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	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Tan Hong Qi (Dr)
Course Author Email	Tan.hong.qi@nccs.com.sg
Course Title	Medical Physics Beam Modelling and Dosimetry
Course Code	PH4611
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	PH4605 Medical Physics for Radiotherapy
Co-requisites	Nil
Pre-requisite to	Nil
Mutually exclusive to	Nil
Replacement course to	Nil
Remarks (if any)	

Course Aims

This course is designed to prepare you for a career relating to clinical medical physics in the field of radiation oncology. This is a second course in radiotherapy physics and the focus will be on understanding different dose calculation algorithms in commercial treatment planning system (TPS) and the importance of proper beam modelling during the commissioning of a Linear Accelerator (LINAC) and TPS. Practical knowledge on commissioning measurement and treatment planning will also be introduced through the lab components in this course. The expertise gained in this course will present you with career opportunities in this growing and meaningful field.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Explain the importance of performing a rigorous beam modelling during TPS commissioning.
ILO 2	Describe the working principles of Type A, B and C dose calculation algorithms and their clinical implications.
ILO 3	Describe the working principles of analytical kernel-based dose calculation algorithms.
ILO 4	Describe the mathematical framework of monte-carlo based dose calculation algorithm.
ILO 5	Describe the steps to commission MC-based algorithm in compliance with TG 157.
ILO 6	Describe the steps to commission IMRT in compliance with TG 119.
ILO 7	Create a valid CT calibration curve in TPS.
ILO 8	Explain how to collect high quality commissioning data with water tank and ion chambers.
ILO 9	Explain how to import, model and validate the beam model in the TPS.
ILO 10	Create and evaluate basic 3DCRT and electron treatment plans based on the commissioned TPS.
ILO 11	Create and evaluate basic IMRT and VMAT treatment plans based on the commissioned TPS.
ILO 12	Describe dose volume histogram (DVH) and different plan quality metrics.

Course Content

Lecture 1: Overview of dose calculation algorithms in modern TPS, beam modelling in TPS commissioning (TG 53)

Lecture 2: Analytical dose calculation algorithms in photon & CT calibration curves

Lecture 3: Analytical dose calculation algorithm in proton

Lecture 4: Monte Carlo radiation transport algorithm I

Lecture 5: Monte Carlo radiation transport algorithm II

Lecture 6: Monte Carlo dose calculation algorithms in TPS – photon

Lecture 7: Monte Carlo dose calculation algorithms in TPS – electron and proton therapy

Lecture 8: Commissioning MC-based algorithm (TG157) & Intensity modulated radiotherapy (IMRT)

Lecture 9: Research topics in dose calculation algorithms

Clinical tutorial 1: Beam data collection for photon therapy and beam modelling (TG119)

Clinical tutorial 2: Beam data collection for electron and proton therapy and beam modelling

Clinical tutorial 3: Treatment planning I : 3DCRT & electron

Clinical tutorial 4: Treatment planning II: IMRT and VMAT

Students are expected to travel to NCCS for clinical tutorials.

Reading and References (if applicable)

1. J. P. Gibbons. (2019). *Khan's The Physics of Radiation Therapy* (6th edition), Lippincott Williams & Wilkins. ISBN13: 978-1496397522
2. O. N. Vassiliev. (2017). *Monte Carlo Methods for Radiation Transport: Fundamentals and Advanced Topics*, Springer. ISBN13: 978-3319441405
3. V. Frank, S. Joao. (2021). *Monte Carlo techniques in radiation therapy : introduction, source modelling and patient dose calculations*, CRC Press. ISBN13: 978-1032078526
4. E.B. Podgorsak. (2005). *Radiation Oncology Physics: a Handbook for Teachers and Students*, International Atomic Energy Agency, Vienna. ISBN13: 978-9201073044

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	Course Introduction and Overview of dose calculation algorithms in modern TPS, beam modelling in TPS commissioning (TG 53)	1	Lecture Notes	In-person	Classroom Lecture
2	Analytical dose calculation algorithms in photon & CT calibration curves	2, 3, 7	Lecture Notes	In-person	Classroom Lecture
3	Clinical Tutorial 1: Beam data collection for photon therapy and beam modelling (TG119)	8, 9	Lecture Notes	In-person	Simulation Lab 1
4	Analytical dose calculation algorithm in proton	2, 3	Lecture Notes	In-person	Classroom Lecture
5	Monte Carlo radiation transport algorithm I	2, 4	Lecture Notes	In-person	Classroom Lecture + Tutorial 1
6	Clinical Tutorial 2: Beam data collection for electron and proton therapy and beam modelling	8, 9	Lecture Notes	In-person	Simulation Lab 2

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
7	Monte Carlo radiation transport algorithm II	4	Lecture Notes	In-person	Classroom Lecture
8	Clinical Tutorial 3: Treatment planning I : 3DCRT & electron	10, 12	Lecture Notes	In-person	Simulation Lab 3
9	Monte Carlo dose calculation algorithms in TPS – photon	4, 5, 6	Lecture Notes	In-person	Classroom Lecture + Tutorial 2
10	Clinical Tutorial 4: Treatment planning II: IMRT and VMAT	6, 11, 12	Lecture Notes	In-person	Simulation Lab 4
11	Monte Carlo dose calculation algorithms in TPS – electron and proton therapy	4, 5	Lecture Notes	In-person	Classroom Lecture
12	Commissioning MC-based algorithm (TG157) & Intensity modulated radiotherapy (IMRT)	6, 7	Lecture Notes	In-person	Classroom Lecture + Tutorial 3
13	Research topics in dose calculation algorithms	1-12	Lecture Notes	In-person	Student's presentation

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	In the lecture, student will be first motivated with the relevant technology and processing techniques of electronic devices, followed by lectures that further explains the working principles and physics. Wrap up questions will also be provided.
Tutorials	Discussion on tutorial questions will help to improve the understanding of the main concepts learned in lectures. A part of the teaching in this course is based on the laboratory visits and field experiments. The lab demonstration session will be held in National Cancer Centre Singapore (NCCS) where the students will be able to familiarise themselves with treatment planning systems and equipments for collecting beam data.

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(Assignment Report)	All	Not Applicable	10	Individual	Holistic	Extended Abstract
2	Continuous Assessment (CA): Others(Clinical Tutorial)	6,8,9,10,11,12	Not Applicable	15	Individual	Analytic	Relational
3	Continuous Assessment (CA): Assignment(Assignment Presentation)	All	Not Applicable	25	Individual	Holistic	Extended Abstract
4	Summative Assessment (EXAM): Final exam()	All	Not Applicable	50	Individual	Analytic	Extended Abstract

Description of Assessment Components (if applicable)

Students will be given the tutorial questions at least 1 week before the tutorial week and they are required to be present during the tutorial. There is also a presentation assessment to present on related journal articles. Students will need to physically attend all clinical tutorial unless he/she are absence due to legitimate reason.

Formative Feedback

You will receive formative feedback through discussion within tutorial lessons.

You will receive both written and/or oral feedback on your report and presentation.

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)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

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 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.

Appendix 1: Assessment Rubrics for Assignment Report

Criteria Description	**Assessment**				**Score**
	Poor (0)	**Adequate (1)**	**Good (2)**	**Excellent (3)**	
REPORT STRUCTURE & ORGANISATION Consider the layout of the report - a clear and concise abstract followed by logical sequences on the written chapters, and good finishing in conclusion and suggestion of prospective development in the topic surveyed.	Report is poorly organised	Report is adequately organised	Report is well organised	Report is excellently organised	Max 3
QUALITY OF REPORT CONTENT Consider the level of work presented in the report, particularly the quality of the technical content in the abstract and written chapters. Write-up is in good English with minimal grammatical errors and spellings.	Quality of work presented is poor	Quality of work presented is marginally acceptable	Good quality of work presented	Excellent quality of work presented	Max 3
INFORMATION GATHERING & LITERATURE REVIEW Consider the degree of preparation on the information gathering related to the work. Literature review with extensive use of relevant references.	Poor information gathering	Only minimal effort of information gathering is shown	Good effort of information gathering is shown	Excellent information gathering is presented	Max 3
RESULTS & DISCUSSIONS Consider if interpretation and discussion of results are put into context, main points picked for discussion, understanding of underlying assumptions and limitation while being rationale to various approaches.	Poor or no discussion	Only minimal discussion is presented	Good discussion and in-depth analysis in presented	Excellent discussion and new ideas is presented	Max 3
				Total	Max 12

Appendix 2: Assessment Rubrics for Assignment Presentation

Criteria Description	**Assessment**				**Score**
	Poor (0)	**Adequate (1)**	**Good (2)**	**Excellent (3)**	
FUNDAMENTAL UNDERSTANDING Consider the student's ability to explain the technical knowledge learnt, specifically from physics viewpoint. Also consider the coherence between the presentation and the contents of the report submitted.	Fails to demonstrate the relevant technical understanding.	Able to demonstrate the relevant technical understanding.	Demonstrate good understanding of the technical knowledge	Demonstrate excellent understanding and strong command of the technical knowledge	Max 3
PRESENTATION, ORGANISATION AND MATERIALS Consider the degree of preparation of the presentation materials – informative, and appropriateness on the topics discussed; consider the clarity and context of the slides.	Ideas were poorly presented and visuals were not helpful to audience.	Ideas were vaguely presented and visuals were marginally helpful to audience.	Ideas were presented clearly and visuals were helpful to audience.	Exceptional presentation skills with highly informative materials.	Max 3
CLARITY, LANGUAGE USE AND ACCURACY Consider the student's ability to give a clear and concise presentation – appropriate choice of words, understandable, minimal stoppage, proper pace and good timing.	Poor verbal and communication skills	Able to communicate ideas and relates to others.	Communicates and explains ideas clearly and concisely.	Communicates in a highly convincing and persuasive manner.	Max 3
QUESTIONS AND ANSWERS Consider the student's ability to explain his/her work in the Q&A session – able to provide unambiguous and logical answers confidently.	Unable to answer any questions asked.	Limited capability in answering questions	Able to answer most queries raised.	Confidently respond to all queries raised and able to provide new ideas	Max 3
				Total	Max 12