**Shyama Prasad Mukherji College for women**

**Teaching Plan(26 August 2022 - 13 December 2022)**

**Course and Year: B.Sc (Hons) Mathematics 2nd year**

**Semester: III**

**Taught individually or shared: Shared**

**Paper: BMATH305 Theory of Real Functions**

**Faculty: Mrs Neeru Jain and Mrs Tripti Anand**

**No. of Classes** (per week)**: 5 Lectures**

**Course Objectives:** It is a basic course to study real valued functions and will help develop analytical ability to understand the main concepts of calculus, namely, limits, continuity, differentiability and applications.

**Course Learning Outcomes:** This course will enable the students to:

1. Have a rigorous understanding of the concept of limit of a function.
2. Learn about continuity and uniform continuity of functions defined on intervals.
3. Understand geometrical properties of continuous functions on closed and bounded intervals.
4. Learn the concept of differentiability using limits, leading to a better understanding for applications.
5. Introduction to applications of mean value theorems and Taylor’s theorem.

**Teaching Plan**

**Name of the Unit:**

**Unit 1-**  **Limits of functions**

Limits of functions ( approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits & limits at infinity.

**Unit 2 –Continuous functions and their properties**

Continuous functions, sequential criterion for continuity & discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

**Readings prescribed in the syllabus for unit 1 and 2**

1. R. G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons (2003)

**Unit 3 –** **Derivability and its applications**

Differentiability of a function at a point & in an interval, Carathéodory’s theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle’s theorem, Mean value theorem and applications, intermediate value property of derivatives , Darboux’s theorem.

**Unit 4 -**  **Taylor’s Theorem and its Applications**

Taylor’s polynomial , Taylor’s theorem with Lagrange’s form of remainder, application of Taylor’s theorem in error estimation , relative extrema and to establish a criterion for convexity. Taylor’s series expansions of exponential & trigonometric functions(

**Readings prescribed in the syllabus for unit 3 and 4**

1. R. G. Bartle & D.R. Sherbert (2015), Introduction to Real Analysis, John Wiley & Sons (4th edition) ,wiley India Edition , New Delhi.

**Additional readings suggested in syllabus**

1. A. Mattuck, Introduction to Analysis, Prentice Hall (1999).
2. S. R. Ghorpade & B. V. Limaye, A Course in Calculus and Real Analysis – Springer (2006)
3. K. A. Ross, Elementary Analysis: The Theory of Calculus, Springer (2004).

**Readings, e- references to be given to students but not prescribed in syllabus**

1. Denlinger,Charles G. (2011) Elements of real analysis. Jones and Bartlett indiapvt ltd, students edition, reprint 2015

2. A First course in Real analysis –M.K.Singal and Asha Rani Singal

3. An Introduction to the Theory of Real Functions by R.D.Sarma

4. Bilodeau , Gerald G,Thie,Paul R and Keough , G.E. (2010). An introduction to Analysis 2 nd edition, Jones and BartlettIndia pvt ltd, students edition reprint 2015

5. A basic course in real analysis , Ajit kumar and S. Kumaresan ,CRC press , A chapman and hall book

6. **Some important e resources – NPTEL SWAYAM online lectures on analysis**

[**https://nptel.ac.in/courses/111/106/111106053/**](https://nptel.ac.in/courses/111/106/111106053/)

[https://freevideolectures.com/course/3268/a-basic-course-in-real-analysis](https://freevideolectures.com/course/3268/a-basic-course-in-real-analysis" \t "_blank)

[https://freevideolectures.com/course/3201/real-analysis-i](https://freevideolectures.com/course/3201/real-analysis-i" \t "_blank)

**Weekly teaching plan**

**WEEK 1:** Limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria ( [1] section4.1, chapter 4)

Week 2 : Algebra of limits of functions with examples, Squeeze theorem

( [1] section4.2, chapter 4 )

**Week 3 :** Definition and illustrations of one sided limits , infinite limits and limit at infinity

( [1] section4.3, chapter 4)

Week 4 and 5 : Continuous functions, sequential criterion for continuity & discontinuity. Algebra of continuous functions and composition of continuous functions

( [1] section5.1 and 5.2, chapter 5 )

**Week 6 and 7:** Continuous functions on an interval, boundedness theorem , maximum-minimum theorem, intermediate value theorem, location of roots theorem, preservation of intervals theorem

( [1] section 5.3, chapter 5 )

**Week 8**: Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

( [1] section 5.4.1-5.4.3, chapter 5 )

**Week 9 and 10** : Differentiability of a function at a point & in an interval, Carathéodory’s theorem, algebra of differentiable functions ,chain rule

( [1] section 6.1.1-6.1.7, chapter 6 )

**Week 11 and 12** : Relative extrema, interior extremum theorem. Rolle’s theorem, Mean value theorem and applications, intermediate value property of derivatives , Darboux’s theorem.

( [1] section 6.2, chapter 6 )

**Week 13 and 14** : Taylor’s polynomial , Taylor’s theorem with Lagrange’s form of remainder, application of Taylor’s theorem in error estimation , relative extrema and to establish a criterion for convexity. Taylor’s series expansions of exponential & trigonometric functions.

( [1] section 6.4.1-6.4.6, chapter 6 ) and ( [1] example 9.4.14 ,page 286, chapter 9)

* **Methodology of Teaching:** Interactive lectures, refering to videos and lectures online , discussions and problem solving in tutorial class. **Lecture classes and tutorials will be held in offline mode and E resources will be shared through Google classroom .**
* Each topic will be explained with examples.
* Students will be involved in discussions and encouraged to ask questions.
* Concepts will be illustrated through CAS
* **Presentations**

**Students will be encouraged to give small presentations and refer to different books to give alternative proofs of theorems**.

**ASSESSMENT**

Tentative dates of Assessment ; Assignments and Tests (time frame):

Assignment 1- third week of September 2022

Test 1- first week of October 2022

Assignment 2- last week of october

Test 2- first week of november

Test 3- last week of november

**Criteria of Assessment: tests, assignments ,concept clarity, presentation skills , timely submission of assignments.**