**Course Title:** Analytical Geometry **Full marks:** 100

**Course number:** Math. Ed. 434 **Pass marks:** 35

**Nature of course:** Theory **Period per weeks:** 6

**Level: Bachelor Degree Total Period:**150

**Time per period:** 55 minutes

**1. Course Description**

This course *Analytic**Geometry* deals with the properties of geometric figures using coordinate system. It is concerned with two or three dimensions in which students will be able to generalize the nature and properties of geometric shapes using algebraic properties. Analytic geometry is widely used in various branches of science. This geometry also creates the foundation of most modern fields of geometry including algebraic differential, discrete and computational geometry. It is concerned with defining and refreshing geometrical shapes in a numerical way and extracting numerical information from shape’s numerical definitions and representations.

**2. General objectives**

The general objectives of this course are as follows:

* To familiarize students with different co-ordinate systems in analytical geometries of two and three dimensions.
* To make the students able to understand different conic sections and describe their natures.
* To acquaint students in describing analytically the structure of space, special relation with lines, planes and relations between them in 3-space.
* To make students able to generalize the general equation of second degree and conditions to represent conics and conicoids with their properties.
* To make a deep understanding of plane sections and generating lines of conicoids.

**3 .Specific Objectives and Contents**.

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| **Specific Objectives** | **Contents** | |
| * Describe the transformation of coordinates of axes * Derive transformation of coordinates of axes through translation and rotation * Define invariants in orthogonal transformations | **Unit-I Transformation of Co-ordinates (6)**  1.1 Translation of axes  1.2 Rotation of axes  1.3 Combination of translation and rotation of axes,  1.4Invariants in orthogonal transformation. | |
| * Discuss the nature of curves obtained by conic sections namely parabola, ellipse, hyperbola and interpretation as a locus of a point * Determine the equation of parabola, ellipse and hyperbola and discuss their nature. * Derive equations of tangents and normal to parabola, ellipse and hyperbola and discuss their properties * Define pole and polar on parabola, ellipse and hyperbola | Unit-II Conic Sections (30)  2.1 Parabola:  2.1.1 Introduction of conic sections  2.1.2 Review of equations of tangent and normal  2.1.3 Equations of pair of tangents,  2.1.4 Director circle  2.1.5 Chord of contact  2.1.6 Pole and polar  2.1.7 Properties of pole and polar.  2.2 Ellipse  2.2.1 Equation of ellipse  2.2.2 Auxiliary circle and eccentric angles  2. 2.3 Position of a point  2. 2.4 Tangent and normal  2. 2.5 Pair of tangents from an external point  2. 2.6 Director circle  2. 2.7 Chord of contact,  2. 2.8 Pole and polar and their properties  2. 2.9 Chord with a given middle point  2. 2.10 Diameter, Conjugate diameter  2. 2.11 Equiconjugate diameters and its properties  **2.3 Hyperbola**  2.3.1 Equation of hyperbola  2.3.2Parametric coordinates and conditions of tangency  2.3.3 Equation of tangent and normal  2.3.4 Chord or contact  2.3.5 Pair of tangents  2.3.6 Auxiliary circle and director circle  2.3.7Conjugate points and lines  2.3.8Equation of chord  2.3.9 Rectangular hyperbola  2.3.10 Asymptotes and its equations  2.3.11 Equation of diameter and its properties  2.3.12Conjugate diameters and its properties. | |
| * Represent conics in polar coordinates. * Derive equations of conics in polar coordinates. * Trace conics in polar form. * Determine equations of chord, tangent and normal. | **Unit-III Polar Equation of a Conic (12)**  3.1Polar co-ordinate system  3.2 Polar equation of conics  3.3 Equation of directrix  3.4Tracing conics in polar form  3.5Equations of chord, tangent and normal  3.6 Point of intersection of two tangents 3.7 Equation of pair of tangents  3.8 Equation of chord of contact. | |
| * Derive the representation of general equation of second degree as a conic section under certain conditions. * Discuss different properties of conic section of the second degree equation. * Determine equations of asymptotes, tangents, and normal, director circle, and chord of contact. * Discuss pole, poler and chord of the general conic. | **Unit-IV Conic Sections Represented by General Equation of Second Degree (18)**  4.1General equation of second degree and conics represented by this equation  4.2 Nature and centre of conic  4.3 Reduction of centre of conic to standard form  4.4 Equation of asymptotes  4.5 Equation of tangent and normal  4.6Conditions of tangency  4.7 Pair of tangents from an external point  4.8 Equation of director circle and chord of contact  4.9 Pole and polar and their properties  4.10 Chord of the general conic with given middle point  4.11 Diameter of the conic  4.12 Conjugate diameters  4.13 Intersection of conics  4.14 Equation of conic through the intersection of two conics. | |
| * Review the rectangular Cartesian co-ordinates in 3-dimension, change of origin, section formula, direction cosines, direction ratios, projection and angle between two lines * Relate Cartesian co-ordinates, spherical co-ordinates and cylindrical co-ordinates of a point. * Define plane in 3D and establish linear equation representing a plane. * Find equation of plane in intercept form, normal form and reduce general equation of plane in normal form. * Determine plane through three points, plane through the intersection of two planes. * Determine angle between two planes and plane bisecting the angle between two planes. * Establish condition for homogeneous equation to represent a pair of planes | **Unit-V Plane (15)**  5.1 Review the three dimensional Cartesian co-ordinates  5.2 Cylindrical and spherical co-ordinates of a point  5.3 General equation of first degree  5.4 Linear equation of a plane  5.5 Angle between two planes  5.6 Angle between a line and a plane  5.7 Plane through three points  5.8 Plane through the intersection of two planes  5.9 Length of perpendicular from a point to a plane  5.10 Bisectors of angles between two planes  5.11 Pair of planes  5.12 Conditions for homogeneous second degree equation to represent a pair of planes  5.13Angle between two planes represented by a second degree homogeneous equation. | |
| * Derive the equation of straight line in symmetrical form and equation of straight line joining two points. * Transform general equation to symmetrical form. * Find angle between a line and a plane. * Derive the condition for a line to lie in a plane. * Derive the condition for co- planarity of lines. * Find the shortest distance between two lines. | **Unit-VI Straight Lines (17)**  6.1 Equation of a straight line in symmetrical form  6.2 Perpendicular distance of a line from a point  6.3 Two forms of the equation of a line  6.4 Angle between a line and a plane 6.5Condition for a line to lie in a plane  6.6 Plane containing a line coplanar lines, 6.7 Shortest distance between two lines. | |
| * Determine equation of a sphere in different conditions. * Determine the intersection of two spheres. * Discuss the intersection of a sphere and a time. * Find the equation of a tangent plane and determine the condition of tangency. | **Unit-VII Sphere (10)**  7.1 Equation of a sphere  7.2 General equation of a sphere  7.3 Equation of a sphere through four points  7.4 Plane section of a sphere  7.5 Equation of a sphere with a given diameter  7.6 Intersection of a two spheres  7.7 Spheres through the given circle  7.8 Intersection of a sphere and a line 7.9 Equation of tangent plane  7.10 Condition of tangency |
| * Find equation of a cone and cylinder * Determine the condition of general equal of second degree to represent a cone. * Find equation of a cone with a generic conic as a base, * Find angles between two lines in which a plane cuts a cone, * Find equation of tangent lines, planes and condition of tangency, * Find equation of a reciprocal cone, enveloping cone and right circular cone and cylinder. | **Unit-VIII Cone and Cylinder (10 )**  8.1 Cone with vertex at origin  8.2 Condition for the general equation of second degree to represent a cone  8.3 Coordinates of the vertex of a cone  8.4 Equation of a cone with a given vertex and given conic as base  8.5 Angle between the lines in which a plane cuts a curve  8.6 Condition that a curve has three mutually perpendicular generaters  8.7 Tangent lines and tangent plane at a point  8.8 Condition for tangency  8.9 Equations of reciprocal cone, enveloping cone and right circular cone, enveloping cylinder and right circular cylinder. |
| * Write equation and identify the shapes of ellipsoid, hyperboloid of one-sheet and two-sheets. * Find equation of a line with a conicoid. * Find equations of tangent planes. * Find equation of normal from a given point, cubic curves through the feet of the normal and cone through six normals. * Derive equation of polar plane of a point and find the pole of a given plane, * Find equation of enveloping cone and cylinder * Find diametrical plane, principal plane and conjugate diameters of the ellipsoid. | **Unit-IX Central Conicoid (12)**  9.1Equations and shapes of ellipsoid and hyperboloid  9.2 Intersection of a line with a conicoid  9.3 Equation of a tangent plane  9.4 Condition of tangency  9.5 Equation of normal  9.6 Cubic curves through the feet of the normals and cone through six normals,  9.7 Director sphere  9.8 The plane of contact  9.9 Polar plane of a point  9.10 Pole of a given line  9.11 Properties of polar planes and polar lines  9.12 Locus of chords bisected at a given point  9.13 Locus of middle points of a system of parallel chord  9.14 Enveloping cone and enveloping cylinder  9.15 Diametral plane and principal plane 9.16 Conjugate diameter and conjugate diametral planes of ellipsoid  9.17 Properties of conjugate semi-diameters. |
| * Discuss the plane sections of conicoids * Determine the nature ,the lengths ,and the direction ratios of the axes of a plane of a given conicoid * Discuss generating lines and condition for a line to be a generator of conicoid * Deal with properties of generating lines of hyperboloid of one sheet * Discuss the generating lines of a hyperbolic paraboloid and its properties | **Unit-X Plane sections and Generating Lines of Conicoids**  (**20**)  10.1 Nature of the plane sections of a central conocoid  10.2 Axes of acentral plane section 10.3Areas of plane sections  10.4 Condition for the section to be a rectangular hyperbola  10.5 Axes of non-central plane sections  10.6 Parallel plane sections  10.7 Circular sections  10.8 Umbilics  10.9 Axes of plane sections of paraboloids  10.10 Circular sections of paraboloids  10.11Generating lines of a hyperboloid one sheet  10.12Condition for a line to be a generator of the conicoid  10.13 Properties of generating lines of hyperboloid of one sheet  10.14 Projections of the generators of a hyperboloid on any principal plane  10.15 Perpendicular generators  10.16 Properties of generating lines of hyperbolic paraboloid. |

**4. Instructional Techniques**

The nature of this course being theoretical, teacher-centred instructional techniques will be dominant in teaching-learning process. The teacher will adopt the following techniques.

**4.1 General instructional techniques**

* Lecture with illustration
* Discussion
* Demonstration
  1. **Specific instructional techniques**
* Inquiry and question-answer (for all units)
* Assignment and presentation (for all units)
* Individual and group work presentation

**5. Evaluation**

Students will be evaluated on the basis of written test in between and at the end of the academic session, the classroom participation, presentation of the assignment (reports) and other activities. The scores obtained will be used only for feedback purposes. The office of the controller of examination will conduct annual examination at the end of the academic session to evaluate student's performance. The types, number and marks of the subjective and objective questions will be as follows:-

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| --- | --- | --- | --- |
| **Types of questions** | **Total questions to be asked** | **No. of questions to be answered and allotted** | **Total marks** |
| Group A: Multiple choice items | 20 questions | 20 1 marks | 20 |
| Group B: Short questions | 8 with 3 alternative questions | 8 7 marks | 56 |
| Group C: Long questions | 2 with 1 alternative question | 2 12 marks | 24 |

**6. Recommended and Reference Books**

**6.1 Recommended Books**

Koirala S.P., Pandey U.N. & Pahari N.P. (2009), *Analytic geometry* Kathmandu; Vidyarthi Prakashan (P) Ltd. (Third revised ed. 2016). (For all units)

Joshi M.R. (1997); *Analytic geometry*, Kathmandu; Sukunda Pustak Bhandar

Loney S.L. (1984): *The elements of coordinate geometry*; New Delhi: S. Chand and company Pvt. Ltd.

6.2 **Reference Books**

Chatterjee, D. *Analytical solid geometry*,New Delhi :Prentice Hall of India Private limited.

Narayan S. and Mittal P. K. (2001), *Analytical Solid geometry*, New Delhi: S. Chand and Company Pvt. Ltd.

Pandit, R.P. and Pathak, B. R., (2069) *Fundamentals of geometry* Kathmandu: Indira Pandit.

Prasad Lalji, (1990). *Analytical Solid geometry*, Panta: Paramount Publication

Sthapit, Y. R. & Bajracharya, B.C. (1992). *A textbook of three dimensional geometry*. Kathmandu: Sukunda Pustak Bhandar.

Thomas, G. B. & Finney R. L. (2004), *Calculus and analytic geometry* New Delhi: Pearson publication.

Mittal P.K.(2007).,*Analytical geometry.* Delhi: Vrinda publications (P) LTD