Calcul différentiel et intégral I

Lecturers
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Course mnemonic
MATH-F101

ECTS credits
15 credits

Language(s) of instruction
French

Course period
First and second terms

Campus
Plaine

Course content

First semester :

- Introduction and motivations.
- Real numbers.
- Convergence of real sequences.
- Convergence of series.
- For one variable functions :
  - limits,
  - continuity and properties of continuous functions : extreme value theorem, interval theorem, inverse function theorem, intermediate value theorem,
  - derivability, mean value theorem, polynomial approximation, extrema, l'Hospital's rule,
  - construction of the Riemann integral,
  - fundamental theorem of analysis.

Second semester :

- Differential equations.
- Generalisation to multivariable functions of what has been taught for one variable functions.
- Curves and curve integrals.
- Surfaces and vector analysis.
- The Stokes, Green and divergence theorems.
- The Banach fixed point theorem, the inverse function theorem and the implicit function theorem.

Objectives (and/or specific learning outcomes)

First part of a course whose objective is to introduce various ideas, methods and tools which are basic in mathematics and in physics.

After this teaching unit, a student will be able

- Solve certain simple differential equations.
- Deduce properties the real numbers from their axioms.
- Determine is a sequence or a series does converge and, if it does, to which number.
- Decide if a function admits a limit when such or such parameter tends to a certain value, and what is its value.
- Show that functions coming from various contexts are or are not continuous.
- Compute the directional derivatives, the gradient, the curve integral of a function described by an analytic expression.
- Apply the fundamental theorem of analysis in various situation.
- Master notions such as the convergence of sequences and series, the continuity, the derivability and the integrability of a function of one or several variables, the resolution of differential equations of the first or second order, implicit and inverse functions, Lagrange multipliers integration along a curve or a surface.

Pre-requisits and co-requisits

Courses having this one as pre-requisit

MATH-F201 | Calcul différentiel et intégral II | 10 crédits, MATH-F204 | Mécanique analytique | 10 crédits, MATH-F211 | Topologie | 5 crédits, MATH-F306 | Optimisation | 5 crédits and PHYS-F201 | Thermodynamique | 5 crédits

Required knowledge and skills

The material is covered in depth from the start. Nevertheless, a habit of mathematical reasoning is an essential asset.

Teaching method and learning activities

- Courses in class (4 hours per week).
- Exercise sessions with an assistant (2 hours per week) and small groups working sessions (2 hours per week).

Contribution to the teaching profile

Acquérir et exploiter un savoir

1. S'approprier les concepts fondamentaux en mathématique.
2. Assimiler les notions de base en analyse.
3. Maîtriser les principes du raisonnement logique et être capable de fonder sur ceux-ci une argumentation sans faille.

Comprendre les spécificités de la démarche scientifique et la pratiquer

1 Comprendre des critères de rigueur, une argumentation, des techniques de démonstration.

2 Comprendre comment se dégage un concept à partir d'observations, d'exemples.

3 Comprendre un processus d'abstraction et son rôle dans le développement d'une théorie.

4 Comprendre le rôle parfois simplificateur du processus de généralisation d'une théorie.

5 Comprendre l'intérêt de l'unification de théories existantes.

6 Identifier des questions qui se posent au sein d'une théorie.

7 Explorer les conséquences d'un résultat mathématique.

Communiquer

1 Concevoir et rédiger avec rigueur un résultat ou une théorie mathématique.

2 Utiliser un langage clair et rigoureux, adapté au public-cible.

Éthique et relation avec la société

1 Apprendre à pratiquer l'autocritique relativement à la validité d'un argument.

References, bibliography and recommended reading

Syllabus available on the *Université virtuelle* (UV). The paper version is available at the PUB.

Other references :

- Amann, Herbert ; Escher, Joachim. Analysis I. Birkhäuser Verlag, Basel, 2005.
- Amann, Herbert ; Escher, Joachim. Analysis II. Birkhäuser Verlag, Basel, 2008.
- Amann, Herbert ; Escher, Joachim. Analysis III. Birkhäuser Verlag, Basel, 2009.
- Mawhin, Jean. Analyse : Fondements, techniques et évolution, 2e édition, De Boeck Université, 1997.
- Protter, Murray H. A first course in real analysis, Springer, 1991.
- Tao, Terence. Analysis I. Texts and Readings in Mathematics, 37. Hindustan Book Agency, New Delhi, 2006. 24, 29, 31
- Tao, Terence. Analysis II. Texts and Readings in Mathematics, 38. Hindustan Book Agency, New Delhi, 2006.

Course notes

Podcast, Syllabus and Université virtuelle

Other information

Place(s) of teaching

Plaine

Contact(s)

Mélanie Bertelson (2.O7.111) - Melanie.Bertelson@ulb.be (Q1)

Bruno Premoselli (2.O7.102) - Bruno.premoselli@ulb.be (Q2).

Evaluation method(s)

written examination

Evaluation method(s) (additional information)

All information is to be found on the UV page of the course. In brief:

- An optional test is organised during the *semaine tampon*, on October 30. It is aimed at introducing the students to the kind of expectation their professors have.
- The knowledge of the material covered during the first semester (theory and exercises) is evaluated in January via a 3 hours long written exam on campus.
- The knowledge of the material covered during the second semester (theory and exercises) is evaluated in May or June via a 3 hours long written exam on campus.
- For students who have failed the course at the end of the June examination period, a written exam is organised in August or September.

Determination of the mark (including the weighting of partial marks)

The final note is the average of the notes obtained for the two semesters, provided both are larger than or equal to 7/20. Else, the final note cannot be larger than 7/20.

The detailed rules for constructing the final note is available on UV.

Main language(s) of evaluation

French

Programmes

Programmes proposing this course at the faculty of Sciences

BA-MATH | Bachelor in Mathematics | unit 1 and BA-PHYS | Bachelor in Physics | unit 1