NORTH SOUTH UNIVERSITY

Center of Excellence in Higher Education

The first private university in Bangladesh

Department of Mathematics and Physics

Course Title	Real Analysis
Course Code	MAT-370
Semester	
Course Coordinator	
Instructor & Department Information	
Instructor's Name	
Office Room	
Office Hours	
Email Address	

Course & Section Information	
Prerequisites	MAT250
Class Time & Location	
Credit Hours	3:0
Text Book	Introduction to Real Analysis by Robert G Bertle, D. R. Sherbert
Reference Book	

Marks Distribution: **(Subject to change according to the directives from UGC/NSU)**

Assessment Strategy and Grading Scheme	
Grading tool	**Marks**
Attendance and class performances	05%
Assignments (At least 3 assignments)	10%
Quizzes (Best 2 quizzes out of at least 3 quizzes)	20%
Midterm	30%
Final Exam	35%

Grading Policies: As per NSU grading policy.
Attendance Policy: As per NSU policy.

Academic Integrity Policy: The Department of Mathematics and Physics does not tolerate academic dishonesty by its students. At a minimum, students must not be involved in cheating, copyright infringement, submitting the same work in multiple courses, significant collaboration with other individuals outside of sanctioned group activities, or fabrication. Students are advised that violations of the Student Integrity Code will be treated seriously, with special attention given to repeated offenses.

Please see the NSU Student Handbook, Sections: "Disciplinary Actions" and "Procedures and Guidelines".

Makeup & Exam policy: NO makeup for quizzes and NO Formative assessment will be retaken under any circumstances. If a student misses the Midterm and/or Final exams due to circumstances beyond their control (official valid documents are required) and is informed beforehand (if possible), reasonable arrangements may be considered. **Students may get to see/recheck their midterm and Final exam scripts.**

Course Short Description
This course provides a rigorous introduction to real analysis, the theoretical foundation of calculus. Topics include the construction and properties of real numbers, sequences and series, limits, continuity and uniform continuity, differentiation, the Riemann integral, and the fundamental theorem of calculus. The course also introduces complex analysis including complex functions, limits, continuity, analyticity, the Cauchy–Riemann equations, and the fundamental theorem of complex calculus. Emphasis is placed on proofs, counterexamples, and the development of mathematical reasoning.

<table>
<tr><td>Course Objectives</td><td>1. To develop a rigorous understanding of the real number system and its completeness property.
2. To master the epsilon-delta arguments for limits, continuity, differentiation, and integration.
3. To study sequences of functions, uniform convergence, and its impact on continuity, differentiability, and integrability.
4. To extend real analysis concepts to complex variables, focusing on analytic function, Cauchy-Riemann equations, and the fundamental theorem of complex calculus.</td></tr>
<tr><td>Course Learning Outcomes</td><td>Upon successful completion of this course, students will be able to:
<table>
<tr><td>(CO-1)</td><td>Prove fundamental properties of real numbers, including the completeness axiom, Archimedean property, and density of rationals.</td></tr>
<tr><td>(CO-2)</td><td>Analyze sequences and series of real numbers, limit theorems, monotone convergence, Cauchy criterion, and subsequential limits.</td></tr>
<tr><td>(CO-3)</td><td>Apply ε-δ definition to examine continuity, uniform continuity, differentiability, and Riemann integrability of real functions; prove the Fundamental Theorem of Calculus.</td></tr>
<tr><td>(CO-4)</td><td>Investigate pointwise and uniform convergence of function sequences; state and apply the Weierstrass M-test and the theorem on interchange of limits.</td></tr>
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Mapping of Course Outcomes

CLOs	Course Outcomes (CO)	**Bloom's taxonomy domain/level** (C: Cognitive P: Psychomotor A:Affective)	Delivery methods and activities	Assessment tools
CO-1	Prove fundamental properties of real numbers, including the completeness axiom, Archimedean property, and density of rationals.	**C1, C2, C3, C4**	Lectures, notes	Quiz, Assignment, Midterms, Final Exam
CO-2	Analyze sequences and series of real numbers using ε-N definitions, limit theorems, monotone convergence, Cauchy criterion, and subsequential limits.	**C2, C3, P2**	Lecture, notes, group discussion	Assignment, Class participation, Quiz, Midterms
CO-3	Apply ε-δ definition to examine continuity, uniform continuity, differentiability, and Riemann integrability of real functions; prove the Fundamental Theorem of Calculus.	**C1, C2, C3**	Lecture, notes	Discussion, Quiz, Midterms, Final Exam
CO-4	Investigate pointwise and uniform convergence of function sequences; state and apply the Weierstrass M-test and the theorem on interchange of limits	**C2, C3, C6, P3**	Lecture, notes, group discussion	Assignment, Discussion, Class participation

<u>Contents</u>

Lecture	Topics	Article no. in the textbook	Assessment tools	Learning Outcomes
1, 2	Basics: Sets and Functions, Mathematical induction, Finite and Infinite sets	1.1, 1.2, 1.3,	Quiz1, Midterm Assignment I	CO-1
3, 4, 5, 6	The Real Numbers: Algebraic and Order properties, Absolute value, Completeness properties of R, supremum & infimum, Archimedean property, density of Rationals, Intervals, Uncountability, Cantor's theorem.	2.1, 2.2, 2.3, 2.4, 2.5	Quiz1, Midterm Assignment I	CO-1 CO-2
7, 8, 9, 10	Sequences and series: convergence, definition, Limit theorems, Monotone sequences, Subsequences. Bolzano-Weierstrass Theorem, Cauchy sequences. Divergent subsequences, Infinite series, Limits of functions, $\epsilon - \delta$ definition, Limit Theorems.	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 4.1, 4.2, 4.3,	Midterm Assignment I Discussions Midterm	CO-1

11	**Midterm examination**			
12, 13, 14	Continuous Functions, Continuous Functions on Intervals, Uniform Continuity, Continuity and Gauges, Monotone and Inverse Functions	5.1, 5.2, 5.3, 5.4, 5.5, 5.6,	Discussions, Quiz 2 Final exam	CO-2, CO-3
15, 16, 17	Differentiation: The Derivative, The Mean Value Theorem, L'Hospital's Rules, Taylor's Theorem.	6.1, 6.2, 6.3, 6.4	Discussions, Quiz 3 Final exam	CO-1, CO-3
18, 19, 20,	Riemann Integral, Riemann integrability, Conditions of integrability, properties, Fundamental theorem of calculus (first and second forms) and its ri gorous proof. The Darboux Integral	7.1, 7.2, 7.3, 7.4	Final exam, Assignment II	CO-3
21, 22,	Sequence of functions: Pointwise and Uniform Convergence, exponential and logarithmic functions, Interchange of Limits, The Trigonometric Functions.	8.1, 8.2, 8.3, 8.4	Final exam	CO-4
23, 24	Infinite Series, Absolute convergence, Test of absolute convergence	9.1, 9.2, 9.3	Final exam	CO-4
Final Exam (Declared by the Controller of Examinations)				