NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2023/2024	**Semester**	2
Course Coordinator	Asst Prof. Tong Ling / Dr Antonio Alvarez		
Course Code	BG2103		
Course Title	Signal Processing in Biosystems (Core)		
Pre-requisites	Nil		
No of AUs	3		
Contact Hours	26 hours lecture, 12 hours tutorial		
Proposal Date	18 October 2019		

Course Aims

The main aim for this 13-week programme is to offer a complete and concise knowledge for the acquisition and extracts a priori desired information from bio-system. To achieve this aforesaid aim, 5 main areas of signals processing in biosystem are focused: (1) Discussion of an overall views and fundamental ideas in of signals and systems. (2) Identification and processing of the different types of signals. (3) Comprehension and examination of signals acquired in an infinitesimally short amount of time in the ideal situation, and sampled with finite period in the practical case. (4) Conception of signals and systems from a time- and frequency-stand point. (5) Development of methodology for desired signals extractions and noise reductions.

Intended Learning Outcomes (ILO)

The main outcome is the understanding the characteristic of the signal in bio-systems and use of signal processing techniques for improving the signal for further analysis.

Upon successfully completing this course, you should be able to (in corresponding to the 5 main areas of focus in the course aims above):

1) Discuss the basic concepts of signals and systems;
2) Perform calculations and distinguishes on the various types of signals;
3) Carry out evaluations of signals in the continuous-time or discrete-time domain;
4) Analyse signals and systems in the time and frequency domain for performing conversion between these two domains; and
5) Design digital filters.

Course Content

The course content is as follows:

- Education of the importance and nature of biomedical signal processing;
- Comprehension of the different types and characteristics of signals;
- Operation and calculation on different commonly used signals;
- Comprehension of correlation between the input and output of a system (time-invariant and linear system in particular);
- Determination of the convolution between signals;
- Explanation of synthesis and analysis of Fourier series in continuous-time domain signals;
- Education of the Fourier transform and inverse Fourier transform in continuous-time domain signals;
- Explanation of digital signal processing system operation;
- Determination of the discrete Fourier transform (DFT) and inverse discrete Fourier transform for sequence of data;
- Education of fast Fourier transform for sequence of data;
- Determination of the z-transform and inverse z-transform for given discrete-time sequence;
- Education of digital filter design;

- Explanation of finite impulse response filters and infinite impulse response filters design; and
- Comprehension and application the window method in filter design.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
1. Continuous Assessment (40%) Quizzes will be conducted	ILO (1 – 5)	EAB SLOs a, b, c	40%	Individual	N.A. not project-based
2. Final Examination (60%) (2hrs, Closed Book, exam paper not allowed to be removed from exam hall)	ILO (1 – 5)	EAB SLOs a, b, c	60%	Individual	N.A. not project-based
Total			100%		

Mapping of Course ILOs to EAB Graduate Attributes

Course Intended Learning Outcomes	Cat	EAB's 12 Graduate Attributes*											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
	Core	◐	◐	◐									
1) Discuss the basic concepts of signals and systems													a
2) Perform calculations and distinguishes on the various types of signals													a, b
3) Carry out evaluations of signals in the continuous-time or discrete-time domain													a, b
4) Analyse signals and systems in the time and frequency domain for performing conversion between these two domains													a, b
5) Design digital filters													a, b, c

Legend:
- ● Fully consistent (contributes to more than 75% of Intended Learning Outcomes)
- ◐ Partially consistent (contributes to about 50% of Intended Learning Outcomes)
- š Weakly consistent (contributes to about 25% of Intended Learning Outcomes)
- Blank Not related to Student Learning Outcomes

Formative feedback

There are various feedback strata throughout this module to ensure your progressive improvement leading up to the examination.

1. Informal feedback
   To ensure inclusiveness, you are encouraged to ask questions and offer viewpoints during lectures. This is to ensure no misunderstanding about the principles taught and the correct knowledge entrenched at all times.
2. Continuous-assessment feedback
   Results and answers are discussed after the continuous assessment. After the quiz, you will have the opportunity to look into the marked script about their individual work and knowledge.

This test is an important milestone for you to measure your performance and take steps to improve, prior to the final exam. Additionally, the quiz answers will be discussed in class.

3. Formal feedback
   Survey will be conducted on NTULearn to obtain feedbacks from you on the teaching style.
4. Examiner's final grading
   You will receive the marker's grading on the overall examination performance after the formal release of exam results.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Lectures begin with the introduction of fundamental concepts, theories and equations. Information is instilled using examples and scenarios that help better understanding. Interactive questions will also be initiated to encourage inquisitiveness, active participation, and to also check if the student is lagging behind. The content presentation in lecture notes is illustrative in nature using mathematics, graphs, shapes, colours, charts and animation. Lecture presentations are created and displayed primarily on MS PowerPoint. During lecture, technology videos of various cutting edge and innovative signal processing methodology will be shown as well.
Tutorial	TBL classroom discussion sessions on tutorial questions and related topics. Each set of answers will be accompanied by additional detailed discussions to invite different viewpoints or additional method in solving the questions from the rest of the class.

Reading and References

1. Eugene N. Bruce, Biomedical signal processing and signal modelling, Wiley, 2001.

Course Policies and Student Responsibilities

General: You are expected to complete all tutorials and quizzes. Moreover, students are expected to take responsibility to follow up with course notes, assignments and course related announcements. You are expected to participate proactively in all tutorial discussions and activities.

Continuous assessments: You are required to attend all continuous assessments.
Absenteeism: Continuous assessments make up a significant portion of your course grade. Absence from continuous assessments without officially approved leave will result in no marks and affect your overall course grade.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you

should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Tong Ling	N1.3-B3-13	6316 8879	Tong.Ling@ntu.edu.sg
Antonio Alvarez			antonio.at@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction and basic concepts of signals and systems	ILO 1, 2	
2	Basic operation on signals and elementary signal	ILO 1, 2, 3	
3	System properties and interconnection of systems	ILO 1, 2, 3	
4	Linear time-invariant systems and convolutions	ILO 1, 2, 3	
5	Fourier series	ILO 1, 2, 3, 4	
6	Fourier transform	ILO 1, 2, 3, 4	
7	Discrete Fourier transform	ILO 1, 2, 3, 4	
8	Digital signal processing	ILO 1, 2, 3, 4	
9	Fast Fourier transform	ILO 1, 2, 3, 4	
10	Z-transform and inverse Z-transform	ILO 1, 2, 3, 4	
11	Infinite and finite impulse response filters	ILO 1, 2, 3, 5	
12	Window method	ILO 1, 2, 3, 5	
13	Filter design steps	ILO 1, 2, 3, 5	

Appendix 2: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change