**Faculty of Sciences**

| MATH2 | Licence en sciences mathématiques (Diploma of the Second Cycle (Licence) in Mathematical Sciences) |
|---|---|

**Programme management**

**MATH** Département de mathématique
**Responsable académique :**Yves Félix
**Contact :**Martine Everard

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**Admission procedure**

The regular conditions and admission procedures are detailed on the web page "Access to studies" :
http://www.ucl.ac.be/etudes/libres/acces.html

**General structure of the programme**

The second cycle of university studies, ("licence") programme in Mathematical Sciences offers three orientations : the classical orientation, the statistics orientation and the mathematical economics orientation. The only students entitled access to the mathematical economics orientation are those who have followed a course on mathematical economics on their MATH 12 programme.

The statistics and mathematical economics orientations are characterised by the presence of a certain number of advanced courses in the corresponding speciality ; they also foster the orientation of the thesis towards the selected speciality. All orientations lead to the same "licencié" degree in Mathematical Sciences.

**Programme content**

### MATH21    First year

**Core courses**

| MATH2171 | A préciser (in French) | |
|---|---|---|
| MATH2480 | Differential geometry[30h+15h] (5 credits)1q (in French) | Yves Félix, Luc Haine, Pierre Van Moerbeke |
| MATH2430 | A préciser (in French) | |
| MATH2111 | A préciser (in French) | |
| SC2140 | Questions of religious sciences[15h] (1 credits)1q (in French) | José Reding |

*This course will be followed in the 1st or2nd year.*

*The students who do not take or pass the oral expression test in English will take the following course :*

| ANGL2461 | Anglais - expression orale pour les mathématiciens[30h] (2 credits)2q | Françoise Stas |
|---|---|---|

**1. Specific programme for the classical orientation**

**A. Compulsory courses**

*Besides the common courses, the students will follow the below-listed compulsory courses :*

| MATH2112 | A préciser (in French) | |
|---|---|---|
| MATH2120 | A préciser (in French) | |
| INMA2325 | A préciser (in French) | |
| PHYS2111 | Introduction to non-linear dynamics[30h+22.5h] (4.5 credits)2q (in French) | Jean Bricmont, Luc Haine |

**B.Options**

*In addition, the students will take courses from the following list, for a total of at least 16 ECTS.*

**1. Algebra - Geometry - Logic**

| MATH2121 | Galois Theory[30h] (3 credits) ⊕ 2q (in French) | Francis Borceux |
|---|---|---|

| MATH2391 | Theory of categories (First part)[22.5h] (2.5 credits)2q (in French) | Francis Borceux, Enrico Vitale (coord.) |
| MATH2392 | Theory of categories (Second part)[22.5h] (2.5 credits)2q (in French) | Francis Borceux, Enrico Vitale (coord.) |
| MATH2450 | Mathematical logic[45h] (4.5 credits)1+2q (in French) | Jean-Roger Roisin |
| MATH2130 | Riemannian geometry[22.5h] (2.5 credits) ⚠ 1q (in French) | N. |

**2 Analysis - Mechanics**

| MATH2401 | Lie groups[22.5h+7.5h] (2.5 credits) ⚠ 2q (in French) | N. |
| MATH2460 | A préciser (in French) | |

**3. Physics**

| PHYS2121 | A préciser (in French) | |
| PHYS2122 | Theoretical and mathematical physics II[22.5h+15h] (3 credits) ⚠ 2q (in French) | N. |
| PHYS2131 | Sperical astronomy and mathematical astronomy[22.5h+15h] (3 credits)1q (in French) | Pascale Defraigne, Jean-Pascal van Ypersele de Strihou |
| PHYS2140 | Internal geophysics[22.5h+15h] (3 credits)1q (in French) | Thierry Camelbeeck, Véronique Dehant |
| PHYS2143 | A préciser (in French) | |

*The Mathematics Department can authorise the registration of another course or seminar of the Physics "licence" on the student's programme.*

**4. Probability- Statistics - Operational Research**

| INMA2471 | Optimization models and methods[30h+22.5h] (5 credits) ⚠ 2q (in French) | François Glineur |
| MATH2440 | Statistical analysis[30h+22.5h] (5 credits)2q (in French) | Ingrid Van Keilegom, Rainer von Sachs |
| STAT2416 | Multivariate probabilities ans statistics[10h+5h] (2.5 credits) (in French) | Ingrid Van Keilegom |

**5. Numerical Analysis**

| INMA2380 | Matrix theory[30h+22.5h] (5 credits)2q (in French) | Paul Van Dooren |
| INMA1170 | Numerical analysis[22.5h+30h] (5 credits)1q (in French) | Pierre-Antoine Absil, Paul Van Dooren, Paul Van Dooren |

**6. Computer Studies**

| INGI2101 | A préciser (in French) | |
| LINF2121 | A préciser (in French) | |
| LINF2125 | Projet de programmation : application de gestion[0h+60h] (6 credits) ⚠ (in French) | Marco Saerens |

**2. Specific programme for the Statistics orientation**

**A. Compulsory courses**

*Besides the courses common to the three orientations, the students will follow the compulsory courses listed below :*

| MATH2440 | Statistical analysis[30h+22.5h] (5 credits)2q (in French) | Ingrid Van Keilegom, Rainer von Sachs |
| INMA2380 | Matrix theory[30h+22.5h] (5 credits)2q (in French) | Paul Van Dooren |
| INMA2471 | Optimization models and methods[30h+22.5h] (5 credits) ⚠ 2q (in French) | François Glineur |
| PHYS2111 | Introduction to non-linear dynamics[30h+22.5h] (4.5 credits)2q (in French) | Jean Bricmont, Luc Haine |
| STAT2411 | Data Analysis[22.5h+7.5h] (5 credits)1q (in French) | Isabelle De Macq (supplée Léopold Simar), Léopold Simar |
| STAT2412 | Linear models[22.5h+7.5h] (5 credits)2q (in French) | Christian Hafner |
| STAT2416 | Multivariate probabilities ans statistics[10h+5h] (2.5 credits) (in French) | Ingrid Van Keilegom |
| STAT2430 | Statistical computing[20h+20h] (7 credits)1q (in French) | Bernadette Govaerts |

**3. Specific programme for the Mathematical Economics orientation**

*Besides the courses common to the three orientations, the students will follow the compulsory courses listed below :*

| PHYS2111 | Introduction to non-linear dynamics[30h+22.5h] (4.5 credits)2q (in French) | Jean Bricmont, Luc Haine |
| MATH2440 | Statistical analysis[30h+22.5h] (5 credits)2q (in French) | Ingrid Van Keilegom, Rainer von Sachs |
| ECON2115 | Micro-economics[60h+30h] (12 credits) (in French) | Jacques-François Thisse |
| INMA2325 | A préciser (in French) | |
| ECON2125 | Macro-economics[60h+30h] (12 credits)1+2q (in French) | David De la Croix, Frédéric Docquier |

MATH22     Second year

*The students must present a thesis (MATH 2999). The choice of a thesis director must be approved by the Mathematics Departement by the third week of the first quadrimester of the second year, at the latest. The preparation of the thesis is equivalent to about 25 credits. The thesis readers are appointed by the Mathematics Departement by the beginning of the 2nd quadrimester of the 2nd year, at the latest. The list of thesis readers will be communicated to the jury secretary.*

## A. Core courses
**Philosophical teachings :**

| | | |
|---|---|---|
| SC2001 | Introduction to contemporary philosophy[30h] (2 credits)2q (in French) | Mark Hunyadi |

*or*

| | | |
|---|---|---|
| SC2220 | Philosophy of science[30h] (2 credits)2q (in French) | Michel Ghins |
| MATH2190 | Mathematical methodology[30h] (3 credits)1q (in French) | Michel Willem |
| MATH2900 | Mathematics Seminar[30h] (3 credits)1+2q (in English) | Camille Debiève, Yves Félix, Alphonse Magnus |

*This seminar is organised in the context of the "Language plan".*

| | | |
|---|---|---|
| SC2140 | Questions of religious sciences[15h] (1 credits)1q (in French) | José Reding |

*This course will be followed in the 1st or 2nd year, according to choice..*

## B. Options

| | | |
|---|---|---|
| SC2002 | Elements of mathematics and physics history[30h] (4.5 credits)1q (in French) | Patricia De Grave |

**1. Algebra - Geometry - Logic**

| | | |
|---|---|---|
| MATH2230 | Algebraical topology[45h] (5 credits)1q (in French) | Yves Félix, Pascal Lambrechts |
| MATH2380 | Number theory[30h] (3 credits)1q (in French) | Jean-Jacques Quisquater, Jean-Pierre Tignol |
| MATH2350 | Cryptography[22.5h] (2.5 credits)2q (in French) | Jean-Jacques Quisquater |
| MATH2220 | Greater geometry[30h] (3 credits)1q (in French) | N. |
| MATH2450 | Mathematical logic[45h] (4.5 credits)1+2q (in French) | Jean-Roger Roisin |
| MATH2121 | Galois Theory[30h] (3 credits) ⊕ 2q (in French) | Francis Borceux |
| MATH2130 | Riemannian geometry[22.5h] (2.5 credits) ⌁ 1q (in French) | N. |
| MATH2391 | Theory of categories (First part)[22.5h] (2.5 credits)2q (in French) | Francis Borceux, Enrico Vitale (coord.) |
| MATH2392 | Theory of categories (Second part)[22.5h] (2.5 credits)2q (in French) | Francis Borceux, Enrico Vitale (coord.) |
| MATH2395 | Discrete mathematics - combinatorial strucutres[30h] (3 credits)2q (in French) | Philippe Delsarte, Jean-Pierre Tignol |

**2. Analysis - Mechanics**

| | | |
|---|---|---|
| MATH2200 | Infinitesimal analysis (complements)[45h] (5 credits)2q (in French) | Thierry De Pauw, Thierry De Pauw |
| MATH2401 | Lie groups[22.5h+7.5h] (2.5 credits) ⌁ 2q (in French) | N. |
| MATH2410 | Differential topology[30h] (3 credits)1q (in French) | Pierre Van Moerbeke |
| MATH2420 | Complex analytic functions[30h] (3 credits)1q (in French) | Pierre Van Moerbeke |
| MATH2421 | Convex analysis and calculation of variations[30h] (3 credits)1q (in French) | Michel Willem |
| MATH2490 | ??? ordinary or partial differential equations[45h] (4.5 credits)1q (in French) | Jean Mawhin |
| INMA2335 | A préciser (in French) | |
| INMA2345 | Differential Equations : boundary value problems[30h] (3 credits)2q (in French) | Denis Bonheure |

**3. Physics**

| | | |
|---|---|---|
| PHYS2140 | Internal geophysics[22.5h+15h] (3 credits)1q (in French) | Thierry Camelbeeck, Véronique Dehant |
| PHYS2143 | A préciser (in French) | |
| PHYS2144 | Universe models[15h] (1.5 credits)2q (in French) | Jean-Marc Gérard |
| PHYS2290 | A préciser (in French) | |

**4. Probability- Statistics - Operational research**

| | | |
|---|---|---|
| MATH2370 | Theory of games[22.5h] (2 credits)1q (in French) | Jean-François Mertens |
| MATH2360 | Stochastic processes (statistics)[30h] (3.5 credits)1q (in French) | Jean-Marie Rolin |
| MATH2372 | Stochastic processes[30h] (3 credits)1q (in French) | Jean-François Mertens |
| MATH2440 | Statistical analysis[30h+22.5h] (5 credits)2q (in French) | Ingrid Van Keilegom, Rainer von Sachs |
| INMA2450 | Combinatorial optimization[30h+15h] (4 credits)1q (in French) | Laurence Wolsey |

| INMA2460 | Optimization : Nonlinear programming[30h+15h] (4 credits)2q (in French) | Yurii Nesterov |
|---|---|---|
| INMA2470 | Discrete stochastic models[30h+22.5h] (5 credits)1q (in French) | Philippe Chevalier |
| STAT2411 | Data Analysis[22.5h+7.5h] (5 credits)1q (in French) | Isabelle De Macq (supplée Léopold Simar), Léopold Simar |
| STAT2412 | Linear models[22.5h+7.5h] (5 credits)2q (in French) | Christian Hafner |
| STAT2416 | Multivariate probabilities ans statistics[10h+5h] (2.5 credits) (in French) | Ingrid Van Keilegom |

**5. Numerical Analysis - Computer Studies**

| MATH2830 | Numerical analysis seminar[30h] (2 credits)1q (in French) | Alphonse Magnus, Paul Van Dooren |
|---|---|---|
| INMA2710 | Numerical algorithms[30h+15h] (4 credits)1q (in French) | Paul Van Dooren |
| INGI2123 | A préciser (in French) | |
| INGI2131 | A préciser (in French) | |
| INGI2132 | Languages and translators[30h+30h] (5 credits) ⌐ 2q (in French) | Baudouin Le Charlier (coord.), Peter Van Roy |
| SINF1252 | Introduction to computer systems[30h+30h] (5 credits)2q (in French) | Marc Lobelle |
| MATH2180 | Numerical analysis II[45h] (4.5 credits)1+2q (in French) | Alphonse Magnus |

**Specific programme for the classical orientation**

*Besides the core courses, the students will take a minimum of 27 credits from the list below, spread over two or three of the five course titles. The activities chosen under any course heading may not surpass 20 credits. A seminar will be subject to examination or a graded piece of work.*

*The Mathematics Department may authorise the registration of a course or seminar not featuring on the list below on the minimal programme of the student, equivalent to 30 hours ; this course will be of a mathematical level analogous to that of those courses. The Mathematics Department may also authorise the registering of a course or seminar chosen from the UCL programmes on the minimal programme of the student.*

*The content of the MATH2392 and MATH2450 courses changes each year. These courses feature on the programme of the first and second year. They may be taken as options both in the first and the second year of the programme.*

**Specific programme for the Statistics orientation**

**A. Compulsory courses**

*Besides the common courses, the students will take the following compulsory courses :*

| MATH2360 | Stochastic processes (statistics)[30h] (3.5 credits)1q (in French) | Jean-Marie Rolin |
|---|---|---|
| STAT2410 | Discrete data analysis.[22.5h+7.5h] (5 credits)2q (in French) | Patrick Bogaert |
| STAT2413 | Non parametric statistics[22.5h+7.5h] (5 credits)1q (in French) | Ingrid Van Keilegom |
| STAT2414 | Times series[22.5h+7.5h] (5 credits)1q (in French) | Rainer von Sachs |

**B. Free-choice courses**

*7 credits, from among :*

| ACTU2111 | Non life Insurance I[30h+15h] (4.5 credits)1q (in French) | Antoine Delwarde (supplée Michel Denuit), Antoine Delwarde (supplée Michel Denuit), Michel Denuit |
|---|---|---|
| INMA2470 | Discrete stochastic models[30h+22.5h] (5 credits)1q (in French) | Philippe Chevalier |
| MATH2372 | Stochastic processes[30h] (3 credits)1q (in French) | Jean-François Mertens |
| STAT2415 | Introduction to Bayesian statistics.[15h] (2.5 credits)2q (in French) | N. |
| STAT2510 | Statistical quality control.[15h] (2.5 credits)2q (in French) | Bernadette Govaerts |
| STAT2520 | Design of experiment.[22.5h+7.5h] (5 credits)2q (in French) | Bernadette Govaerts, Éric Le Boulengé |
| STAT2530 | Statistics in clinical trials.[22.5h+7.5h] (5 credits)2q (in French) | Annie Robert |
| STAT2540 | Survey and Sampling[15h] (2.5 credits)2q (in French) | Yves Berger |
| STAT2550 | Data Mining[15h+15h] (5 credits)2q (in French) | Libei Chen |

**C. Options**

*The minimum option is for 6 credits, to be chosen from one or two of the four following titles :*

*1. Algebra, Geometry - Logic*

*2.Analysis - Mechanics*

*3.Physics*

*5. Numerical Analysis - Computer Studies*

**Specifc programme for the Mathematical Economics orientation**
**A. Compulsory courses**
*Besides the common courses, the students will take the following compulsory courses :*

| | | |
|---|---|---|
| MATH2421 | Convex analysis and calculation of variations[30h] (3 credits)1q (in French) | Michel Willem |
| ECON2135 | Econometrics: methods and applications[45h+45h] (12 credits) (in French) | Luc Bauwens |
| ECON2238 | Financial economics[30h] (4 credits)1q (in French) | Pierre Giot |
| ECON2243 | Game and Information Theory[30h] (4 credits)1q (in French) | Hylke Vandenbussche |

**B. Free-choice courses**
*One course to be chosen from among :*

| | | |
|---|---|---|
| ECON2244 | General Equilibrium Theory[30h] (4 credits)1q (in French) | François Maniquet |
| ECON2245 | Econometrics[30h+15h] (4 credits)2q (in French) | Luc Bauwens |
| ECON2247 | Growth and Development[30h] (4 credits)2q (in French) | Raouf Boucekkine |
| MATH2360 | Stochastic processes (statistics)[30h] (3.5 credits)1q (in French) | Jean-Marie Rolin |
| MATH2372 | Stochastic processes[30h] (3 credits)1q (in French) | Jean-François Mertens |

**C. Options**
*The minimum option is for 6 credits, to be chosen from one or two of the four following courses :*
*1.Algebra - Geometry - Logic*
*2. Analysis - Mechanics*
*3. Physics*
*5. Numerical Analysis - Computer Studies*

## Positioning of the degree within the University cursus

The three orientations may be prolonged by third study cycle (masters) programmes, extended study diplomas and PhDs, either in the same speciality or in a complemetary speciality. For example :
- the DEA in Pure and Applied Mathematics (for research in mathematics)
- the master's programme in statistics, the DES and DEA programmes in Statistics (for an initiation or perfection in the domain of statistics)
- the master's programme in Actuarial Sciences
- the DES in Applied Sciences, orientation : Computer Studies
- the DEA in Economic Sciences, the DES in Econometrics, and the DES in Financial Economics, for "licence" diploma holders in Mathematics coming from the Mathematical Economics orientation.

The "licence" diploma holders in Mathematical Sciences from the Statistics orientation may, in addition, obtain the DES in Statistics in one year instead of two.

The "licence" diploma holders in Mathematical Sciences who have added a certain number of Computer Studies courses to their programme, are entitled access to the second year of the "licence" programme in Computer Studies (orientation : General Computer Studies) in line with certain procedures still to be specified (please address the secretary's office of the MATH Department or the programme manager for the "licence" in Computer Studies).