Department of Mathematics-College of Science

Salahaddin University/Erbil

Subject: Mathematical Analysis I

Course Book – (3rd Class)

Lecturer's name: Ibrahim O. Hamad

Academic Year: 2023-2024 -- First semester

Course Book

1. Course name	**Mathematical Analysis I**
2. Lecturer in charge	Ibrahim Othman Hamad
3. Department/ College	Mathematics / Science
4. Contact	e-mail :ibrahim.hamad@su.edu.krd Tel: (optional) 07504630477
5. Time (in hours) per week	For example Theory: 3 Practical:
6. Office hours	Wensday and Thursday G-A(8:30 – 10:30), G-B(10:30 – 12:30)
7. Course code	
8. Teacher's academic profile	***Education***: **PhD** ***Date***: 25-5-2007 ***Title***: Generalized Curvature and Torsion in Nonstandard Analysis ***Place of Attainments***: Mathematics Department, College of Science, University of Salahaddin\Erbil, Hawler (Erbil), Kurdistan Region, Iraqi. ***Supervisor***: Professor Dr. Tahir Hassan Ismail ***Supervisor Address***: Mathematics Department, College of Computer Science and Mathematics, University of Mosul, Mosul, Iraq. Email: tahir_hs@yahoo.com **M. Sc.** ***Date***: 2-8-2000 ***Title***: A Nonstandard Study on The Taylor Series Development ***Place of Attainments***: Math. Dept.-College of Sci.-Univ. of Salahaddin\Erbil-Iraq. ***Supervisor***: Professor Dr. Tahir Hassan Ismail, **B. Sc**

Date: 27-6-1992

Place of Attainments: Math. Dept.-College of Sci.-Univ. of Salahaddin\Erbil-Iraq Title of the Graduation Project:
Number of Limit Cycles of Nonlinear Autonomous Homogeneous System of Degree Three Academic records

2009 – Present : Assistant (Associate) Professor,
2004 – 2007: PhD student,
2005 – 2009: Lecturer,
2000 – 2005: Assistant Lecturer
1998 – 2000: M.Sc Student,
1993 – 1998: Assistant Researcher in Math. Dept.

Supervising 1 Ph.D + 2 M.Sc. +2 M.Sc.(under Supervision)

Committees Membership and Positions

1. Member of several scientific and other department and college committees.
2. Member of the College Scientific Promotion committee.
3. 2014 Organizer of CIMPA-KURDISTAN-IRAQ research school, Inverse problems: Theory and applications, University of Salahaddin, Erbil, Kurdistan-Iraq, May 5-14, 2014, http://www.cimpa-icpam.org/spip.php?article564 Visiting.
4. 2011 Institute de Mathematiques de Jussieu - Paris, France; for a period one month.
5. 2006 (INSPEM),University of Putra - Kuala Lumpur, Malaysia, for a period 6 month as a second part of PhD research.

unfortunately, we were unable to in compliance with the above invitations because of the politic situation of Iraq at that time

Conferences and Schools:

1. Research School CIMPA UNESCO – EGYPT, Recent Development in the Theory of Elliptic Partial Differential Equations 25/1-3/2/2009. Alexandria, Egypt.
2. CIMPA-UNESCO-IPM School, Repres. Theory of Algebras,15-25-6/, 2008.Tehran, Iran.
3. First Iraq-French Mathematics Conferenc, Cooparation with College of Science 14 -18/11/2009. Hawler (Erbil) - Kurdistan Region, Iraq.

	4. The Second Conference on Mathematical Sciences (CMS'2008) 22-23/10/2008. Jordan, Zarqa. **5.** The Second International Conference of Mathematics 26-30/10/2008. Syria, Aleppo. **6.** International Congress "Nonstandard Methods and Applications in Mathematics- NSM" 25-31/5/ 2006, Pisa,Italy. *unfortunately*, we were unable to in compliance with the above invitations because of the politic situation of Iraq at that time **Publications**: Papers: 20 papers in local and international journals **Books**: Generalized Curvature and Torsion in Nonstandard Analysis, (Nonstandard Technical Treatment for Some Differential Geometry Concepts), LAP Lambert Academic Publishing ISBN 978-3-8443-0763-4, 140 Pages. **Articles** • The Development Project of the Educational Program in Iraq (In Arabic), Journal of Afaq Al- Terbewiyha, Issued by the Ministry of Education – Iraqi Kurdistan Region, No.3(2004), pp 107-114. • Some Notes, About The Integration Subject in the Mathematics Book of 6th Secondary School (In Kurdish) Journal of Assoy Parwardayi, Issued by the Ministry of Education – Iraqi Kurdistan Region, No.38(2003), pp 58-63. **Courses Taught** **1.** ***1993-1998, as an Assistant Researcher***: (*Theoretical*): O.D.E, probability, & Statistics, Euclidean and Non Euclidean Geometry. (*Tutorial*): Euclidean and Non Euclidean Geometry y, Statistics, O.D.E, P.D.E, Topology. (*Computer Laboratory*): Basic, Fortran, and Pascal Language.
9. Keywords	Real Number System, Properties of Real Number System (max, min, u.b, l.b, sup,inf), Completeness, Metric Spaces, Topological Concepts about Metric spaces (open, closed, limit points ,…)

10. Course overview:

This course offers a thorough introduction to the fundamental concepts of mathematical analysis, focusing on the rigorous development of sequences, series, limits, continuity, and metric spaces. The aim is to build a solid foundation for advanced mathematical thinking and proof construction, preparing students for further study in higher mathematics and its applications

11. Course objective:

This course will differ from other math course you have taken because it emphasizes ideas and thinking skills. We don't ask that you memorizes formulas, statements, theorems and results, but rather that you learn to express yourself clearly and accurately; any one who has been in the least interested mathematics, or has even observed other people who are interested init, is aware that mathematics work is work with ideas, we know that a set of axioms and definitions is an attempt to describe the main properties of a mathematical idea. Don't just read it; fight it! Ask your own question look for your own examples discover your own proofs. Is the hypothesis necessary? Is the converse true? What happens in the special cases, what is the general case? What about the degenerate cases? Where does the proof use the hypothesis?

By the end of this course, students will be able to:

1- Understand and apply the concepts of limits and convergence.
2- Analyze the properties of sequences and series.
3- Prove the continuity of functions.
4- Comprehend the structure and properties of metric spaces.
5- Develop and present mathematical proofs effectively.

12. Student's obligation

Students and their obligations throughout the academic year, is the attendance and completion of all tests, exams, assignments.

13. Forms of teaching

Magic board and discussion and allow leg students to write some problems on the board and assignments and I give hard copy of my lecture notes to students before coming lecturer time.

14. Assessment scheme

The course will consist of weekly lectures, problem-solving sessions, and discussion groups. Students are expected to participate actively and complete all assignments on time. Office hours will be available for additional support

The students are required to do two closed book exams during of the study year. The exam has 20 marks, attendance, classroom activities with quizzes 10 marks, workload and assignments 10 marks. There will be a final exam on 60 marks.

15. Student learning outcome:

By the end of this course, students will be able to:

1- Understand and Apply Limits and Convergence: Students will be able to rigorously define and apply the concepts of limits and convergence in the context of sequences and series, demonstrating an ability to prove related theorems and solve related problems.
2- Analyze Sequences and Series: Students will be able to analyze the properties of sequences and series, including convergence tests, and distinguish between different types of convergence (absolute vs. conditional).
3- Prove Continuity of Functions: Students will be able to rigorously define continuity, prove the continuity of functions, and apply fundamental theorems related to continuity such as the Intermediate Value Theorem and Extreme Value Theorem.
4- Comprehend Metric Spaces: Students will be able to define and work with metric spaces, understand and prove properties related to open and closed sets, convergence, completeness, compactness, and connectedness within metric spaces.
5- Develop and Present Mathematical Proofs: Students will be able to construct clear, concise, and rigorous mathematical proofs, demonstrating logical reasoning and an ability to communicate complex mathematical ideas effectively.

16. Course Reading List and References:

References

[1] Bartle R.G & Sherbert D., ***Introduction to Real Analysis***.3ed John Wiley & Sons, **2000**

[2] Chen W. L., ***Fundamental of Analysis***. Lecture Notes-Internet, **2002**

[3] Hemen Dutta & P. N. Natarajan, ***Concise Introduction to Basic Real Analysis***. Taylor & Francis Group, **2022**

[4] Das G., ***Mathematical Analysis***.6ed, McGraw-Hill Book Comp. **2003**

[5] John B. Conway, ***A First Course in Analysis***. Cambridge University Press, **2018**

[6] Pugh C. C., ***Real Mathematical Analysis***. Sp0ringer-Verlag New York, **2002**

[7] Themistocles M. Rassias &Panos M. Pardalos, ***Mathematical Analysis and its Applications***. Springer Nature Switzerland AG **2020**

[8] Tom L. Lindstrom, ***An Introduction to Real Analysis***. American Mathematical Society **2017**

17. The Topics:

Ch I The Real Number System (Weeks 1-3)

1. Introduction and Inadequacy of the Rationales.
2. Method of construction of real numbers.
3. Basic Notations and definitions Needs.
3.1 The Order Axioms.
3.2 Ordered Fields.
3.3 Upper and Lower Bounds.
3.4 Maximum and minimum.
3.5 Supermum and Infimum.

Lecturer's name

3.6 Archimedean Ordered Fields.
3.7 Completeness Axiom.
4. Some Theorem Applications in Real Number System

Ch II Metric Spaces (Weeks 4-6)

1. Some Necessary Inequalities.
2. Basic Metric Notions in $\mathbf{R^n}$.
3. General Metric Space(different type of metric spaces).
4. Some Topological Concepts.
    a. Openness
    b. Closeness
    c. Limit points
    d. Closures
    e. Exterior
    f. Union and intersection of closed and opened sets
5. Metric Subsequences.

Ch III Completeness and Compactness in Metric Spaces (Weeks 7--9)

1. Cauchy Completion of Real Number System.
2. Theorems on Completeness.
3. Compactness of Metric Spaces.
4. Compactness of Real Space
5. Hein Borel Theorem
6. Relation between Completeness and Compactness.

Ch IV Limits and Continuity in the Metric Spaces (Weeks 10--12)

1. Definition of the Limit of the Functions.
2. Equivalent Definition of the Limit.
3. Continuity at a Point.
4. Continuous Functions on Compact Sets.
5. Uniform Continuity.
6. Discontinuities Points and their Types.

Compactness and Uniform Continuous

19. Examinations: Compositional: In this type of exam the questions usually starts with Explain how, furthermore it is like as lecture notes and contains some homework , so there will be continuing assignments of problem outside the lecture notes (note that this problem having small marks).	**19. Examinations:** Compositional: In this type of exam the questions usually starts with Explain how, furthermore it is like as lecture notes and contains some homework , so there will be continuing assignments of problem outside the lecture notes (note that this problem having small marks).
20. Extra notes:	**20. Extra notes:**
21. Peer review **پێداچوونەوەی هاوەڵ**	**21. Peer review** **پێداچوونەوەی هاوەڵ**

19. Examinations: Compositional: In this type of exam the questions usually starts with Explain how, furthermore it is like as lecture notes and contains some homework , so there will be continuing assignments of problem outside the lecture notes (note that this problem having small marks).
20. Extra notes:
21. Peer review **پێداچوونەوەی هاوەڵ**