



**Bharati College**  
**(University of Delhi)**  
Janak Puri, Delhi- 100058  
[www.bharaticollege.du.ac.in](http://www.bharaticollege.du.ac.in)

## Lesson Plan (CORE, Semester IV, January, 2023 to June 2023)

<b>Name of Teacher</b>	Dr. Ankit Gupta	<b>Department</b>	Mathematics
<b>Course</b>	B.Sc (H) Mathematics	<b>Semester</b>	Four
<b>Paper</b>	Riemann Integration & Series of Functions	<b>Academic Year</b>	2022-23

### Learning Objectives

To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration. The sequence and series of real valued functions, and an important class of series of functions (i.e., power series).

### Learning Outcomes

The course will develop a deep and rigorous understanding of:

- Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
- Know about improper integrals including, beta and gamma functions.
- Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence.
- Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum.
- Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.

## Lesson Plan

Week No.	Theme/ Curriculum	Any Additional Information
Week 1-4	<ul style="list-style-type: none"> <li>• Definition of Riemann integration, Inequalities for upper and lower Darboux sums.</li> <li>• Necessary and sufficient conditions for the Riemann integrability, Definition of Riemann integration by Riemann sum and equivalence of the two definitions.</li> <li>• Riemann integrability of monotone functions and continuous functions, Algebra and properties of Riemann integrable functions.</li> <li>• Definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability, Intermediate value theorem for integrals.</li> </ul>	Allocation of Assignment I
Week 5 – 8	<ul style="list-style-type: none"> <li>• First and second fundamental theorems of integral calculus, and the integration by parts.</li> <li>• Improper integrals of Type-I, Type-II and mixed type</li> <li>• Convergence of beta and gamma functions, and their properties.</li> <li>• Definitions and examples of pointwise and uniformly convergent sequence of functions.</li> </ul>	Test Scheduled (Syllabus upto First Fundamental Theorem)
Week 9 - 11	<ul style="list-style-type: none"> <li>• Motivation for uniform convergence by giving examples, Theorem on the continuity of the limit function of a sequence of functions.</li> <li>• The statement of the theorem on the interchange of the limit function and derivative, and its illustration with the help of examples, The interchange of the limit function and integrability of a sequence of functions.</li> <li>• Pointwise and uniform convergence of series of functions, Theorems on the continuity, derivability and integrability of the sum function of a series of functions</li> </ul>	
Week 12 - 14	<ul style="list-style-type: none"> <li>• Cauchy criterion for the uniform convergence of series of functions, and the Weierstrass M-test for uniform convergence.</li> <li>• Definition of a power series, Radius of convergence, Absolute and uniform convergence of a power series.</li> </ul>	Allocation of Assignment II

- |  |   |  |
|--|---|--|
|  | <ul style="list-style-type: none"><li>• Differentiation and integration of power series, Statement of Abel's theorem and its illustration with the help of examples</li></ul> |  |
|--|---|--|

### References

1. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
2. Denlinger, Charles G. (2011). Elements of Real Analysis. Jones & Bartlett (Student Edition). First Indian Edition. Reprinted 2015.
3. Ghorpade, Sudhir R. & Limaye, B. V. (2006). A Course in Calculus and Real Analysis. Undergraduate Texts in Mathematics, Springer (SIE). First Indian reprint.
4. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer.

### Additional Resources

1. Sarma, R. D; Gupta, Ankit; Singh Rajesh (2022). Concepts of Real Analysis (1<sup>st</sup> ed.). Sultan Chand and Sons.

