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

Course Overview

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Cheong Siew Ann
Course Author Email	cheongsa@ntu.edu.sg
Course Title	Seminar in Mathematical physics
Course Code	PH4511
Academic Units	2
Contact Hours	26
Research Experience Components	Research Defined Course (at least 50% of deliverables involve practical research activities: problem identification, hypothesis forming, data collection/analysis/interpretation, result communication)

Course Requisites (if applicable)

Pre-requisites	None
Co-requisites	None
Pre-requisite to	None
Mutually exclusive to	None
Replacement course to	None
Remarks (if any)	None

Course Aims

This course aims to help you in the Double Major BSc. in Physics and Mathematical Sciences (PHMS) appreciate the intimate connections between mathematics and physics, through a series of seminars given by theoretical physicists who employ cutting-edge mathematical tools for their research and pure/applied mathematicians who work in areas of mathematics that can potentially be applied to physics. You will deepen this appreciation by reading up, writing up, and presenting on mathematical physics topics of your own choosing.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Describe how different areas of pure and applied mathematics have been used in physics.
ILO 2	Describe ideas generated in physics that have led to fruitful research in mathematics.
ILO 3	Explain how to search for research papers on mathematical physics topics, read and summarize them, and thereafter communicate the main ideas to an intelligent but non-expert audience.

Course Content

The course will consist of 6 seminars on an assortment of mathematical physics topics, given by speakers invited by the two course co-coordinators. These seminars will comprise one-hour of talk given by the speakers, and another one hour of Q&A. There will also be 10-15 presentations by students in the course, each comprising a 20-min talk given by a student, and another 5 mins of Q&A. You are required to ask at least one question in each seminar. There is plenty of time to do so, since enrolment will be limited to 10-15 PHMS students in each cohort. Questions submitted in the form of emails after the seminar, and after deeper reflection, will also be accepted. You will also write a term paper over the semester. This will be assessed in four stages: (1) a 1-page proposal giving the topic, explaining why it is important, and include 2-3 important references; (2) a 4-page progress report elaborating on the importance of the selected topic, and a preliminary survey of the literature with an expanded bibliography of 5-10 references; (3) a 10-page full report expanding on the literature survey, and an outlook detailing 2-3 future research directions; and (4) a 25-min presentation of the term paper to the PH4511 class.

Reading and References (if applicable)

No designated reading and reference for this course. You will be reading up on different books and journal papers depending on the topic they pick.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Seminar 1	1,2		In-person	
2	Seminar 2	1,2		In-person	
3	Briefing for Term Paper Proposal	1-3		In-person	
4	Seminar 3	1,2		In-person	Submit Proposal
5	Seminar 4	1,2		In-person	
6	Seminar 5	1,2		In-person	
7	Briefing for Term Paper Progress Report	1-3		In-person	
8	Seminar 6	1,2		In-person	Submit Progress Report
9	Presentation for Final Term Paper	1,2		In-person	
10	Presentation for Final Term Paper	1,2		In-person	
11	Presentation for Final Term Paper	1,2		In-person	
12	Presentation for Final Term Paper	1,2		In-person	
13	Presentation for Final Term Paper	1-3		In-person	Submit Final Report

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Seminars (12 hours)	6 seminars by invited speakers, distributed between theoretical physicists and mathematical physicists, to expose you to the use of sophisticated mathematical structures in physics. Each seminar will consist of one hour of talk by the speaker, and another hour of Q&A by the audience and you. The Q&A is to encourage you to think about the talk on the spot, and learn how to ask meaningful questions. However, we allow you to submit questions via email after the talk, and would include such questions for grading.
Term Paper & Presentation (14 hours)	In Week 3, we will not have a seminar, but a briefing on the expectations on the overall term paper. Specifically, we will explain how to find a topic to read up on, how to find the most important papers on the topic, and how to argue for the importance of the topic. In Week 7, we will again use the seminar time to brief you on the expectations of the progress report. In particular, we will explain to you how to incorporate comments from the proposal to fully flesh out the Introduction, how to find more relevant papers, and how to synthesize advances described in these papers into a coherent whole. Thereafter, from Week 9 to Week 13, you will do a 25-min individual presentation on your topic. You are expected to treat these in the same way as seminars given by invited speakers, and engage your peers through asking questions. For the proposal and progress report, we aim to develop your scholarship and communication skills. For the final report and presentation, we aim to develop your communication and presentation skills.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Class Participation(Q&A)	1,2		10	In this assessment component, you will ask each guest or student speaker a question after their presentation. This should be for clarifying any doubt that you might have on definitions, or where the mathematics can be applied to physics.	Individual	Analytic	Multistructural

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
2	Continuous Assessment (CA): Report/Case study(Proposal)	1,2,3		10	In this assessment component, you are to identify a topic where mathematics can be applied to physics, to write a short 2-page proposal consisting of an Introduction to explain why the application of a particular type of mathematics to physics is important, a Literature Survey summarising 3-5 papers describing the mathematics, and a Reference section listing these papers.	Individual	Holistic	Multistructural

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
3	Continuous Assessment (CA): Report/Case study(Progress Report)	1,2,3		20	In this assessment component, you will expand on the topic identified for your term paper, by elaborating on the Introduction you wrote for the proposal, and expand your literature review to 10-15 papers, including some on the application of the mathematics to physics problems. You should also include an Outlook section to describe what else you would include in your final report and presentation.	Individual	Holistic	Multistructural

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
4	Continuous Assessment (CA): Report/Case study(Final Report)	1,2,3		30	In this assessment component, you will finalise your arguments in the Introduction section on why the mathematics is important for the physics problem. You will also consolidate and properly synthesise your literature survey of 20-30 papers, including more physics papers, before replacing the Outlook section in the progress report to a proper Conclusions section.	Individual	Holistic	Multistructural

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
5	Continuous Assessment (CA): Presentation(Presentation)	1,2,3		30	This assessment component is done before the final report submissions, and the aim is two-fold. First, you will learn from the guest speakers on how to present a talk on the application of mathematics to physics problems. Second, through the Q&A session with coordinators and other students, you will gather feedback to improve your final report.	Individual	Holistic	Multistructural

Description of Assessment Components (if applicable)

Formative Feedback

To get you to learn how to ask questions during seminars, we will post your scores after every seminar. We grade these questions out of a maximum of 2 per seminar. If you asked no questions, you will receive 0 mark for that seminar. If you asked a simple question for clarification purposes, you will receive 1 mark for the seminar. You will receive 2 marks if you asked a question that seeks to link the mathematics to physics. If you asked multiple questions, we will note each question and its reply. We will provide the list of all questions (and their replies) to the speaker, and ask him/her to classify the questions. Your Q&A score for a given seminar will be the highest mark given to any of your questions. We will also track your performance for this assessment item over the semester, and provide guidance if you are not doing well.

The overall aim of the term paper and presentation is for you to improve your communication skills. For this purpose, we require submissions at three stages in the writing of the term paper. For the proposal, we require you to pick the topic you

would like to work on, explain why it is important, and identify the most important references you should read for the rest of the term paper. Feedback will be given on your choice of topic, how compelling the explanations are, and whether you have picked the most important references to start from. For the progress report, we require you to identify more references, and start summarizing them. Based on this tentative summary and the proposal feedback, you should improve the Introduction explaining the importance of the topic. We will provide a second round of feedback for this Introduction, to suggest final improvements. We will also feedback on the tentative summary, to educate you on the finer points on literature survey. For the final report, we expect you to have finalized your conclusions and your literature reviews, and also a short conclusion incorporating an outlook on a few future research directions. Our feedback on this final report will focus on whether your literature review is thorough and well thought through, and whether it makes convincing connections between the mathematics reviewed and the physics they believe it can be applied to.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Adaptability	Basic
Communication	Advanced
Curiosity	Intermediate
Information Literacy	Intermediate
Critical Thinking	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 attend all seminars, and participate actively in the Q&A.

Policy (Absenteeism)

Absence from seminars without a valid reason will affect your overall course 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).

Absence Due to Medical or Other Reasons
If you are sick and not able to attend a seminar, please submit a copy of your Medical Certificate (or another relevant document) to the school to obtain official leave. In this case, your seminar grade will be pro-rated based on the seminars you attended. There are no make-up seminars.

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

Rubric for Q&A (10%)

Criteria	0 mark	1 mark	2 marks
Q&A	No questions asked, or question asked not relevant to seminar	Question asked only to clarify definitions or remarks made by speaker	Question asked insightful, with the goal to link the mathematics to its applications in physics
		Total:	/2

Rubric for Term Paper Proposal (10%)

Criteria	Far Exceed Expectations (10)	Exceed Expectations (8-9)	Meet Expectations (6-7)	Below Expectations (4-5)	Far Below Expectations (0-3)
Significance of Topic	Able to explain masterfully what topic is about, and compelling why it is important.	Able to explain masterfully what topic is about, and why it is important.	Able to explain what topic is about, and why it is important.	Able to explain what topic is, but not why it is important.	Not able to explain what topic is, nor why it is important.
Work Done So Far	Able to describe most previous works on the topic, and synthesize them into a coherent body of work.	Able to describe many previous works on the topic.	Able to describe a few previous works on the topic.	Able to list previous works, but not able to describe the work done.	Not able to list previous works, not describe the work done.
Connections with Physics	Excellent explanation of how the topic is connected to physics	Good explanation of how the topic is connected to physics	Simple explanation of how the topic is connected to physics	Poor explanation of how the topic is connected to physics	No explanation of how the topic is connected to physics
				Total:	/30
				Weighted Total:	/10

Rubric for Term Paper Progress Report (20%)

Criteria	Far Exceed Expectations (10)	Exceed Expectations (8-9)	Meet Expectations (6-7)	Below Expectations (4-5)	Far Below Expectations (0-3)
Significance of Topic	Thorough explanations of the topic and its importance, based on comments given on the proposal. Injection of original ideas.	Thorough explanations of the topic and its importance, based on comments given on the proposal.	Expand on the explanation of the topic, and why it is important, based on comments given on the proposal.	Expand on the explanations of the topic or its importance, based on comments given on the proposal.	Did not expand on explanations.
Literature Survey	Thorough survey and synthesis of previous works on the topic, based on comments given on the proposal.	Thorough survey of previous works on the topic, based on comments given on the proposal.	Able to describe many previous works on the topic, based on comments given on the proposal.	Able to describe a few previous works on the topic, based on comments given on the proposal.	No improvements beyond proposal.
Ideas Behind Topic	Able to describe all the main ideas behind the topic, in your own words.	Able to describe all the main ideas behind the topic.	Able to describe most of the main ideas behind the topic.	Able to describe few of the main ideas behind the topic.	Not able to describe any ideas behind the topic.
Connection to Physics	Excellent explanation of how topic is connected to physics, including original ideas	Excellent explanation of how the topic is connected to physics, based on comments given on proposal.	Good explanation of how the topic is connected to physics, based on comments given on proposal.	Simple explanation of how the topic is connected to physics, based on comments given on proposal.	Little or no improvement to explanation, after comments on proposal.
Outlook	Excellent description of remaining work to be done, including	Excellent description of remaining work to be done	Clear description of remaining work to be done	Vague description of remaining work to be done	No description of remaining work to be done

	optional items that can be done if time is available				
				Total:	/50
				Weighted Total:	/20

Rubric for Term Paper Final Report (30%)

Criteria	Far Exceed Expectations (10)	Exceed Expectations (8-9)	Meet Expectations (6-7)	Below Expectations (4-5)	Far Below Expectations (0-3)
Significance of Topic	Excellent explanations of topic and its importance, including the use of original ideas and examples	Excellent explanations of the topic and its importance, based on comments given on the progress report.	Thorough explanation of the topic, and why it is important, based on comments given on the progress report.	Expand on the explanation of the topic, and why it is important, based on comments given on the progress report.	Did not expand on explanations.
Literature Survey	Excellent survey and synthesis of previous works on topic.	Thorough survey and synthesis of previous works on the topic, based on comments given on the progress report.	Thorough survey of previous works on the topic, based on comments given on the progress report.	Able to describe many previous works on the topic, based on comments given on the progress report.	No improvements beyond progress report.
Ideas Behind Topic	Able to describe and synthesize the main ideas behind topic, using your own words.	Able to describe all the main ideas behind the topic, based on comments given on the progress report, in your own words.	Able to describe all the main ideas behind the topic, based on comments given on the progress report.	Able to describe most of the main ideas behind the topic, based on comments given on the progress report.	No improvements beyond progress report.

Conclusions and Outlook	Excellent summary of topic reviewed. Excellent synthesis of possible future works.	Excellent summary of topic reviewed. Excellent description of possible future work.	Clear summary of topic reviewed. Clear description of possible future work.	Vague summary of topic reviewed. Vague description of possible future work.	Vague summary of topic reviewed. No description of possible future work.
References	Between 30 and 50 references	Between 20 and 30 references	About 20 references	Fewer than 20 references	Fewer than 10 references
				Total:	/50
				Weighted Total:	/30

Rubric for Term Paper Final Presentation (30%)

Criteria	Far Exceed Expectations (10)	Exceed Expectations (8-9)	Meet Expectations (6-7)	Below Expectations (4-5)	Far Below Expectations (0-3)
Overall Organization	Background of topic described in extreme depth, and includes original ideas. Excellent time management.	Background of topic described in great depth. Great time management.	Background of topic described in depth. Good time management.	Background of topic described at some depth. Below average time management.	Background of topic not described at any level of details. Poor time management.
Visual Presentation	Visuals very helpful to audience.	Visuals helpful to audience.	Visuals somewhat helpful to audience.	Visuals only of minor help to audience.	Visuals not helpful to audience.
Oral Presentation	Ideas presented very clearly, with illustrative examples. Besides required information, also provided additional	Ideas presented very clearly. All required information provided. No errors.	Ideas presented clearly. Most required information provided. Only minor errors.	Ideas mostly unclear. Provided some of required information. Some major errors.	Ideas not presented clearly. Provided little to none of required information about topic. Major errors.

	information. No errors.				
Q&A	Able to answer all questions showing mastery of topic. Extreme confidence in answering questions.	Able to answer all questions showing understanding of topic. Very confident in answering questions.	Able to answer most questions. Confident when answering questions.	Able to answer a few questions. Shows some confidence when answering questions.	Not able to answer questions. Not confident answering questions.
				Total:	/40
				Weighted Total:	/30