

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

16 credits

Q1 and Q2

Language :	English
Place of the course	Louvain-la-Neuve
Main themes	The Master's thesis is a formative activity that must lead the student to demonstrate his/her ability to : · deal in depth with a physics problem in all its real complexity by conducting a personal research, under the direction of a promoter ; · write a summary of his/her work and defend it in public in a rigorous and educational way, while being able to answer specific questions.
Aims	<p><b>a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M1)</b></p> <p>AA1: 1.1, 1.2, 1.3, 1.4, 1.5                  AA2: 2.1, 2.2, 2.3, 2.4, 2.5                  AA3: 3.1, 3.2, 3.3, 3.4                  AA4 : 4.1, 4.2                  AA5 : 5.1, 5.2, 5.3, 5.4                  AA6: 6.1, 6.2, 6.3, 6.4, 6.5                  AA7 : 7.1, 7.2, 7.3, 7.4, 7.5, 7.6                  1 A.A 8.1 et 8.2</p> <p><b>b. Specific learning outcomes of the teaching unit</b></p> <p>At the end of this teaching unit, the student will be able to :</p> <ol style="list-style-type: none"> <li>appropriate a scientific question and implement a research methodology to answer it ;</li> <li>select the existing relevant bibliography on the subject under study and correctly cite the sources of information ;</li> <li>critically read and summarize a scientific article ;</li> <li>imagine and develop a research strategy to carry out a substantial physics project in a timely manner ;</li> <li>interact with members of a research team ;</li> <li>evaluate and argue the validity of a physical result ;</li> <li>represent complex physical results in graphical form ;</li> <li>write a scientific report respecting the structure and style of the relevant field of physics ;</li> <li>present orally a research subject in physical sciences respecting the constraints of time and using an adequate visual support ;</li> <li>answer the asked questions accurately and concisely.</li> </ol> <p>-----</p> <p><i>The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".</i></p>
Evaluation methods	<p><b>Due to the COVID-19 crisis, the information in this section is particularly likely to change.</b></p> <p>The promoter, after consulting the readers, provides the President of the School of physics at least two working days before the date of the public defense of the Master's thesis with a provisional grade. This grade is based on the following criteria, each of which accounting for 25% : (1) quality of the writing of the manuscript, (2) importance of the student's personal work and scientific quality of the work, (3) degree of independence and initiative of the student, and (4) understanding of the subject and critical thinking of the student. At the end of the public defense, a short discussion takes place in the presence of a moderator (President of the School of physics). The grade awarded is then modulated according to the quality of the presentation and answers to the questions asked by the promoter, the readers and the rest of the audience.</p>
Teaching methods	<p><b>Due to the COVID-19 crisis, the information in this section is particularly likely to change.</b></p> <p>Realization by the student of a research project aimed at originality in physical sciences or didactics of physics under the guidance of a promoter. The different steps are : creation of a relevant bibliography on the subject, reading and understanding of the selected articles, implementation and execution of the project, analysis and interpretation of the results obtained, writing of a synthesis manuscript and oral presentation of the latter. To carry out this project, the student is immersed in a research group with which he can interact.</p>
Content	<b>Organization</b>

This teaching unit consists in the realization by the student of a research project aimed at originality in physical sciences supervised by a promoter, who guides him/her in solving the proposed problem. This project, which is substantial, is conducted in one of the UCL research institutes in which the academic members of the School of physics are assigned (ELI, IMCN, iMMC and IRMP), in one of the federal scientific institutes in which academic members of the School of physics work (Royal Observatory of Belgium and Institute of Space Aeronomy of Belgium) or in a private company. In the first two cases, the promoter is an academic member of the School of physics. In the third, he is a member of the host institution ; an academic member of the School of physics must, however, vouch for the quality of the project.

The student preferably makes contact with his/her teachers before the beginning of the academic year or, if this proves impossible, before the end of the first semester of this year in order to find a promoter and to fix the subject of this/her Master's thesis. This choice has to be endorsed by the Bureau of the School of physics.

Each promoter proposes to the President of the School of physics two names of potential readers for each of the Master's theses he supervises.

The Master's thesis is the subject of two oral presentations : the pre-defense and the defense.

- The pre-defense aims at helping the student to organize his/her results in order to write the final text and possibly to complete his work on minor points. The student is asked to present his/her work in English or French in front of the promoter, the readers and all the interested persons. The presentation lasts about half an hour and is followed by an in-depth discussion. This pre-defense must be held no later than two weeks before the start of the June exam session, or one week before the start of the September exam session if the Master's thesis is presented at this session. The date is fixed in agreement with the promoter and the readers. Students are requested to communicate to the secretariat of the School of physics this date as well as the room where the pre-defense will take place.
- The defense is public. It is done in English or French (the choice of language is made in agreement with the promoter), lasts 15 minutes and is followed by a 15 minute discussion with the promoter (who is invited to ask only one question), the readers and the rest of the audience. It is held on the Monday of the last week of the June exam session, or the September session if the Master's thesis is presented at this session.

Two copies of the manuscript of the Master's thesis will be deposited at the secretariat of the School of physics no later than two weeks before the public defense. The student is responsible for giving a copy to his/her promoter and his/her readers

#### ***Presentation of the manuscript***

The manuscript of the Master's thesis, which can be written in English or French (the choice of language is made in agreement with the promoter), usually includes about thirty pages. It must be printed double-sided and have no plastic cover. Explanatory annexes in addition to the main text, but brief, are tolerated. Any voluminous appendix (details of experimental results and measurements, computer codes of numerical simulations, ...) must be strictly electronic.

The cover must include the following information :

- Université catholique de Louvain
- Faculty of sciences
- School of physics
- Host research institute
- Host research centre
- UCL's logo
- Title of the Master's thesis
- First name and last name of the student
- First names and last names of the promoter and readers
- Thesis presented in view of obtaining the Master's [60] degree in physics
- Academic year 20xx-20yy

#### ***Recommendations***

The organization of the Master's thesis can vary according to the promoter. In some cases, the student works throughout the year directly with his/her promoter. In other cases, he/she will be more often brought to work daily with PhD students or post-doctoral researchers. In all cases, the promoter remains the reference contact on scientific subjects, since it is under his/her direction that the work is done.

It is the responsibility of the student to be regularly present in the host research centre and to solicit discussions with his/her promoter, and it is the responsibility of the promoter to be sufficiently available. As a marker for the promoter, holding a one-hour meeting every one to two weeks is considered normal.

At the beginning of the research work, the student will often be required to devote time to bibliographic research. Many tools are available for this purpose. He/she should not hesitate to inquire with PhD students and post-doctoral researchers.

If his/her work involves experimental measurements and/or numerical simulations, the student will be required to interact with technical staff and/or computer scientists. It should be remembered that their time is divided between multiple tasks of supporting research and teaching. The promoter can provide guidelines for this.

The student is also asked to make thoughtful use of resources (consumables and printing).

The promoter intervenes on the front line in case of personal disputes. In case of litigation with the promoter, the student can contact the President of the School of physics and inform him of the problem.

	<p>The student is advised to keep a personal notebook.</p> <p>A discussion of a scientific nature with the promoter must always precede the writing of the manuscript of the Master's thesis. That said, the first chapters can sometimes be written very early. The difficulty of writing should not be underestimated. PhD students, post-doctoral researchers and promoters will often make numerous remarks (accuracy, grammatical correctness, clarity, referencing, graphics) before a final version. Careful re-readings, spaced one or two days apart, before submitting a version to the promoter, often save a lot of time.</p>
Bibliography	<p>Un portefeuille de lecture minimum est communiqué à l'étudiant.e au début du mémoire.</p>
Other infos	<p>The organization of the Master's thesis can vary according to the promoter. In some cases, the student works throughout the year directly with his/her promoter. In other cases, he/she will be more often brought to work daily with PhD students or post-doctoral researchers. In all cases, the promoter remains the reference contact on scientific subjects, since it is under his/her direction that the work is done.</p> <p>It is the responsibility of the student to be regularly present in the host research centre and to solicit discussions with his/her promoter, and it is the responsibility of the promoter to be sufficiently available. As a marker for the promoter, holding a one-hour meeting every one to two weeks is considered normal.</p> <p>At the beginning of the research work, the student will often be required to devote time to bibliographic research. Many tools are available for this purpose. He/she should not hesitate to inquire with PhD students and post-doctoral researchers.</p> <p>If his/her work involves experimental measurements and/or numerical simulations, the student will be required to interact with technical staff and/or computer scientists. It should be remembered that their time is divided between multiple tasks of supporting research and teaching. The promoter can provide guidelines for this.</p> <p>The student is also asked to make thoughtful use of resources (consumables and printing).</p> <p>The promoter intervenes on the front line in case of personal disputes. In case of litigation with the promoter, the student can contact the President of the School of physics and inform him of the problem.</p> <p>The student is advised to keep a personal notebook.</p> <p>A discussion of a scientific nature with the promoter must always precede the writing of the manuscript of the Master's thesis. That said, the first chapters can sometimes be written very early. The difficulty of writing should not be underestimated. PhD students, post-doctoral researchers and promoters will often make numerous remarks (accuracy, grammatical correctness, clarity, referencing, graphics) before a final version. Careful re-readings, spaced one or two days apart, before submitting a version to the promoter, often save a lot of time.</p>
Faculty or entity in charge	<p>PHYS</p>

<b>Programmes containing this learning unit (UE)</b>				
Program title	Acronym	Credits	Prerequisite	Aims
Master [60] in Physics	PHYS2M1	16		