School of Electrical Engineering and Telecommunications

Term 3, 2021
Course Outline

ELEC3104
Digital Signal Processing (Online Delivery)

Course Staff

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Protocol for Consultations:

- You are encouraged to contact the Head Tutor or your Lab Demonstrator in the first instance, who can respond to your questions on course logistics.
- You are encouraged to contact the Head Tutor Phu Le (phule@unsw.edu.au) in the first instance about course learning, feedback, your marks and content-related questions.
- You are welcome to contact me for any course related matters.
- All email enquiries should be made from your UNSW student email address (please do not use any other email address) with ELEC3104 in the subject line, to ensure that they can be addressed promptly.
- You will be required to submit a scan/photo of your student ID pass to your Lab demonstrator in Week 1

Keeping Informed: Announcements may be made 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.

Primary Learning Mode (This course is delivered **fully online:**

- 2-hour weekly lectures (all students) are delivered fully online
- 1-hour weekly lectures/tutorials (all students) are delivered fully online
- 3-hour weekly laboratories (approximately 20 students per group per tutor) are primarily online.
- There will be an optional 1- hour consultation every week (week 1 to week 10)
- In Weeks 2, 4 and 8, (during the Thursday laboratory classes) there will be a 30-minute Multiple Choice Quiz, consisting of 5 questions (Analytical and MATLAB coding)
- In Week 5, there will be a 2-hour written mid - term exam (Analytical questions and one MATLAB coding question)
- At the end of Week 5, mini-projects will be released.
- In Week 10, there will be a 1-hour written exam and the questions are based on the mini-project.
- The mini-project submission is due on Monday Week 11.
- There **will be** a final exam of 2-hour duration covering the lecture content from Weeks 1 to 10
- This course has been re-designed based on Modified SOLO Taxonomy framework **(see Appendix A)**

Course Summary

Contact Hours: The course consists of 2-hour online **lectures**, 1-hour online **lecture/tutorial**, and 3-hour online **labs** each week from Weeks 1 to 10. (Week 6 is a Flexibility Week and there will be no new material taught during this week) and an optional 1-hour consultation every week.

Class Timetable: You can find the detailed class schedule at the following links:

http://timetable.unsw.edu.au/2021/ELEC3104.html

ELEC3104	Day	Time	Mode of delivery	Name
Lectures	Tuesday	12noon - 2pm	Online	Professor E Ambikairajah
Lecture/Tutorials	Tuesday	3pm - 4pm	Online	Professor E Ambikairajah
Labs	Thursday	10am – 1pm	Online	Above Lab Demonstrators
	Thursday	2pm – 5pm	Online	Above Lab Demonstrators
Consultations (Optional)	Thursday	7pm – 8pm	Online	Dr Phu Le Professor E Ambikairajah

- You must attend the same lab timeslot throughout Week 1 to Week 10.
- **You cannot move timeslots once you have chosen your preferred lab times in Week 1.**

Note: You are required to commit at least 15 hours per week to your learning, including self-study in order to complete the above assessments successfully.

Context and Aims

Signal Processing is the process of measuring, manipulating and analysing real-world signals. ELEC3104 Digital Signal Processing is an introductory course which takes students through the fundamentals of discrete time signal and systems theory.

Aims

The course aims to equip students with:

- An understanding of the time and frequency domain representations of signals and systems.
- The skills to identify the correct type of filter required for a given problem and to demonstrate the design and implementation of a digital filter.
- An understanding of multi-rate processing and multi-rate systems.

Indicative Course Schedule

Week	Lecture	Mode
1	Topic 1: DSP Fundamentals	Online
2	Topic 1: DSP Fundamentals & Topic 2: Discrete- time systems & **Multiple Choice Quiz**	
3	Topic 2: Discrete- time systems & Topic 3**:** Digital filter fundamentals	
4	Topic 3: Digital filter fundamentals & **Multiple Choice Quiz**	
5	Topic 4: Digital Oscillator fundamentals & **Mid-term written exam**	
6	***Flexibility Week – No new material taught***	Online
7	Topic 5: Digital Filter designs	
8	Topic 5: Digital filter designs & Topic 6: Multirate systems & **Multiple Choice Quiz**	
9	Topic 6: Multirate systems	
10	**Revision** (Topics 1 to 6) & **Mini-project written exam**	

Assessment

1. Mid-term exam (120 min written & Matlab coding exam, Week 5) 20%
2. Three Multiple Choice Quizzes (3 x 5%, Weeks 2, 4 and 8) 15%
3. *Mini-project exam (60 min written exam, Week 10) 15%
4. Mini-project report (including your Matlab code) 15%
5. *Final exam 35%

***You must pass the mini-project exam and the final exam, with an overall mark of at least 50% in the course in order to pass the course.**

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 at least 12 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a 3rd year course in the School of Electrical Engineering and Telecommunications at the University of New South Wales. It is a core course for students following a BE (Electrical) or (Telecommunications) program and other combined degree programs, and an elective for Computer Engineering students.

Pre-requisites and Assumed Knowledge

The pre-requisite for this course is ELEC2134, Circuits and Signals. It is essential that students are familiar with basic circuit theory, signal analysis and transform methods. It is further assumed that students are familiar with the MATLAB environment, and have good computer literacy.

Note: MATLAB Tutorial Videos: **http://eemedia.ee.unsw.edu.au/MatlabTutorial/index.htm**

Subsequent Courses

The course is a pre-requisite for all professional electives in the Signal Processing group, including ELEC4621 Advanced Digital Signal Processing and ELEC4622 Multimedia Signal Processing.

Learning outcomes

At the end of the course students should be able to:

1. Analyse linear time-invariant systems
2. Demonstrate competency in time and frequency domain analysis of signals and systems including transform methods
3. Design and analyse digital filters for a given specification
4. Implement a simple multi-rate system

This course addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix B***.

Syllabus

Processing and analysis of continuous (analogue) and discrete-time (digital) signals. Sampling continuous signals: the sampling theorem, reconstruction, aliasing and the z-transform. Filter impulse and frequency responses, stability and digital oscillators. The Discrete Fourier Transform (DFT). Fundamentals of the design and realisation of finite impulse response (FIR) and infinite impulse response (IIR) digital filters. Linear and non-linear phase filters. Decimation, interpolation, multi-rate digital signal processing.

Teaching Strategies

Delivery Mode

The entire analytical component of the course will be delivered via online lectures and online laboratories and discussions with assigned lab demonstrators.

Learning in this course

1. You are expected to learn from all online lectures every week and participate in the weekly labs with allocated lab demonstrators.
2. You must prepare well for your weekly online MATLAB coding laboratory discussion with the demonstrators
3. Each week, you must reflect on the content that you have learnt from the topics that has been taught in the lectures.
4. You must attend all the-labs/mini-project sessions, assessments, and exams.
5. Reading additional texts will further enhance your learning experience.
6. Group learning is also encouraged (each online lab group will have 20 students and will be further divided into subgroups of 5 students per group).
7. For an online course such as this, it is *vital* that you undertake adequate self-directed study every week during the term.

Weekly Laboratory classes

The laboratory program is an important aspect of this course and will **commence in Week 1**. Through the laboratory component, you will progressively encounter the elements of the syllabus. The laboratory sessions are designed to help you develop your practical skills using MATLAB. The aim of the laboratory component is to ground the analytical subject material in a real-world problem, where the skills and knowledge you learn throughout the course will be applied in real engineering design work
.
The mini-project which will be released in Week 5 is designed to provide hands-on exposure to the applications of the concepts learnt in the course, in implementing a DSP system. You are strongly encouraged to discuss your mini-project implementation with your lab demonstrators to complement your self-directed learning.

The mini-project is designed to provide an increasing complexity from Pass (Level 2) to High Distinction (Level 5) levels as per the Modified SOLO Taxonomy (Appendix A). The taxonomy encourages students to think about which level they are currently at, with their mini-project learning, and what they need to do in order to progress to the next level.

Laboratory Exemption

There is no laboratory exemption for this online course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this online course must take the labs and mini-project. If, for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a lab, please contact your assigned demonstrator.

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the term. Ongoing assessment occurs through online assessments such as the midterm exam (Week 5), Multiple Choice Quizzes (Weeks 2, 4 & 8) and the mini-project project exam in Week 10 (plus the project report) and then the final exam.

Mid-term written exam (20%)

There is a midterm exam, on **Thursday of Week 5 during your lab time**. This exam will be 2 hours long. The exam will cover all the topics covered in the lectures from Week 1 to Week 5 (inclusive) and all the labs covered from Week 1 to Week 4.

The exam consists of 4 analytical questions (with many parts) and one MATLAB coding question. Questions must be answered as per the Modified SOLO Taxonomy.

A sample paper will be released on Moodle in Week 4.

Multiple Choice Quiz (15%)

In Weeks 2, 4 and 8, there will be a 30-minute Multiple Choice Quiz (each worth 5%) consisting of 5 multiple choice questions during the Thursday laboratory class.

Three analytical questions will be mainly based on the lecture content, and the remaining **two** questions will be based on MATLAB exercises that you are doing, or have done, during the laboratory classes. Each exam will be available for only 30 minutes as per the Table 2 of this document. After 30 minutes, the system will automatically submit what you have done. Only one attempt of each of these quizzes is allowed. There will be no negative marking of multiple-choice questions – you will only receive marks for correct answers and will not be marked down for incorrect answers.

Mini-project written exam (15%)

The mini-project (individual work) will be released in Week 5 and you are expected to complete it by the end of Week 10. This mini-project must be completed individually, it is not a team project. The mini-project will be assessed in Week 10 (during the lab session time slot) in the form of a 60-min written exam (15%),

The exam consists of 4 questions (with many parts). Questions must be answered as per the Modified SOLO Taxonomy.

You must pass the mini-project written exam to pass the course

Mini-project report (15%)

You must submit a mini-project report [2500 (5 pages) to 4000 words (8 pages)] by **9.00 pm Monday 22 November 2021 (Week 11).**

Your project report should consist of name, student ID, date of submission, title of the report, abstract, description of the project, equations if any, diagrams, MATLAB plots, results, conclusion, etc. Fonts should be Times New Roman or Arial, and font size should be 12 point for the body text, larger sizes could be used for the headings.

The report will be marked on the basis of the level of understanding of the project, description of the project, presentation of the results, conclusion, and clarity of communication exhibited by the report.

Late submissions will be penalised by 20% per day (including weekends).

Final written exam (35%)
There will be one final examination, testing your understanding of the principles and your analytical skills through a number of problems. You must pass this final exam to pass the course.

A sample paper will be released on Moodle in Week 10.

- ✓ The final exam will be 2 hours long + 10 min reading time + 15 minutes uploading time
- ✓ You must answer a maximum of 4 questions (each question will have multiple parts) in the final exam.
- ✓ The final exam questions will be presented in the SOLO Modified Taxonomy as follows:
  - The exam will be in the following layout:
    - ❖ Four questions under Level 2
    - ❖ One question under Level 3
    - ❖ One question under Level 4
    - ❖ One question under Level 5
  - In doing the exam, you can choose which questions you want to complete, depending on what Level you are aiming for:
    - ❖ If you are aiming to achieve **Level 2**, you will need to **answer all four questions under Level 2**.
    - ❖ If you are aiming to achieve **Level 3**, you will need to answer **any three Level 2 questions and one Level 3 question**.
    - ❖ If you are aiming to achieve **Level 4**, you will need to answer **any two Level 2 questions, one Level 3 question and one Level 4 question**.
    - ❖ If you are aiming to achieve **Level 5**, you will need to **answer any one of the Level 2 questions, one Level 3 question, one Level 4 question and one Level 5 question.**
  - Under the SOLO Modified Taxonomy, the maximum marks you can achieve are as follows:
    - ❖ If you complete all four questions under Level 2 correctly, the maximum mark you can achieve is 64.
    - ❖ If you complete any three questions under Level 2 correctly and one Level 3 question correctly, the maximum mark you can achieve is 74.
    - ❖ If you complete any two questions under Level 2 correctly, one Level 3 question correctly, and one Level 4 question correctly, the maximum mark you can achieve is 84.
    - ❖ If you complete any one question under Level 2 correctly, one Level 3 question correctly, one Level 4 question correctly, and one Level 5 question correctly, the maximum mark you can achieve is 100.
- ✓ The final exam will cover all topics covered in the Term (MATLAB coding will not be included in the final exam)

Requirements to pass the course
A satisfactory performance (50% or greater) overall in the course, and in **each** of the following, is a necessary requirement to pass this course:

- Mini-project exam (week 10)
- Final exam

Table 1: Relationship of Assessment Methods to Learning Outcomes

	Learning Outcomes			
Assessment	**1**	**2**	**3**	**4**
Multiple Choice Quiz (15%)	✓	✓	✓	-
Mid-term written exam (20%)	✓	✓	-	-
Mini-Project written exam (15%)	✓	✓	✓	✓
Mini-Project Report (15%)	✓	✓	✓	✓
Final written Exam (35%)	✓	✓	✓	✓

Table 2: Overview: Activities and Assessments

Week	Activities and Assessments	Date	Time
2	Multiple Choice Quiz 1 on Moodle (5%)	23/09/21 Thursday	11:30am (Morning group) 3:30pm (Afternoon group)
4	Multiple Choice Quiz 2 on Moodle (5%)	07/10/21 Thursday	11:30am (Morning group) 3:30pm (Afternoon group)
	Mid-term written exam sample paper released	08/10/21 Friday	Release time: 9:00am
5	Mid-term written exam (20%)	14/10/21 Thursday	10:00am – 12noon (Morning group) 2:00pm to 4:00pm (Afternoon group)
	Release of mini-project (individual)	15/10/21 Friday	Release time: 9:00am
8	Multiple Choice Quiz 3 on Moodle (5%)	4/11/21 Thursday	11:30am (Morning group) 3:30 pm (Afternoon group)
10	Mini-Project written exam (15%)	18/11/21 Thursday	10:00am – 11:00 am (Morning group) 2:00 pm to 3:00pm (Afternoon group)
	Final written exam sample paper released	19/11/21 Friday	Release time: 9:00am
	Mini-Project Report submission (15%)	22/11/21 Monday	Latest submission time 9:00pm.
Note: Please forward any feedback on the course to the weekly comments link in SurveyMonkey on Moodle. Open on Friday 9:00am and will close on the same day at 9:00pm			

Course **Resources**

Reference books

- E. Ambikairajah, ELEC3104: Lecture Notes, (2021)
- A. Andreas, Digital Filters Analysis Design and Signal Processing, McGraw-Hill, 2018.
- A. V. Oppenheim, R. W. Schafer, & P. Buck, Discrete-Time Signal Processing, Prentice-Hall, 2010.
- S. K. Mitra, Digital Signal Processing, McGraw-Hill, 2011.
- J. Proakis & D. Manolakis, Digital Signal Processing, Prentice-Hall, 2007.
- A. Antoniou, Digital Signal Processing – Signals, Systems and Filters, McGraw-Hill, 2016

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

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 **fifteen hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including online discussions, online labs 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 this online study with employment and other activities.

Attendance and Online Participation

Weekly participation in online labs with the assigned tutor is vital for this course. If you do not participate in the weekly labs you may be removed from this course.

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. Assessment of applications for Special Consideration will be managed centrally and the University has introduced a "fit to sit/submit" rule. You will no longer be required to take your original documentation to The Nucleus for verification. Instead, UNSW will conduct source checks on documentation for verification purposes. 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. If you sit an exam or submit an assignment, you are declaring yourself well enough to do so.

Continual Course Improvement

This course is being offered for the first time based on SOLO Taxonomy for the online offering. The SOLO taxonomy has been adapted for this course to include 6 Hierarchical levels and the taxonomy encourages students to think about which level they are currently at with their learning, and what they need to do in order to progress to the next level.

Your feedback is valuable to improve the course. Please forward any feedback (positive or negative) on the course to the course convener or via the weekly comments link in SurveyMonkey on Moodle. This will ensure we can make adaptive changes throughout the term.

Towards Week 10, you will be asked by UNSW to provide feedback via the online student survey myExperience.

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

Modified SOLO Taxonomy Framework

- The Structure of Observed Learning Outcomes (SOLO) taxonomy is a framework for analysing students' depth of knowledge.
- The SOLO taxonomy has been adapted for this course to include 6 Hierarchical levels (Levels 0 to 5) of increasing complexity in students' understanding of topics studied.

Why does this matter to you?

- The taxonomy encourages students to think about which level they are currently at with their learning, and what they need to do in order to progress to the next level.
- The SOLO taxonomy has been adapted for this course to include Pass, Credit, Distinction and High Distinction levels to help students understand the different levels (Levels 0 to 5) on the learning curve, and what they need to do to progress.
- If you are happy with your current level of learning and don't want to deepen your knowledge to progress to the next level, that is entirely your choice. At an absolute baseline, all students must achieve a Pass level (i.e. be at Level 2) as a total final mark (≥50%) at completion of the course, if you want to pass the course.
- The Course is designed to provide an increasing complexity from Pass (Level 2) to High Distinction (Level 5) levels as shown on the Taxonomy Framework diagram below.
- All Tutorial questions will be levelled as per the SOLO taxonomy for this course. You must do Level 2 (Pass) questions as a baseline. If you choose to attempt any other questions in the tutorial beyond Level 2, please complete other questions in sequential order (i.e. attempt Level 3 first, before doing Level 4 etc)

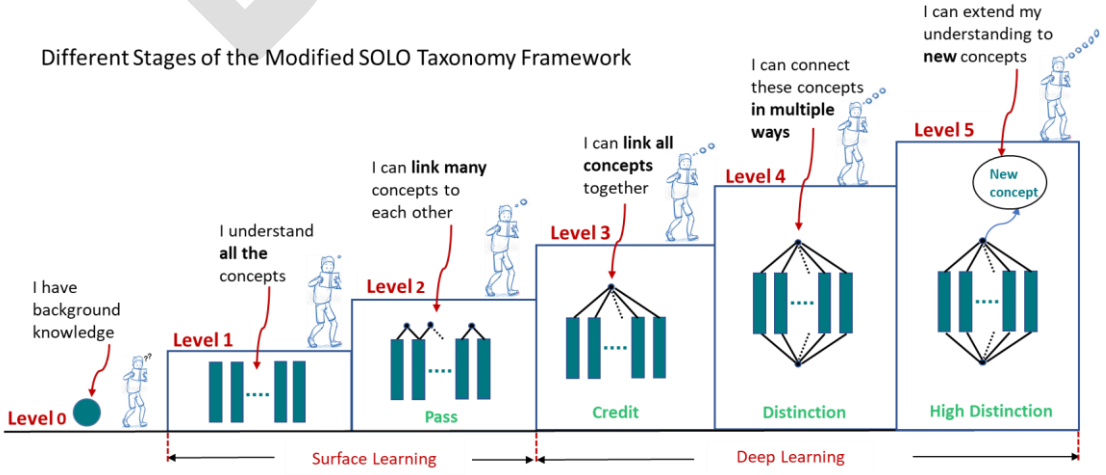
Different Stages of the Modified SOLO Taxonomy Framework

Level 0: The students don't have any understanding about the topic, but have the pre-requisite knowledge to commence this course.

Level 1: Very basic understanding, where their knowledge accrues in greater quantity. They understand all of the concepts.

Level 2: Students know all the concepts and are able to link many of the concepts to each other.

Levels 3, 4 & 5: All concepts known, and additionally there is a deep understanding that comes with a qualitative change in how the concepts are understood. They are able to connect the concepts in multiple ways. Surface knowledge (Levels 1 & 2) is required as a baseline, in order to develop deep knowledge



Appendix B

Engineers Australia (EA) Professional Engineer Stage 1 Competency Standards

Competency Standards		Learning Outcomes (LO)
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	1,2
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	1,2
	PE1.3 In-depth understanding of specialist bodies of knowledge	2,3,4
	PE1.4 Discernment of knowledge development and research directions	-
	PE1.5 Knowledge of engineering design practice	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	1, 2, 3, 4
	PE3.2 Effective oral and written communication (professional and lay domains)	4
	PE3.3 Creative, innovative and pro-active demeanour	3, 4
	PE3.4 Professional use and management of information	-
	PE3.5 Orderly management of self, and professional conduct	1, 2, 3, 4
	PE3.6 Effective team membership and team leadership	-