Discipline Specific Core (DSC): 04 Credits

DSC 9 (IV.1) Pedagogical Explorations in Ancient Indian Geometry and Mathematics

Discipline Specific Core

1. Credit Distribution of the course

Course title & Code DSC 9 (IV.1)	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pedagogical Explorations in Ancient Indian Geometry and Mathematics	**4**	**3**	**0**	**1**	**Undergraduate**	**NIL**

2. Learning Objectives

This course aims to engage learners in exploring the rich mathematical traditions of ancient India through a pedagogical lens, emphasizing the geometry, trigonometry, and early calculus ideas that emerged from texts such as the *Sulba-sutras* and *Siddhantas*. It seeks to cultivate an understanding of how mathematical thought evolved through practical needs—altar constructions, measurement, astronomy—and how these contexts can serve as powerful learning tools in modern classrooms. The course encourages participants to reconstruct ancient geometric methods using both traditional materials (rope, pegs, and sand diagrams) and modern technological tools such as GeoGebra and dynamic geometry software. Learners will analyze original mathematical problems, interpret their conceptual underpinnings, and reframe them as inquiry-based activities that connect historical insights with contemporary pedagogical practices. Through this exploration, participants will develop pedagogical content knowledge (PCK) to design culturally rooted, hands-on learning experiences that promote conceptual understanding, creativity, and appreciation of India's mathematical heritage.

3. Learning Outcomes

By the end of this course, students will be able to:

- Interpret, model, and reconstruct geometrical and algebraic ideas from ancient Indian mathematical sources using both hands-on and digital tools.

- Design classroom activities, lesson plans, and teaching modules that integrate historical mathematical concepts—such as altar geometry, sine computation, and early notions of series—into modern mathematics education.
- Translate abstract mathematical ideas into tangible learning experiences through constructivist, inquiry-based, and visual pedagogies.
- Critically evaluate the educational value of ancient mathematical approaches and understand how indigenous reasoning and problem-solving methods can enrich the teaching of geometry, trigonometry, and calculus.
- Develop the skills and insight necessary to bridge cultural and conceptual dimensions of mathematics in contemporary classroom practice.

4. Syllabus **[45 hours]**

Unit I Sulba Geometry - Introduction to *Sulba*-sutras; Constructing a square of given side; Constructing a square of area equal to a given rectangle; Constructing a rectangle of area equal to a given square; Squaring the circle and its inverse problem; Geometrical representation of Ö2; Application to the construction of different types of Fire Altars - *Caturasrsa citi*, *Parimandala Smasana citi*, *Rathachakra citi*, *Ubhayata-Prauga citi*, *Prauga citi*, *Shyena citi*. **[15 hours]**

Unit II Circle & Shadow Geometry - Chord of one sixth circle; Circumference-Diameter ratio; Computation of Sine table geometrically; Derivation of sine differences (Method of interpolation); Testing of level of verticality; Radius of the shadow sphere; Application to the gnomonic shadow due to lamp post and tip of the gnomonic shadow from the lap post and height of the latter; Theorems on square of hypotenuse and on square of half chord; Arrows of intercepted arcs of intersecting circles. **[12 hours]**

Unit III Classical Algebra & Series - Progressive series; Permutation and Combination; Pascal triangle and Binomial Theorem; Indeterminate equations of first and second degree; Trigonometric identities; Trigonometric Series; Sine-Cosine-Tan series; Convergency of π-series. **[9 hours]**

Unit IV Early Indian Calculus - The concept of Differential and Integral Calculus as described in ancient Indian texts. **[9 hours]**

5. Practicals **[30 hours]**

- Rope-and-peg constructions of squares and rectangles on the ground ("Sulba Lab")
- Use of GeoGebra to simulate and compare ancient geometric constructions.
- Designing a "mini fire altar" model (using cardboard or clay) demonstrating geometric transformations.
- Outdoor shadow experiments with lamp posts and sticks to measure height and angles (gnomonic studies)
- Creating a geometric sine table using compass and ruler, followed by a digital replication using GeoGebra.

- Exploration of chord geometry using dynamic geometry software—students reconstruct arc and chord relations.
- Pascal triangle construction through physical counters and spreadsheet modeling.
- Understand infinite series using iterative geometric patterns.
- Designing a digital visualization for series convergence inspired by π-series.
- Comparing ancient series approximations with modern calculus computations.

6. Essential Readings

- Sarasvati Amma, T.A. (2017). *Geometry in Ancient and Medieval India*. Motilal Banarsidas Publishers.
- Shukla, K.S. & Sarma, K.V. (1976). *Aryabhatiya of Aryabhat*. Indian National Science Academy, New Delhi.
- Bag, A.K. (1979). *Mathematics in Ancient and Medieval India*. Chaukhamba Orientalia.

7. Suggestive Readings

- Patwardhan, K.S., Naimpally, S.A. & Singh, S.L. (2015). *Lilavati of Bhaskaracarya: Treatise of Mathematics of Vedic Traditions.* Motilal Banarsidas Publishers.
- Bhanumurthy, T.S. (2008). *A Modern Introduction to Ancient Indian Mathematics.* New Age International Publishers.