

240/MATP/CC401

Session: 2025-26			
Part A – Introduction			
Subject	Mathematics		
Semester	IV		
Name of the Course	Sequence and Series		
Course Code	CC-A4		
Course ID	240/MATP/CC401		
Course Type: (CC/MIC/MDC/ /VOC/AEC/VA C/SEC)	CC		
Course Learning Outcomes(CLOs)	After completing this course, the learner will be able to: <ol style="list-style-type: none"> 1. Understand basic concepts of compact set, denumerability, sequences, their limits and boundedness. 2. Learn about the convergence and divergence of a sequence. 3. Attain skills to determine convergence of a series of real numbers by applying various tests. 4. To know absolute and conditional convergence of alternating series and apply theory to check the convergence of arbitrary series. 		
CLO 5 is related to the practical Component.			
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	25	5	30
End Term Assessment Marks	50	20	70

Examination Time	3 Hours	3 Hours	100
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Part B - Course Content

Instructions for Paper- Setter Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking Course Learning Outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topic	Contact Hours
I	Open covers, Compact sets and Heine-Borel Theorem. Denumerable and non-denumerable sets, Denumerability of integers, rationals and non-denumerability of real numbers. Sequence: Real Sequences and their convergence, Theorem on limits of sequence, Bounded and monotonic sequences,	11
II	Cauchy's sequence, Cauchy general principle of convergence, Subsequences, Sub sequential limits. Limit superior and limit inferior. Infinite series: Convergence and divergence of Infinite Series, Comparison tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series.	12
III	D-Alembert's ratio test, Raabe's test, Logarithmic test, de Morgan and Bertrand's test, Cauchy's Nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test. Alternating series, Leibnitz's test, Absolute and conditional convergence,	11
IV	Arbitrary series: Abel's lemma, Abel's test, Dirichlet's test, Insertion and removal of parenthesis, re-arrangement of terms in a series, Riemann's Re-arrangement theorem, Pringsheim's theorem (statement only), Multiplication of series, Cauchy product of series, (definitions and examples only).	11

Practical

The practical component of the course has two parts

30

(A) Problem Solving- Questions related to the following problems will be solved and

their record will be maintained in the Practical Notebook:

1. Problem demonstrating that the set of rational numbers is not order complete.
2. Practical Problems on finding lub and glb of a set.
3. Problem solving to find limit point of a set using Bolzano Weierstrass Theorem.
4. Problems solving using monotone convergence theorem.
5. Practical problems demonstrating the use of Cauchy's first and second theorems for convergence of sequences.
6. Problem solving on limit inferior and limit superior of a sequence.
7. Practical problem on convergence/divergence of positive term series demonstrating the application of various convergence tests.
8. Problem solving on
 - i. Conditional convergence and
 - ii. Absolute convergence of an alternating series.
9. Practical problem to demonstrate Cauchy product of two convergent series need not be convergent.
10. Practical problem to demonstrate Cauchy product of two divergent series need not be divergent.
11. Practical problem to demonstrate the denumerability of the cartesian product of denumerable sets.
12. Practical problem to demonstrate the non-denumerability of the set of irrationals.

(B) The following practicals will be done using MAXIMA software and their record will be maintained in the practical note book:

1. Testing the convergence of infinite series of positive terms by the use of sequence of partial sums.
2. Testing the convergence of an infinite positive term series
3. Testing the absolute convergence of an alternating series and comment about conditional convergence.
4. Practical problems on the convergence of series with arbitrary terms.
5. Testing the convergence/divergence/oscillation behavior of sequences of real numbers.
6. Determine the lub and glb of the subset of real numbers and observe whether they belong to the set or not.

Suggested Evaluation Methods

<p>Internal Assessment:</p> <p>➤ Theory 25</p> <ul style="list-style-type: none"> ● Class Participation: 5 ● Seminar/presentation/assignment/quiz/class test etc.: 10 ● Mid-Term Exam: 10 <p>➤ Practicum 5</p> <ul style="list-style-type: none"> ● Seminar/Demonstration/Viva-voce/Lab records etc.: 5 	<p>End Term Examination:</p> <p>➤ Theory 50</p> <ul style="list-style-type: none"> ● Written Examination <p>➤ Practicum 20</p> <ul style="list-style-type: none"> ● Lab record, viva-voce, write up and execution of the program
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Part C-Learning Resources

Recommended Books:

1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to Advanced Calculus*. Pearson Education.
2. C. Aliprantis & O. Burkinshaw (1998). *Principles of Real Analysis* (3rd edition). Academic D Pres.
3. R. G. Bartle & D. R. Sherbert (2015). *Introduction to Real Analysis* (4th edition). Wiley India.
4. G. G. Bilodeau, P. R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis*. Springer-Verlag.
6. K. A. Ross (2013). *Elementary Analysis: The Theory of Calculus* (2nd edition). Springer.
7. W. Rudin (1976). *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.
8. R. R. Goldberg (1970). *Real Analysis*. Oxford & I. B. H. Publishing Co., New Delhi.
9. S. Narayan & P. K. Mittal (2005). *A Course in Mathematical Analysis*. S. Chand and company, New Delhi.
10. S. C. Malik & S. Arora (2021). *Mathematical Analysis*. Wiley Eastern Ltd., Allahabad.