**Course Title:** Fundamentals of Geometry **Full marks:** 100

**Course number:** Math. Ed. 428 **Pass marks:** 35

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

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

### 1. Course Description

The course is provides essential mathematical knowledge as well as practical skills to the foundation of Euclidean geometry still taught in secondary level of school. Euclidean geometry is an example of mathematical structure based on a small set of intuitively appearing definitions, axioms and postulates that re fundamental to prove any statement.

### 2. General Objectives

The general objectives of this course are as follows:

1. To make students able to explain axiomatic system of Euclidean geometry
2. To enable the students to understand foundation of Euclidean geometry, congruence, parallelism, similarity, convexity, circles and circular arc
3. To make the students familiar with various methods of finding areas of plane figures and volumes of solids
4. To equip the students to different concepts of topology
5. To acquaint the students with the projective and transformation geometry

**3. Specific Objectives and Contents**

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| **Unit** | **Specific Objectives** | **Contents** |
| I | * Explain history of development of geometry as a mathematical system * Describe historical development of geometry * Discuss the axiomatic system and its properties | Unit I: Axiomatic System 5  * 1. Development of geometry as a Mathematical system   2. Historical Development of Geometry   3. Axiomatic system and their properties |
| II | * Explain the foundation properties of Euclidean geometry * Describe basic properties of sets in a line, rays and angles, polygons and circles. | Unit II: Foundation of Euclidean Geometry **15**  2.1 Foundation properties  2.3 Basic properties of sets in a line,  2.4 Basic properties of Rays and Angles.  2.5 Polygons and circles |
| III | * Explain notion and conditions of congruence. * Prove theorems on congruence of triangles and polygons | Unit III: Congruence 15  * 1. The notion of congruence   2. Congruence condition   3. Some theorem on congruence of triangles and polygons |
| IV | * State parallel postulate and its implication * Explain conditions of parallelism * Explain the properties of triangles and circles | Unit IV: Parallelism 15  * 1. Parallel postulate and its some implication,   2. Quadrilateral and its properties   3. Properties of triangles and circles |

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| V | * Explain conditions of similarities. * Prove theorems on similarities Pythagoras theorem, | Unit V: Similarities 15 5.1 Conditions of similarities  5.2 Similarity of triangles  5.3 Pythagoras theorem.  5.4 Similarities and congruence of polygons |
| VI | * Discuss convexity of plane figures and convex solids * Explain angle and arc properties and tangency properties of circle | Unit VI: Convexity, Circular and Circular Arcs 15  * 1. Plane convex figures   6.2 Convex solids  6.3 Angle and arc properties of circles  6.4 Tangency properties of circles |
| VII | * Compute the area and volume of plane and solids figures | Unit VII: Area and Volume 20 **7.1 Area of plane figure:** triangle, quadrilateral, polygons. apothems, area of circles, cone, parallelepiped, surface area of sphere  **7.2 Volume of solid:** Cavalleri's principle, prism, pyramids, cone and sphere |
| VIII | * Provide an overview of transformation geometry. * Investigate isometric transformations, non-isometric and inversion transformation. * Explain fundamental concepts of projective geometry and projective properties * Define real projective plane * Prove some elementary properties of projective plane * Discuss the principle of duality in projective geometry * Prove the theorem of Desgargues * Explain projective transformation | Unit VIII: Transformation and Projective Geometry 20  * 1. Isometric transformations: Reflection, Translation, Half-turn, Rotation, Glide reflection and their equations in analytic and in matrix form.   2. Non-isomeric transformation. Dilation, Enlargement and reduction, Stretch, Shear.   3. Inversion transformations: Inverse point, feature of inversion, geometric construction of inverse points. Inverse of a line, a circles and a curve and related equations   8.4 Fundamental concepts of projective geometry,  8.5 The axiom of real projective plane - Projective properties   * 1. Co-ordinatization of projective plane,   8.7 Duality. Perspectivity, The theorem of Desgargues.  8.8 Projective transformation |
| IX | * Explain the development of non-Euclidean geometry. * Describe the angle of parallelism * Explain development of hyperbolic geometry and its related results. * Compare different type of geometry | **Unit IX: Non-Euclidean Geometry 20**  9.1 Development of Non Euclidean Geometry  9.2 The angle of parallelism 9.3 The hyperbolic geometry- Model of hyperbolic geometry, hyperbolic parallel postulates, some results in hyperbolic geometry 9.4 Hyperbolic results concerning polygons  9.5 Elliptic geometry- Model of elliptic geometry, Elliptic parallel postulates, Postulates of elliptic geometry, some results in elliptic geometry  9.6 Comparison of three geometries |
| X | * Discuss the concepts and terminology associated with network * Prove the result of Euler's discovery about networks * Explain Koenisberg Bridge Problem * Describe Polyhedra - Euler's Formula for Polyhedra * Classify surfaces topologically | Unit X: Topology 10 10.1 Topology and geometry,  10.2 Networks - Euler's discovery about networks,  10.3 Koenisberg Bridge Problem,  10.4 Polyhedra - Euler's Formula for Polyhedra  10.5 Topological surface - Euler's characteristics of surface |

**4. Instructional Strategies**

Because of theoretical nature of course, the student centered approach will be used in teaching learning process. As teacher are free to follow the methods suitable for them and the students, they may adopt the following teaching learning strategies.

**4.1. General Instructional Techniques**

Lecture and illustration

Discussion

Demonstration

**4.2 Specific Instructional Techniques**

Inquiry and question answer

Individual and group work, project work

Classroom presentation

**5. Evaluation**

The Office of Controller of Examination, Tribhuvan University will conduct the annual examination at end of the year to evaluate students' performance. The questions of theoretical part in the final examination will contains the question from whole course carrying fifty marks. The types, number and marks of the objective and subjective questions that will be asked in final examination by the Office of the Controller of Examination is as follows:

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| --- | --- | --- | --- |
| Types of questions | Total questions | Number of questions & their marks | Total marks |
| **Group A:** Multiple choice questions | 20 questions | 1 × 20 marks | 20 |
| **Group B:** Short answer questions | 8 questions (or 3 alternative questions) | 8 × 7 marks | 56 |
| **Group C:** Long answer question | 2 questions (or 1 question) | 2 × 12 Marks | 24 |

**6 Recommended Books:**

Kelly, P. J. & Ladd, N. E. (1987). *Fundamental of Mathematical Structure: Geometry*. New Delhi: Eurasia Publishing House (Pvt) Ltd.

Wallace, E. C and Wets, S. F (1998): *Roads to Geometry*. Delhi: Prentice Hall of India.

**7. References:**

Banks, H. (1963): *Elements of Mathematics*. Boston: Alyn and Bacon Inc.

Eves, H. (1995). *College Geometry*. Delhi: Narosa Publishing House.

Pandit, R. P. (2014). *Fundamentals of Geometry.* Kathmandu: Indira Pandit

Seidenberg, A. (1962). *Lectures in Projective Geometry*. D. Van Nostrand Company Inc.

Wolf, H. E. (1945): *Introduction to Non Euclidean Geometry*. New York: Holt Rinehart and Winston.