ELEC9722
Digital Image Processing

Course Outline – Semester 2, 2015

Never Stand Still | Faculty of Engineering | School of Electrical Engineering and Telecommunications

Course Staff

Course Convener: Prof. David Taubman, Room EE303, d.taubman@unsw.edu.au
Tutor: As above
Laboratory Contact: Dr. Reji Mathew, Room EE316, reji@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, after the lecture class times in the first instance, rather than via email. Lecturer consultation times will be advised during lectures. ALL email enquiries should be made from your student email address with ELEC9722 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 the subject web-site – this subject uses the School of EE&T's subjects repository at http://subjects.ee.unsw.edu.au/~elec9722. 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, a 1-hour tutorial, and a 3-hour laboratory session every two weeks.

	Day	Time	Location	Weeks
Lectures	Monday	4pm–7pm	ChemSc M10 (4-6pm) EEG25 (6-7pm)	w1-w12 all
Presentations	Monday	4pm–7pm	as above	week 13
Test	Friday	5pm – 6pm	EE214	week 6
Labs	Friday	3pm – 6pm	EE214	w2-w12 even only

Context and Aims

This course gives students the fundamentals of digital image processing, covering some topics from the following list:. The following topics are typically covered:

- Image models and physical imaging systems;
- Visual perception, colour processing and colour reproduction;
- Linear shift invariant filtering and filter design;
- Linear transforms;
- Mathematical morphology;
- Compression of images;
- Image enhancement;
- Image analysis, matching, edge detection, feature extraction, etc.

Assumed Prior Knowledge

Students taking this course should have an existing familiarity with digital signal processing and basic linear algebra, including concepts such as convolution, sampling, interpolation, Fourier transforms, Z-transforms, vector spaces and matrix operations. Some of these topics are reviewed briefly, but such review cannot substitute for a lack of fundamental knowledge. It is also expected that most or all students will have some familiarity with Matlab, although this can be picked up easily.

Relationship to ELEC4622

Elec4622 (Multimedia Signal Processing) and Elec9722 (Digital Image Processing) are courses that have substantial commonality. It would be possible to merge them into a single course, but not without losing some important features from each of them. In 2015, these courses are both being offered together. In order to maximize the learning outcomes for all students, including those who may be enrolled in both, the following partial fusion of the courses is proposed for S2'2015.

1. Both courses will share a common 3 hour block of lectures each week. Traditionally, ELE4622 had only 2 or 2.5 hours of lectures per week and indeed there will be some topics covered in these lectures that are examinable only for ELEC9722 students, but all students are encouraged to attend all lectures to benefit from the material.
2. Both courses will have scheduled laboratories, which is something that has previously not been available for the postgraduate course (9722).
    - ELEC4622 laboratories take place in odd weeks; the last three of these involve substantial implementation tasks that are assessed, each worth 10% of the ELEC4622 course weighting.
    - ELEC9722 students have separate laboratory sessions in even weeks, in which they are required to complete the same first three laboratories as ELEC4622, including the first assessed lab which is worth 10% of the ELEC9722 course. This is the only common assessment component of the two courses. After this, the ELEC9722 laboratories exist to support a group project that is worth 30% of the overall assessment for that course.
    - Students enrolled in both ELEC4622 and ELEC9722 are required to complete an additional project to replace the common assessment component.
3. ELEC9722 students are required to write a report and present the outcome of their group project during the lecture slot assigned to Week 13. During that week, ELEC4622 students do not have any scheduled lecture, but all are invited to attend the presentations and learn from the experience.

Assessment for ELEC9722

- Final exam: 60%
- Midterm quiz (taken during the lab in Week 6): 10%
- One laboratory project (assessed in Labs in Week 8): 10% (+ possible bonus)
- One group project (with presentation in Week 13): 20%

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

Labs for ELEC9722

It is unusual for postgraduate subjects to include laboratories, but this is a feature that has been repeatedly requested by students over many years. Labs are undoubtedly highly beneficial for learning, although only some of the course content can be learnt through labs. Since most practical image processing work is conducted using C/C++ and this does not show any signs of changing in the future, all students of ELEC9722 will be required to complete a set of preliminary laboratory experiments that involve implementing relatively simple yet important image processing tasks from scratch, using the C programming language as the primary vehicle (with C++ as an option that can be picked up at the same time). This laboratory work includes one assessed lab project in Week 8.

The remaining laboratory sessions will be made available to assist students in working towards implementation components of their larger group project for the course.

Inclusion of this laboratory component means an increase in the number of contact hours for the course. However, students whose employment arrangements make it difficult to attend the laboratories on a regular basis will be permitted to do most of the laboratory related work off campus in their own time, **subject to approval** by the lecturer in charge.

Group Project for ELEC9722

20% of the assessment for this course is based on a group project, where the groups should consist of 3 to 4 students each. You will need to inform the lecturer by Week 6 of the composition of your group and an initial proposed topic, with topics being finalized by Week 8 at the latest.

Possible topics for the group project will be discussed in the Week 4 laboratory session.

The topic of the group project should lie at least partly outside the materials covered in lectures, as outlined in the course schedule below. The project work must involve both a survey of academic literature relevant to the topic and an implementation that demonstrates key concepts related to the topic. Students within a group must be in agreement on the topic to be considered and help each other to learn new concepts and implement a useful demonstration. The implementation may be in Matlab or C/C++ and should be submitted along with the project report.

Assessable materials for the group project are a seminar, a final report and the implementation source code, all of which are to be submitted in Week 13 at the same time as the seminar. Each seminar will be assigned a duration of 20 minutes, including at least 5 minutes for questions.

In general, students within a group may be awarded quite different marks if their contributions are unequal. The awarding of marks to the group project will involve:

1. Overall quality of the project report and seminar presentation
2. Peer assessment within the group
3. Assessment of understanding and question handling during the presentation
4. Input from the laboratory demonstrator regarding contribution of group members.

Student learning outcomes

At the successful completion of the course the student should:

1. An appreciation of the fundamentals of Digital Image processing, including the topics of filtering, transforms, morphology, colour and image analysis.
2. The ability to implement basic image processing algorithms in C and Matlab.
3. The skill base necessary to further explore advanced topics in Digital Image Processing.
4. The ability to make a positive professional contributions in the field of Digital Image Processing.

Course schedule (tentative)

Week	Begins	Lab / Quiz	Lecture Topic(s)
1	27 July	--	Continuous and discrete LSI systems + review of native programming in C
2	3 Aug	Lab	Multi-dimensional filtering, memory organization and management
3	10 Aug		Imaging systems, resampling and aliasing considerations in 2 and 3 dimensions
4	17 Aug	Lab	Multidimensional Filter design
5	24 Aug		Correlation and Discrete Fourier transforms + Image Analysis 1 (9722 only)
6	31 Aug	Midterm Test + Lab	Multi-resolution processing + Image Analysis 2 (9722 only)
7	7 Sep		Introduction to shape and morphological processing + Image Transforms 1 (9722 only)
8	14 Sep	Lab	Segmentation and texture analysis + Image Transforms 2 (9722 only)
9	21 Sep		Introduction to Colour
Mid-Session Break			
10	5 Oct	Lab	**NB: Monday is a public holiday**
11	12 Oct		Introduction to motion estimation + Image Compression 1 (9722 only)
12	19 Oct	Lab	Motion estimation continued + Image Compression 2 (9722 only)
13	26 Oct		Group Project Presentations

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

Course Web-site:

For all course materials, project descriptions, problem sets and so forth, the official web-site for this course is at http://subjects.ee.unsw.edu.au/~elec9722.

Announcements:

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

Other Matters

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 http://www.lc.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://my.unsw.edu.au/student/atoz/ABC.html), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **ten to twelve hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to 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.

Also, based on past experience, the students who struggle most with the material in this subject are those who fail to attend all lectures.

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 attend all examinations scheduled for your course, including in-class tests. You must also submit all assessable laboratory projects for assessment in the designated laboratory session and week, allowing adequate time for laboratory demonstrators to mark your work. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult the following URL:

https://my.unsw.edu.au/student/atoz/SpecialConsideration.html.

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 Course and Teaching Evaluation and Improvement Process. You can also provide feedback to ELSOC who can raise your concerns or positive feedback 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.

One change that was introduced this year in response to previous years' feedback has been to extend the lectures to 3 hours per week. While it might not be necessary for all 3 hours to be used in every week, this will provide sufficient opportunity for students to absorb challenging concepts. Students are strongly encouraged to ask questions during lectures, in response to which the lecturer will provide alternate perspectives on the material to clear up any misunderstandings.

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:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

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 Competency Standard

	Program Intended Learning Outcomes	
led ge an d	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	✓

	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	✓
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓
	PE1.4 Discernment of knowledge development and research directions	
	PE1.5 Knowledge of engineering design practice	✓
	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	✓
	PE2.2 Fluent application of engineering techniques, tools and resources	✓
	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	✓
	PE3.4 Professional use and management of information	
	PE3.5 Orderly management of self, and professional conduct	✓
	PE3.6 Effective team membership and team leadership	