

## Syllabus template

<b>Semester: I</b>				
<b>Programme: Mathematics</b>				
<b>Course: Demystifying Curves and Surfaces</b>				
<b>Paper code: M1MT230111T</b>				<b>Credits: 3</b>
<b>Hours/week: 3</b>				
<b>Category: Core/MDC/SEC/VAC: MDC</b>				
<b>Theory / Practical / Composite: Theory</b>				
<b>No of Modules: NA</b>				
<p><b>Course Overview:</b> This course explores the beauty of curves and surfaces, revealing how algebraic equations shape the geometry we visualise. Beginning with conic sections and their remarkable properties, students learn the calculus-based techniques for studying tangents, normals, arc length, asymptotes, concavity, and inflexion points. The course then extends to lines and planes in three-dimensional space, approached through both scalar and vector techniques. With a focus on intuition, clear geometric insight, and problem-solving, students learn not only to analyse curves and surfaces but also to truly understand the geometry behind them.</p>				
<p><b>Course Outcome:</b> On successful completion of this course, students will be able to:</p>				
<p>1. <b>Explain</b> the classification and geometric properties of conic sections, and interpret their standard and parametric forms.</p>				
<p>2. <b>Determine and apply</b> the equations of tangents and normals to plane curves in various forms to solve geometric problems.</p>				
<p>3. <b>Identify and compute</b> horizontal, vertical, and oblique asymptotes of algebraic curves.</p>				
<p>4. <b>Analyse</b> the concavity, convexity, and points of inflexion of curves using derivative-based criteria.</p>				
<p>5. <b>Recognise and construct</b> envelopes of one-parameter and certain two-parameter families of curves, including identifying curves as envelopes of their tangents.</p>				
<p>6. <b>Formulate and solve</b> problems involving straight lines and planes in three-dimensional space using both scalar and vector approaches, and <b>evaluate</b> spatial relationships such as angles, distances, and intersections.</p>				
<p><b>Prerequisites:</b></p> <p>1. <i>A working knowledge of coordinate geometry in two dimensions (straight lines and basic conics).</i></p> <p>2. <i>Familiarity with differential calculus, including derivatives, the chain rule, and basic curve sketching ideas.</i></p> <p>3. <i>Basic understanding of vectors and vector operations (addition, scalar multiplication, dot product).</i></p> <p>4. <i>Comfort with solving systems of linear equations and the concept of rank will be helpful for the 3D geometry module.</i></p>				
<b>SYLLABUS</b>				
<b>UNIT/Module</b>	<b>CONTENT</b>	<b>HOURS or NUMBER OF CLASSES</b>	<b>CO Mapping</b>	<b>COGNITIVE LEVEL</b>
<b>I. Recapitulation of Conic</b>	Focus-directrix definition of a conic. Classification of conics	<b>10 hours</b>	<b>CO1</b>	<b>K2, K3</b>

<p><b>Sections</b></p>	<p>as parabola, ellipse and hyperbola based on eccentricity. Equations of axis, directrix and focal chords. Standard equations of conics in Cartesian and Parametric form. Reflection properties of parabola, ellipse and hyperbola-Polar equation of conics.</p>			
<p><b>II. Applications of Calculus</b></p>	<p><b>Tangent –Normal [5]:</b> Idea of tangents and normal to a plane curve given in explicit, implicit and parametric form. Tangents at the origin of any rational algebraic curve. Angle between the radius vector and tangent at a point of the curve-expression of the differential arc length in Cartesian as well as Polar coordinates. Angle between two intersecting curves.</p> <p><b>Rectilinear Asymptotes [4]:</b> Ideas of vertical, horizontal and oblique asymptotes to a curve given in Cartesian equation, working rule for finding the asymptotes of the most general algebraic curve of certain finite degree.</p> <p><b>Concavity, Convexity &amp; Point of inflexion [2]:</b> Criteria based on derivatives with geometric visualisation (only Cartesian equations of curves to be dealt)</p> <p><b>Envelopes [3]:</b> Envelope of a one-parameter family of curves given in the Cartesian form. Recognising any curve as the envelope of the family of its tangents. Envelope of a two-parameter family of curves where the parameters themselves are functionally related.</p>	<p><b>14 hours</b></p>	<p><b>CO2, CO3, CO4, CO5</b></p>	<p><b>K3, K4</b></p>

<p><b>III. Familiarity with straight lines and planes in 3D</b></p>	<p>Working knowledge of the rank of a matrix and consistency–inconsistency of a system of linear equations in three variables as prerequisites. [2] Equation of a plane passing through three non-collinear points, Normal and intercept form of the equation of a plane. Joint equation of a pair of planes passing through the origin [2]. Necessary and sufficient conditions for <math>\vec{r} \cdot \vec{n}_1 = p_1</math> and <math>\vec{r} \cdot \vec{n}_2 = p_2</math> to represent a pair of parallel planes (rank method). Distance between two parallel planes [2]. How to find the line of intersection of two non-parallel planes. Equation of any plane passing through the line of intersection of two non-parallel planes. Condition for the given planes meeting in (i) a point, (ii) a line (rank method) [3]. Scalar and vector approach for the derivation of different forms of equations of a straight line in 3D. Idea of direction cosines and direction ratios. [3] Angle b/w two straight lines- Conditions of parallelism and perpendicularity. [1] Shortest distance b/w two skew lines-Equation of the line of shortest distance (vector treatment) [2]</p>	<p><b>15 hours</b></p>	<p><b>CO6</b></p>	<p><b>K3, K4, K5</b></p>
<p><b>Text Books</b></p>				
<p>1. An Introduction to Analysis: Differential Calculus (Part-1): Maity and Ghosh.</p>				
<p>2. Differential Calculus: Shanti Narayan and Mittal.</p>				
<p>3. Advanced Calculus (Applications): Debasish Sengupta.</p>				
<p>4. Application of Calculus: Sitansu Bandyopadhyay and Sunil Kumar Maiti.</p>				

5. Analytical Geometry of two and three dimensions and Vector Analysis: R.M.Khan.
6. Advanced Analytical Geometry: Chakraborty and Ghosh.
<b>Suggested readings</b>
1. Calculus: Michael Spivak.
2. Calculus (Vol. 1): Tom. M. Apostol.
3. An Elementary Treatise on Co-ordinate Geometry of Three Dimensions: Robert J.T.Bell.
4. The Elements of Coordinate Geometry: S.L. Loney.
<b>Web Resources</b>
1.
2.
3.
4.
<b>Evaluation:</b> Theory CIA: 10+3+2=15; Semester Exam: 35.
<b>Paper Structure for Theory Semester Exam Module:</b> 7 questions each carrying 5 marks need to be answered out of 11 questions.

### Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	<b>Explain</b> the classification and geometric properties of conic sections, and interpret their standard and parametric forms.	<b>K2, K3</b>
CO2	<b>Determine and apply</b> the equations of tangents and normals to plane curves in various forms to solve geometric problems.	<b>K3</b>
CO3	<b>Identify and compute</b> horizontal, vertical, and oblique asymptotes of algebraic curves.	<b>K3</b>
CO4	<b>Analyse</b> the concavity, convexity, and points of inflexion of curves using derivative-based criteria.	<b>K4</b>
CO5	<b>Recognise and construct</b> envelopes of one-parameter and certain two-parameter families of curves, including identifying curves as envelopes of their tangents.	<b>K4</b>
CO6	<b>Formulate and solve</b> problems involving straight lines and planes in three-dimensional space using both scalar and vector approaches, and <b>evaluate</b> spatial relationships such as angles, distances, and intersections.	<b>K3, K4, K5</b>