School of Electrical Engineering and Telecommunications

Term 2, 2019
Course Outline

ELEC9721
Digital Signal Processing: Theory and Applications

COURSE STAFF

Course Convener: Prof Andrew Dempster, Room 409, EEB G17 a.dempster@unsw.edu.au
Lecture/Laboratory Support: Ben Southwell, Room 401, EEB G17, b.southwell@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, during the allocated lecture class times in the first instance, rather than via email. Lecturer consultation times will be advised during lectures. You are welcome to email staff, 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 ELEC9721 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 has 3 hours timetabled per week. In the early weeks, this will consist of 2 hours of lectures, and a 1-hour laboratory session. In later weeks, this pattern will change – see the program below. Lectures will be recorded and made available on Moodle, technology permitting.

Lectures/ Laboratories	Day	Time	Location
	Monday	2pm - 5pm	EET 108

Context and Aims

The course is an elective in EET programs:

8338 MEngSc Satellite Systems Engineering/ Electrical Engineering/ Telecommunications/ Systems and Control

ELEC9721 Digital Signal Processing and Applications, is a 6 UoC post-graduate course that aims to give students the fundamentals of digital signal processing as well as exploring some important and illustrative applications. The course starts by defining and understanding signals why they are

processed. It then investigates signal processing tools and the mathematical concepts they are based on. Finally, some applications demonstrate the concepts learned. Topics to be covered: digital signals and systems; digital filter design; statistical and adaptive signal processing; multi-rate systems and filter banks; time-frequency analysis; DSP applications.

Pre-requisites: Although the course has no formal pre-requisites, strong knowledge of linear algebra and experience in MATLAB is necessary.

Indicative Lecture Schedule

Wk No.	Monday 2-3 pm EET 108	Monday 3-4 pm EET 108	Monday 4-5 pm EET 108
1	Introduction to DSP	Z Transform	
2	Digital Fourier Transform		**Lab 1A (as a tute)**
3	Introduction to Digital Filters		**Lab 1B (assessed)**
4	FIR Filters		**Lab 2A**
5	IIR Filters		**Lab 2B**
6	Finite Wordlength Effects	**EXAM**	
7	Random Processes/ Adaptive DSP		**Lab 3A**
8	Multirate DSP		**Lab 3B**
9	Time-Frequency Analysis		**Lab 4**
10	**Tute**		**Lab 5**

Assessment

Assessment for the course includes:

- Laboratory 25%
- Mid-session exam 15%
- Final examination 60%

Laboratory work (25%): The laboratory work will be assessed in real-time in the lab sessions. Lab 1A is not assessed; the others are. It is essential that you arrive at each lab having revised lecture materials (and attempted problems from the problem sheet) in advance of each laboratory, and having completed any requested preparation for the labs. Without preparation, marks above 50% may be difficult to obtain. No lab reports are required in this course.
Note that *laboratory assessment will be conducted individually, not on a per-group basis*. Please also note that *you must pass the laboratory component in order to pass the course*.

Mid-session examination (15%): The mid-session examination tests your general understanding of the course material, and questions may be drawn from any course material up to the end of week 4.

Final examination (60%): The exam in this course is mostly a standard closed-book 2 hours written examination, with one question requiring programming, compatible with the lab work performed during the semester. The examination tests analytical and critical thinking and a thorough understanding of the course material in a controlled fashion. Please note that *you must pass the final exam in order to pass the course*. University approved calculators are allowed.

Course Details

Credits

This is a 6 UoC course and the expected workload is 10–12 hours per week throughout the 10 week term.

Relationship to Other Courses

This is a postgraduate course in the School of Electrical Engineering and Telecommunications, available to selected undergraduates. It is an elective in several MSc programs.

Pre-requisites and Assumed Knowledge

There are no formal pre-requisites for this course. Entry into the relevant MSc program is considered the qualification. It is essential that you are familiar with basic electronics and signal processing before this course is attempted.

Learning outcomes

Upon successfully completing the course, students should have an understanding of Digital Signal Processing, as well as knowledge of some of its applications. Students will also understand signals and transforms, filters, random variables and statistical signal processing, and time-frequency analysis among other topics.

The course delivery methods and course content address a number of core UNSW *graduate attributes*:
a. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the tutorial exercises and laboratory work.
b. The ability to engage in independent and reflective learning, which is addressed by tutorial exercises together with self-directed study.
c. The skills of effective communication, which are addressed by the viva-style verbal assessment in the laboratory.
d. Information literacy, which is addressed by the assignments and project.

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 standard as outlined in ***Appendix C***.

Syllabus

See Lecture Schedule

Teaching Strategies

Delivery Mode

The course consists of the following elements: lectures, laboratory work, and tutorial questions. The lectures are the primary mode of teaching. Laboratory work is sometimes combined with analytical work as a form of assignment. The laboratories will be assessed regularly. Pre-preparation for laboratory work is essential, particularly for any analytical work corresponding to the laboratory. Tutorials also will be given regularly, which aim to provide in-depth quantitative and qualitative understanding of DSP concepts.
Laboratory classes will start from the first day with the compulsory Introductory MATLAB laboratory. You will need to bring to the laboratories:

- A USB drive for storing MATLAB script files
- Your lecture notes, laboratory preparation and/or any other relevant course materials

Together with your attendance at classes, your self-directed reading, completion of problems from the problem sheet and reflection on course materials will all form the basis of your understanding of this course.

Learning in this course

You are expected to attend all lectures and tutorials in order to maximise learning. In addition to the lecture notes/video, you should read relevant sections of the recommended texts and related technical materials. Group learning is also encouraged. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

The core material for the course is the set of lecture notes. All that is required for the course is contained within them. The lectures have been derived from several sources, the most important of which is the Kaplan textbook. If the student was to buy one textbook, this one is recommended. As with almost any software-based learning experience, there is no substitute for writing and running code. The more familiar the student is with the Matlab exercises, the more likely that person is to understand and be able to use the theoretical ideas presented in lectures.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Ongoing assessment occurs through the labs and the mid-semester exam.

Laboratory Assessment

Laboratories are primarily about learning, and the laboratory assessment is designed mainly to check your knowledge as you progress through each stage of the laboratory tasks. You are required to maintain a lab book for recording your observations. Other assessment will be based on Matlab programs developed in the lab.

It is essential that you complete the laboratory preparation before coming to the lab. After completing each activity, your work will be assessed by the laboratory demonstrator. Both the results sheet and your lab book will be assessed by the laboratory demonstrator.

Assessment marks will be awarded according to your preparation, how much of the lab you were able to complete, your understanding of the experiments conducted during the lab, the quality of the code you write during your lab work (according to the guidelines given in lectures), and your understanding of the topic covered by the lab.

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.

Final Exam

The exam in this course is a standard closed-book 2 hour written examination, comprising up to five compulsory questions. 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. *Please note that you must pass the final exam in order to pass the course.*

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes						
Assessment	**1**	**2**	**3**	**4**	**5**		
Quizzes	✓	✓	✓	✓	✓		
Assignments	✓	✓	✓	✓	✓		
Final Quiz	✓	✓	✓	✓	✓		

COURSE RESOURCES

Textbooks

There are many signal processing books appropriate for this course. Some that were used in preparing the course are:

V K Ingle and J G Proakis, “Digital Signal Processing Using Matlab”, 4th ed., Cengage, 2017

M H Hayes, “Digital Signal Processing”, 2nd ed., Schaum’s Outlines, McGraw Hill, 2012

S D Stearns and D R Hush, “Digital Signal Procesing with examples in Matlab”, 2nd ed., CRC, 2014

J M Giron-Sierra, “Digital Signal Processing with Matlab Examples, vol 1”, Springer, 2017

S Ramamurthy, “Digital Filters and Signal Processing”, Medtec, 2014

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

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/guide), 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 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.

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 digital and information literacy and lifelong learning skills through assignment work.
- Developing ethical practitioners who are collaborative and effective team workers, through group activities, seminars and tutorials.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.
- Developing citizens who can apply their discipline in other contexts, are culturally aware and environmentally responsible, through interdisciplinary tasks, seminars and group activities.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

	Program Intended Learning Outcomes	
PE1: Knowledge and Skill Base	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	-