

<b>Academic Year</b>	2019/20	<b>Semester</b>	1
<b>Course Coordinator</b>	Asst. Prof. Liew Chi Hin Timothy		
<b>Course Code</b>	PH4421		
<b>Course Title</b>	Final Year Project		
<b>Pre-requisites</b>	12 AU of PH3XXX		
<b>Mutually Exclusive</b>	PH4405 Final Year Project, PH4407 Industrial Internship II, PH4413 Professional Internship, PH4415 Final Year Project, PH4417 Professional Internship, PH4701 OEP12, PH4702 OEP12, PH4703 OEP6, PH4704 OEP6, PH4900 Professional Internship I (Co-op), PH4901 Professional Internship II (Co-op)		
<b>No of AUs</b>	10AU		
<b>Contact Hours</b>	-		
<b>Proposal Date</b>	30 May 2019		

#### Course Aims

PH4421 Final Year Project aims to allow you to gain insights into the breadth and diversity of research work in Physics. You will learn to critically review scientific literature, systematically collect data, and logically analyze results in a selected specialized area of study. You will also develop and polish your oral and written communication skills. After going through the rigorous research process, you will be well-prepared for higher degree studies (M.Sc / Ph.D), or technically demanding and investigative work in the industries.

#### Intended Learning Outcomes (ILO)

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

1. determine appropriate research methodologies;
2. apply problem-solving and critical thinking skills in the research context;
3. analyse and critically review scientific literature such as journal papers;
4. analyze data in a systematic manner;
5. analyze, evaluate and interpret results;
6. explain findings in summarized form and justify your conclusions;
7. describe the significance of problems addressed through the writing of report and presentations;
8. explain and defend your work to reviewers.

<b>Course Content</b>					
<p>You will experience independent learning through research work in your chosen project field under the supervision of one or more professors. At the end of the project, you are required to produce a thesis report, give a seminar-style presentation, and undergo an in-person oral examination (viva).</p>					
<b>Assessment (includes both continuous and summative assessment)</b>					
<ul style="list-style-type: none"> <li>You will be assessed by supervisor(s) and examiner(s) from NTU.</li> </ul>					
<b>Component</b>	<b>Course LO tested</b>	<b>Related Programme LO or Graduate Attributes</b>	<b>Weighting</b>	<b>Team / Individual</b>	<b>Assessment Rubrics</b>
1. Presentation	LO 6-8	Communication (1,2) Competency (3,6,7)	20%	Individual	Rubrics marking-Appendix 1
2. Thesis Report	LO 1-7	Competency (1,2,3,4,5,6,7) Creativity (1,2) Communication (1,2)	20%	Individual	Rubrics marking-Appendix 2
3. Thesis Viva	LO 6-8	Communication (1,2) Competency (3,6)	20%	Individual	Rubrics marking-Appendix 3
4. Supervisor assessment of research experience demonstrated during FYP	LO 1-8	Creativity (1,2) Competency (1,2,3,4,5,6,7) Character (1,2,3) Civic-Mindedness (1) Communication (1,2,3)	40%	Individual	Rubrics marking-Appendix 4
Total			100%		
<b>Formative feedback</b>					
<p>You will receive formative feedback in written or verbal form from your supervisor(s) on the progress of your research project.</p>					
<b>Learning and Teaching approach</b>					
<b>Approach</b>	<b>How does this approach support students in achieving the learning outcomes?</b>				
<b>Active Learning</b>	<p>You will have the opportunity to learn to be responsible, independent, self-disciplined and self-motivated. You are expected to become better at managing your time, resources and emotions in this independent supervised research work. You would be acquiring critical and logical thinking skills, and creative problem-solving skills. You would gain confidence in your work and yourselves, and develop excellent oral and written communication skills. These skills would prepare you well for higher degree studies (M.Sc / Ph.D), or technically demanding and investigative work in the industries.</p>				

### Reading and References

Reading materials are dependent on the selected field of study and specific to each project. The supervising faculty will recommend reading materials, and you will be expected to carry out a comprehensive literature review as well.

### Course Policies and Student Responsibilities

#### 1. General

You are expected to complete all assigned readings and activities, attend all lab sessions/ research meetings punctually and complete all scheduled tasks by due dates. You are expected to take responsibility to follow up with notes, assignments and related announcements for research sessions you have missed. You are expected to participate in all research discussions and activities.

#### 2. Absenteeism

Absence from lab sessions/ research meetings without a valid reason will affect overall course grade. Valid reasons include Medical Certificate\* or Official Letter of Excuse.

#### 3. Compulsory Thesis Report, Thesis Viva and Presentation

Students are required to submit a thesis report. In addition, they will be required to give a presentation of their FYP and undergo a thesis viva. All these will have to be done by due dates set by supervisor(s). The scores will be included in the course assessment.

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

### 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

None; a faculty member appropriate to the chosen research topic will supervise the project.

### Planned Weekly Schedule

To be discussed and agreed on between you and your supervising faculty.

**Appendix 1: Examiner's Assessment Rubrics for Final Year Project Presentation**  
**Part I: Presentation (20%)**

	<b>Far Exceed Expectations (21-25)</b>	<b>Exceed Expectations in some areas (16-20)</b>	<b>Meet Expectations (11-15)</b>	<b>Meet Expectations in some areas (6-10)</b>	<b>Below Expectations (0-5)</b>	<b>Score</b>
<p><b>Overall Organization</b> (Did the student describe the background behind the project, framework for experimental, theoretical, or computational studies, emphasized the original results obtained and their significance, and concluded appropriately? Good time management?)</p>	<p><u>Absolutely significant.</u> Background behind project was <u>described in extreme depth and original concepts developed.</u> <u>Excellent time management.</u></p>	<p><u>Reasonably significant or had made non-trivial improvements</u> on existing ideas. Background behind project was <u>described in great depth.</u> <u>Great time management.</u></p>	<p><u>Not totally significant but had made some minor improvements</u> on existing ideas. Background behind project was <u>described in depth.</u> <u>Good time management.</u></p>	<p><u>Not totally significant but had made modifications (not necessarily improvements) on existing ideas.</u> Background behind project was <u>described in some depth.</u> <u>Below average time management.</u></p>	<p>The project was a <u>direct copy of (cited) existing ideas without the slightest modifications.</u> Background behind project was <u>not described in any depth.</u> <u>Poor time management.</u></p>	<b>/ 25</b>
<p><b>Visual Presentation</b> (Are the slides informative? Are review slides included? Are the slides too cluttered or too sparse?)</p>	<p>Visuals were <u>very helpful</u> to audience.</p>	<p>Visuals were <u>helpful</u> to audience.</p>	<p>Visuals were <u>somewhat helpful</u> to audience.</p>	<p>Visuals were <u>mostly unhelpful</u> to audience.</p>	<p>Visuals were <u>not helpful</u> to audience.</p>	<b>/ 25</b>
<p><b>Oral Presentation</b> (Was the presentation audible? Was it monotonous, or did the student inject emphases at key points? Was the relevant physics brought across clearly and concisely?)</p>	<p>Ideas were presented <u>very clearly.</u> Provided <u>more than the required</u> information about the project; <u>completely accurate.</u></p>	<p>Ideas were <u>presented clearly.</u> Provided <u>required</u> information about the project; <u>mostly accurate.</u></p>	<p>Ideas were presented <u>somewhat clearly</u> (i.e. generally able to follow but could be more precise, concise). Provided <u>most of the required</u> information about the project; <u>mostly accurate.</u></p>	<p>Ideas were <u>mostly unclear.</u> Provided <u>some of the required</u> information about the project; <u>some major errors.</u></p>	<p>Ideas were <u>not presented clearly.</u> Provided <u>little to none of the required</u> information about the project; <u>major errors.</u></p>	<b>/ 25</b>

	<b>Far Exceed Expectations (21-25)</b>	<b>Exceed Expectations in some areas (16-20)</b>	<b>Meet Expectations (11-15)</b>	<b>Meet Expectations in some areas (6-10)</b>	<b>Below Expectations (0-5)</b>	<b>Score</b>
<b>Q&amp;A</b> (Did the student understand the questions, and answer to the point? Was the student confident in his/her answer?)	<u>Very productive discussions and deep analyses;</u> critique extends beyond the requirements of the project into new scenarios.	<u>Productive discussions and analyses;</u> critique of how different aspects of the project interact with each other and their impact on the project.	<u>Adequate discussions and analyses;</u> critique of more than one aspect of the project, but unable to connect them.	<u>Little discussions and analyses;</u> critique involved only a single aspect of the project.	<u>No discussions, analyses or critique.</u>	<b>/ 25</b>
					<b>Total:</b>	<b>/ 100</b>

**Appendix 2: Examiner's Assessment Rubrics for Final Year Project Presentation**  
**Part II: Thesis Report (20%)**

	Far Exceed Expectations (21- 25)	Exceed Expectations in some areas (16-20)	Meet Expectations (11-15)	Meet Expectations in some areas (6-10)	Below Expectations (0-5)	Score
<p><b>Difficulty &amp; Originality</b> (Is the project a new initiative, or is it similar to a previous or ongoing project? Is setting up the experiment or analyzing the data challenging? Does the project involve very sophisticated theory, or does it require very heavy and challenging code development?)</p>	Project was <u>very challenging</u> in carrying out.	Project was <u>challenging</u> in carrying out.	Project was <u>moderately challenging</u> to carry out.	Project was <u>slightly challenging</u> to carry out.	Project was <u>not challenging at all</u> to carry out.	/ 25
<p><b>Effort</b> (Is the work done consistent with the required time for the project, i.e. 5 hours a week for 28 weeks?)</p>	Work done was <u>very consistent</u> with the required time for the project.	Work done was <u>consistent</u> with the required time for the project.	Work done was <u>somewhat consistent</u> with the required time for the project.	Work done was <u>mostly inconsistent</u> with the required time for the project.	Work done was <u>totally inconsistent</u> with the required time for the project.	/ 25
<p><b>Original Contribution</b> (Has the student designed or constructed equipment? Has the student developed theoretical models? Has the student written computer programmes?)</p>	<u>Absolutely original and groundbreaking.</u>	<u>Not totally original</u> but had made <u>non-trivial improvements</u> on existing ideas.	<u>Not totally original</u> but had made <u>some minor improvements</u> on existing ideas.	<u>Not totally original</u> but had made <u>modifications</u> (not necessarily improvements) on existing ideas.	The project was a <u>direct copy of existing ideas without the slightest modifications.</u>	/ 25

	<b>Far Exceed Expectations (21-25)</b>	<b>Exceed Expectations in some areas (16-20)</b>	<b>Meet Expectations (11-15)</b>	<b>Meet Expectations in some areas (6-10)</b>	<b>Below Expectations (0-5)</b>	<b>Score</b>
<p><b>Quality of Thesis</b>            (Is the thesis clear? Is the organization and prose coherent? Was a proper literature review conducted? Were the references properly cited? Is the error analysis appropriate? Are the figures and graphs informative? Supervisors should also take into account how much help the student needed to complete the thesis.</p>	<p><u>Very productive discussions and deep analyses;</u> critique extends beyond the requirements of the project into new scenarios.</p> <p><u>Very large number of cited works, both text and visual,</u> were present to support the ideas proposed in the thesis.</p>	<p><u>Productive discussions and analyses;</u> critique of how different aspects of the project interact with each other and their impact on the project.</p> <p><u>Large number of cited works, both text and visual,</u> were present to support the ideas proposed in the thesis..</p>	<p><u>Adequate discussions and analyses;</u> critique of more than one aspect of the project, but unable to connect them.</p> <p><u>Some cited works, both text and visual,</u> were present to support the ideas proposed in the thesis.</p>	<p><u>Little discussions and analyses;</u> critique involved only a single aspect of the project.</p> <p><u>Very few cited works, both text and visual,</u> were present to support the ideas proposed in the thesis..</p>	<p><u>No discussions, analyses or critique.</u></p> <p><u>Absence of any cited works,</u> both text and visual.,to support the ideas proposed in the thesis</p>	<b>/ 25</b>
					<b>Total:</b>	<b>/ 100</b>

**Appendix 3: Examiner's Assessment Rubrics for Final Year Project Presentation**  
**Part III: Thesis Viva (20%)**

	<b>Far Exceed Expectations (21-25)</b>	<b>Exceed Expectations in some areas (16-20)</b>	<b>Meet Expectations (11-15)</b>	<b>Meet Expectations in some areas (6-10)</b>	<b>Below Expectations (0-5)</b>	<b>Score</b>
<b>Understanding of Theory</b> (Did the student have a firm grasp of the physical theories behind the project? Does the student appreciate the motivation behind the project, and the significance of the study?)	Demonstrated <u>extremely thorough understanding</u> of the research project.	Demonstrated <u>thorough understanding</u> of the research project.	Demonstrated <u>considerable understanding</u> of the research project.	Demonstrated <u>limited understanding</u> of the research project.	Demonstrated <u>completely no understanding</u> of the research project.	<b>/ 25</b>
<b>Understanding of Implementation</b> (Did the student have a good understanding on the experimental design, instrumentation, data acquisition and analysis? Did the student have a good understanding of theoretical or computational frameworks and methods?)	Identifies, with an <u>extremely high degree</u> of understanding, how research skills and knowledge can be applied.	Identifies, with a <u>high degree</u> of understanding, how research skills and knowledge can be applied.	Identifies, with a <u>considerable degree</u> of understanding, how research skills and knowledge can be applied.	Identifies, with <u>some degree</u> of understanding, how research skills and knowledge can be applied.	Identifies, with <u>no degree</u> of understanding, how research skills and knowledge can be applied.	<b>/ 25</b>
<b>Independent &amp; Original Contribution</b> (Did the student receive any help from graduate students in the group? How much guidance did the student received from the supervisor? Did the student frequently inject original ideas into the project?)	Shares research ideas, and plans with an <u>extremely high degree of independency.</u>	Shares research ideas, and plans with a <u>high degree of independency.</u>	Shares research ideas, and plans with a <u>considerable degree of independency.</u>	Shares research ideas, and plans with <u>some degree of independency.</u>	Shares research ideas, and plans with <u>no degree of independency.</u>	<b>/ 25</b>

	<b>Far Exceed Expectations (21-25)</b>	<b>Exceed Expectations in some areas (16-20)</b>	<b>Meet Expectations (11-15)</b>	<b>Meet Expectations in some areas (6-10)</b>	<b>Below Expectations (0-5)</b>	<b>Score</b>
<b>Q&amp;A</b> (Was the student able to make educated guesses when asked open-ended questions? Did the student employ sound arguments in his/her reasoning?)	<u>Very productive discussions and deep analyses;</u> critique extends beyond the requirements of the project into new scenarios.	<u>Productive discussions and analyses;</u> critique of how different aspects of the project interact with each other and their impact on the project.	<u>Adequate discussions and analyses;</u> critique of more than one aspect of the project, but unable to connect them.	<u>Little discussions and analyses;</u> critique involved only a single aspect of the project.	<u>No discussions, analyses or critique.</u>	<b>/ 25</b>
					<b>Total:</b>	<b>/ 100</b>

**Appendix 4: Supervisor's Assessment Rubrics for Final Year Project Presentation (40%)**

	<b>Far Exceed Expectations (21-25)</b>	<b>Exceed Expectations in some areas (16-20)</b>	<b>Meet Expectations (11-15)</b>	<b>Meet Expectations in some areas (6-10)</b>	<b>Below Expectations (0-5)</b>	<b>Score</b>
<p><b>Initiative &amp; Motivation</b> (Did the student appear motivated to complete the tasks assigned to him/her? Did the student take the initiative to read up on project, and proactively clarify doubts with his/her supervisor and colleagues?)</p>	Demonstrated <u>extremely strong motivation and initiative</u> throughout the research project.	Demonstrated <u>strong motivation and initiative</u> throughout the research project.	Demonstrated <u>reasonably strong motivation and initiative</u> throughout the research project.	Demonstrated <u>a moderate amount of motivation and initiative</u> throughout the research project.	Demonstrated <u>a lack of motivation and initiative</u> throughout the research project.	<b>/ 25</b>
<p><b>Practical Ability and Creativity</b> (Did the student complete his/her assigned tasks satisfactorily? Did the student expect supervisor input for simple problems, or did the student come up with innovative solutions of his/her own?)</p>	<u>Completed all assigned tasks</u> , with an <u>extremely high degree</u> of understanding, how research skills and knowledge can be applied.	<u>Completed most of the assigned tasks</u> , with a <u>high degree</u> of understanding, how research skills and knowledge can be applied.	<u>Completed a considerable number of assigned tasks</u> , with a <u>considerable degree</u> of understanding, how research skills and knowledge can be applied.	<u>Completed a few of the assigned tasks</u> , with <u>some degree</u> of understanding, how research skills and knowledge can be applied.	<u>Completed none of the assigned tasks</u> , with <u>no degree</u> of understanding, how research skills and knowledge can be applied.	<b>/ 25</b>

<p><b>Personal Discipline</b>            (Did the student have a good management scheme for the data and calculations done for the project? Is the student neat, and focused on his/her work?)</p>	<p>Developed an <u>excellent</u> management scheme for the data and calculations done for the project.</p>	<p>Developed an <u>above average</u> management scheme for the data and calculations done for the project.</p>	<p>Developed an <u>average</u> management scheme for the data and calculations done for the project.</p>	<p>Developed a <u>below average</u> management scheme for the data and calculations done for the project.</p>	<p>Developed an <u>extremely bad</u> management scheme for the data and calculations done for the project.</p>	<p>/ 25</p>
	<p><b>Far Exceed Expectations</b>            (21-25)</p>	<p><b>Exceed Expectations in some areas</b>            (16-20)</p>	<p><b>Meet Expectations</b>            (11-15)</p>	<p><b>Meet Expectations in some areas</b>            (6-10)</p>	<p><b>Below Expectations</b>            (0-5)</p>	<p><b>Score</b></p>
<p><b>Group Dynamics</b>            (Did the student provide regular updates to his/her supervisor? Did the student work well with other members of the research group?)</p>	<p>Shares research ideas, and plans with an <u>extremely high degree of effectiveness.</u></p>	<p>Shares research ideas, and plans with a <u>high degree of effectiveness.</u></p>	<p>Shares research ideas, and plans with a <u>considerable degree of effectiveness.</u></p>	<p>Shares research ideas, and plans with <u>some degree of effectiveness.</u></p>	<p>Does not share research ideas, and plans with <u>extremely bad degree of effectiveness.</u></p>	<p>/ 25</p>
					<p><b>Total:</b></p>	<p>/ 100</p>

**Graduate Attributes**

**What we want our graduates from Physics and Applied Physics to be able to do:**

Upon the successful completion of the PHY, APHY and PHMA programs, graduates should be able to:

<b>Competency</b>	1	demonstrate a rigorous understanding of the core theories and principles of physics involving (but not limited to) areas such as classical mechanics, electromagnetism, thermal physics and quantum mechanics  [PHMA only] demonstrate a rigorous understanding of the core theories and principles of mathematical sciences involving (but not limited to) areas such as analysis, algebra and statistical analysis
	2	read and understand undergraduate level physics content independently;
	3	make educated guesses / estimations of physical quantities in general;
	4	apply fundamental physics knowledge, logical reasoning, mathematical and computational skills to analyse, model and solve problems;
	5	develop theoretical descriptions of physical phenomena with an understanding of the underlying assumptions and limitations;
	6	critically evaluate and distinguish sources of scientific/non-scientific information and to recommend appropriate decisions and choices when needed;
	7	demonstrate the ability to design and conduct experiments in a Physics laboratory, to make measurements, analyse and interpret data to draw valid conclusions.

<b>Creativity</b>	1	propose valid approaches to tackle open-ended problems in unexplored domains;
	2	offer valid alternative perspectives/approaches to a given situation or problem.

<b>Communication</b>	1	describe physical phenomena with scientifically sound principles;
	2	communicate (in writing and speaking) scientific and non-scientific ideas effectively to professional scientists and to the general public;
	3	communicate effectively with team members when working in a group.

<b>Character</b>	1	uphold absolute integrity when conducting scientific experiments, reporting and using the scientific results;
	2	readily pick up new skills, particularly technology related ones, to tackle new problems;
	3	contribute as a valued team member when working in a group.

<b>Civic Mindedness</b>	1	put together the skills and knowledge into their work in an effective, responsible and ethical manner for the benefits of society.
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