

UNIVERSITY OF MADRAS
M.Sc. DEGREE PROGRAMME IN MATHEMATICS
SYLLABUS WITH EFFECT FROM 2023-2024

Title of the Course		REAL ANALYSIS I					
Paper Number		CORE II					
Category	Core	Year	I	Credits	5	Course Code	428C1B
		Semester	I				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		5	1	--	6		
Pre-requisite		UG level real analysis concepts					
Objectives of the Course		To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.					
Course Outline		<p>UNIT-I : Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on $[a, x]$ as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.</p> <p>Chapter – 6 : Sections 6.1 to 6.8</p> <p>Infinite Series : Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.</p> <p>Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18</p> <p>UNIT-II :The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.</p> <p>Chapter - 7 : Sections 7.1 to 7.14</p>					

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	<p>UNIT-III : The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter-Differentiation under integralsign-Lebesgue criteriaon for existence of Riemann integrals. Chapter - 7 : 7.15 to 7.26</p> <p>UNIT-IV :Infinite Series and infinite Products - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesarosummability - Infinite products. Chapter - 8 Sec, 8.20, 8.21 to 8.26 Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23</p> <p>UNIT-V: Sequences of Functions – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. Chapter -9 Sec 9.1 to 9.6, 9.8,9.9,9.10,9.11, 9.13</p>
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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Recommended Text	Tom M.Apostol : <i>Mathematical Analysis</i> , 2 nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.
Reference Books	<ol style="list-style-type: none"> 1. Bartle, R.G. <i>Real Analysis</i>, John Wiley and Sons Inc., 1976. 2. Rudin,W. <i>Principles of Mathematical Analysis</i>, 3rd Edition. McGraw Hill Company, New York, 1976. 3. Malik,S.C. and Savita Arora. <i>Mathematical Anslysis</i>, Wiley Eastern Limited.New Delhi, 1991. 4. Sanjay Arora and Bansi Lal, <i>Introduction to Real Analysis</i>, Satya Prakashan, New Delhi, 1991. 5. Gelbaum, B.R. and J. Olmsted, <i>Counter Examples in Analysis</i>, Holden day, San Francisco, 1964. 6. A.L.Gupta and N.R.Gupta, <i>Principles of Real Analysis</i>, Pearson Education, (Indian print) 2003.
Website and e-Learning Source	http://mathforum.org , http://ocw.mit.edu/ocwweb/Mathematics , http://www.opensource.org , www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1:Analyze and evaluate functions of bounded variation and Rectifiable Curves.

CLO2:Describe the concept of Riemann-Stieltjes integral and its properties.

CLO3:Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.

CLO4:Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.

CLO5: Formulate the concept and properties of inner products, norms and measurable functions.

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1
CLO5	3	1	2	3	3	3	3	2	1