**Shyama Prasad Mukherji College**

**Teaching Plan(Academic session: 2022-23)**

**Course and Year: BSc (Hons) Mathematics - II yr.**

**Semester: III**

**Taught individually or shared: Shared**

**Paper: BMATH307: Multivariate Calculus (Theory)**

**Faculty: Ms. Neeru Jain and Ms. Kundan Mishra**

**No. of Classes** (per week)**: 4 Lectures and 4 Practical (For each group)**

**Total Marks:** 150 (Theory: 75 + Internal Assessment: 25 + Practical: 50)

**Duration:** 14 Weeks (56 Hrs. Theory + 56 Hrs. practical) **Examination:** 3 Hrs.

**Course Objectives:** To understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables. Also, the emphasis will be on the use of Computer Algebra Systems by which these concepts may be analyzed and visualized to have a better understanding

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

1. The conceptual variations when advancing in calculus from one variable to multivariable discussions.
2. Inter-relationship amongst the line integral, double and triple integral formulations
3. Applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

**Teaching Plan**

**Name of the Paper :Multivariate Calculus**

**Unit-1:Calculus of Functions of Several Variables**

Functions of several variable Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Totaldifferential anddifferentiability, Chain rule, Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes andnormal lines.

**Unit 2: Extrema of Functions of Two Variables andProperties of Vector Field**

Extrema of functions of two variables, Method of Lagrange multipliers,Constrained optimization problems; Definition of vector field, Divergence and curl

**Unit 3: Double and Triple Integrals**

Double integration over rectangular and nonrectangular regions, Double integrals in polar coordinates, Triple integral over a parallelepiped and soild regions, Volume by triple integrals, triple integration in cylindrical andspherical coordinates, Change of variables in double and triple integrals.

**Unit 4: Green's, Stokes’s and Gauss Divergence Theorem**

Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral; Surface integrals, Stokes' theorem, The Gauss divergencetheorem.

**Reference:**

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.

**Additional Reading:**

1. [John H. Hubbard](https://www.amazon.in/John-H-Hubbard/e/B001HCZXV6/ref=dp_byline_cont_book_1)& [Barbara Burke Hubbard](https://www.amazon.in/s/ref=dp_byline_sr_book_2?ie=UTF8&field-author=Barbara+Burke+Hubbard&search-alias=stripbooks),(1998),Vector Calculus, Linear Algebra and Differential Forms: A Unified Approach, PearsonPublications.
2. [Theodore Shifrin](https://www.amazon.in/Theodore-Shifrin/e/B001IXNP9G/ref=dp_byline_cont_book_1),(2004)Multivariable Mathematics: Linear Algebra, Multivariable Calculus, and Manifolds,Wiley Publications.
3. [George B. Thomas](https://www.amazon.in/s/ref=dp_byline_sr_book_1?ie=UTF8&field-author=George+B.+Thomas&search-alias=stripbooks) &[Joel Hass](https://www.amazon.in/Joel-Hass/e/B00IXOGD3S/ref=dp_byline_cont_book_2)(2018)Thomas' Calculus Fortheenth Edition By Pearson.
4. [S Balachandra Rao](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22S+Balachandra+Rao%22&source=gbs_metadata_r&cad=6) (1992), Differential Calculus ,New Age InternationalPublications.
5. NP BaliGolden Differential Calculus by Laxmi Publications.

e-references[1] Mathematical Science - VLE , University of Delhi.

[2] Paul’s Online Math’s Notes

[3] NPTEL Video Lectures

[4] mathfaculty.fullerton.edu/mathews/n2003/Web

No of classes required to complete the unit (approx.): Scheduled Time (app.)

1. Unit I: 20 Classes 16 Aug to 20 Sep

2. Unit II: 8 Classes 21 Sept to 15 Oct

3. Unit III: 16 Classes16Octto 5 Nov

4. Unit IV: 12 Classes 6 Nov to 25 Nov

Methodology of Teaching: [1] Online teaching Platform is used for teaching such as:

Google meet, Microsoft Team or Zoom.

[2] Using Different software (Mathematica, Latex, R

and MS- Office) and online available Resources.

[2] Visualize the Mathematical Concept by 2D -Imaging

through some software.

[4] Guide, how to read and write research articles and

elaboration of the research papers.

[5] Mentor students to present research, paper and

poster.

[6] Participating in the academic activities with the

students by visiting different colleges.

ASSESSMENT

Tentative date of assessments/ assignments (time frame):Test -1 in the mid of sept.

Test-2 and Assignment-1 in mid of Oct.

Test -3 and Assignment-2 in mid of Nov.

Criteria of Assessment: Written Tests/Assignments/Presentations/Mock Tests/Viva Voice

Examinations/Performance in Inter-College academic activities.

**Teaching Plan (Weekly)**

**Week 1:** Definition of functions of several variables, Graphs of functions of two variables – Level curves and surfaces, Limits and continuity of functions of two variables.

[1] Chapter 11 (Sections 11.1 and 11.2)

**Week 2:** Partial differentiation, and partial derivative as slope and rate, Higher order partial derivatives. Tangent planes, incremental approximation, Total differential.

[1] Chapter 11 (Sections 11.3 and 11.4)

**Week 3:** Differentiability, Chain rule for one parameter, Two and three independent parameters.

[1] Chapter 11 (Sections 11.4 and 11.5)

**Week 4:** Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes and normal lines.

[1] Chapter 11 (Section 11.6)

**Week 5:** First and second partial derivative tests for relative extrema of functions of two variables, and absolute extrema of continuous functions.

[1] Chapter 11 [Section 11.7 (up to page 605)]

**Week 6:** Lagrange multipliers method for optimization problems with one constraint, Definition of vector field, Divergence and curl.

[1] Chapter 11 [Section 11.8 (pages 610-614)], Chapter13 (Section 13.1)

**Week 7:** Double integration over rectangular and nonrectangular regions. [1] Chapter 12 (Sections 12.1 and 12.2)

**Week 8:** Double integrals in polar co-ordinates, and triple integral over a parallelepiped.

[1] Chapter 12 (Sections 12.3 and 12.4)

**Week 9:** Triple integral over solid regions, Volume by triple integrals, and triple integration in cylindrical coordinates.

[1] Chapter 12 (Sections 12.4 and 12.5)

**Week 10:** Triple integration in spherical coordinates, Change of variables in double and triple integrals.

[1] Chapter 12 (Sections 12.5 and 12.6)

**Week 11:** Line integrals and its properties, applications of line integrals: mass and work.

[1] Chapter 13 (Section 13.2)

**Week 12:** Fundamental theorem for line integrals, Conservative vector fields and path independence.

[1] Chapter 13 (Section 13.3)

**Week 13:** Green's theorem for simply connected region, Area as a line integral, Definition of surface integrals

[1] Chapter 13 [Sections 13.4 (pages 712 to 716), 13.5 (pages 723 to 726)] Week 14: Stokes' theorem and the divergence theorem.

[1] Chapter 13 [Sections 13.6 (pages 733 to 737), 13.7 (pages 742 to 745)]