UCL Université catholique de Louvain

# LMAT1321

*2015-2016*

# Functional analysis and partial differential equations

| 7.0 credits | 45.0 h + 45.0 h | 1q |
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| Teacher(s) : | Willem Michel ; |
| Language : | Français |
| Place of the course | Louvain-la-Neuve |
| Inline resources: | Site iCampus ( > http://icampus.uclouvain.be/claroline/course/index.php?cid=MAT1321).<br><br>The textbook « Functional Analysis. Fundamentals and Applications » is<br><br>available online. |
| Prerequisites : | & mp;lt;!--{cke_protected}{C}%3C!%2D%2D%0A%20%2F*%20Font%20Definitions%20*%2F%0A%40font-face%0A%09%7Bfont-family%3A%22Cambria%20Math%22%3B%0A%09panose-1%3A2%204%205%203%205%204%206%203%202%204%3B%0A%09mso-font-charset%3A0%3B%0A%09mso-generic-font-family%3Aauto%3B%0A%09mso-font-pitch%3Avariable%3B%0A%09mso-font-signature%3A3%200%200%200%201%200%3B%7D%0A%40font-face%0A%09%7Bfont-family%3A%22%E3%83%92%E3%83%A9%E3%82%AE%E3%83%8E%E8%A7%92%E3%82%B4%20Pro%20W3%22%3B%0A%09mso-font-charset%3A0%3B%0A%09mso-generic-font-family%3Aroman%3B%0A%09mso-font-pitch%3Aauto%3B%0A%09mso-font-signature%3A0%200%200%200%200%200%3B%7D%0A%20%2F*%20Style%20Definitions%20*%2F%0Ap.MsoNormal%2C%20li.MsoNormal%2C%20div.MsoNormal%0A%09%7Bmso-style-unhide%3Ano%3B%0A%09mso-style-qformat%3Ayes%3B%0A%09mso-style-parent%3A%22%22%3B%0A%09margin%3A0cm%3B%0A%09margin-bottom%3A.0001pt%3B%0A%09mso-pagination%3Awidow-orphan%3B%0A%09font-size%3A12.0pt%3B%0A%09font-family%3A%22Times%20New%20Roman%22%3B%0A%09mso-fareast-font-family%3A%22Times%20New%20Roman%22%3B%0A%09mso-bidi-font-family%3A%22Times%20New%20Roman%22%3B%0A%09mso-ansi-language%3AEN-US%3B%0A%09mso-fareast-language%3AEN-US%3B%7D%0Ap.CorpsA%2C%20li.CorpsA%2C%20div.CorpsA%0A%09%7Bmso-style-name%3A%22Corps%20A%22%3B%0A%09mso-style-unhide%3Ano%3B%0A%09mso-style-parent%3A%22%22%3B%0A%09margin%3A0cm%3B%0A%09margin-bottom%3A.0001pt%3B%0A%09mso-pagination%3Awidow-orphan%3B%0A%09font-size%3A12.0pt%3B%0A%09mso-bidi-font-size%3A10.0pt%3B%0A%09font-family%3AHelvetica%3B%0A%09mso-fareast-font-family%3A%22%E3%83%92%E3%83%A9%E3%82%AE%E3%83%8E%E8%A7%92%E3%82%B4%20Pro%20W3%22%3B%0A%09mso-bidi-font-family%3A%22Times%20New%20Roman%22%3B%0A%09color%3Ablack%3B%0A%09mso-ansi-language%3AFR%3B%7D%0A.MsoChpDefault%0A%09%7Bmso-style-type%3Aexport-only%3B%0A%09mso-default-props%3Ayes%3B%0A%09font-size%3A10.0pt%3B%0A%09mso-ansi-font-size%3A10.0pt%3B%0A%09mso-bidi-font-size%3A10.0pt%3B%7D%0A%40page%20WordSection1%0A%09%7Bsize%3A612.0pt%20792.0pt%3B%0A%09margin%3A70.85pt%2070.85pt%2070.85pt%2070.85pt%3B%0A%09mso-header-margin%3A36.0pt%3B%0A%09mso-footer-margin%3A36.0pt%3B%0A%09mso-paper-source%3A0%3B%7D%0Adiv.WordSection1%0A%09%7Bpage%3AWordSection1%3B%7D%0A%2D%2D%3E--& mp;gt;<br>Cours LMAT1121, LMAT1122, LMAT1131, LMAT 1221 (or equivalents).<br>*The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.* |
| Main themes : | Banach, Hilbert, Lebesgue, and Sobolev spaces, dual spaces, elliptic problems. |
| Aims : | Contribution of the course to learning outcomes in the Bachelor in Mathematics programme. By the end of this activity, students will have made progress in:<br>By the end of the programme, the graduate is able to:<br>1) recognise and understand a basic foundation of mathematics.<br>Choose and use the basic tools of calculation to solve mathematical problems.<br>Recognise the fundamental concepts of important current mathematical theories.<br>Establish the main connections between these theories, analyse them and explain them through the use of examples.<br>2) identify, by use of the abstract and experimental approach specific to the exact sciences, the unifying features of different situations and experiments in mathematics or in closely related fields (probability and statistics, physics, computing).<br>3) show evidence of abstract thinking and of a critical spirit.<br>Argue within the context of the axiomatic method Recognise the key arguments and the structure of a proof.<br>Construct and draw up a proof independently.<br>Evaluate the rigour of a mathematical or logical argument and identify any possible flaws in it.<br>Distinguish between the intuition and the validity of a result and the different levels of rigorous understanding of this same result.<br>4) be clear, precise and rigorous in communicating.<br>Write a mathematical text in French according to the conventions of the discipline.<br>Structure an oral presentation in French, highlight key elements, identify techniques and concepts and adapt the presentation to the listeners' level of understanding.<br>Communicate in English (level C1 for reading comprehension, level B2 for listening comprehension and for oral and written expression, CEFR). |

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| | 5) learn in an independent manner.<br>Find relevant sources in the mathematical literature.<br>Read and understand an advanced mathematical text and locate it correctly in relation to knowledge acquired.<br><br>Learning outcomes specific to the course. By the end of this activity, students will be able to:<br>-Use functional spaces to solve analytical problems,<br>- Use the basic principles of functional analysis.<br>- Identify the natural norm or inner product to solve analytical problems.<br>- Define the natural notion of weak solutions.<br>- Identify dual spaces.<br><br>*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".* |
| Evaluation methods : | Assessment is based on a written examination that focuses on theory and on exercises. The examination tests knowledge and understanding of fundamental concepts and results, ability to construct and write a coherent argument, and mastery of the techniques of calculation. |
| Teaching methods : | Learning activities consist of lectures and exercise sessions.The lectures aim to introduce fundamental concepts, to explain them by showing examples and by determining their results, to show their reciprocal connections and their connections with other courses in the programme for the Bachelor in Mathematics. The exercise sessions aim to teach how to select and use calculation methods and how to construct proofs. The two activities are given in presential sessions. |
| Content : | The lectures on Functional Analysis are devoted to the basic properties of the main functional spaces and their use to solve elliptic problems. They are devoted to the main abstract tools and their applications. The main parts of the lectures are:<br>-Norms and inner products.<br>-Banach and Hilbert spaces.<br>-Convex sets and functions.<br>-Lebesgue spaces.<br>-Dual spaces |
| Bibliography : | The textbook « Functional Analysis. Fundamentals and Applications » is available online. |
| Faculty or entity in charge: | MATH |

## Programmes / formations proposant cette unité d'enseignement (UE)

| Intitulé du programme | Sigle | Credits | Prerequis | Acquis d'apprentissage |
|---|---|---|---|---|
| Minor in Mathematics | LMATH100I | 7 | - |  |
| Bachelor in Mathematics | MATH1BA | 7 | LMAT1121 **and** LMAT1122 **and** LMAT1131 **and** LMAT1221 |  |