Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	AY2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Tan Hong Qi (Dr), Seow Poh Choo (Dr)
Course Author Email	Tan.hong.qi@nccs.com.sg, seow.poh.choo@sgh.com.sg
Course Title	Non-ionizing medical imaging and processing
Course Code	PH3302
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	PH3301
Co-requisites	Nil
Pre-requisite to	Nil
Mutually exclusive to	Nil
Replacement course to	Nil
Remarks (if any)	

Course Aims

The main objective of the “Non-ionizing medical imaging and processing” course is to give you a bachelor-level introduction to the application of non-ionizing radiations in biomedical imaging. The first half of the course focuses on the required computing knowledge for a clinical medical physicist which includes image and signal processing, basic computer hardware architecture and health informatics. The second half of the course covers the physical and biological foundations, engineering solution, diagnostic and research applications of ultrasound and magnetic resonance imaging physics, including the various imaging techniques (structural, functional, spectroscopic, etc.). The theoretical bases of the study material will be given via lectures, tutorials and e-learning, whereas ample hands-on experience will also be provided.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Explain the different computer hardware architecture and its functions
ILO 2	Describe computer-aided diagnosis, DICOM, PACS and different types of medical images
ILO 3	Use MATLAB to import, process and perform analysis on medical images
ILO 4	Apply and describe linear filtering and the role of different types of kernel to process image using MATLAB
ILO 5	Apply and describe edge and line detection and thresholding to solve image processing problem using MATLAB
ILO 6	Explain and implement discrete Fourier transform and filtering in the frequency domain using MATLAB
ILO 7	Describe different algorithms for image registration
ILO 8	Describe different imaging modalities of Ultrasound and the imaging artefacts
ILO 9	Describe clinical use and bioeffects of Ultrasound
ILO 10	Explain the basic physical principles of magnetic resonance imaging and spin physics
ILO 11	Identify and describe the main components of an MRI scanner and the workflow of a MR centre
ILO 12	Explain pulse sequences and how tomographic images are generated
ILO 13	Explain the foundations of structural imaging (T1, T2, PD, etc.) and distinguish the anatomical information in different MR sequences
ILO 14	Explain the foundations of MR diffusion (DWI and DTI), echo planar imaging (EPI) and functional imaging (fMRI)
ILO 15	Explain the foundations of chemical shift imaging/ magnetic resonance spectroscopic imaging (MRSI)
ILO 16	Describe the different MRI artifacts and safety concerns in MRI

Course Content

1. Medical imaging, DICOM standards and health informatics
2. Introduction to MATLAB for medical image processing
3. Linear filtering theory
4. Image feature detection, grey-level thresholding and edge detection
5. 2D Discrete Fourier transform and filtering in frequency domain
6. Image registration application and algorithm
7. Ultrasound physics
8. Ultrasound imaging modes and clinical application
9. Nuclear magnetic resonance and spin physics
10. MRI scanner hardware and clinical application
11. Pulse sequences in MRI
12. Structural MRI imaging (T1, T2, PD)
13. Diffusion MRI, Functional MRI (fMRI) and Echo planar imaging (EPI)
14. Magnetic resonance spectroscopic imaging (MRSI)
15. MRI artefacts, quality assurance and safety

The lecture hours are not necessarily coinciding with the above sequence; as four 3-hour long practicals in an MRI centre take place during the course.

Reading and References (if applicable)

R. Gonzalez and R. Woods (2017). Digital Image Processing. 4th Edition. Pearson. ISBN-13 : 978-9353062989

E. Samei and D. J. Peck (2019), Hendee's Physics of Medical Imaging. 4th Edition. John Wiley & Sons. ISBN-13: 978-0470552209

D. W. McRobbie, E. A. Moore, M. J. Graves, M. R. Prince (2009), *MRI from Picture to Proton*. 2nd edition. Cambridge University Press. ISBN-13: 978-0521683845

J. T. Bushberg (2020), *The Essential Physics of Medical Imaging*. 4th edition. Wolter Kluver. ISBN-13: 978-1975103224

NOTE: The above readings comprise the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	1	1,2	Lecture Notes	In-person	Classroom Lecture
2	2-3	3,4	Lecture Notes	In-person	Classroom Lecture
3	4	5	Lecture Notes	In-person	Classroom Lecture + Tutorial 1
4	5	6	Lecture Notes	In-person	Classroom Lecture
5	6	7	Lecture Notes	In-person	Classroom Lecture + Tutorial 2
6	7	8	Lecture Notes	In-person	Classroom Lecture
7	8	9	Lecture Notes	In-person	Classroom Lecture + Midterm Test 1
8	9	10	Lecture Notes	In-person	Classroom Lecture
9	10-11	11-12	Lecture Notes	In-person	Classroom Lecture
10	12	13	Lecture Notes	In-person	Classroom Lecture
11	13	14	Lecture Notes	In-person	Classroom Lecture + Tutorial 3
12	13-14	14-15	Lecture Notes	In-person	Classroom Lecture + Tutorial 4

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
13	15	16	Lecture Notes	In-person	Classroom Lecture + Midterm Test 2

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	The lectures aim at providing the students with basic information about the subject, but more importantly also a strong motivation to look into the detailed literature of the subject and to read the mandatory course literature, but also the relevant scientific literature available in the internet and in form of textbooks and scientific publications.
Tutorial	The tutorials aim to assess the students understanding about the subject and determine the students' ability to explain technical knowledge. It also serves as a feedback to the instructors to emphasize on the areas where the students are lacking.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment(Tutorials)	All	Not Applicable	10	Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(Midterm Test 1)	1-7	Not Applicable	15	Individual	Analytic	Relational
3	Continuous Assessment (CA): Test/Quiz(Midterm Test 2)	10-15	Not Applicable	15	Individual	Analytic	Relational
4	Summative Assessment (EXAM): Final exam()	All	Not Applicable	60	Individual	Analytic	Extended Abstract

Description of Assessment Components (if applicable)

The CA will be mainly based on tutorial assignments and mid-term assessments.

Formative Feedback

You will receive formative feedback through discussion within tutorial lessons.

Feedback is also given after each term test on the common mistakes and level of difficulty of the problems. Past exam questions and content of previous examiner's report will be discussed in lecture.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Communication	Intermediate
Creative Thinking	Intermediate
Curiosity	Advanced
Learning Agility	Advanced
Problem Solving	Advanced

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

Absence Due to Medical or Other Reasons

If you are sick and unable to attend your class (particularly the mid-terms), you must:
1. Send an email to the instructor regarding the absence.
2. Submit the Medical Certificate* or official letter of excuse to to your Home school.

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

There will not be any make-up test and the weightage of the first midterm will be re-distributed to second midterm and vice versa. In the event where student miss both the mid-terms with valid reasons, the total course marks would subsequently be rescaled to a base of 100%.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
If you feel like your performance in the class is being impacted by your experiences outside of class;
If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;
Please speak to your teaching team, our school pastoral officer [ENTER NAME OF SCHOOL PASTORAL OFFICER HERE] or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Point-based marking (not rubric-based)