provide an efficient and balanced learning experience, laboratory sessions are designed to closely follow the relevant developments in lectures. A portion of each laboratory session is used to provide practical demonstration of strategies for implementing concepts very recently taught in lectures.

- Independent thinking and problem solving are very important aspects of this course, since it is only by independently tackling a challenging problem that the student becomes confident in his/her understanding. A second portion of most laboratory sessions is devoted to the completion and interactive assessment of

multimedia processing solutions, which students must have designed in their own time, based on a thorough understanding of the lecture materials.

Delivery Mode

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- Tutorials, which allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material;
- Laboratory sessions, which support the formal lecture material and also provide you with practical design, implementation and debugging skills;

Learning in this course

You are expected to attend all lectures, tutorials, labs, and the mid-term exam in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed during the lab. In addition to the lectures, you should read the comprehensive typeset lecture notes provided via Moodle. Group learning is also encouraged. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending formal classes throughout the course.

Tutorial classes

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. The importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class.

Laboratory program

The laboratory schedule is deliberately designed to provide practical exposure to the concepts conveyed in lectures soon after they are covered in class. You are required to attend laboratory. Laboratory attendance WILL be kept, and you MUST attend at least 80% of labs.

Laboratory Exemption

There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course must take the labs. If, for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a lab, you will need to apply for a catch-up lab during another lab time, as agreed by the laboratory coordinator.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the term. Ongoing assessment occurs through a series of laboratory projects and the mid-term exam.

Laboratory Assessment

Initial laboratory sessions in the course are to help you become familiar with key concepts required to undertake the series of three laboratory projects. These projects require you to develop solutions to a series of connected tasks that are each focussed on a particular aspect of the material taught in lectures. You will need to write your own programs in C/C++ to solve the problem, and you will need to be able to know whether your solution is a correct one or not. This last point is easily overlooked – it is one thing to write a program that compiles and produces an output, but quite a different thing to know that the output is correct. This is a key attribute of a competent engineer and it comes from understanding the fundamentals that are taught in lectures.

It is essential that you prepare as much as possible of your solution to each project before attending the lab, since in most cases your solution will be marked in the second part of the laboratory session. Demonstrators are there to help you, but less so once marking commences. It is essential that you document your approach to solving the problem, using labeled diagrams that you can refer to during marking.

Mid-Term Exam

The mid-term examination tests your general understanding of the course material, and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any material already covered in the course schedule. It may contain questions requiring some (not extensive) knowledge of laboratory material, and will definitely contain numerical and analytical questions. Marks will be assigned according to the correctness of the responses.

The midterm exam will be held during the extra laboratory slot on Thursday from 2pm-3pm, in Week 5.

Final Exam

The exam in this course is a two-hour written examination. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course (including laboratory), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Relationship of Assessment Methods to Learning Outcomes

	Learning Outcomes			
Assessment	**1**	**2**	**3**	**4**
Laboratory practical projects	✓	✓	✓	✓
Mid-term exam	✓	✓	✓	-
Final exam	✓	✓	✓	-

COURSE RESOURCES

Textbooks

Prescribed:

- A complete set of typeset lecture notes for the course, written by Prof. Taubman, are available via the course web-site. These might be ammended from time to time over the running of the course, but are nonetheless very stable. They should be treated like a textbook and read carefully as essential prescribed material for the course.

On-line resources

All course materials, project descriptions, problem sets and so forth will appear on the course Moodle page.

A full set of live recorded video lectures from the 2019 instantiation of the course are also available at: http://eemedia.ee.unsw.edu.au/ELEC4622/index.htm

Announcements

Announcements concerning course information will be given in the lectures and/or via Moodle. You might also be sent email with important announcements, which will be sent to your student email address via Moodle.

OTHER MATTERS

Dates to note

Important Dates available at: https://student.unsw.edu.au/dates

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/policy), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both formal classes and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application **prior to the start** of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the "fit to sit/submit" rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the online student survey myExperience. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
https://student.unsw.edu.au/guide
https://www.engineering.unsw.edu.au/electrical-engineering/resources

APPENDICES

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;

- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.

Appendix C: Engineers Australia (EA) Professional Engineer Stage 1 Competency Standards

Competency Standards		Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	1, 2, 3, 4
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	1, 2, 3, 4
	PE1.3 In-depth understanding of specialist bodies of knowledge	1, 2, 3, 4
	PE1.4 Discernment of knowledge development and research directions	
	PE1.5 Knowledge of engineering design practice	2, 3, 4
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice	
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving	2, 3, 4
	PE2.2 Fluent application of engineering techniques, tools and resources	1, 2, 3, 4
	PE2.3 Application of systematic engineering synthesis and design processes	
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects	

PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability	
	PE3.2 Effective oral and written communication (professional and lay domains)	
	PE3.3 Creative, innovative and pro-active demeanour	4
	PE3.4 Professional use and management of information	4
	PE3.5 Orderly management of self, and professional conduct	
	PE3.6 Effective team membership and team leadership	

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