جامعـــة خليفـــة
Khalifa University

MATH 324 Real Analysis I
(4 Lectures, 0 Laboratory – 4 Credits)

Prerequisite: MATH 101 and MATH 112

Course Catalog Description:
This course gives students a thorough understanding of essential concepts in analysis such as real numbers, limits, continuity, and convergence of sequences and series. The course also covers a rigorous definition of derivative and construction of the Riemann integral and their properties including the Fundamental Theorem of Calculus. Students are required to read and write proofs using a precise knowledge of definitions and theorems.

Textbook:
Analysis with an Introduction to Proof by Steven R. Lay, Publisher: Pearson, 5th Edition, 2005, ISBN: 9780321747471.

Reference Materials:
- *Undergraduate Analysis* by Serge Lang, Publisher: Springer Verlag, 2nd Edition, 2005, ISBN: 9788184896282.
- *Elementary Analysis* by Kenneth A. Ross, Publisher: Springer, 2nd Edition, 2013, ISBN: 9781461462705.

Course Topics:
1. Introduction: review of tautologies, contradictions and equivalence, open sentences and quantifiers; methods of proof in mathematics: direct method, contrapositive method, contradiction method (3 lectures)
2. Sets and functions: indexed families of sets and their properties, image and inverse image of functions and their properties (5 lectures)
3. Real number systems: countability of R and Q, order properties of Q and its order incompleteness, construction of R from Q using Dedekind cuts axioms (6 lectures)
4. Order completeness of R: least upper bound property and equivalent conditions including the nested interval property, bounded sets, and their properties, supremum and infimum of sets, Bolzano-Weierstrass theorem (7 lectures)
5. Topological properties of R: interior points, limit points, isolated points, boundary points, frontier points, open sets, closed sets, perfect sets, compact sets, and connectedness (6 lectures)
6. Sequences: definition of convergent sequence, bounded sequences, monotone sequences and their convergence, limsup and liminf and convergence criterion, subsequences, Cauchy sequences and their convergence criterion (8 lectures)
7. Limits and continuity: epsilon-delta definition of limit, basic properties of continuous functions, uniform continuity, bounded functions, continuous functions on compact sets, Intermediate Value Theorem (10 lectures)
8. Differentiation: derivatives, the Mean Value theorem, L'Hospital's Rule, Taylor's theorem (5 lectures)
9. Riemann integral: definition, properties, the Fundamental Theorem of Calculus (6 lectures)
10. Series: series of numbers, definition of convergent series, geometric series, the comparison test, integral test with proof, ratio test, absolute and conditional convergence, alternating series and Leibniz test (4 lectures)

Structure and Learning Methodologies:
Lectures will be either 4 x 50 minutes per week or 2 x 75 and 1 x 50 minutes per week. Lectures will be presented using the whiteboard, and may be complemented with handouts and/or PowerPoint slides.

Assessment:
All course learning outcomes are assessed using the following assessment tools.

Coursework (Quizzes and assignments)	40%
Semester Examination	25%
Final Examination	35%

Contribution to Applied Mathematics & Statistics Students Outcomes (AMS-SOs):

a	b	c	d	e	f	g	h	i	j	k	l
H	---	H	---	---	---	---	---	---	---	---	---

H – High M – Medium L – Low

Course Learning Outcomes & AMS-SOs:

No	Course Learning Outcomes	AMS-SOs
1	Identify and prove topological properties of sets of real numbers.	a, c
2	Determine and prove the main properties of sequences.	a, c
3	Prove the continuity of a function.	a, c
4	Prove the convergence/divergence of an infinite series.	a, c
5	Prove classical theorems in real analysis.	a, c