Teaching Plan (Nov 2021 – March 2022)

MATH101: Calculus

Total Marks: 150 (Theory: 75, Internal Assessment: 25 and Practical: 50)
Workload: 4 Lectures, 4 Practicals (per week) **Credits:** 6 (4+2)
Duration: 14 Weeks (56 Hrs. Theory + 56 Hrs. Practical) **Examination:** 3 Hrs.

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful in understanding their applications in planetary motion, design of telescope and to the real- world problems. Also, to carry out the hand on sessions in computer lab to have a deep conceptual understanding of the above tools to widen the horizon of students' self- experience.

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

i) Learn first and second derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.
ii) Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
iii) Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
iv) Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.

Course Content:

Month	Topic
Nov	**Unit 1: Derivatives for Graphing and Applications** The first-derivative test for relative extrema, Concavity and inflection points, Second-derivative test for relative extrema, Curve sketching using first and second derivative tests; Limits to infinity and infinite limits, Graphs with asymptotes, L'Hôpital's rule; Applications in business, economics and life sciences; Higher order derivatives, Leibniz rule.
Dec	**Unit 2: Sketching and Tracing of Curves** Parametric representation of curves and tracing of parametric curves (except lines in $\mathbb{R}^3$), Pc coordinates and tracing of curves in polar coordinates; Techniques of sketching conics, Reflection properties of conics, Rotation of axes and second degree equations, Classificatio into conics using the discriminant. ***Graded Comprehensive Assignment will be provided from Unit I and II as a part of Interr assessment.***

Jan	**Unit 3: Volume and Area of Surfaces** Volumes by slicing disks and method of washers, Volumes by cylindrical shells, Arc length, Arc length of parametric curves, Area of surface of revolution; Hyperbolic functions; Reduction formulae. ***Graded PowerPoint presentation will be assigned as group project work from Unit III and will be considered a part of Internal assessment.***
Feb	**Unit 4: Vector Calculus and its Applications** Introduction to vector functions and their graphs, Operations with vector functions, Limits and continuity of vector functions, Differentiation and integration of vector functions; Modeling ballistics and planetary motion, Kepler's second law; Unit tangent, Normal and binormal vectors, Curvature. ***Viva-voce on Unit IV for Internal Assessment***
March	***Revision of Syllabus*** ***Taking up doubts*** ***Extra practice to underperformers*** ***Additional practice questions of higher difficulty order to meritorious students.*** ***Practical Examinations***

- To make the lectures interesting, use of PPTs and audio visual presentations will be made.
- The students would be encouraged to solve real life business/ managerial problems by applying the statistical concepts learnt in assignments, tests or project.
- Demonstration of statistical computation will be done through application like MS Excel and other statistical software like SPSS or PSPP.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
3. 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:

i. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas*' *Calculus* (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

Practical / Lab work to be performed in Computer Lab.

List of the practicals to be done using Mathematica /MATLAB /Maple/Scilab/Maxima etc.

1. Plotting the graphs of the following functions:

ax, $[x]$(greatest integer function), $\sqrt{ax+b}$, $\overline{|ax+b|}$, $c \pm |ax+b|$, $x^{\pm n}$, x^n $(n \in \mathbb{Z})$, $\frac{|x|}{x}$, $\sin\left(\frac{1}{x}\right)$, $x\sin\left(\frac{1}{x}\right)$, and $e^{\pm\frac{1}{x}}$, for $x \neq 0$,

e^{ax+b}, log ($+b$), $1/(ax+b)$, sin ($ax+b$), cos($ax+b$),
| sin($ax+b$)|, | cos($ax+b$)|.

Observe and discuss the effect of changes in the real constants *a*, *b* and *c* on the graphs.

2. Plotting the graphs of polynomial of degree 4 and 5, and their first and second derivatives, and analysis of these graphs in context of the concepts covered in Unit 1.
3. Sketching parametric curves, e.g., trochoid, cycloid, epicycloid and hypocycloid.
4. Tracing of conics in Cartesian coordinates.
5. Obtaining surface of revolution of curves.
6. Graph of hyperbolic functions.
7. Computation of limit, Differentiation, Integration and sketching of vector-valued functions.
8. Complex numbers and their representations, Operations like addition, multiplication, division, modulus. Graphical representation of polar form.
9. Find numbers between two real numbers and plotting of finite and infinite subset of $\mathbb{R}$.
10. Matrix operations: addition, multiplication, inverse, transpose; Determinant, Rank, Eigenvectors, Eigenvalues, Characteristic equation and verification of the Cayley Hamilton theorem, Solving the systems of linear equations.

Teaching Plan (Theory of BMATH101: Calculus):

Week 1: The first-derivative test for relative extrema, Concavity and inflection points, Second-derivative test for relative extrema, Curve sketching using first and second derivative tests.
[3] Chapter 4 (Section 4.3).

Week 2: Limits to infinity and infinite limits, Graphs with asymptotes, Vertical tangents and cusps, L'Hôpital's rule.
[3] Chapter 4 (Sections 4.4 and 4.5).

Week 3: Applications of derivatives in business, economics and life sciences. Higher order derivatives and Leibniz rule for higher order derivatives for the product of two functions.
[3] Chapter 4 (Section 4.7).
[2] Chapter 5 (Sections 5.1, 5.2 and 5.4).

Week 4: Parametric representation of curves and tracing of parametric curves (except lines in $\mathbb{R}^3$), Polar coordinates and the relationship between Cartesian and polar coordinates.
[3] Chapter 9 [Section 9.4 (Pages 471 to 475)].
[1] Chapter 10 (Sections 10.1, and 10.2 up to Example 2, Page 707).

Weeks 5 and 6: Tracing of curves in polar coordinates. Techniques of sketching conics**:** parabola, ellipse and hyperbola.
[1] Sections 10.2 (Pages 707 to 717), and 10.4 up to Example 10 Page 742)].

Week 7: Reflection properties of conics, Rotation of axes, Second degree equations and their classification into conics using the discriminant.
[1] Sections 10.4 (Pages 742 to 744) and 10.5.

Weeks 8 and 9: Volumes by slicing disks and method of washers, Volumes by cylindrical shells, Arc length, Arc length of parametric curves.
[1] Chapter 5 (Sections 5.2, 5.3 and 5.4).

Week 10: Area of surface of revolution; Hyperbolic functions.
[1] Sections 5.5 and 6.8.

Week 11: Reduction formulae, and to obtain the iterative formulae for the integrals of the form**:** $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$ and $\int \sin^m x \cos^n x\,dx$.
[1] Chapter 7 [Sections 7.2 and 7.3 (Pages 497 to 503)].

Week 12: Introduction to vector functions and their graphs, Operations with vector functions, Limits and continuity of vector functions, Differentiation and tangent vectors.
[3] Chapter 10 (Sections 10.1 and 10.2 up to Page 504).

Week 13: Properties of vector derivatives and integration of vector functions; Modeling ballistics and planetary motion, Kepler's second law. [3] Chapter 10 [Sections 10.2 (Pages 505 to 511) and 10.3].

Week 14: Unit tangent, Normal and binormal vectors, Curvature. Sections 12.4 and 12.5.

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Learn first and second derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2.	Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.		
3.	Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.		
4.	Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.		

Keywords: Concavity, Extrema, Inflection point, Hyperbolic functions, Leibniz rule,L'Hôpital's rule, Polar and parametric coordinates, Vector functions.