# THEORY OF ELLIPTIC CURVES AND ITS APPLICATIONS II

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| 1 | Course Title: | THEORY OF ELLIPTIC CURVES AND ITS APPLICATIONS II | |
| 2 | Course Code: | MAT6112 | |
| 3 | Type of Course: | Optional | |
| 4 | Level of Course: | Third Cycle | |
| 5 | Year of Study: | 1 | |
| 6 | Semester: | 2 | |
| 7 | ECTS Credits Allocated: | 5.00 | |
| 8 | Theoretical (hour/week): | 3.00 | |
| 9 | Practice (hour/week): | 0.00 | |
| 10 | Laboratory (hour/week): | 0 | |
| 11 | Prerequisites: | none | |
| 12 | Language: | Turkish | |
| 13 | Mode of Delivery: | Face to face | |
| 14 | Course Coordinator: | Prof. Dr. OSMAN BİZİM | |
| 15 | Course Lecturers: | Prof. Dr. Osman Bizim | |
| 16 | Contact information of the Course Coordinator: | Uludağ Üniversitesi, Fen-Edebiyat Fakültesi<br>Matematik Bölümü, Görükle Bursa-TÜRKİYE 0 224 294 17 57 / obizim@uludag.edu.tr | |
| 17 | Website: | | |
| 18 | Objective of the Course: | The theory of elliptic curves brings important areas of mathematics such as abstract algebra, number theory and related fields. The aim of this course is to make the students get all connections among all these areas. The goal is to teach the elementary theory of elliptic curves. So students can bring new ideas the theory of elliptic curves and have the ability conduct original research and independent publication. | |
| 19 | Contribution of the Course to Professional Development: | | |
| 20 | Learning Outcomes: | | |
| | | **1** | Learn the elliptic curves over C, construction of elliptic functions, analytic and algebraic maps. |
| | | **2** | Learn Elliptic curves over global fields, heights on elliptic curves, the rank of an elliptic curve. |
| | | **3** | Learn Siegel's theorem, Shafarevich's theorem and Roth's theorem. |
| | | **4** | Learn computing the Mordell-Weil group an examples. |
| | | **5** | Learn algorithmic aspects of elliptic curves and Lenstra's elliptic curve algorithm. |
| | | **6** | Learn cohomology of finite groups and Galois cohomology, non abelian cohomology. |
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| 21 | Course Content: | | |
| | **Course Content:** | | |

| Week | Theoretical | Practice |
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| **1** | Algebraic varieties and maps between varieties, algebraic curves and maps between them. | |
| **2** | The Riemann-Roch theorem, the geometry of elliptic curves, Weiestrass's equations, isogenies, dual isogenies. | |
| **3** | Endomorphism rings and the automorphism groups, the formal group of an elliptic curve, formal logarithm. | |
| **4** | Formal groups in characteristic p, elliptic curves over finite fields, the Weil conjecture, calculating the Hasse invariant. | |
| **5** | Elliptic curves over C, construction of elliptic functions, analytic and algebraic maps. | |
| **6** | Elliptic curves over local fields, minimal Weierstrass equations, reductions and points of finite order. | |
| **7** | Elliptic curves over global fields, heights on elliptic curves, the rank of an elliptic curve. | |
| **8** | Siegel's theorem, Shafarevich's theorem and Roth's theorem. | |
| **9** | Computing the Mordell-Weil group an examples. | |
| **10** | The Selmer and Shafarevich-Tate groups. | |
| **11** | The twists of elliptic curves and applications over some family of elliptic curves. | |
| **12** | Algorithmic aspects of elliptic curves and Lenstra's elliptic curve algorithm. | |
| **13** | Elliptic curves in characteristics 2 and 3. | |
| **14** | Cohomology of finite groups and Galois cohomology, non abelian cohomology. | |

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| **22** | Textbooks, References and/or Other Materials: | [1] Rational Points on Elliptic Curves, J. H. Silverman ve J. Tate,<br>[2]The Arithmetic of Elliptic Curves, J. H. Silverman,<br>[3]Elliptic Curves, L. C. Washington.<br>[4] Introduction to Elliptic Curves and Modular Forms, N. Koblitz. |
| **23** | Assesment | |

| **TERM LEARNING ACTIVITIES** | **NUMBER** | **WEIGHT** |
|---|---|---|
| Midterm Exam | 0 | 0.00 |
| Quiz | 0 | 0.00 |
| Homeworks, Performances | 0 | 0.00 |
| Final Exam | 1 | 100.00 |
| Total | 1 | 100.00 |
| Contribution of Term (Year) Learning Activities to Success Grade | | 0.00 |
| Contribution of Final Exam to Success Grade | | 100.00 |
| Total | | 100.00 |
| Measurement and Evaluation Techniques Used in the Course | | |

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| **24** | **ECTS / WORK LOAD TABLE** |

| Activites | Number | Duration (hour) | Total Work Load (hour) |
|---|---|---|---|
| Theoretical | 14 | 3.00 | 42.00 |
| Practicals/Labs | 0 | 0.00 | 0.00 |
| Self study and preperation | 14 | 5.00 | 70.00 |
| Homeworks, Performances | 0 | 0.00 | 0.00 |
| Projects | 0 | 0.00 | 0.00 |
| Field Studies | 0 | 0.00 | 0.00 |
| Midterm exams | 0 | 0.00 | 0.00 |
| Others | 14 | 5.00 | 70.00 |
| Final Exams | 1 | 13.00 | 13.00 |
| Total Work Load | | | 195.00 |
| Total work load/ 30 hr | | | 6.50 |
| ECTS Credit of the Course | | | 5.00 |

| 25 | CONTRIBUTION OF LEARNING OUTCOMES TO PROGRAMME QUALIFICATIONS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PQ1 | PQ2 | PQ3 | PQ4 | PQ5 | PQ6 | PQ7 | PQ8 | PQ9 | PQ10 | PQ11 | PQ12 | PQ13 | PQ14 | PQ15 | PQ16 |
| ÖK1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| ÖK2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| ÖK3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| ÖK4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| ÖK5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| ÖK6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| LO: Learning Objectives PQ: Program Qualifications | | | | | | | | | | | | | | | | |
| Contribution Level: | 1 very low | | 2 low | | 3 Medium | | 4 High | | 5 Very High | | | | | | | |