**SYLLABUS**

1. **GENERAL**

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| **SCHOOL** | Applied Economic and Social Sciences |
| **SECTION** | Regional and Economic Development |
| **LEVEL OF STUDIES**  | Undergraduate |
| **COURSE CODE** | 6505 | **SEMESTER OF STUDY** | 5 ο |
| **COURSE TITLE** | [Real Analysis for Economists](https://www.reddit.com/r/academiceconomics/comments/rxlfsn/how_does_real_analysis_relate_to_economics/)  |
| **TEACHER** | Dimitris Tsiotas |
| **INDEPENDENT TEACHING ACTIVITIES** *where credit is awarded for discrete parts of the course e.g. lectures, laboratory exercises, etc. If credit is awarded for the whole course, indicate the weekly teaching hours and the total number of credits* | **WEEKLY TEACHING HOURS** | **TEACHING/CREDIT UNITS** |
| Lectures | 4 | 5 |
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| *Add rows if necessary. The teaching organisation and the teaching methods used are described in detail in 4.* |  |  |
| **TYPE OF COURSE***Background , General Knowledge, Scientific Area, Skills Development* | Scientific Area Course |
| **PREREQUISITE COURSES:** |  |
| **LANGUAGE OF TEACHING AND EXAMINATION:** | Greek |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** |  |
| **ELECTRONIC COURSE PAGE (URL)** | The course will be presented together with notes and other supporting material in the https://oeclass.aua.gr/eclass/ |

1. **LEARNING OUTCOMES**

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| **Learning Outcomes** |
| *The learning outcomes of the course are described as the specific knowledge, skills and competences of an appropriate level that students will acquire after successful completion of the course.**Consult Annex A* * *Description of the Level of Learning Outcomes for each cycle of study according to the Qualifications Framework of the European Higher Education Area*
* *Descriptive Indicators for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning*

*and Annex B** *Learning Outcomes Writing Comprehensive Guide*
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| Knowledge:* To Know and understand fundamental concepts of Real Analysis.

Competencies:* Το distinguish the concepts of metric and topological space and multidimensional spaces.
* To know the mathematical methods and techniques used in the study of metric and topological spaces.
* To become familiar with sequences and series of functions.
* To know the theory concerning the completeness of metric spaces and its importance for some important existence theorems in analysis.
* To understand important concepts in Economic Theory using mathematical methods.
* To use mathematical methods in economic modeling/standardization.

Skills:* To have exercised their inductive, creative and associative thinking and perception in the study of economic phenomena and problems, through the study of problems in metric and topological spaces and relating or connecting them to relevant theoretical approaches in economics, probability theory and regional science.
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| **General skills** |
| *Taking into account the general competences that the graduate should have acquired (as listed in the Diploma Supplement and listed below), which one(s) does the course aim at?* |
| ***Search, analysis and synthesis of data and information, using the necessary technologies*** *Adapting to new situations* ***Decision-making*** *Autonomous work* *Teamwork* *Working in an international environment* *Working in an interdisciplinary environment* ***Generating new research ideas***  | *Project planning and management* *Respect for diversity and multiculturalism* ***Respect for the natural environment*** *Demonstrate social, professional and ethical responsibility and sensitivity to gender issues* *Exercise of criticism and self-criticism* ***Promoting free, creative and inductive thinking*** |
| Search, analysis and synthesis of data and information, also using the necessary technologiesPromotion of free, creative and inductive thinkingGenerating new research ideasAdaptation to new situationsDecision making |

1. **COURSE CONTENT**

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| Real numbers, Numerable and supernumerary sets, Sequences and series of numbers, Representations of real numbers, Elements of set theory, Cantor's set and function, Topological spaces, Metric spaces, Spaces with norm, Open and closed sets, Interior and closure (closed case) of a set, Accumulation points, Derivative set, Types of real functions (monotone, blocked wavelet, absolutely continuous, convex, etc.), Types of real functions (monotone, blocked wavelet, absolutely continuous, convex, etc.) etc.), Sequences in metric spaces. Sequences and series of functions, Uniform convergence and applications, Sequences and series of functions, Uniform convergence, The fixed point theorem, Complexity, Compact metric spaces, Continuity, Uniform continuity, Lipschitz functions, Derivation and integration of sequences and series of functions, Consequential spaces, Continuous function spaces, Topology of uniform convergence, Applications to Economics and Regional Science |

1. **TEACHING and LEARNING METHODS - EVALUATION**

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| **METHOD OF DELIVERY***Face-to-face, Distance learning, etc.* | Lectures and meetings with students  |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES***Use of ICT in Teaching, Laboratory Training, Communication with students* | Working with complex functional relationships and graphs (using Mathematica/open source programs). - Use of PowerPoint for lectures and eClass.- Email contact with students for clarifications about the course either directly or via video conferencing (Zoom, Microsoft Teams, Skype). |
| **ORGANISATION OF TEACHING***The way and methods of teaching are described in detail.**Lectures, Seminars, Laboratory Exercise, Field Exercise, Study & Analysis of Literature, Tutoring, Practical (Placement), Clinical Exercise, Artistic Workshop, Interactive teaching, Educational visits, Study visits, Project work, Writing work / assignments, Artistic creation, etc.**The student's study hours for each learning activity as well as the hours of unguided study are indicated so that the total workload at semester level corresponds to the ECTS standards.* |

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| ***Activity*** | ***Semester workload*** |
| Lectures | 52 hours |
| Laboratory exercises | 52 hours |
| Study of course material (material taught) | 21 hours |
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| Course Total | 125 hours |

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| **STUDENT ASSESSMENT** *Description of the evaluation process**Language of Evaluation, Evaluation Methods, Formative or Inferential, Multiple Choice Test, Multiple Choice Test, Short Answer Questions, Test Development Questions, Problem Solving, Written Work, Report, Oral Examination, Oral Examination, Public Presentation, Laboratory Work, Clinical Examination of a Patient, Artistic Interpretation, Other**Explicitly identified assessment criteria are stated and if and where they are accessible to students.* | Final written examination without the use of books or notes. Optional written progress during the semester. |

1. **RECOMMENDED-BIBLIOGRAPHY**

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| **Basic textbooks:**1. Walter Rudin, (2000) Principles of Mathematical Analysis. Translation by Demosthenes Stalidis, Leader Books.
2. Skoutaris, N. (2016) Real Analysis, Korfiatis.
3. K. Stathakopoulos (1999) Pragmatic Analysis, Aithra Publications.
4. D. Betsakos (2016) Introduction to Real Analysis, Kyriakidis Bros.
5. P. Xenikakis, (1995) Pragmatic Analysis, Ziti Publications.
6. Georgiou D., Eliadis S., Megaritis A. (2018) Real Analysis, 3rd Edition, Tziola.
7. Anousis M., Tsolomytis A., Felouzis B. (2014) Real Analysis, S. Athanasopoulos & Co.

**Foreign Language Bibliography**1. Gerald B. Folland, (1999) Real Analysis, Modern Techniques and Their Applications, Second Edition, John Wiley and Sons, Inc.
2. Manfred Stoll. (2001) Introduction to Real Analysis, Second Edition, Addison Wesley.
3. Tom Apostol. (1985) Mathematical Analysis. Second Edition, Addison Wesley publishing company.
4. Ok, E. A. (2011). Real analysis with economic applications. Princeton University Press.

*Indicative bibliography*1. Feudel, F., & Biehler, R. (2021). Students’ understanding of the derivative concept in the context of mathematics for economics. Journal für Mathematik-Didaktik, 42(1), 273-305.
2. Amiel, Y., & Cowell, F. (1994). Monotonicity, dominance and the Pareto principle. Economics Letters, 45(4), 447-450.
3. Jordan, G. J., & Fortin, M. J. (2002). Scale and topology in the ecological economics sustainability paradigm. Ecological Economics, 41(2), 361-366.
4. Murota, K. (2016). Discrete convex analysis: A tool for economics and game theory. Journal of Mechanism and Institution Design, 1(1), 151-273.
5. Carfi, D. (2007). S-Linear Algebra in Economics and Physics. Applied sciences, 9.
6. Navascués, M. A., Rajan, P., & Chand, A. K. B. (2022). Binary Operations in Metric Spaces Satisfying Side Inequalities. Mathematics, 10(1), 11.
7. Jleli, M., & Samet, B. (2018). On a new generalization of metric spaces. Journal of Fixed Point Theory and Applications, 20(3), 1-20.
8. Kawamura, A., Steinberg, F., & Ziegler, M. (2016, July). Complexity theory of (functions on) compact metric spaces. In 2016 31st Annual ACM/IEEE Symposium on Logic in Computer Science (LICS) (pp. 1-10). IEEE.
9. Frolkina, O. (2020). All projections of a typical Cantor set are Cantor sets. Topology and its Applications, 281, 107192.
10. Golmankhaneh, A. K., & Balankin, A. S. (2018). Sub-and super-diffusion on Cantor sets: Beyond the paradox. Physics Letters A, 382(14), 960-967.
11. Swaminathan, A., & Sivaraja, S. (2020). Fuzzy maximal, minimal open and closed sets. Advances in Mathematics: Scientific Journal, 9, 7741-7747.
12. Mukharjee, A. (2017). More on maximal, minimal open and closed sets. Communications of the Korean Mathematical Society, 32(1), 175-181.
13. Chen, T., & Sun, W. (2020). Iterated weak and weak mixed-norm spaces with applications to geometric inequalities. The Journal of Geometric Analysis, 30(4), 4268-4323.
14. Reijonen, A. (2019). Derivatives of inner functions in weighted mixed norm spaces. The Journal of Geometric Analysis, 29(3), 1859-1875.
15. Ahmed, A., & Kamal, A. (2015). Series expansions on some analytic function spaces. Journal of Computational and Theoretical Nanoscience, 12(8), 1586-1593.
16. Wang, M. K., Chu, Y. M., & Zhang, W. (2019). Monotonicity and inequalities involving zero-balanced hypergeometric function. Math. Inequal. Appl, 22(2), 601-617.
17. Chen, X., & Christensen, T. M. (2015). Optimal uniform convergence rates and asymptotic normality for series estimators under weak dependence and weak conditions. Journal of Econometrics, 188(2), 447-465.
18. Gardiner, S., & Manolaki, M. (2016). A convergence theorem for harmonic measures with applications to Taylor series. Proceedings of the American Mathematical Society, 144(3), 1109-1117.
19. Drapeau, S., Jamneshan, A., Karliczek, M., & Kupper, M. (2016). The algebra of conditional sets and the concepts of conditional topology and compactness. Journal of Mathematical Analysis and Applications, 437(1), 561-589.
20. Lawson, J., Wu, G., & Xi, X. (2020). Well-filtered spaces, compactness, and the lower topology. Houst. J. Math, 46(1), 283-294.
21. Mahanta, S., & Samanta, S. K. (2017). Compactness in multiset topology. Int. J. Math. Trends Tech.(IJMTT), 47, 275-282.
22. Dovgoshey, O., & Shcherbak, V. (2022). The range of ultrametrics, compactness, and separability. Topology and its Applications, 305, 107899.

 *Indicative Articles*1. Anderson, R. M. (1991). Non-standard analysis with applications to economics. Handbook of mathematical economics, 4, 2145-2208.
2. Royden, H. L., & Fitzpatrick, P. (1988). Real analysis (Vol. 32). New York: Macmillan.
3. Bartle, R. G., & Sherbert, D. R. (2000). Introduction to real analysis (Vol. 2). New York: Wiley.
4. Folland, G. B. (1999). Real analysis: modern techniques and their applications (Vol. 40). John Wiley & Sons.
5. Aliprantis, C. D., & Burkinshaw, O. (1998). Principles of real analysis. Gulf Professional Publishing.
6. Kolmogorov, A. N., & Fomin, S. V. (1975). Introductory real analysis. Courier Corporation.
7. Stein, E. M., & Shakarchi, R. (2009). Real analysis. Princeton University Press.
8. Finkenstadt, B., & Rootzén, H. (Eds.). (2003). Extreme values in finance, telecommunications, and the environment. CRC Press.
9. Sydsæter, K., Hammond, P., Seierstad, A., & Strom, A. (2008). Further mathematics for economic analysis. Pearson education.
10. Judd, K. L. (1998). Numerical methods in economics. MIT press.
11. Carter, M. (2001). Foundations of mathematical economics. MIT press.
12. Roberts, F. S. (1978). Graph theory and its applications to problems of society. Society for industrial and applied mathematics.
13. Rockafellar, R. T. (1974). Conjugate duality and optimization. Society for Industrial and Applied Mathematics.
14. McLennan, A. (2018). Advanced fixed point theory for economics (Vol. 25). Singapore: Springer

*Related scientific journals*Real Analysis Exchange (Michigan State University Press)Journal of Algebra (Academic Press Inc)Journal of Mathematical Economics (Elsevier)Mathematical and Financial Economics (Springer)Journal of Pure and Applied Algebra (Elsevier)Linear and Multilinear Algebra (Taylor & Francis)Communications in Algebra (Taylor & Francis)Topology and its Applications (Elsevier)Advances in Mathematics (Elsevier)Handbook of Algebra (Elsevier)Algebra and Logic (Springer)Algebraic and Geometric Topology (Mathematical Sciences Publishers) |