

Semester-I

Paper I: Calculus

Total Marks: 100 (Theory: 75 and Internal Assessment: 25)

Workload: 5 Lectures, 1 Tutorial (per week) **Credits:** 6 (5+1)

Duration: 14 Weeks (70 Hrs.) **Examination:** 3 Hours.

Course Objectives: Calculus is referred as 'Mathematics of change' and is concerned with describing the precise way in which changes in one variable relate to the changes in another. Through this course, students can understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.

Course Learning Outcomes: The students who take this course will be able to:

- i) Understand continuity and differentiability in terms of limits.
- ii) Describe asymptotic behavior in terms of limits involving infinity.
- iii) Use derivatives to explore the behavior of a given function, locating and classifying its extrema, and graphing the function.
- iv) Understand the importance of mean value theorems.
- v) Learn about Maclaurin's series expansion of elementary functions.

Unit 1: Continuity and Differentiability of Functions

Limits and Continuity, Types of discontinuities; Differentiability of functions, Successive differentiation, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit 2: Tracing of Curves

Tangents and normals, Curvature, Singular points, Asymptotes, Tracing of curves.

Unit 3: Mean Value Theorems and its Applications

Rolle's theorem, Mean value theorems, Applications of mean value theorems to monotonic functions and inequalities; Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series expansion of e^x , $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Maxima and minima; Indeterminate forms.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). Wiley India Pvt. Ltd. New Delhi. International Student Version. Indian Reprint 2016.
2. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.

Additional Reading:

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

Teaching Plan (Paper-I: Calculus):

Weeks 1 and 2: Limits and continuity, Types of discontinuities.

[1] Chapter 1 (Sections 1.1 to 1.6)

[2] Chapter 2 (Section 2.7).

Week 3: Differentiability of functions.

[1] Chapter 1 (Section 2.2).

Week 4: Successive differentiation, Leibnitz theorem. [2] Chapter 5.

Week 5: Partial differentiation, Euler’s theorem on homogeneous functions.

[2] Sections 12.1 to 12.3.

Week 6: Tangents and normals.

[2] Chapter 8 (Sections 8.1 to 8.3).

Week 7: Curvature, Singular points.

[2] Chapter 10 (Sections 10.1 to 10.3, up to Page 224), and Chapter 11 (Sections 11.1 to 11.4).

Weeks 8 and 9: Asymptotes, Tracing of Curves.

[2] Chapter 9 (Sections 9.1 to 9.6), and Chapter 11 (Section 11.5).

Weeks 10 and 11: Rolle’s theorem, Mean value theorems: Lagrange’s mean value theorem, Cauchy’s mean value theorem with geometrical interpretations, Applications of mean value theorems to monotonic functions and inequalities.

[2] Chapter 7 (Sections 7.4 to 7.6).

Week 12: Taylor’s theorem with Lagrange’s and Cauchy’s forms of remainder, Taylor’s series.

[2] Chapter 7 (Section 7.7).

Week 13: Maclaurin’s series expansion of e^x , $\sin x$, $\cos x$, $\log(1+x)$, and $(1+x)^m$.

[2] Chapter 7 (Section 7.8).

Week 14: Maxima and minima; Indeterminate forms.

[2] Chapter 15 (Sections 15.1 to 15.3).

[1] Chapter 6 (Section 6.5).

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Understand continuity and differentiability in terms of limits.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students to be given homework/ assignments. (iv) Discuss and solve the problems in the class.	<ul style="list-style-type: none"> • Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • End-term examinations.
2.	Describe asymptotic behavior in terms of limits involving infinity. Use derivatives to explore the behavior of a given function, locating and classifying its extrema, and graphing the function.		
3.	Understand the importance of mean value theorems. Learn about Maclaurin’s series expansion of elementary functions.		

Keywords: Curvature, Euler’s theorem on homogeneous functions, Leibnitz theorem, Maclaurin's theorem, Mean value theorems, Indeterminate forms Singular points and asymptotes, Tangents and normals, Taylor’s series.