

SCIENTIFIC HERITAGE OF SANSKRIT

Course Code: M23SN02DE
Discipline Specific Elective Course
Postgraduate Programme in
Sanskrit Language and Literature
Self Learning Material



SREENARAYANAGURU
OPEN UNIVERSITY

SREENARAYANAGURU OPEN UNIVERSITY

The State University for Education, Training and Research in Blended Format, Kerala

SREENARAYANAGURU OPEN UNIVERSITY

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Pathway

Access and Quality define Equity.

Scientific Heritage of Sanskrit

Course Code: M23SN02DE

Semester - III

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Postgraduate Programme
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(With Model Question Paper Sets)



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Scientific Heritage of Sanskrit

Course Code: M23SN02DE

Semester- III

Discipline Specific Elective Course
MA Sanskrit Language and Literature

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MESSAGE FROM VICE CHANCELLOR

Dear learner,

I extend my heartfelt greetings and profound enthusiasm as I warmly welcome you to Sreenarayanaguru Open University. Established in September 2020 as a state-led endeavour to promote higher education through open and distance learning modes, our institution was shaped by the guiding principle that access and quality are the cornerstones of equity. We have firmly resolved to uphold the highest standards of education, setting the benchmark and charting the course.

The courses offered by the Sreenarayanaguru Open University aim to strike a quality balance, ensuring students are equipped for both personal growth and professional excellence. The University embraces the widely acclaimed "blended format," a practical framework that harmoniously integrates Self-Learning Materials, Classroom Counseling, and Virtual modes, fostering a dynamic and enriching experience for both learners and instructors.

The University aims to offer you an engaging and thought-provoking educational journey. The postgraduate programme in Sanskrit offers a special mix of language and literature studies. While the programme covers various aspects of Sanskrit literature and provides the necessary credits, its main goal is to help learners better understand how different types of literature connect with society. We have also made sure to introduce learners to the newest developments in Sanskrit literature. This programme operates on this premise, and the Self Learning Material is designed to reflect this balanced approach.

Rest assured, the university's student support services will be at your disposal throughout your academic journey, readily available to address any concerns or grievances you may encounter. We encourage you to reach out to us freely regarding any matter about your academic programme. It is our sincere wish that you achieve the utmost success.



Warm regards.
Dr. Jagathy Raj V. P.

01-01-2025

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BLOCK-01

Scientific Heritage of Sanskrit

Block Content

- Unit 1: General study of Mathematical literature in Sanskrit
- Unit 2: Development of Astronomy in India
- Unit 3: The contributions of Kerala School
- Unit 4: Major concepts and anticipations





General study of Mathematical Literature in Sanskrit

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse.
- ❖ understand the evolution of scientific thought through the history of scientific literature in Sanskrit.
- ❖ develop an understanding of specific contributions in the fields of Mathematics and Astronomy

Background

Indian civilization is one of the oldest in human history. For centuries, it remained largely unrecognized by many, its contributions overlooked or underappreciated. However, this ancient civilization has played a pivotal and direct role in shaping the development of mathematics as we know it today. This unit aims to explore the history of Indian civilization, with a particular focus on the development of mathematics in ancient and medieval India, as well as to provide a general overview of mathematical literature in Sanskrit.

Keywords

Veda-s, Vedāᅅga-s, Śulba, Bhuja-koᅇi-karᅅa-nyāya, Taittiriyasamhita, Kalpa, Varahasamhita

Discussion

Indian mathematics boasts a rich and ancient heritage, with a history spanning several millennia. The development of Indian mathematics can be categorized into the following broad periods:



1. The Ancient Period/Vedic Period (Prior to 600 BCE)
2. *Sūtra*/Jain Period (600 BCE to 400 CE)
3. Classical Period (400 CE to 1200 CE)
4. Medieval Period/Kerala School of Mathematics (1200 CE to 1750 CE)

1. 1.1. The Ancient Period/Vedic Period (Prior to 600 BCE)

The earliest known work in human history is the *R̥gveda*, which consists of 1,028 *sūkta-s* containing 10,462 *mantra-s*. These *mantra-s* were composed in the millennia preceding 2000 BCE, during what historians refer to as the Vedic period. The ancient period, as defined by historians, extends up to 600 BCE. During this time, the *Veda-s* and the auxiliary texts of the *Vedāṅga-s* were composed.

The four *Veda-s*—*R̥k̄*, *Yajus*, *Sāma*, and *Atharvan*—are collections of hymns and *mantra-s*, and within them, several mathematical concepts can be found. Some of these include:

- ◆ Rig, Yajus Sama and Atharva

- ◆ Enumeration of numbers in powers of 10 up to 10¹⁹ (*Taittirīya-samhitā*, 7.2.20)
- ◆ Odd number series found in *Taittirīya-samhitā*, 7.2.11
- ◆ Even number series found in *Taittirīya-samhitā*, 7.2.13

These mathematical elements reflect the advanced understanding of numbers and patterns in early Indian thought.

The six *Vedāṅga-s*/auxiliaries of *Veda-s* - include *Śikṣā*, *Kalpa*, *Vyākaraṇa*, *Nirukta*, *Jyotiṣa* and *Chandas*. *Kalpa* is again sub-divided into four main sections- *Śrautasūtra-s*, *Gṛhyasūtra-s*, *Dharmasūtra-s* and *Śulbasūtra-s*. Among these, the *Śulbasūtra-s* specifically address the construction of sacrificial fireplaces and altars, which are crucial elements in the performance of Vedic rituals. They contain detailed instructions on the measurement and geometrical design of sacrificial altars. The altars are often constructed in specific shapes, and the *Śulbasūtra-s* provide guidelines for their construction in accordance with the sacred principles laid out in the *Veda-s*.

- ◆ Sulbasutra is the subdivision of Kalpa

Śulbasūtra-s form an important class of texts within the *Kalpa* literature, focusing on the precise construction of fireplaces and altars, often of complex geometrical shapes, to ensure the proper conduct of Vedic rituals. Currently, seven *Śulbasūtra* texts are known to us: Baudhayana, Manu, *Āpastamba*, *Kātyāyana*, *Maitrāyaṇa*, *Vārāha*, and *Vādhūla*. Among these seven, the Baudhayana, Manu, *Āpastamba*, and *Kātyāyana Śulbasūtra-s* are of particular importance. They are the oldest, providing valuable insights into the early development



of Geometry.

Among the most remarkable achievements of the Vedic *Śulbakāra-s* (sacrificial altar builders), as documented in the *Śulba* texts, are:

1.1.1.1. The Precise Statement *bhuja-koṭi-karṇa-nyāya* or the Pythagorean Theorem:

The *Śulba* texts contain an early form of the Pythagorean Theorem, known today for its statement that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the other two sides. This concept of *bhuja-koṭi-karṇa-nyāya*, integral to geometry, was articulated long before Pythagoras, with clear evidence of its use in the construction of Vedic altars.

1.1.1.2. Evaluation of $\sqrt{2}$ to a High Degree of Accuracy:

The Vedic *Śulbakāra-s* also developed methods to approximate $\sqrt{2}$ to a remarkable degree of precision. This was crucial for altar construction, as they needed to form right-angled isosceles triangles with sides in the ratio of $1:1:\sqrt{2}$.

1.1.1.5 Recognition of the Irrationality of $\sqrt{2}$:

Perhaps even more impressively, the *Śulba* texts demonstrate an early realization that $\sqrt{2}$ is an irrational number—that is, it cannot be expressed as a ratio of two integers.

1.1.1.4. Rational and irrational triangles:

The texts describe methods for constructing both rational (whole number) and irrational triangles.

1.1.1.5. Determining the East-West line:

A key concept for aligning altars according to cardinal directions.

1.1.1.6. Perpendicular bisectors and geometry of basic shapes:

The construction of squares, rectangles, and trapeziums with specified dimensions.

1.1.1.7. Conversion between geometric shapes:

Methods for transforming a square into a circle (and vice versa), a rectangle into a square (and vice versa), and even a rhombus of a given area.

These achievements reflect the sophisticated mathematical knowledge embedded in the *Śulba* texts, which were not only essential for

- ◆ Sulba texts - Mathematical knowledge embedded

the construction of precise sacrificial altars but also contributed to the broader development of geometry in ancient civilizations.

1.1.2. *Sutra/Jain Period (600 BCE to 400 CE)*

The *Sutra/Jain* period is also known as the early Classical period. Historians generally place the emergence of Buddhism and Jainism around 500 BCE. These two religions also made notable contributions to the field of mathematics.

In Buddhist thought, mathematics is regarded as a noble art, referred to as *Saṅkhyāna*—the science of numbers. The Jain tradition also places great emphasis on mathematical learning, incorporating it as a key part of their philosophical education. The Jains divide their sacred texts into four primary categories: *Dravyānuvyaṅga*, *Carana-karaṇānuvyaṅga*, *Gaṇitānuvyaṅga*, and *Dharmakathānuvyaṅga*. Among these, *Gaṇitānuvyaṅga* specifically covers arithmetic and astronomy. Several Jain texts, such as *Sūrya-prajñapti*, *Candra-prajñapti*, *Sthānāṅga-sūtra*, *Bhagavati-sūtra*, *Tattvārthādhigama-sūtra*, and *Anuyogadvāra-sūtra*, contain significant mathematical insights.

A key figure from this period is *Piṅgala*, who authored the *Chandas-sūtra* in the 3rd century BCE. This seminal work on chandas (metrical structures in Sanskrit poetry) introduced concepts of permutations, combinations, and binary numbers. His *Meru-Prastara* (meaning “Mount Meru arrangement”) is now recognized as an early form of what we today call Pascal’s Triangle. Ancient Indian astronomical texts such as *Sūrya-siddhānta* also belong to this era.

1.1.3. *Classical Period (400 CE – 1200 CE)*

The later classical period is from the 4th to the 12th century CE. During this time, numerous mathematicians and astronomers made groundbreaking contributions, which later spread to various regions around the world.

Aryabhata, born in 476 CE, is a cornerstone figure of this period. At the age of 23, he composed the *Āryabhaṭīya*, which remains one of the earliest datable texts on astronomy and mathematics. This work covers a wide range of topics, including the decimal place value system, the properties of geometrical figures, algebra, and trigonometry. Aryabhata also approximated π (pi) as 3.1416, accurate to four decimal places. His unique system of numeration, using syllables to represent numbers, made his work both innovative and influential.

Varahamihira, another prominent figure of the 6th century, lived in Ujjain and wrote significant works such as the *Pañca-siddhāntikā* (a treatise on astronomy) and the *Brhatsamhitā* (an encyclopedic text on natural phenomena).

- ◆ Sankhyana - the science of numbers

- ◆ Aryabhatiya – a text on astronomy and mathematics



In the 7th century, Brahmagupta, born in Binamala (now part of Gujarat and Rajasthan), made revolutionary contributions to mathematics and astronomy. His *Brāhma-sphuṭa-siddhānta* introduced important concepts such as negative numbers and zero in calculations. Brahmagupta also established formulas for the diagonals and areas of cyclic quadrilaterals.

Bhaskara I, another 7th century mathematician, wrote an influential commentary on Aryabhata's work, known as *Āryabhaṭīya-Bhāṣya*. His writings, such as *Mahābhāskarīya* and *Laghubhāskarīya*, were significant contributions to the study of astronomy.

The 9th century saw *Śrīdhara*, who authored *PāṭiGaṇita*, a famous book on arithmetic. *Mahāvira*, a Jain mathematician, composed *Gaṇita-sāra-saṅgraha* in 850 CE, a treatise focused entirely on mathematics, with more than 1,000 verses.

By the 11th century, Bhaskara II (also known as Bhaskara the Great), born in 1114 CE, emerged as one of the most renowned mathematicians in Indian history. Bhaskara's *Siddhānta-śirōmaṇi*, an astronomical work, is also widely regarded as a monumental achievement. *Siddhānta-śirōmaṇi* includes four parts viz., *BījaGaṇita*, *GrahaGaṇita*, *Golādhyāya* and *Līlāvātī* - covering a wide range of mathematical topics, including arithmetic, algebra, and geometry. The *Līlāvātī* later became a popular textbook across India.

- ◆ Bhaskara's *Siddhānta-śirōmaṇi*, an astronomical work

1.1.4. Medieval Period/Kerala School of Mathematics (1200 CE to 1750 CE)

From the 13th to the 18th century CE, India saw a period of significant intellectual activity in mathematics and astronomy, particularly in Kerala. During this time, many commentaries and glosses were written on earlier works, and the Kerala School of Astronomy flourished.

Mādhava of *Saṅgama-grāma* (c. 1340 – 1425 CE), popularly known as *Goḷavid* (master of spherics) in the tradition, often considered the founder of the Kerala School, made groundbreaking discoveries in infinite series and calculus. *Venvāroha* is the most popular work of *Mādhava*. Though only fragments of his works remain, *Mādhava*'s contributions to trigonometry, including the infinite series for sine and cosine functions, were centuries ahead of their time. These series were later independently rediscovered in Europe by Gregory, Newton, and Leibniz.

- ◆ *Mādhava* of *Saṅgama-grāma* was great mathematician of Kerala

Vaṭaśeri Parameśvara, a key figure in the Kerala School and *Mādhava*'s disciple, contributed over 30 works on astronomy and Mathematics, many of which involved long-term observations and refinements of earlier astronomical theories. Some of his ma-



major works are *DṛgGaṇita*, *Goḷadīpikā*, *Grahaṇamaṇḍana*, *Grahaṇanyāyadīpikā*, *Grahaṇāṣṭaka* and *Bhaṭadīpikā* (Commentary on *Āryabhaṭīya*).

In the 16th century, *Keḷallūr Nilakantha Somayājīn* (1444–1545 CE) further advanced these ideas with his *Tantra-sangraha*, a work of 432 verses composed in just six days. He also wrote *Āryabhaṭīya-Bhāṣya* (Gloss on *Āryabhaṭīya*), making significant contributions to both mathematics and astronomy.

Jyeṣṭhadeva, a contemporary of *Keḷallūr Nilakantha Somayājīn*, authored the *Yuktibhāṣā*, which presents detailed proofs of Madhava's and Nilakantha's mathematical and astronomical discoveries.

Many other scholars, such as *Putumāṇa Somayājī*, *Citrabhānu*, and *Śaṅkaravāriyar*, continued to advance the study of mathematics and astronomy, producing influential works throughout the medieval period.

Conclusion

The rich history of Indian mathematics is preserved in a vast array of manuscripts, with estimates suggesting more than 9,000 texts on mathematics and astronomy alone. Sadly, many of these were lost during foreign invasions. Nevertheless, the surviving works, along with the contributions of modern scholars like S Rangacharya, K.V Sarma and others, have ensured that the mathematical legacy of ancient India is recognized worldwide.

Summarised Overview

Indian mathematics has a long and storied history, evolving through several key periods. The Ancient/Vedic period (before 600 BCE) laid the foundation with mathematical insights embedded in the *Veda-s* and *Vedāṅga* texts. These early texts, such as the *Śulbasūtra-s*, contain remarkable geometric concepts, including an early form of the Pythagorean Theorem and approximations of $\sqrt{2}$, demonstrating sophisticated mathematical knowledge for the construction of sacrificial altars. The *Sūtra/Jain* period (600 BCE to 400 CE) saw the rise of Buddhist and Jain mathematical traditions, with contributions to arithmetic, astronomy, and combinatorics, including *Piṅgala's* work on permutations and binary numbers. Notable texts from this era include Jain works on astronomy and the *Chandassūtra*, which laid the groundwork for later developments in mathematics.

The Classical period (400 CE to 1200 CE) witnessed groundbreaking contributions from mathematicians such as *ĀryaBhaṭa*, who introduced the decimal place value system



and approximated pi with great accuracy. Other figures like Brahmagupta and Bhaskara I expanded on algebra and geometry, with Bhaskara II's *Siddhānta-śirōmaṇi* becoming one of the most significant works in mathematics and astronomy. The Kerala School (1200 CE to 1750 CE) emerged as a center of innovation, with *Mādhava's* discoveries in infinite series and trigonometry laying the foundation for calculus. Key figures like Nilakantha *Somayājīn* and *Jyeṣṭhadeva* further advanced mathematical and astronomical understanding. Although many works were lost over time, the surviving manuscripts ensure that India's rich mathematical legacy continues to be recognized globally, influencing both Eastern and Western scientific thought.

Assignment

1. Prepare a note on Śulbasūtra-s and its Mathematical importance.
2. Analyse the Mathematical Contributions of Jains.
3. Enlist the major texts in the fields of Indian Mathematics and Astronomy.
4. Analyze the groundbreaking contributions of Aryabhata during the Classical Period.
5. Trace the lineage and intellectual connections within the Kerala School of Mathematics.
6. Discuss the mathematical contributions found within the Vedic texts

Suggested Reading

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2. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.
3. *Kerala School of Mathematics: Trajectories and Impact*, Ed. N. K. Sundareswaran, Ganga books, Calicut, 2014

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1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K. Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.





Development of Astronomy in India

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ understand the evolution of scientific thought through the history of scientific literature in Sanskrit
- ❖ develop an understanding of specific contributions in the fields of Astronomy
- ❖ familiarisation with the literature pertaining to the Indian scientific advancements

Background

India was the first to establish key markers for measuring time, such as years, months, weeks, and days, through the ancient science of astronomy. These early innovations laid the foundation for a more organized understanding of the world. Indian astronomers made significant contributions, accurately determining aspects like Earth's rotation, the zodiac, planetary distances, and the length of the year. This unit offers an overview of important astronomical works and authors, tracing the evolution of Indian astronomy over time.

Keywords

VedāṅgaJyotiṣa, Atharvaveda-Jyotiṣa, Pañcasiddhānta-s, Vardhamana Mahaveera, Aryabhattacharya, Earth rotation theory of Aryabhata

Discussion

1.2.1.Astronomy in India: Pre-scientific and Scientific Phases

Indian astronomy, written in Sanskrit, can be divided into two main periods: the Pre-scientific and the Scientific phases. The shift from the pre-scientific to the scientific phase marks a significant development in the field, as it was during this time that foundational principles were established and systematic methods for calculation were developed.



- ◆ Pre-scientific phase

The scientific phase began around 500 CE with the work of *Ārya Bhaṭṭa* (born in 476 CE). From this point, Indian astronomy evolved continuously, lasting until the 17th century across India and extending into the 19th century in regions like Kerala. Prior to this, from about 4000 BCE (when the Vedic hymns were composed) until 500 CE, Indian astronomy was in its Pre-scientific phase.

1.2.1.1. Pre-scientific Astronomy

1.2.1.1.1. Astronomy and Mathematics in the Vedas

The Vedas, primarily focused on religious rituals and philosophical doctrines, include incidental references to astronomy and mathematics. These texts, such as the *Brāhmaṇa-s*, *Āraṇyaka-s*, and *Upaniṣad-s*, contain valuable insights into celestial concepts but are not systematic or scientific in nature. For example, the *Rgveda* views the Sun as the central cosmic force, a source of light and life, and associates it with Varuṇa, a deity who charts its path along the ecliptic. The idea of the Sun passing through twelve segments of the zodiac is symbolized by the “twelve suns.” The Moon is often depicted as reflecting the Sun’s light, as seen in the *Taittirīya-Saṃhitā*.

- ◆ The Vedas also describe the Earth as spherical

The Vedas also describe the Earth as spherical, with references to this concept in the *Śatapatha-Brāhmaṇa* and *Rgveda*. While Vedic cosmology is rooted in religious themes, it reveals an evolving understanding of the natural world, including celestial bodies and the cycles of time. This early awareness laid the foundation for later developments in Indian astronomy and mathematics, integrating time-keeping with religious observance.

1.2.1.1.2. Vedāṅga-Jyotiṣa

The *Vedāṅga-Jyotiṣa*, attributed to the sage Lagadha and dated to around 1200 BCE, is a key text in Vedic astronomy. Unlike the earlier, more casual references to celestial phenomena found in the *Rgveda* and *Yajurveda*, this text organizes the observation and calculation of celestial movements to assist in the proper conduct of Vedic rituals.

- ◆ *Jyotiṣa* one of the six *Vedāṅga-s*

One of the six *Vedāṅga-s* (disciplines supporting Vedic rituals), it outlines methods to track the positions of the Sun, Moon, and stars, focusing on important points like solstices, new moons, full moons, and the 27 *nakṣatra-s* (lunar mansions). The text also provides guidelines for calculating *tithi-s* (lunar days), *parvan-s* (special days), and *viṣuvat* (equinoxes), all necessary for proper ritual timing.

The time system in *Vedāṅga-Jyotiṣa* is based on a five-year cycle, using a solar year of 366 days and lunar months of about 29.5 days. To synchronize the solar and lunar calendars, two extra months (*adhimāsa*) are added every five years. This cycle begins with the



conjunction of the Sun and Moon in the *nakṣatra Dhanīṣṭhā* and coincides with the winter solstice (*Uttarāyaṇa*). Although the 27-*nakṣatra* system was central to early Indian astronomy, it was later replaced by the more precise 12-*rāśi* (zodiacal) system in later traditions.

1.2.1.1.3. *Atharvaveda-Jyotiṣa*

Another significant text in Vedic astronomy is the *Atharvaveda-Jyotiṣa*, a work of 162 verses divided into seven chapters. Presented as a dialogue between Brahma and the sage *Kaśyapa*, the text primarily focuses on astrology, though it contains some astronomical content. It introduces various units of time, including:

- ♦ Muhūrta: A period of 48 minutes.
- ♦ Karaṇa: A time division for determining auspicious moments.
- ♦ Yoga: A combination of celestial positions.
- ♦ Tithi: A lunar day.
- ♦ Vāra: A day of the week.

- ♦ *Atharvaveda-Jyotiṣa - Nakṣatra-prakaraṇa and Garbhādhāna-prakaraṇa*

The *Atharvaveda-Jyotiṣa* also explores the astrological effects of actions performed at specific times. Two sections—*Nakṣatra-prakaraṇa* and *Garbhādhāna-prakaraṇa*—are dedicated to astrological calculations related to the lunar mansions and the timing of important life events, such as conception.

1.2.1.1.4 Astronomy and Cosmography in Jainism

As in other ancient Indian traditions, religious needs played a pivotal role in stimulating the development of astronomical knowledge in Jainism. Jain cosmography, however, introduced unique and distinctive ideas that set it apart from the Vedic system. These cosmological theories were woven into the Jain worldview, particularly as reflected in texts like the *Jambūdvīpa-prajñapti* and other canonical writings.

- ♦ *Jainism - Jambūdvīpa - prajñapti*

The Jain worldview depicted a universe structured around concentric, flat islands, with *Jambūdvīpa* (the central island) at the core. At the center of *Jambūdvīpa* stood the grand mountain *Sudarśa-Meru*. This physical structure influenced their astronomical theories significantly. To account for the daily movements of the Sun and Moon across this unique geography, the Jains proposed the existence of two Suns and two Moons, each illuminating different parts of the Earth on alternating days. This notion was a direct result of their cosmological theories, which envisioned a world quite distinct from the spherical, heliocentric view later developed by modern astronomy.

In terms of measuring the length of the year, lunar months, *tithi-s*



(lunar days), and intercalary months, Jain astronomical calculations largely mirrored those of the *Vedāṅga-Jyotiṣa*.

1.2.1.1.5 The Five *Siddhāntas*

A pivotal moment in the history of Indian astronomy is marked by the work of *Varāhamihira* in the 6th century CE. His treatise, the *Pañcasiddhāntikā* (written around 505 CE), is a crucial document that preserves the principles and findings of five important early astronomical treatises: the *Paitāmaha*, *Vasiṣṭha*, *Pauliṣa*, *Romaka*, and *Saura-siddhānta*-s. These systems were developed during the early centuries of the Common Era and were influential in shaping the astronomical understanding of the time. Each system contributed valuable insights into various aspects of celestial mechanics, but the *Saurasiddhānta* emerged as the most precise, particularly in the calculation of solar and lunar movements.

- ◆ *Varāhamihira - Pañcasiddhāntikā*

1.2.1.2. Scientific Indian Astronomy:

1.2.1.2.1. The Contributions of *ĀryaBhaṭa*

ĀryaBhaṭa I (born 476 CE) is considered the pioneering figure who ushered in scientific astronomy in India. His two works, the *ĀryaBhaṭa-siddhānta* and the *Āryabhaṭīya*, laid the foundations for a more systematic and scientific approach to astronomy, marking a clear departure from the mythological and ritualistic ideas that prevailed in earlier periods. *ĀryaBhaṭa*'s astronomical principles were based on direct observations, calculations, and geometric analysis, and they would go on to influence Indian astronomy for centuries.

- ◆ *ĀryaBhaṭa-siddhānta*: This was *ĀryaBhaṭa*'s first major work. Although the original text is not available in full, it is preserved in quotations from later scholars like *Varāhamihira*, *Brahmagupta*, and *Bhāskara I*. *ĀryaBhaṭa*'s work in this text represented a significant step forward in astronomical thinking, especially in its departure from the traditional geocentric model of the universe.
- ◆ *Āryabhaṭīya*: Written in 499 CE, the *Āryabhaṭīya* is *ĀryaBhaṭa*'s most famous work and is considered the foundational text of scientific planetary astronomy in India. It is divided into four sections, each dealing with different aspects of astronomy and mathematics:
 - ◆ *Gītikā-pāda*: Introduces basic astronomical concepts, such as the positions of the planets, their apogees, nodes, and the diameters of celestial bodies like the Earth. It also discusses the obliquity of the ecliptic and the inclination of planetary orbits.
 - ◆ *Gaṇita-pāda*: Deals with mathematical and geometrical methods, especially in arithmetic, geometry, and trigonometry. *Āry-*



aBhaṭa uses these to solve astronomical problems.

- ♦ *Kālakriyā-pāda*: Describes how to calculate time and explains the motion of planets using the concept of epicycles. Methods for determining the mean and true positions of planets are outlined here.
- ♦ *Goḷa-pāda*: Focuses on the motion of celestial bodies like the Sun, Moon, and planets and discusses the calculation and graphical representation of solar and lunar eclipses.

- ♦ *Āryabhaṭīya* – a text of scientific planetary astronomy in India.

While the *Āryabhaṭīya* is a highly advanced text, it was not as systematically organized as the later works of scholars like Brahmagupta, *Bhāskara I*, and *Bhāskara II*. Nonetheless, it laid the foundation for the future development of Indian astronomy and mathematics. *ĀryaBhaṭa* introduced the concept of planetary motion based on epicycles, which was a significant advance in celestial mechanics. He also made accurate calculations of solar and lunar eclipses, improving on the models of earlier astronomers.

(a) Earth's Rotation: A Groundbreaking Theory

- ♦ *Āryabhaṭīyas* – theory that the Earth rotates on its axis

One of *ĀryaBhaṭa*'s most important contributions was his theory that the Earth rotates on its axis. This was a revolutionary idea, as it contradicted the widely accepted belief at the time that the Earth was stationary at the center of the universe. *ĀryaBhaṭa* stated that the Earth rotates once in a "sidereal day," which lasts about 23 hours, 56 minutes.

ĀryaBhaṭa's explanation was based on the idea that the Earth rotates through one minute of arc in a *prāṇa* (1/6 of a *vinādi*, roughly equal to 4 sidereal seconds). This was in stark contrast to the geocentric model, which imagined the Earth as the fixed center of the universe.

(b) Opposition to *ĀryaBhaṭa*'s Theory

ĀryaBhaṭa's theory of the Earth's rotation faced significant opposition from later astronomers. Scholars like *Varāhamihira*, Brahmagupta, Lalla, and *Bhāskara II* criticized his ideas, raising practical objections to the notion of a rotating Earth. For example:

- ♦ Brahmagupta questioned the possibility of Earth's rotation, asking, "If the Earth rotates through one minute of arc in one *prāṇa*, where does the rotation begin, and why don't tall objects, like towers, fall over?"
- ♦ Lalla argued that if the Earth were rotating at such a speed, birds would not return to their nests, and objects thrown vertically would fall to the west. He also wondered how such a slow speed could explain the Earth's revolution around the universe in one



day.

Despite these criticisms, *Āryabhata's* theory of Earth's rotation had a lasting impact and became a key element in the development of Indian astronomy.

1.2.1.2.2. *Varāhamihira* (c. 578 CE)

Varāhamihira, a contemporary of *Āryabhata*, is one of the most influential figures in Indian astronomy and astrology. His seminal work, the *Pañca-siddhāntikā*, synthesizes the astronomical teachings of five early *Siddhāntas*: *Paitāmaha*, *Vasiṣṭha*, *Lomaśa*, *Romaka*, and *Saura*. The text consists of 18 chapters and 442 verses, offering insights into the state of Indian astronomy during the 6th century. *Varāhamihira's* work is pivotal as it marks the transition of Indian astronomy from ritualistic to more scientific methodologies. Notably, he adopts the epoch of Śaka 427 (505 CE) for astronomical calculations, a key moment in the standardization of time-reckoning in Indian astronomy.

- ◆ *Varāhamihira's* *Pañca-siddhāntikā*

1.2.1.2.3. *Brahmagupta* (c. 598 CE)

Brahmagupta's *Brāhma-sphuṭa-siddhānta* (628 CE) is a comprehensive text that synthesizes earlier astronomical knowledge and introduces new methods. The 24 chapters of this work cover not only astronomy but also arithmetic, algebra, and geometry, with a significant emphasis on astronomical diagrams and instruments. *Brahmagupta* critiques previous scholars like *Āryabhata* and *Varāhamihira*, offering his own approaches to planetary positions, eclipses, and lunar months. His other work, the *Khaṇḍa-khādyaka* (665 CE), builds on *Āryabhata's* ideas and was later commented upon by scholars like *Āmarāja*, *Bhattotpala*, and *Lalla*. *Brahmagupta's* contributions laid the foundation for later astronomers, including *Bhāskara II*, who adopted *Brahmagupta's* logical and systematic approach.

- ◆ *Brahmagupta's* *Brāhma-sphuṭa-siddhānta*

1.2.1.2.4. *Bhāskara I* (629 CE)

Bhāskara I was a key figure in the *Āryabhatan* school of astronomy. His two major works, the *Mahābhāskarīya* and *Laghubhāskarīya*, expand upon *Āryabhata's* theories, especially in planetary motion and the calculation of eclipses. These texts were highly influential, particularly in Kerala, where they shaped the development of astronomy for generations. *Bhāskara I* also authored a commentary on the *Āryabhatīya*, which serves as an important resource for understanding the evolution of Indian mathematics and astronomy.

- ◆ *Mahābhāskarīya* and *Laghubhāskarīya*

1.2.1.2.5. *Lalla* (8th Century CE)

Lalla was an influential scholar who systematically explained *Āryabhata's* teachings. His work, *Śiṣyādhīvrddhida*, in around 1,000 verses, provides a comprehensive exposition of *Āryabhata's* meth-



ods. Lalla is especially known for his commentary on Brahmagupta's *Khaṇḍa-khādyaka*, where he clarifies *Āryabhata*'s Midnight system. Lalla also contributed to the fields of arithmetic and mensuration, authoring works like *PāṭiGañita* and *Siddhānta-tilaka*, which addressed mathematical principles and calculations.

1.2.1.2.6. *Mahāvīra* (c. 850 CE)

A Jain mathematician, *Mahāvīra* made significant contributions to arithmetic, algebra, and geometry. His treatise, *Ganita-sārasaṅgraha*, presents a wide range of mathematical problems, many of which were illustrated for clarity. *Mahāvīra* is particularly notable for introducing the concept of the ellipse and deriving formulas for its area and perimeter. His work remains an important milestone in the development of Indian mathematics and continues to be studied by later scholars.

1.2.1.2.7. *Śrīdhara* (c. 900 CE)

Śrīdhara was a major figure in the development of arithmetic and mensuration. His work *PaṭiGañita* is a comprehensive treatise on basic arithmetic, which became a crucial resource for teaching and learning. The treatise is structured with 118 definitions and 133 examples, providing clear explanations of mathematical principles. *Śrīdhara* also wrote a condensed version of his work, *Pāṭiganitasāra* or *Triśatikā*, which gained popularity in regions such as Telugu, Kannada, and Gujarati. His contributions also influenced the development of *BījaGañita* (algebra) and were cited by later astronomers like *Bhāskara II*.

- ◆ *Śrīdhara's Paṭiganita*

1.2.1.2.8. *Sūryasiddhānta* (650–950 CE)

The author of the *Sūryasiddhānta* remains unknown, but this text is one of the most influential in North India. The *Sūryasiddhānta*, which consists of 14 chapters and around 500 verses, provides a comprehensive overview of Hindu astronomy. It does not focus on arithmetic or algebra, nor does it contain illustrative problems, but its computational techniques and parameters were revolutionary at the time. The text is presented as a dialogue between the Sun and the demon Maya, giving it an aura of ancient wisdom. Although it likely redacts earlier works such as the *Brahmasphuṭasiddhānta* and the *Saura-siddhānta*, the *Sūryasiddhānta* reflects the ongoing evolution of Indian astronomical knowledge. It was a foundational text for later calendrical works.

1.2.1.2.9. *Muñjāla* (932 CE)

Muñjāla, a Kashmiri astronomer, authored the *Laghumānasa*, a concise manual of astronomical computations in 60 verses. This work introduced novel methodologies that would later influence oth-



er scholars, including *Śrīpati*, who based his own calendrical work, *Dhruvamānasa-karāna*, on the *Laghumānasa*. *Muñjala*'s contributions were integral to the development of astronomical and calendrical studies, and his ideas were expounded upon by later scholars like *Parameśvara* and *Sūryadeva-Yajvan*.

1.2.1.2.10. *Śrīpati* (1039 CE)

Śrīpati was a significant figure in medieval Indian astronomy, known for his work, the *Siddhāntaśekhara*, a comprehensive text with 20 chapters and 890 verses. Notably, Chapter 17 of this work critiques the Rahu eclipse theory, while Chapter 19 discusses the use of astronomical instruments. *Śrīpati*'s contributions also include the *Gaṇitatilaka*, a work on arithmetic and geometry that was later commented upon by *Simhatilaka-sūri*. One of his major contributions was his calculation of the Equation of Time, which corrects the discrepancies caused by the obliquity of the ecliptic and the east-west line indicated by the gnomonic shadow.

1.2.1.2.11. *Bhāskara II* (b. 1114 CE)

Bhāskara II, also known as *Bhāskarācārya*, is the most renowned Indian astronomer of the medieval period. His monumental work, *Siddhāntaśiromani*, consists of multiple treatises, including:

- ◆ *Līlāvātī* (13 chapters) on arithmetic and geometry, still used as a textbook in schools.
- ◆ *Bījaganita* (11 chapters) on algebra, which remains a cornerstone of medieval Indian mathematics.
- ◆ *Gaṇitādhyāya* (12 chapters) and *Golādhyāya* (14 chapters), which focus on planetary motion, eclipses, and time-reckoning.

Bhāskara II's approach to astronomy was both systematic and precise, and his works became foundational for later studies, especially in northern India. His *Karanakutūhala* (1183 CE) is another important work focused on calendrical astronomy. The commentaries on *Bhāskara II*'s texts, such as the *Vāsana*, solidified their authority and ensured their survival through manuscripts.

1.2.1.2.12. *Gaṇeśa-Daivajña* (b. 1507 CE)

Gaṇeśa-Daivajña, from Nandigrama, is best known for his *Grahalāghava* (also called *Siddhāntarahasya*), one of the most popular calendrical texts in Indian astronomy. His works, known for their poetic style, were extensively commented upon and have been a key part of the Indian astronomical tradition. *Gaṇeśa* also authored manuals on lunar calendars, such as *Brhat-tithi-cintāmaṇi* and *Laghu-tithi-cintāmaṇi*, and on astronomical instruments like the *Pratoda-yantra*, *Sudhirañjana-yantra*, and *Tarjanī-yantra*. His

- ◆ *Bhāskara II*'s *Līlāvātī*, *Bījaganita* and *Gaṇitādhyāya*

- ◆ *Brhat-tithi-cintāmaṇi* and *Laghu-tithi-cintāmaṇi*



commentaries on *Bhāskara II*'s works, especially the *Līlāvātī* and *Siddhāntaśiromani*, remain crucial resources for students and practitioners of Indian astronomy.

These scholars, along with their monumental works and commentaries, played an essential role in the development of Indian astronomy, mathematics, and calendrical studies. The evolution of this tradition reflects an ongoing commitment to precision and systematization, with each generation contributing to the refinement of earlier ideas and the introduction of new methods. The legacy of these figures continues to shape the study of astronomy and mathematics in India today.

Summarised Overview

Indian astronomy can be divided into two phases: the Pre-scientific and the Scientific phases. The Pre-scientific phase (from around 4000 BCE to 500 CE) focused on celestial observations related to religious rituals, with texts like the Vedas providing early insights into astronomy and mathematics. The *Vedāᅅga-Jyotiᅅa*, a key text around 1200 BCE, formalized the study of celestial movements to aid in Vedic rituals, and the *Atharvaveda-Jyotiᅅa* introduced concepts of time units and auspicious moments. In parallel, Jainism contributed unique cosmological models. The Scientific phase began with *ĀryaBhaᅅa* around 500 CE, who introduced systematic methods for astronomical calculations, including the revolutionary theory of Earth's rotation. His influence, alongside the works of other notable scholars like *Varāhamihira* and Brahmagupta, laid the groundwork for a more scientifically structured understanding of astronomy.

The later period saw continued advancements through figures such as *Bhāskara II*, whose works in algebra and astronomy, especially the *Siddhāntaśiromani*, became foundational in Indian astronomy. Commentaries on the works of *ĀryaBhaᅅa*, Brahmagupta, and *Bhāskara I*, along with innovations in calendrical studies by scholars like *Gaᅅeᅅa-Daivajña*, helped refine astronomical models and systems across generations. These works not only focused on planetary motion and eclipses but also enhanced the precision of astronomical tools and calculations, influencing both practical and theoretical astronomy in India.

Assignment

1. Comment on the Prescientific Indian Astronomy and *VedāᅅgaJyotiᅅa*.
2. Prepare a chart enlisting the major texts and authors of Scientific Indian Astronomy.
3. Explain the main astronomical contributions of *ĀryaBhaᅅa*, particularly his theory of the Earth's rotation and the criticisms thereupon.
4. Analyze the transition from pre-scientific to scientific astronomy in India, focusing on



the contributions of Āryabhaṭa I

5. Describe the role of Varāhamihira's Pañcasiddhāntikā in the history of Indian astronomy.
6. Compare and contrast the approaches and contributions of Śrīdhara and Mahāvīra towards Mathematics and their relevance in astronomical studies during their respective periods.
7. Examine the multifaceted contributions of Brahmagupta to both Astronomy and Mathematics.

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.
2. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.
3. *Kerala School of Mathematics: Trajectories and Impact*, Ed. N. K. Sundareswaran, Ganga books, Calicut, 2014

Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K. Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.





The contributions of Kerala School

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ acquaint with major texts in the field of Kerala School of Mathematics
- ❖ gain a general awareness of the contributions made by Kerala School of Mathematics
- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit

Background

The Kerala School of Mathematics, which flourished between the 14th and 17th centuries, represents one of the most remarkable yet often overlooked intellectual traditions in the history of mathematics and astronomy. Contrary to the earlier belief that India's scientific contributions stagnated after *Bhāskara-II*, it is now clear that a vibrant school of mathematicians and astronomers in Kerala continued to make significant advancements during the medieval period. This unit is designed to gain a general awareness of the contributions made by Kerala School and to become acquainted with major texts in the fields of Kerala School.

Keywords

Bhaṭṭa-samskāra, Kaṭapayādi, BhūtaSāṅkhyā, Parahita, Numerical notations, Nararuchi, Haridatta, Saṅgamagrama Madhava, Sankaranarayana

Discussion

- ◆ Kerala has a rich intellectual tradition

For a long time, most Indologists believed that after *Bhāskara-II*, the renowned author of *Līlavatī*, no significant original contributions were made in the fields of mathematics and astronomy in India. However, it is now widely acknowledged that a vibrant school of astronomers thrived in Kerala during the medieval period, roughly between 1350 and 1700 CE. This intellectual tradition, which began with *Saṅgamagrāma Mādhava* (c. 1340–1425) and continued



through *Acyuta Piṣāroṭi* (c. 1550–1621), was marked by a series of groundbreaking advancements.

This long, uninterrupted tradition contributed significantly to mathematical analysis, long before similar concepts emerged in Europe. Noteworthy contributions from Kerala school include (1) the development of the Gregory series for the inverse tangent, (2) the Leibniz series, (3) Newton's power series for sine and cosine, and (4) Taylor's series for approximating these functions.

Let's first analyze the features that distinguish the Kerala School of Mathematics.

1.3.1. Basic Features of Kerala School of Mathematics:

1.3.1.1. Spirit of Inquiry

At the outset, it is important to highlight the intellectual outlook and spirit of inquiry that characterised Kerala's astronomers and mathematicians in their investigations. E.g., *Vaṭaśśeri Parameśvaran Nampūtiri* (c. 1360–1455 CE), a prolific writer of the Kerala School of Mathematics, emphasizes the importance of determining the true positions of the planets, which differ from those derived using the Parahita system. *Parameśvara* asserts that only the observed positions should be considered accurate, as stated in authoritative texts. He encourages scholars and experts in spherics to strive for this accuracy. Reflecting on this, *Parameśvara*, after careful study of ancient texts and precise observations of planetary positions, undertakes to compose an astronomy manual - *Dr̥gGaṇita* for his disciples seeking true knowledge. This reflects the spirit of inquiry that characterized the Kerala School.

- ♦ *Vaṭaśśeri Parameśvaran Nampūtiri*, a prolific writer of Kerala School of Mathematics

1.3.1.2. Solidarity with ĀryaBhaṭa's system:

At least from the 7th Century, Kerala Mathematicians and astronomers were deeply influenced by *ĀryaBhaṭa*'s system of calculation. Kerala scholars were heavily involved in revising, supplementing, and improving *ĀryaBhaṭa*'s system of calculations in astronomy and mathematics. Scholars like *Parameśvara*, *Nīlakanṭha Somayajin*, and others refined Aryabhata's ideas, aiming to achieve more accurate astronomical results.

1.3.1.3. Usage of various systems for numerical notations:

- ♦ *Kaṭapayādi* is a unique numerical notation system used in Kerala

(a) *Kaṭapayādi* System:

Kaṭapayādi is a unique numerical notation system used in Kerala to express numbers through letters. The *Kaṭapayādi* system, attribut-



ed to *Vararuci*, is significant for its ability to represent long and complex numbers in the form of seemingly meaningful expressions or verses, which could be easily remembered and verified.

Rules for *Kaṭapayādi*

- ◆ Each letter corresponds to a specific digit (e.g., क (ka) = 1, ख (kha) = 2, etc.).
 - ◆ In conjunct letters, only the final consonants are considered for value.
 - ◆ All vowels and the two consonants (both *ñā* and *na*) represent the value zero.
- ◆ Numbers are calculated in reverse order.

The following table shows the numerical values assigned to each consonant in the *Kāṭapayādi* system.

Consonant	Numerical Value						
क (ka)	1	ट (ṭa)	1	प (pa)	1	य (ya)	1
ख (kha)	2	ठ (ṭha)	2	फ (pha)	2	र (ra)	2
ग (ga)	3	ड (ḍa)	3	ब (ba)	3	ल (la)	3
घ (gha)	4	ढ (ḍha)	4	भ (bha)	4	व (va)	4
ङ (ṅa)	5	ण (ṇa)	5	म (ma)	5	श (śa)	5

च (ca)	6	त (ta)	6			ष (ṣa)
छ (cha)	7	थ (tha)	7			स (sa)

Let us now try to understand this system with the help of a few examples.

- A. The word *mati* represents 65 (*ma* - 5, *ti* - 6).
- B. *Hari* corresponds to 28 (*ha* 8, *ri* 2)
- C. *Hara* also represents 28 (*ha* 8 *ra* 2).
- D. The word *bhavati* corresponds to 644 (*bha* - 4, *va* - 4 *ti* -6).
- E. *Rāghavāya* represents 1442 (*Rā* - 2, *gha* - 4, *vā* - 4, *ya* -1).
- F. The word *Paśupati* represents 6151 (*pa*-1, *śu*-5, *pa*-1, *ti*-6).

The phrase *ācāryavāgabhedyā*, using the rules above, represents the number 1434160 (*ā* - 0, *cā* - 6, *rya* - 1, *vā* - 4, *ga* -3, *bhe* - 4 *dyā*



- 1) , and so on.

This system helped mathematicians record large numbers in a compact and easily recallable form.

(B) *Bhūta-Saṅkhyā* system:

◆ *Bhūta-Saṅkhyā* system

Another system of notation used in Kerala and across India was the *Bhūta-Saṅkhyā*, which associated specific words or concepts with numbers as popular in the tradition. For instance:

- Synonyms for “sky” (e.g., खम्, आकाशः) represent the number 1.
- Synonyms for “eye” (e.g., नयनं, नेत्रम्), and “hand” (e.g., भुजः) represent the number 2.
- Synonyms for “quality” (e.g., गुण) represent the number 3.
- Synonyms for “Vedas” or “ocean” (e.g., वेद, अब्धि) represent the number 4.
- Synonyms for “elements” or “senses” or “arrows” (e.g., भूतम्, इन्द्रियम्, बाणम्) represent the number 5.
- Synonyms for “taste” (e.g., रस) represent the number 6.
- Synonyms for “sage” (e.g., ऋषि) represent the number 7.
- Synonyms for “snake” or “elephant” (e.g., नाग, गज) represent the number 8.
- Synonyms for “nanda” represent the number 9.
- Synonyms for “direction” (e.g., दिक्) represent the number 10.
- Synonyms for “Rudra” (e.g., रुद्र) represent the number 11.
- Synonyms for “sun” (e.g., सूर्य) represent the number 12.

Let us try to understand this system with the help of a few examples.

- A. Using the system, *nanda-nayanābdi* corresponds to 429 (nanda for 9, *nayana* for 2 and *abdi* for 4).
- B. The number 1230 may be expressed as *ākāśa-guṇa-netra-Candra* (*ākāśa* for 0, *guṇa* for 3, *netra* for 2, *Candra* for 1)
- C. *kha-bāna-Sūrya* represents 1250 (*kha*-0, *bāna*-5, *Sūrya* -12)

This form of notation was often used in poetry or verses to encode numbers. All these systems of numerical notations highlight Kerala’s innovative contributions to the development of astronomical and mathematical systems in ancient India, combining tradition with advanced methods for accurate calculations and record-keeping.



1.3.1.4. Concern for Accuracy

The concern Kerala astronomers had for the accuracy of their computations is evident in a statement made by *Parameśvara* in his work *Grahaṇamaṇḍana*, an extensive treatise on the computation of eclipses. Toward the end of the text, *Parameśvara* humbly acknowledges that the times of contact and other computed results may occasionally differ slightly from actual observed positions. He quickly clarifies that these small discrepancies are likely due to factors he was unable to account for or those that had not yet been identified. However, *Parameśvara* expresses confidence that with further observations and experimentation, it would be possible to identify the necessary corrections that would eliminate even these minor differences.

- ◆ *Parameśvara's Grahaṇamaṇḍana*

1.3.1.5. Continuity of Tradition

One of the most notable aspects of Kerala's astronomical and mathematical heritage is the continuous transmission of traditional knowledge, passed down from father to son or teacher to disciple over generations. Some of these knowledge lines span several centuries. For example, the lineage of astronomers that stretches from the 13th to the 17th centuries include:

- ◆ Kerala's astronomical and mathematical heritage is the continuous transmission of traditional knowledge

Govinda *Bhaṭṭatiri* of *Talakkuḷam* (1237–95)

→ Pupil: Grandfather of *Parameśvara* (13th -14th century)

→ *Parameśvara* (c. 1360–1455)

→ Son: Damodara (15th century)

→ Pupil: *Keḷallūr Nīlakanṭha Somayājīn* (1444 -1545)

→ Pupil: *Jyeṣṭhadeva* (c. 1500 -1600)

→ Pupil: *Acyuta Piṣāroṭi* (1550 -1621)

These key features distinguish the Kerala school of mathematics. Now, we discuss some key astronomers and mathematicians of the Kerala school, highlighting their significant contributions.

1.3.1.5.1. *Vararuci* (c. 4 CE)

Vararuci is said to be a legendary figure in Kerala's astronomical tradition. It is believed he lived in the early 4th century, with his lifetime inferred from the recorded dates of birth and death of his eldest son, Meḷattol Agnihotri. These dates are derived from two Kali chronograms: *yajñasthānam surakṣyam* (Using *Kaṭapayādi* system of numerical notation, this phrase corresponds to 12,70,701), corresponding to A.D. 343, and *purudhīḥ samāsryaḥ* (12,57,921), marking his death around A.D. 378.



- ◆ *Vararuci* is credited with introducing the kaṭapayādi system

Local manuscript traditions attribute to *Vararuci* the authorship of the *Candra-vākya-s* (or ‘Moon Sentences’), a collection of 248 *vākya-s* also known as *Vararuci-vākya-s*. The first verse begins with the words *gīrnaḥ śreyaḥ*. *Vararuci* is also credited with introducing the *Kaṭapayādi* system, a method of representing numbers using syllables, which was employed in these very verses.

1.3.1.5.2. Haridatta (c. 650–700 CE)

- ◆ Haridatta introduced the Parahita system of astronomical computation

Haridatta, active during the 7th century, made significant contributions to Kerala’s astronomical tradition. In 683 CE, at Tirunavaya in Kerala, he introduced the Parahita system of astronomical computation, which offered notable improvements over the *ĀryaBhaṭa* system. One of his key innovations was the introduction of the *Śakābda-samskāra* (also known as *Bhaṭa-samskāra*), a correction that enhanced the precision of astronomical calculations. His treatise *Graha-cāranibandhana* serves as the primary manual for the Parahita system. Haridatta also authored the *Mahā-mārga-nibandhana*, a comprehensive work on astronomy referenced in the *Graha-cāra-nibandhana*, although the text itself has yet to be discovered. The Parahita system gained widespread adoption and played a pivotal role in the evolution of Kerala’s astronomical practices, solidifying Haridatta’s influence on the region’s scientific heritage.

1.3.1.5.3. Śaṅkaranārāyaṇa (c. 825–900)

- ◆ *Śaṅkaranārāyaṇa*’s work is a commentary on the *Laghubhāskariya*

Ravi Varma, the 9th century ruler of the Cera dynasty of Kerala, had *Śaṅkaranārāyaṇa*, a disciple of Govindasvāmin, as his chief court astronomer. *Śaṅkaranārāyaṇa* hailed from Kollapuri, located on the Arabian coast (Identified as modern-day Kollam). His only known work is a commentary on the *Laghubhāskariya*, which he completed in AD 869. This commentary not only offers valuable insights into the subject matter of the original text but also sheds light on the significant interest shown by the royal court in promoting astronomical studies.

The work indicates the presence of an astronomical observatory at the capital city, Mahodayapuram (modern-day Kodungallur). It reveals that buildings in the city were constructed with mathematical principles in mind. Additionally, arrangements were made to announce the times of the day, suggesting a well-organized approach to timekeeping. These details highlight an environment that strongly supported the advancement of astronomy in that region of India.

Śaṅkaranārāyaṇa presented the standard mathematical methods of *ĀryaBhaṭa*, such as the solution to the indeterminate equation $by = ax \pm c$ (where a , b , and c are integers), which is known as the Kuṭṭakāra method. The determination of Mati—referring to the optional number in a guessed solution—distinguishes *Śaṅkaranārāyaṇa*’s ap-



proach from the original method as presented by *Bhāskara I*.

(a) Period After *Śaṅkaranārāyaṇa*

For approximately three centuries following *Śaṅkaranārāyaṇa*, Kerala does not appear to have produced any notable astronomers or mathematicians. During this time, scholars in the region may have focused primarily on preserving and transmitting existing knowledge across generations. In contrast, North India experienced significant advancements in these fields. In A.D. 1170, *Bhāskara II* wrote the *Siddhāntaśiromaṇi*, a comprehensive work in four parts: *Līlāvati*, *BījaGaṇita*, *GrahaGaṇita*, and *Goḷādhyāya*. This text became widely influential across India, sparking renewed interest in astronomical and mathematical studies. As a result, from the thirteenth century onward, Kerala witnessed the rise of an uninterrupted tradition of scholarly work that lasted for nearly five centuries.

1.3.1.5.4. *Saṅgamagrāma Mādhava* (c. 1340–1425 CE)

Mādhava of *Saṅgamagrāma* is widely regarded as the “father” of the Kerala School of Mathematics due to his pioneering work that influenced both Indian and global mathematics. His contributions laid the groundwork for developments that would later form key elements of modern calculus, trigonometry, and series expansions. Much of what we know about *Mādhava* of *Saṅgamagrāma* (often referred to simply as *Mādhava*) comes from the quotations of his predecessors and later scholars. *Mādhava*’s works were largely transmitted through his disciples and later scholars who quoted or referred to his teachings in their own works. As a result, we have limited access to his original writings, but his contributions are well-documented through the works of later scholars.

Mādhava, later known as *Goḷavit* (“Master of Spherics”), was a brilliant mathematician and astronomer from *Saṅgamagrāma*, near modern-day Irinjalakkuda in Kerala. He belonged to the Emprān sub-caste of Kerala Brahmins, and his family was known as *Ilaññippaḷḷi*. *Mādhava*’s contributions were groundbreaking. His work *Veṅvāroha* (c. 1400) presented a streamlined method for calculating the true positions of the Moon at intervals of every 36 minutes. Other notable works include *Lagnaprakaraṇa*, which contains a table of moon mnemonics accurate to the second, and *Mahājyānayanaprakāra* and *Madhyamānayanaprakāra*, which contain revolutionary theorems and computational methods adopted by later scholars.

Mādhava’s *AGaṇita* (likely part of a larger work titled *AGaṇita-pañcāṅga*) provides evidence of his extensive contributions to astronomical calculations. His work, often quoted by later scholars, possibly included computational procedures, theorems, and formu-

- ♦ *Mādhava* of *Saṅgamagrāma* is widely regarded as the “father” of the Kerala School of Mathematics



las that have yet to be fully identified. *Mādhava* is also thought to have authored *Goḷavāda*, from which his title *Goḷavit* likely derives. *Mādhava*'s intellectual legacy laid the foundation for future developments in Kerala's astronomical and mathematical traditions.

1.3.1.5.5. *Vaṭaśēri Parameśvaran Nampūtiri* (c. 1360–1455 CE)

Parameśvara, one of Kerala's most prominent astronomers, refined the Parahita system with his *Veṅvāroha*. His contributions to Indian mathematics and astronomy are significant and enduring. *Parameśvara* hailed from *Aśvatthagṛāma* (modern *Alattūr* of Malappuram), located on the banks of the Nila River in Kerala. He dedicated over fifty-five years to astronomical research and observation, meticulously recording eclipses in his work *Siddhantadīpikā*.

♦ *Vākyadīpikā* and *Bhā-dīpikā*

Parameśvara was a prolific author, with around thirty works on astronomy and astrology, including *Drgganita*, three treatises on spherical astronomy (All goes by the same name - *Goladīpikā* I–III), and works on eclipses like *Grahaṇāṣṭaka* and *Grahaṇamaṇḍana*. His commentaries on key texts, such as the *Āryabhaṭīya*, *Līlāvati* and *Sūryasiddhānta*, are invaluable for historians of mathematics and astronomy. Two of his works, *Vākyadīpikā* and *Bhā-dīpikā*, remain lost but may yet be discovered. Regardless, *Parameśvara*'s surviving contributions continue to influence the study of mathematics and astronomy, securing his legacy as a central figure in Kerala's intellectual history.

1.3.1.5.6. *Keḷallūr Nīlakaṇṭha Somayājīn* (c. 1444–1545 CE)

Nīlakaṇṭha Somayājīn, a centenarian astronomer from Kundapura (South Malabar), was a renowned figure in Kerala's astronomical tradition, rivalling his teacher, *Parameśvara*. His biography is provided in the colophon of his *Bhāṣya* on the *Āryabhaṭīya*, where he details his background and education. *Nīlakaṇṭha* was born in 1444 and was a pupil of *Parameśvara* and his son Damodara, with additional instruction from a teacher named Ravi.

A polymath, *Nīlakaṇṭha* made substantial contributions to astronomy. His *Tantrasaṅgraha* (c. 1500) is a comprehensive treatise, while works like *Grahaṇanirnaya* and *CandracchāyāGaṇita* (accompanied by his commentary) offer revised methods in these subjects. In *Golasāra* and *Siddhāntadarpaṇa*, he calculated astronomical constants and explained the reasoning behind them.

Nīlakaṇṭha's most significant work, however, is his extensive *Bhāṣya* on the *Āryabhaṭīya*, a monumental contribution to Indian as-



- ◆ Nīlakaṇṭha Somayājīn wrote bhashya on the Aryabhatīya

tronomy that solidified his place as one of the leading astronomers of his time. He emphasized the importance of continuous observation and investigation, explored infinite series expansions of trigonometric functions, and addressed problems in algebra and spherical geometry.

1.3.1.5.7. Jyeṣṭhadeva (c. 1500–1610 CE)

Jyeṣṭhadeva is best known for authoring the *Yuktibhāṣā* (or *Gaṇita-nyāya-saṅgraha*), a systematic exposition of mathematical principles in Part I and astronomical reasoning in Part II. The Sanskrit version, *Gaṇita-yukti-bhāṣā*, is also attributed to him. An ancient manuscript reveals that Jyeṣṭhadeva was a student of Damodara of Vaṭaśseri and came from the Paraññoṭṭu family of Ālattūr, South Malabar. He held *Keḷallūr Nilakantha Somayājīn* in high regard, citing Nilakantha's *Tantrasaṅgraha* at the start of his own treatise. Jyeṣṭhadeva also taught *Acyuta Piṣāroṭi*, who expressed reverence for him in the conclusion of his *Uparāga-kriyā-krama*. Tradition links Jyeṣṭhadeva to the authorship of the *Drkkaraṇa*, a metrical astronomical work in Malayalam. Though the treatise does not explicitly name its author, a chronogram places its composition around A.D. 1603, aligning with Jyesthadeva's era.

The tradition of the Kerala School of Mathematics continued with scholars such as Trkkuṭaveli Śaṅkara Vāriyar, who lived near modern Ottapalam. He studied under Nīlakaṇṭha Somayājīn, Jyeṣṭhadeva, and Netranārayana. Like *Keḷallūr Somayājīn*, this versatile commentator preserved a rich collection of historical knowledge passed down orally. *Acyuta Piṣāroṭi* was another renowned scholar in the fields of grammar, astronomy, medicine, and Mathematics. The date of his death is recorded in an obituary verse by his disciple, *Melputtūr Nārayana Bhaṭṭa*, which provides a Kali chronogram “*vidyātma svar asarpāt*” (Using *Kaṭapayādi*, Kali year 1,724,514, corresponding to 1621 CE). *Acyuta Piṣāroṭi* lived in Trikkandiyur, located in the Tirur region of Kerala. He studied under the guidance of Jyeṣṭhadeva and made significant contributions to the field of astronomy, particularly the discovery of the technique of ‘reduction of the ecliptic,’ which was an advanced method for refining astronomical calculations.

It is noteworthy that even in modern times, traditional scholars like Puliur Purushottaman Namputiri, V P K Potuval, etc., continue to compose compendiums on astronomy and manuals of computation in Sanskrit. What is particularly striking is that Western advancements, corrections, and methods have been thoughtfully acknowledged and seamlessly integrated into these Sanskrit texts. These updates are further elucidated in the accompanying Malayalam commentaries, demonstrating a unique fusion of ancient knowledge with contemporary scientific developments.



Summarised Overview

For a long time, it was believed by most Indologists that after *Bhāskara-II*, the famous author of *Līlavatī*, no significant original contributions were made to Indian mathematics and astronomy. However, it is now recognized that a vibrant intellectual tradition flourished in Kerala from roughly 1350 to 1700 CE. This tradition, initiated by *Śaṅgagrāma Mādhava* and continued through scholars like *Acyuta Piṣāroṭi*, introduced groundbreaking advancements in mathematics and astronomy. Notably, the Kerala School developed the Gregory series for the inverse tangent, Leibniz's series, Newton's power series for sine and cosine, and Taylor's series—concepts that were centuries ahead of their European counterparts. This tradition is also distinguished by a deep spirit of inquiry, a commitment to accuracy in astronomical observations, and a continuous transmission of knowledge through generations.

Key features of the Kerala School included a blend of traditional methods and innovations, such as the refinement of *ĀryaBhaṭa*'s systems and the introduction of unique numerical notations like the *Kaṭapayādi* and *Bhūta-Saṅkhyā* systems. The *Kaṭapayādi* system allowed for the representation of large numbers in mnemonic forms, aiding in memory and computation, while the *Bhūta-Saṅkhyā* system encoded numbers through symbolic words, often seen in poetic verses. Scholars such as *Mādhava*, *Parameśvara*, *Nīlakanṭha Somayājīn*, and *Jyeṣṭhadeva* made profound contributions to the development of mathematical and astronomical theories, creating a legacy that influenced both Indian and global scientific thought.

Assignment

1. The following phrases occur in the *Candravākya* text. Find the numbers represented by the following words in *Kaṭapayādi* system.

- (i) गीर्नः श्रेयः (*gīrnaḥ śreyah*)
- (ii) धेनवः श्रीः (*dhenavaḥ srīḥ*)
- (iii) रुद्रस्तु नम्यः (*rudrastu namyaḥ*)
- (iv) भवो हि याज्यः (*bhavo hi yājyaḥ*)
- (v) धन्येयं नारी (*dhanyeyam nārī*)
- (vi) धनवान् पुत्रः (*dhanavān putraḥ*)
- (vii) गृह्याः सुराः राज्ञा (*grhyāḥ surāḥ rajñā*)



(viii) बालेन कुलम् (*bālena kulam*)

(ix) धनुभिः खलैः (*dhanubhiḥ khalaiḥ*)

(x) दश सूनुवः (*daśa sūnavah*)

2. Prepare a chart listing the major texts and authors associated with the Kerala School of Mathematics.
3. Prepare a short note on the basic features of Kerala School of Mathematics.
4. Explain *BhūtaSāṅkhyā* system of numerical notation with your own examples.
5. Explain *Kaṭapayādi* system of numerical notation with your own examples.
6. Discuss the foundational contributions of Saṅgamagrāma Mādhava to the Kerala School and to the broader history of Mathematics.
7. Explore the significance of Jyeṣṭhadeva's *Yuktibhāṣā* as a systematic exposition of Mathematical and Astronomical reasoning within the Kerala School.
8. Evaluate the multifaceted contributions of Keṭṭallūr Nīlakaṅṭha Somayājīn to the Kerala School.

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.
2. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.
3. *Kerala School of Mathematics: Trajectories and Impact*, Ed. N. K. Sundareswaran, Ganga books, Calicut, 2014

Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K. Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.





Major Concepts and Anticipations

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ develop an understanding of specific contributions in the fields of Mathematics and Astronomy
- ❖ understand the evolution of scientific thought through the history of scientific literature in Sanskrit

Background

So far, we've looked at the study of mathematics in Sanskrit, the history of astronomy in India, and the contributions of the Kerala School. In this unit, we will give an overview of some important discoveries and anticipations in Indian mathematics and astronomy.

Keywords

Śulbasūtra, Bhuja-Koṭi-Karna-Nyāya, āyāma, vistāra, karṇa, pariṇāha, viṣkamba, akṣṇā

Discussion

The Kerala School of Mathematics made groundbreaking advancements in computational techniques, particularly in astronomy, long before similar discoveries were made in the West. By aligning computational results with observational data, they used algebra, geometry, and concepts of limits to achieve notable results in areas such as ecliptic reductions, summations, and integrations. These achievements, particularly in infinite series transformations associated with Leibniz, were first highlighted by Charles M. Whish in a 1832 paper, where he presented formulas from key Keralite texts like *Tantrasaṅgraha*, *Yuktibhāṣa*, *Karaṇapaddhati*, and *Sadratnamālā*.



However, Whish's discoveries were largely ignored for over a century, with historians of mathematics and Indian literature assuming that Indian science had little to contribute after Bhaskara II, instead attributing progress to Western influences. It wasn't until the 1940s that scholars like Professor C.T. Rajagopal and his colleagues began revisiting Whish's work, examining it with modern mathematical perspectives. Notable contributions came from figures such as Rama Varma Maru Thampuran and A.R. Akhileswara Aiyar, who expanded on the 1948 edition of *Yuktibhāṣā*. Later scholars, including T.S. Kuppanna Sastri, T.A. Saraswathi, and R.C. Gupta, continued to explore these topics.

Indian mathematicians and astronomers were known for their rigorous reasoning, which allowed them to anticipate many significant mathematical concepts later discovered in the West. Their work, grounded in algebra, geometry, and limits, produced impressive results despite challenges, offering valuable insights into the rich history of scientific development in India. Let's go over some key concepts in Indian mathematics.

1. 4.1. *Bhuja-Koṭi-Karna-Nyāya* (Pythagorean Theorem)

One of the fundamental theorems in geometry is the theorem known as Pythagoras' Theorem. However, historical records indicate that the earliest precise statement of this theorem is found in the *Baudhāyana-Sulbasūtra*, a text composed between 1200 BCE and 800 BCE. The famous Greek mathematician Pythagoras (c. 570–495 BCE) is often credited with this theorem, but it is likely that the theorem was known at least three centuries earlier, making it more appropriate to refer to it as the Baudhāyana Theorem. The Pythagorean theorem, which we typically learn in school, also appears in the work on geometry by Euclid (circa 300 BCE). The theorem was later attributed to Pythagoras by Greek historians. Additionally, particular instances of this result have been found in Babylonian mathematical texts dating back to around 2000 BCE.

◆ Baudhāyana Theorem

1.4.1.1. Theorem

In the *Baudhāyana-Sulbasūtra*, the theorem is expressed as follows:

दीर्घचतुरश्रस्याक्ष्णयारज्जुः पार्श्वमानी तिर्यङ्ग्रानी च यत्पृथग्भूते कुस्तस्तदुभयं करोति ।
(*Baudhāyana-Sulbasūtra*)

(Note: *dīrghacaturaśra* is rectangle, *akṣṇā* is the diagonal, *pārśvamāni* and *tiryāṅmāni* are the lateral and vertical sides of the rect-



angle)

Translation:

The rope corresponding to the diagonal of a rectangle makes whatever is made by the lateral and the vertical sides individually.

Explanation:

In the *Śulbasūtra*-s, the statement of the theorem concerns the square of the diagonal of a rectangle. This formulation directly correlates with the theorem as it relates to a right-angled triangle, where the diagonal of the rectangle serves as the hypotenuse of the triangle. Essentially, any right-angled triangle can be viewed as half of a rectangle, and its hypotenuse is the same as the rectangle's diagonal.

In a right-angled triangle, the theorem describes the relationship between the three sides, which are referred to by different terms in Indian geometry. The sides are the *bhuja* (base), *koṭi* (height), and *karna* (hypotenuse). Thus, the theorem is referred to as the *Bhuja-Koṭi-Karna-Nyāya* in later Indian mathematical texts.

Mathematical Expression:

For a right-angled triangle ΔABC , the relationship is expressed as:

$AC^2=AB^2+BC^2$ where AC is the *karna* (hypotenuse), AB is the *koṭi* (height), and BC is the *bhuja* (base).

1.4.1.1. Bhuja-Koṭi-Karna-Nyāya in Mānava-Śulba-sūtra:

In *Mānava-Śulba-sūtra*, it is stated that

आयामं आयामगुणं विस्तारं विस्तरेण तु ।

समस्य वर्गमूलं यत् तत् कर्णं तद्विदो विदुः ॥

This can be translated as:

“The square root of the sum of the squares of the *āyāma* and *vistāra* gives the *karna*.”

Modern Notation:

Using modern mathematical symbols, this can be written as $\sqrt{\text{āyāma}^2 + \text{vistāra}^2} = \text{karna}$.

Note:

- ♦ *Āyāma*: Represents the length of one side or a linear dimension.
- ♦ *Vistāra*: Refers to an extension or breadth, another linear dimension.



- ♦ *Karṇa*: The hypotenuse or diagonal (similar to the hypotenuse in a right triangle).

This formula is essentially an ancient version of the Pythagorean theorem, relating the three sides of a right-angled triangle.

1.4.1.3 ĀryaBhaṭa's Version of *Bhuja-Koṭi-Karna-Nyāya*

The *Bhuja-Koṭi-Karna-Nyāya* is also cited in the works of ancient Indian astronomer and mathematician ĀryaBhaṭa. His version of the theorem is stated as:

यः भुजावर्गः कोटीवर्गः च सः कर्णवर्गः एव स्यात् । (Āryabhaṭīya, II.17)

- ♦ ĀryaBhaṭa's Version of *Bhuja - Koṭi-Karna-Nyāya*

A lucid translation is: "In a right-angled triangle, the square of the base plus the square of the upright is equal to the square of the hypotenuse itself."

This formulation is essentially the same as the Pythagorean theorem and highlights the deep mathematical understanding that Indian scholars had long before Pythagoras.

1.4.2. ĀryaBhaṭa's Formula for the Area of a Circle

ĀryaBhaṭa provides the formula to find the area of a circle as follows:

समपरिणाहस्यार्धं विष्कम्भार्धहतमेव वृत्तफलम् ।

- ♦ ĀryaBhaṭa's formula for the area of a circle

This can be translated as:

"The area of a circle is half the product of the circumference and the semi-diameter."

(Note: *Pariṇāha* is the circumference and *viṣkambārdha* is the semi-diameter)

Modern Notation:

Since the circumference of a circle is $2\pi r$ the semi-diameter is 'r' we get:

$$\begin{aligned} \text{Area of the circle} &= \text{half of circumference } (\pi r) \times \text{semi-diameter}(r) \\ &= \pi r^2 \end{aligned}$$

1.4.3. Value of π

Indian mathematicians understood the importance of π in calculating the area and circumference of circles, which was crucial for astronomical calculations and the design of structures such as altars and temples. The value of π has been a subject of significant study in Indian mathematics for over a millennium. Indian mathematicians, starting from ancient texts, were among the first to approximate π



with impressive accuracy, laying the groundwork for later mathematical developments. *ĀryaBhaṭa* also provides an approximation for π that is correct to four decimal places.

ĀryaBhaṭa's statement is as follows:

चतुरधिकं शतमष्टगुणं द्वाषष्टिस्तथा सहस्राणाम् ।

अयुतद्वयविष्कम्भस्य आसन्नो वृत्तपरिणाहः ।।

This can be translated as:

“Take 100 added to 4, multiplied by 8, and then add 62,000; This is the approximate circumference of a circle whose diameter is 20,000.

Explanation:

In the verse, the values of circumference and diameter are given. Since we know that π is the ratio between circumference and diameter, the value of π can be deduced from this statement.

Calculation:

$$\text{Given Circumference} = (100 + 4) \times 8 + 62,000 = 62,832$$

$$\text{Given Diameter} = 20,000$$

$$\pi = 62,832 / 20,000 = 3.1416$$

This approximation, as given by *ĀryaBhaṭa*, is accurate to four decimal places, which is a remarkable achievement for his time. Many other Indian mathematicians, such as *Saṅgamgrāma* Madhva, further refined the value and provided more accurate approximations. The Kerala School developed several infinite series to calculate π , such as the Madhava-Leibniz series and Madhava's series for sine and cosine. These methods provided an efficient way to compute π and were known in India long before they became widely recognized in Europe.

1.4. 4. Significant Anticipations by Indian Mathematicians

Below are some key anticipations found in Indian texts, which can be compared with Western discoveries in modern mathematics:

1.4.4.1. Reduction to the Ecliptic by Tycho Brahe (1546–1601)

This was first enunciated by *Acyuta Piṣāroṭi* (1550–1621) in his *Sphuṭanirnaya* (4.2), further simplified in his later work *Uparāga-kriyākrama* (1583), and is also referenced in the *Rāśigolasphuṭānīti* (47).

- ♦ *Āryabhaṭa* provides an approximation for π that is correct to four decimal places



- ◆ Significant Anticipations by Indian Mathematicians

1.4.4.2. Irrationality of π by Lambert (1671)

The concept of irrational numbers was clearly articulated by Nilakantha *Somayājīn* (1444–1545) in his commentary on the *Āryabhaṭīya*. He explains the impossibility of measuring both the diameter and circumference of a circle with the same unit in exact integers, thereby highlighting the irrational nature of π . This thought is expressed in the verses: “Measuring with a unit that divides the diameter exactly, the circumference will always result in a remainder, indicating an irrational number.”

1.4.4.3. Leibniz’s Power Series for π

The power series for π , which Leibniz developed, can be traced back to the work of *Mādhava* of *Saṅgamagrāma* (1360–1425), as reflected in his verse quoted by *Śaṅkara Vāriyar* (1500–1560) in his commentary on the *Līlāvātī* of *Bhāskara II*.

1.4.4.4. Gregory and Leibniz’s Series for the Inverse Tangent

This series, developed by James Gregory (1638–1675) and Leibniz, was already enunciated by *Mādhava* in the 14th century, as cited in *Śaṅkara Vāriyar*’s commentary on the *Līlāvātī*.

1.4.4.5. Newton’s Power Series for Sine and Cosine

The power series for sine and cosine, as formulated by Newton, was anticipated in the works of *Mādhava*, as seen in verses quoted in the anonymous commentary on *Nilakaṅṭha Somayājī*’s *Tantrasaṅgraha*.

1.4.4.6. Newton-Gauss Interpolation Formula (up to Second Order)

This interpolation formula, a fundamental result in numerical analysis, was first presented by Govindasvami (c. 800–850) in his commentary on the *Mahābhāskarīya* of *Bhāskara I*.

1.4.4.7. Newton-Sterling Interpolation Formula of the Second Order

This formula was anticipated in the *Dhyanaṅgraha* of Brahmagupta (625 CE) and revised in *Bhāskara II*’s *Siddhānta-śiromaṇi* (c. 1114).

1.4.4.8. Taylor Series Approximation for Sine and Cosine Functions (Up to Second Order)

Mādhava of *Saṅgamagrāma* had already developed an approximation for sine and cosine functions in the 14th century, which is cited in the commentary of *Nilakaṅṭha Somayājī* on the *Āryabhaṭīya*. This concept was further refined by *Parameśvara* in his commentary on *Bhāskara I*’s *Laghubhāskarīya*.



1.4.4.9. Gregory's Expansion of the Third-Order Taylor Series Approximation for Sine (1668)

An equivalent formula for the first four terms of the Taylor series expansion was presented by *Parameśvara* in his *Siddhāntadīpikā*, where he discusses the expansion in terms similar to those used by Gregory.

1.4.4.10. Lhuillier's Formula for the Circumradius of a Cyclic Quadrilateral (1782)

Parameśvara also discussed the circumradius of cyclic quadrilaterals in his commentary on the *Līlāvati* of *Bhāskara II*, demonstrating an early understanding of this geometric concept.

1.4.4.11. Mean Value Theorem of Differential Calculus

The principle of the Mean Value Theorem, a cornerstone of differential calculus, was presented by *Parameśvara* in his *Siddhāntadīpikā*, offering a parallel result to that later formalized in Western mathematics.

Conclusion

Students of mathematics and astronomy need to recognize the vast contributions of Indian scholars such as Govindasvami, *Mādhava*, *Parameśvara* and *Nīlakaṇṭha* who laid the groundwork for numerous advancements in mathematical theory and practice. The above examples only scratch the surface of the profound mathematical knowledge present in Indian texts. Further research and exploration are essential to fully appreciate the breadth and depth of these discoveries and their influence on the evolution of scientific thought, particularly in the development of modern mathematics and astronomy.

Summarised Overview

Indian mathematicians, particularly from the Kerala School, made significant contributions to mathematics and astronomy long before similar discoveries were recognized in the West. The Kerala School applied advanced techniques in algebra, geometry, and limits, achieving groundbreaking results in areas like ecliptic reductions and infinite series. These discoveries were first highlighted by Charles M. Whish in 1832, though they were largely ignored until the 1940s when scholars like C.T. Rajagopal began to recognize their importance.

One of the earliest known formulations of the Pythagorean Theorem (the *Bhuja-Koṭi-Karna-Nyāya*) appears in the *Baudhāyana-Śulbasūtra* (1200–800 BCE), long before Pythagoras. *ĀryaBhaṭa* also provided an approximation of π accurate to four decimal places.



Other Indian mathematicians, like Mādhva, refined this approximation further, laying the groundwork for the modern infinite series used by Leibniz and Newton.

Indian mathematicians anticipated several key Western discoveries:

- The reduction to the ecliptic (*Acyuta Piṣāroṭi*),
- The irrationality of π (Nilakantha *Somayājīn*),
- The power series for π and Taylor series for trigonometric functions (*Mādhava*),
- Various interpolation formulas (Govindasvami and Brahmagupta).

These contributions demonstrate the advanced mathematical and astronomical knowledge in ancient India, which influenced modern science. Further research into these works reveals their profound impact on the development of global scientific thought.

Assignment

1. Examine the *Bhuja-Koṭi-Karna-Nyāya*, its historical roots in the *Baudhāyana-Śulbasūtra*, and its relationship with the Pythagorean theorem.
2. Investigate the mathematical innovations of *ĀryaBhaṭa*, particularly his formula for the area of a circle and his approximation of π . Compare these contributions to similar Western discoveries, and discuss their implications for the history of mathematics.
3. Analyze the anticipations of key mathematical concepts in Indian texts, such as the irrationality of π , the Madhava-Leibniz series, and Newton's power series for sine and cosine. How do these early Indian formulations compare with later Western mathematical discoveries?
4. Prepare a detailed list of key technical terms used in Indian mathematics, such as “*Bhuja*,” “*Koṭi*,” “*Karṇa*,” and others. Provide their meanings, contextual usage in ancient texts, and modern equivalents.
5. Explain the theorem concept in Sulbasutra .

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.
2. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.
3. *Kerala School of Mathematics: Trajectories and Impact*, Ed. N. K. Sundareswaran, Ganga books, Calicut, 2014



Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K.Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.

SGOU

BLOCK-02

Development of Ayurveda in India

Block Content

- Unit 1: General Study on major works in Ayurveda
- Unit 2: Major Concepts in Ayurveda
- Unit 3: Kerala Tradition of Ayurveda
- Unit 4: Major translated works in Malayalam from Sanskrit on Ayurveda





General Study on Major Works in Ayurveda

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ familiarisation with the literature pertaining to Ayurveda
- ❖ acquainting with the texts on Ayurveda

Background

This unit explores the evolution of Ayurvedic texts, highlighting six major works that have shaped the practice of Ayurveda over millennia. It covers the Bṛhatrayī, the three foundational texts - Caraka-saṁhitā, Suśruta-saṁhitā, and Aṣṭāṅgahṛdayam - which laid the groundwork for Ayurvedic medicine, and the Laghutrayī, a set of later texts that introduced significant advancements in diagnosis, pharmacology and treatment.

Keywords

Caraka-saṁhitā, Suśruta-saṁhitā, Aṣṭāṅga sangraha, Madhavanidhana, Sarangdhara saṁhita, Bhavaprakasa

Discussion

2.1.1. The Evolution of Ayurvedic Texts: Major Works and Contributions

In the early Vedic period, the practice of medicine was closely intertwined with mystical and religious elements. Over time, however, this approach evolved, incorporating more systematic, empirical observations. Successive generations of Ayurvedic scholars fortified the system with a solid philosophical framework, transforming Ayurveda from a mystical tradition into a well-defined medical discipline. Much of the material originally found in the Vedas was compiled,



- ◆ *Caraka-saṁhitā*, the *Suśruta-saṁhitā*, and the *Aṣṭāṅgahṛdayam*

critically analyzed, and systematically restructured. While several important works from this period have been lost, three foundational texts remain central to the practice of Ayurveda: the Caraka-saṁhitā, the Suśruta-saṁhitā, and Vāgbhata's Aṣṭāṅgahṛdayam. These three works, collectively known as the Brhatrayī, have enjoyed enduring reverence for over two millennia. While these texts have undergone various revisions and additions over time, the versions we possess today are at least 1,200 years old. Written in Sanskrit, they represent the vast and rich repository of knowledge concerning the Indian system of medicine.

2.1.1.1. Caraka-saṁhitā

- ◆ *Caraka-saṁhitā*, is meticulously structured into eight sections, further subdivided into 120 chapters

The Caraka-saṁhitā stands as the foundational text for Ayurvedic internal medicine (*Kāyacikitsā*) and is regarded as the oldest of the three principal texts. Likely compiled around the 1st century BCE, it remains the primary source for understanding the core principles of Ayurveda. It is attributed to Ātreya and represents the teachings of the Ātreya School of Physicians. The text is meticulously structured into eight sections, further subdivided into 120 chapters.

The opening section of the Caraka-saṁhitā introduces the basic principles of Ayurveda, which underpin the entire medical system. Following this, the text elaborates on the physiological and anatomical features of the human body, detailing the various etiological factors that contribute to the onset of disease. The work provides an in-depth understanding of diagnostic methodologies, treatment approaches, and prognostic evaluation.

A prominent feature of the Caraka-saṁhitā is its focus on preventive healthcare. It provides comprehensive guidelines on daily and seasonal regimens, dietetics, and social conduct that foster mental well-being. Its chapter on dietetics, in particular, is a significant contribution, offering extensive insights into the relationship between food and health.

The text's curative aspects include detailed descriptions of medicinal plants, their properties, and various herbal formulations. Additionally, it introduces therapeutic practices such as śodhana (elimination therapy) and offers insights into rejuvenation therapies and methods to combat the ageing process. These chapters continue to inspire contemporary research in areas such as anti-ageing and preventive healthcare.

The Caraka-saṁhitā is not merely a medical text but a work of literary excellence. Written in both prose and poetic verses, it stands as a Sanskrit classic, its beauty and depth offering inspiration to scholars and practitioners alike. The text's holistic approach—integrating



medical, social, and philosophical elements—remains a source of profound insight.

2.1.1.1.1. Time Period and Historical Context

The Caraka-saṁhitā was likely written during the period between Pāṇini and King Kaniṣka (c. 1st-2nd century BCE). Since Vāgbhata references many of the topics covered in the Caraka-saṁhitā, it can be concluded that the Caraka-saṁhitā predates Vāgbhata's work. Although both the Caraka-saṁhitā and Suśruta-saṁhitā share foundational principles, the latter emphasizes the surgical tradition of Dhanvantari. This suggests that the original Suśruta text likely predates the Caraka-saṁhitā, although its final revisions, which incorporated Charaka's principles, occurred after the compilation of the Caraka-saṁhitā.

The final editor of the Caraka-saṁhitā was Drḍhabala, who is credited with presenting the text in its complete form around the 4th century CE. The work underwent three major stages of compilation and revision:

1. **Agniveśa-tantra (c. 1000 BCE)** – The earliest version of the text, attributed to Agniveśa.
2. **Charaka's Additions (c. 2nd century BCE)** – The contributions made by Charaka, which significantly enriched the original work.
3. **Drḍhabala's Reformation (c. 4th century CE)** – The final compilation and editing, which resulted in the text as we know it today.

These stages highlight the gradual refinement of Ayurvedic knowledge over time, reflecting the dynamic and evolving nature of the tradition.

2.1.1.1.2. Caraka-saṁhitā: Structure and Content

- ♦ *Caraka-saṁhitā*, is divided into eight sections, known as *Aṣṭāṅga*

The Caraka-saṁhitā is a monumental work in Ayurveda, systematically divided into eight sections, known as Aṣṭāṅga, which collectively form the complete text. Each section consists of subsections called Sthāna-s or chapters. The content of these sections covers various aspects of Ayurvedic philosophy, diagnosis, treatment, and prevention.

Here is an overview of the eight sections (Aṣṭāṅga) of the Caraka-saṁhitā, their respective chapters (Sthānas), and their contents:

1. **Sūtra-sthāna (Foundational Principles)** – This section consists of 30 chapters and introduces the core concepts of Ayurveda, including the nature of health, disease, and treatment. It also covers the role of the physician, the idea of the three doshas (Vāta, Pitta, Kapha), and various diagnostic methods.



2. **Nidāna-sthāna (Etiology and Diagnosis)** – Comprising eight chapters, this section focuses on the causes of diseases, their classification, and the diagnostic techniques used to identify them.
3. **Vimanā-sthāna (Therapeutics)** – This section, consisting of 8 chapters, explores different therapeutic strategies, including the use of medicinal plants, treatment modalities, and dietary recommendations.
4. **Śarīra-sthāna (Anatomy and Physiology)** – Made up of 6 chapters, this section provides detailed information on the structure and functioning of the body, including the study of anatomy, physiology, and embryology.
5. **Indriya-sthāna (Prognosis Based on Sensory Organs)** – Comprising 12 chapters, this section focuses on the diagnostic and prognostic aspects of diseases, primarily determined through the sensory responses of the patient.
6. **Cikitsā-sthāna (Therapeutics)** – This section spans 30 chapters and is dedicated to the treatment of diseases, detailing various medicinal approaches and therapeutic practices.
7. **Kalpa-sthāna (Pharmaceutics and Toxicology)** – Consisting of 12 chapters, it provides an in-depth exploration of pharmacy, including the preparation, dosage, and administration of medicines. It also covers the identification of signs of misuse and methods for handling poisons.
8. **Siddhi-sthāna (Achieving Success in Treatment)** – This section, made up of 12 chapters, outlines the indicators of successful treatment, the importance of hygiene, and practices that contribute to a healthier lifestyle.

2.1.1.2. Suśruta-saṁhitā

Suśruta, the founder of the Dhanvantari School of Surgery, is revered in Ayurveda as the father of surgery. The Suśruta-saṁhitā contains highly sophisticated descriptions of surgical instruments. Its classifications of fractures, wounds, abscesses, and burns, as well as its detailed discussions on procedures for plastic surgery and ano-rectal surgery, have withstood the test of time. Suśruta also introduces original concepts of pathogenesis and describes a dissection technique using the maceration method. His anatomical knowledge, including the understanding of bones, joints, nerves, the heart, blood vessels, and circulation, is remarkably accurate and highly commendable. The descriptions of the marma-s (vital points in the body) are strikingly similar to the system of acupuncture points used in traditional Chinese medicine. Suśruta emphasizes the importance of both theoretical and practical knowledge and outlines methods for the development of surgical skills.

◆ *Suśruta* is known as the father of Ayurveda



2.1.1.2.1 Evolution of Āyurveda as per the Suśruta-saṁhitā

According to the Suśruta-saṁhitā, the sages (Suśruta, Upādhe-
nava, Vaitarana, Durabhra, Pauṣkalavata, Karāvīrya, Gopurarakṣita)
initially struggled to grasp the full extent of human suffering caused
by both exogenous and endogenous diseases. They approached
Dhanvantari, the king of Kāśī, renowned for his expertise in surgery.
The sages sought his guidance in learning Ayurveda to alleviate hu-
man suffering and improve people’s quality of life.

Dhanvantari explained that Ayurveda is a branch of the *Atharvave-
da*. Brahman, the creator, had originally formulated this science of
life in a treatise of one hundred thousand verses. Aware of the limita-
tions of human intellect and the brevity of life, Brahmā divided this
vast knowledge into eight specialities, including medicine, surgery,
and others. Brahmā passed this knowledge to Prajāpati, who imparted
it to the Aśvīnī-kumāra-s, who in turn passed it to Indra, from
whom Dhanvantari learned the science. Dhanvantari, in turn, taught
Suśruta and other disciples.

2.1.1.2.2. Importance of the Suśruta-saṁhitā

The Suśruta-saṁhitā provides a detailed description of the dissec-
tion of the human body, with practical training using models made
from fruits, flowers, and tree barks, referred to as “yogya.”

◆ *Suśruta-saṁhitā*
lists 125 different
surgical instru-
ments.

- ◆ **Surgical Instruments and Procedures:** The text lists 125 differ-
ent surgical instruments and details various operations in plastic
surgery, ophthalmology, gynaecology, neurosurgery, orthopae-
dics, and more.
- ◆ **Pathogenesis and Metabolism:** It describes subtypes of Pitta
and its relationship with the five elements necessary for healthy
metabolism.
- ◆ **Plastic Surgery:** Suśruta is regarded as the first plastic surgeon,
having performed surgeries for cleft lip, cleft palate, and rhino-
plasty.
- ◆ **Anesthesia and Pain Management:** While the text does not of-
fer extensive information on anaesthesia, it mentions that patients
were anaesthetized using alcohol, and other references suggest
the use of plant powders.

2.1.1.3. VāgBhaṭa: The Pillar of Classical Āyurveda

VāgBhaṭa, the revered author of the *Aṣṭāṅga-saṅgraha*, is regard-
ed as one of the most influential figures in the classical tradition of
Āyurveda. He is often referred to as Vṛddha-VāgBhaṭa (the Elder
VāgBhaṭa) to distinguish him from his successor, Bāla-vāgBhaṭa
(the Younger VāgBhaṭa), whose work is known as the *Aṣṭāṅgaḥr-*



- ◆ *Vāgbhaṭa* : The Pillar of Classical Āyurveda

daya. Vāgbhata's contributions represent a bridge between earlier foundational texts and the later developments in Ayurvedic medical knowledge.

The birthplace of Vṛddha-*vāgbhaṭa* is believed to be in Sindh, an ancient region that is now part of modern-day Pakistan. His teacher was the Buddhist scholar Avalokita, and his exposure to Buddhist teachings is reflected in his writings, which feature references to Buddhist deities and concepts. This Buddhist influence distinguishes the *Aṣṭāṅga-saṅgraha* from other Ayurvedic works, as it integrates elements of Buddhist philosophy and healing.

2.1.1.4. The *Aṣṭāṅga-saṅgraha*: A Comprehensive Compendium

The *Aṣṭāṅga-saṅgraha* is the third major text in the classical triad of Ayurvedic works, alongside the Caraka-saṁhitā (the foundational text of internal medicine) and the Suśruta-saṁhitā (the classical text on surgery). Together, these three texts form the core of ancient Indian medical knowledge. Vāgbhata's work is notable for its comprehensiveness, addressing all eight branches of Āyurveda, thus the term *Aṣṭāṅga* (Eight branches) is incorporated in the title.

- ◆ The *Aṣṭāṅga-saṅgraha* is organized into 150 chapters

The *Aṣṭāṅga-saṅgraha* is organized into 150 chapters, systematically covering a wide range of medical disciplines. The following is an overview of its structure:

Structure of the *Aṣṭāṅga-saṅgraha*

1. *Sūtra*-Sthāna – 40 Chapters
2. Śarīra-Sthāna – 12 Chapters
3. Nidāna-Sthāna – 16 Chapters
4. Cikitsā-Sthāna – 24 Chapters
5. Kalpa-Sthāna – 8 Chapters
6. Uttara-Sthāna – 50 Chapters

Total: 150 Chapters

2.1.1.4.1. Main Topics in the Sections of the *Aṣṭāṅga-saṅgraha*

1. *Sūtra*-Sthāna

- ◆ Being Healthy (Svasthavṛtta) – Chapters 3 to 11
- ◆ Pharmacology (Dravya-Guna-Vijñāna) – Chapters 12 to 18
- ◆ Study of Body Humors, Tissues, and Waste Products (Doṣa - Dhātu - Mala -Vijñāna) – Chapters 19 to 20



- ◆ Disease Knowledge (Roga-Vijñāna) – Chapter 22
- ◆ Medicine & Detoxification Therapies (Cikitsā, *Pañcakarma*) – Chapters 23 to 40

2. Śarīra-Sthāna

- ◆ Anatomy – Chapters 1 to 8
- ◆ Bad Prognostic Signs (Arista-Vijñāna) – Chapters 9 to 12

3. Nidāna-Sthāna

- ◆ Etiology – Chapters 1 to 16

4. Cikitsā-Sthāna

- ◆ Treatments – Chapters 1 to 24

5. Kalpa-Sthāna

Recipes and Formulae for Detoxification – Chapters 1 to 7

6. Uttara-Sthāna

- ◆ Pediatrics – Chapters 1 to 6
- ◆ Psychiatry & Infectious Diseases – Chapters 7, 8
- ◆ E.N.T. (Ear, Nose, Throat) – Chapters 11 to 28
- ◆ Surgery – Chapters 29 to 35
- ◆ Toxicology – Chapters 40 to 48
- ◆ Rejuvenation & Aphrodisiacs – Chapters 49, 50

2.1.1.4.2. Characteristic Features of the *W-saṅgraha*

Vṛddha-vāgBhaṭa systematically compiled critical knowledge from both the Caraka -sāṃhitā and Suśruta-sāṃhitā while introducing several important concepts that would shape future developments in Ayurvedic medicine. Below are some of the novel and important ideas introduced by VāgBhaṭa:

New Important Topics Not Found in Caraka and Suśruta-sāṃhitā-s

1. New Plants for Specific Diseases

In the *Sūtra-Sthāna*, VāgBhaṭa introduces several new plants for specific diseases, such as:

- ◆ Adhatoda vasica for bleeding disorders
- ◆ Solanum xanthocarpum for cough

- ◆ Turmeric for diabetes mellitus
- ◆ Garlic for neurological disorders
- ◆ Popcorn for vomiting
- ◆ Castor oil for musculoskeletal and rheumatic problems
- ◆ Iron for anaemia
- ◆ Commiphora mukul for nervous disorders

2. Relationship Between Diseases and Body Humors

For the first time, Vāgbhata explicitly links diseases with imbalances in the three doṣa-s (Vāta, Pitta, and Kapha). He also connects the hyper states of bodily fluids, such as rasa (lymph), with Kapha and diseases related to a hyper state of blood with Pitta.

3. Introduction of Grape-Wine

Vāgbhata introduces grape wine as part of medicinal liquors used in Ayurvedic therapies.

4. Rejuvenation Tonics

In the rejuvenation section, Vāgbhata mentions new tonics such as Semecarpus anacardium (Bhallātaka), Piper longum (Pippali), Garlic, and Shilajit (Black Bitumen).

5. New Aphrodisiac Therapy

Vāgbhata introduces a unique aphrodisiac therapy wherein medicated pastes are applied to the feet to enhance potency.

6. ENT and Surgical Principles

Many foundational principles regarding ENT and surgery are explained for the first time in this text.

7. Use of Processed Toxins for Treatment

Vāgbhata mentions that toxins, when properly processed, can be used as effective treatments for certain diseases.

Commentaries on the Aṣṭāṅga-saṅgraha

- ◆ Śāśīlekhā is the commentary of Aṣṭāṅga-saṅgraha

Several commentaries have been written on the Aṣṭāṅga-saṅgraha, but one of the most widely available and authoritative is the Śāśīlekhā, written by Indu. This commentary remains a key source for understanding the deeper concepts of the text and its application in modern Ayurvedic practice.



2.1.2.II. Later Ayurvedic Texts: Advancements and External Influences

As Āyurveda evolved over centuries, several later texts emerged, reflecting advancements in medical knowledge and the growing influence of external cultures, particularly during the periods of Muslim rule and European trade. These texts broadened the scope of Ayurvedic practice, particularly in the areas of diagnosis, pharmacology, alchemical processes, and surgical techniques. Three important works of this later phase - Mādhvanidāna, Śāraṅghara-saṁhitā and Bhavaprakāśa are known as Laghutrayī in Ayurveda literature.

2.1.2.1. Mādhava-nidāna

- ◆ *Mādhava-nidāna* emphasizes disease identification and diagnosis

Mādhava-nidāna, authored by *Mādhava* (or Madhavācārya) in the 12th century, marks a significant shift in the field of diagnosis. Unlike earlier texts that focused primarily on treatment and remedies, *Mādhava-nidāna* emphasizes disease identification and diagnosis. It comprises 1,522 verses across 69 chapters.

Special Features of *Mādhava-nidāna*

- ◆ Rheumatism (Āmavāta): Describes the disease in great detail for the first time, with a thorough classification.
- ◆ Neurological Conditions (Vāta-vyādhi): Provides a scientific description of neurological disorders caused by Vāta imbalances.
- ◆ Abdominal Colics: Discusses it as a distinct condition with detailed aetiology and treatment.
- ◆ Acid-Peptic Ulcer Disease (Amla-pitta): Introduces a novel description of acid-peptic ulcers.
- ◆ Other conditions such as Elephantiasis, Urticaria, Obesity, and Gynecological Issues are also discussed in depth.

2.1.2.2. Śāraṅghara-saṁhitā

- ◆ *Śāraṅghara-saṁhitā* is a key work within the *Laghutrayī*

Written by Śāraṅghara in the 14th century, the Śāraṅghara-saṁhitā is a key work within the Laghutrayī, or the “Smaller Triad” of Ayurvedic classics. This text is essential for understanding medicinal preparations, particularly those involving alchemy and the use of mercury (Rasa-śāstra). It introduces a variety of pharmaceutical preparations and detoxification methods.

Importance of *Śāraṅghara-saṁhitā*

- ◆ Mercury and Rasa-śāstra: Focuses on the use of mercury in therapeutic applications.
- ◆ Pulse Diagnosis: Marks the first comprehensive discussion of



pulse examination for diagnosis.

- ◆ Pharmacology: Includes new medicinal substances such as Opium and Nutmeg.

2.1.2.3. Bhāva-prakāśa

Authored by Bhāvamiśra in the 16th century, the Bhāva-prakāśa is a massive text consisting of 10,831 verses. Reflecting the growing globalization of medical knowledge, it includes a discussion of syphilis (referred to as Firanga Roga or “foreigner’s disease”) in response to the Portuguese presence in India.

Significance of Bhava-prakāśa:

- ◆ Introduces new terminologies, such as easier ways to remember the five elements (*Pañca -MahāBhūta*)
- ◆ Materia Medica: Adds new medicinal substances and introduces classifications for different types of herbs.
- ◆ Diagnosis and Examination: Pioneers new methods of patient examination, including Darśana (Inspection), Sparśana (Palpation), and Praśna (Interrogation).

These later Ayurvedic texts reflect the continual evolution of Ayurvedic knowledge, integrating indigenous advancements with external influences, and addressing new diseases, treatments, and methodologies that would define the practice of Ayurveda for centuries to come.

Summarised Overview

Over centuries, Ayurveda evolved from a mystical tradition to a comprehensive medical system, with foundational texts and later works building on earlier knowledge. These texts are categorized into the Bṛhatrayī (three major classical texts) and Laghutrayī (three later texts), each contributing unique advancements.

Bṛhatrayī (Three Major Classical Texts)

1. Caraka-saṁhitā (1st century BCE): It focuses on internal medicine and details diagnosis, treatment, prevention, and rejuvenation therapies. It emphasizes the role of diet and lifestyle in health and introduces herbal remedies.
2. Suśruta-saṁhitā (6th century BCE): The foundational text for surgery covers surgical techniques, anatomy, plastic surgery, and the use of surgical instruments. It also includes early descriptions of anesthesia and dissection methods.
3. Aṣṭāṅgahṛdayam (7th century CE) by Vāgbhaṭa: A synthesis of Caraka and Suśruta, it covers eight branches of Ayurveda, including internal medicine, surgery, toxicology,



and rejuvenation. It introduces new medicinal plants and the relationship between doṣa-s and diseases.

Laghutrayī (Three Later Texts)

4. *Mādhava-nidāna* (12th century CE): Focuses on diagnosis and disease classification, detailing conditions like rheumatism, neurological disorders, and peptic ulcers.
5. *Śāraṅgdhara-saṁhitā* (14th century CE): Introduces alchemical practices (including the use of mercury) in treatments and emphasizes pulse diagnosis and new pharmaceutical preparations.
6. *Bhāva-prakāśa* (16th century CE): A large work that discusses new diseases (e.g., syphilis) and expanded diagnostic methods while incorporating global influences and new medicinal substances.

These texts collectively represent Ayurveda's development into a sophisticated medical system, integrating philosophical, empirical, and therapeutic knowledge.

Assignment

1. Give an overview of the Three Main Ayurvedic Texts: Caraka-saṁhitā, Suśruta-saṁhitā, and Aṣṭāṅgahṛdayam
2. Analyse the role of the Caraka-saṁhitā in Preventive Healthcare
3. Comment on the Contributions of Suśruta-saṁhitā to Surgical Practices in Ayurveda
4. Explain the key Features of the Aṣṭāṅgahṛdayam by *Vāgbhaṭa*
5. Prepare a note on Laghutrayī texts of Ayurveda.
6. Discuss the evolution of medical practice from the early Vedic period to the compilation of the Bṛhatrayī, highlighting the key changes and influences that shaped this transformation.
7. Evaluate Suśruta's contributions to the field of surgery as described in the Suśruta-saṁhitā.
8. Explain the importance of the Śāraṅgdhara-saṁhitā in the context of later Ayurvedic developments

Reference / Suggested Reading

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Major Concepts in Ayurveda

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an awareness of the major concepts in Ayurveda
- ❖ develop an understanding of specific contributions in the fields of Ayurveda

Background

Āyurveda, an ancient system of medicine from India, emphasizes the harmonious balance between the body, mind, and spirit. It offers a holistic approach to health by focusing not only on disease prevention but also on the promotion of overall well-being. Central to Āyurvedic philosophy are the concepts of the three doshas—Vāta, Pitta, and Kapha—each representing different bioenergetic forces in the body. Understanding these doshas and their influence on various physiological and psychological functions is key to maintaining health and preventing disease. This write-up delves into the core principles of Āyurveda, including the doshas, causes of disease, and how seasonal and dietary factors affect the body's balance.

Keywords

Āyu, Vāta, Pitta, Kapha, Kāyachikitsā, Śālakya, Śalyachikitsā, Agadatantra, Bhūtavidyā, Kāumarabhr̥tyam, Rasāyanam, Vājīkaraṇam

Discussion

2.2.1. What is Āyurveda?

Āyurveda, an ancient system of medicine, is rooted in the philosophy that health arises from harmony between mind, body, and spirit. Derived from the Sanskrit words Āyuh (life) and Vid (knowledge), Āyurveda translates to “the knowledge of life”. The goal of Āyurveda is not just to treat disease but to maintain overall well-being by promoting balance.

- ◆ Āyurveda - the knowledge of life



Etymology of Āyurveda:

- ◆ आयुः (शरीरेन्द्रियसत्त्वात्मसंयोगः) अस्मिन् विद्यते इत्यायुर्वेदः (Life exists in the union of the body, senses, soul, and mind)
- ◆ आयुः विद्यते, ज्ञायते अनेन इत्यायुर्वेदः (Life is understood through Āyurveda)
- ◆ आयुः विद्यते, विचार्यते अनेन इति इत्यायुर्वेदः (Life is considered through this knowledge.)
- ◆ आयुः अनेन विन्दति, प्राप्नोति इत्यायुर्वेदः (By following Āyurveda, one attains health.)

2.2.2. The Three Doshas: Vāta, Pitta, and Kapha

The core of Āyurvedic philosophy revolves around the three doshas: Vāta, Pitta, and Kapha. These doshas represent the energies of the body and mind, with each one governing a particular physiological function. The balance or imbalance of these doshas determines an individual's health.

- ◆ Three Doshas: Vāta, Pitta, and Kapha

2.2.2.1. Vāta Dosha

Vāta is the principle of motion in the body. It is responsible for all bodily functions related to movement, such as circulation, respiration, and the movements of the muscles and joints. The term Vāta is derived from the Sanskrit word vāyu (wind), indicating its association with air and space.

Properties of Vāta:

- ◆ Rūkṣa (dry), Laghu (light), Cala (mobile), Sūkṣma (subtle), Śīta (cold), Khara (rough)
- ◆ Functions: Governs activities such as breathing (Ucchvāsaniśvāsa), circulation, excretion, movement, and speech.
- ◆ Imbalances in Vāta lead to conditions like anxiety, insomnia, and constipation.

The **functions of Vāta** include:

- ◆ Utsāha: Enthusiasm and the initiation of physical and mental activities.
- ◆ Ucchvāsaniśvāsa: The process of inhalation and exhalation, or respiration.
- ◆ Cestā: Voluntary movements, such as walking, speaking, and reproduction.
- ◆ Vegapravartana: Reflex activities such as urination, defecation,



and sneezing.

- ◆ Samyaggatyā ca dhātūnām: Coordination of the tissues and organs through proper movement.

Vāta and the Nervous System: The activities of Vāta correspond closely with the functioning of the nervous system. Vāta controls the transmission of nerve impulses, the movement of muscles, and the communication between the brain and body. The normal operation of the Vāta dosha ensures smooth movement and coordination within the body.

2.2.2.2. Pitta Dosha

- ◆ Pitta is associated with fire and water elements

Pitta is the energy responsible for digestion, transformation, and metabolism in the body. It governs all the processes involving heat, such as digestion, absorption, and the conversion of food into energy. Pitta is associated with fire and water elements.

Properties of Pitta:

- ◆ Tīkṣṇa (sharp), Uṣṇa (hot), Snigdha (oily), Laghu (light), Sara (fluid), Drava (liquid)
- ◆ Functions: Digestion, metabolism, hunger and thirst, vision, and intelligence.
- ◆ Imbalances in Pitta lead to conditions like inflammation, heart-burn, ulcers, and irritability.

The **functions of Pitta** include:

- ◆ Pākrī: The digestive process, where food is broken down and nutrients are absorbed.
- ◆ Uṣma: Heat production and energy metabolism.
- ◆ Darśana: Vision and perception involving the transformation of light energy into visual stimuli.
- ◆ Kṣut: Hunger, which signals the need for food intake.
- ◆ Ruci: Taste or the pleasure of eating, regulated by the satiety center in the brain.
- ◆ Prabhā: The glow of the skin and overall vitality, which can be a reflection of Pitta health.

Pitta and the Digestive System: Pitta governs all digestive and metabolic processes, such as the breakdown of food in the stomach, absorption of nutrients in the intestines, and the transformation of nutrients into energy. It also regulates the secretion of digestive enzymes and hormones that manage bodily functions, including the



synthesis of proteins and the production of heat.

2.2.2.3. Kapha Dosha

- ◆ Kapha is associated with the elements of water and earth

Kapha is the principle of cohesion and stability. It is responsible for the structure of the body, the lubrication of joints, and the maintenance of tissue strength. Kapha is associated with the elements of water and earth.

Properties of Kapha:

- ◆ Snigdha (smooth), Śīta (cold), Guru (heavy), Manda (slow), Ślakṣṇa (smooth), Sthira (stable)
- ◆ Functions: Provides structure to the body, maintains immunity, and lubricates joints and organs.
- ◆ Imbalances in Kapha lead to obesity, diabetes, lethargy, and cough-related ailments.

The **functions of Kapha** include:

- ◆ Stability: Kapha gives the body its physical structure and maintains the stability of all systems.
- ◆ Nourishment: Kapha is the energy that maintains the integrity of tissues, nourishes cells, and provides moisture and lubrication to joints and organs.
- ◆ Immunity: Kapha is responsible for the body's natural immunity against diseases and its capacity for self-healing.

Kapha and the Body's Structure: Kapha is responsible for the formation and growth of bodily tissues. It regulates the fluids and keeps the internal systems in harmony. It also ensures that the body's cellular matrix remains stable, protecting it from external disruptions. An imbalance of Kapha can cause the body to become sluggish, leading to weight gain and respiratory problems.

2.2.3. The Three Doshas and the *Bhūta-s* (Vāta, Pitta, and Kapha)

The doshas represent the three fundamental energies that govern all physiological and psychological functions:

- ◆ Vāta (वात): Composed of Air and Ether, Vāta governs movement, circulation, and respiration.
- ◆ Pitta (पित्त): Composed of Fire and Water, Pitta is responsible for metabolism, digestion, and transformation.
- ◆ Kapha (कफ): Composed of Earth and Water, Kapha controls structure, stability, and lubrication in the body.



2.2.4. The Causes of Disease in Āyurveda

- ◆ Disease (रोग) is the imbalance or dysfunction of the three doshas

According to Āyurveda, the primary cause of disease (रोग) is the imbalance or dysfunction of the three doshas (the fundamental bio-energies) – Vāta, Pitta, and Kapha – which govern all physiological and psychological processes. The root cause of the disease is considered to be the improper interactions between these doshas and various external or internal factors, leading to an imbalance.

The classical verse explaining the causality of disease is:

कालबुद्धीन्द्रियार्थानां योगो मिथ्या न चाति च ।

द्वयाश्रयाणां व्याधीनां त्रिविधो हेतुसङ्ग्रहः ॥ (Caraka-samhitā -1/54)

This verse highlights that diseases arise from the incorrect interaction of time, intellect, sense organs, and the environment, leading to the imbalance of the doshas.

2.2.5. The Eight Branches of Āyurveda

- ◆ Āyurveda is a comprehensive medical system with eight primary branches

Āyurveda is a comprehensive medical system with eight primary branches or “limbs,” each focusing on a specific aspect of health and treatment:

1. Kāyachikitsā (कायचिकित्सा) - Internal Medicine: Focuses on the treatment of diseases affecting the body.
2. Śālakya (शालक्यम्) - Ear, Nose, and Throat (ENT): Addresses conditions related to the sensory organs and head.
3. Śalyachikitsā (शल्यचिकित्सा) - Surgery: Deals with surgical procedures, including the treatment of wounds and fractures.
4. Agadatantra (अगदतन्त्रम्) - Toxicology: Involves the study of poisons and their antidotes.
5. Bhūtavidyā (भूतविद्या) - Psychology: Focuses on mental health and spiritual healing.
6. Kāumarabhr̥tyam (कौमारभृत्यम्) - Gynecology and Pediatrics: Deals with women’s health, including pregnancy, childbirth, and care for children.
7. Rasāyanam (रसायनम्) - Rejuvenation and Anti-Aging: Aims at prolonging life and maintaining youthfulness.
8. Vājīkaraṇam (वाजीकरणम्) - Reproductive and Sexual Health: Focuses on enhancing fertility and sexual vitality.



2.2.6. Who is Svastha (Healthy person)?

In Āyurveda, the term Svastha means a state of health, which is defined as:

समदोषाः समाग्निश्च समधातुमलक्रियः ।

प्रसन्नात्मेन्द्रियमनः स्वस्थ इत्यभिधीयते ।।

◆ Svastha - when their doshas (Vāta, Pitta, and Kapha) are in balance

A person is considered Svastha or healthy when their doshas (Vāta, Pitta, and Kapha) are in balance, the digestive fire (Agni) is functioning optimally, the bodily tissues (Dhātus) are nourished, and the excretory processes (Malas) are functioning properly. Additionally, the person's senses (Indriyāṇi) are clear, and the mind (Manas) is in a state of balance and tranquillity.

1. **Doshas:** Vāta (Air), Pitta (Fire), Kapha (Earth and Water)
2. **Agni:** Digestive fire, especially Jāṭharāgni (the stomach fire)
3. **Dhātus:** The seven bodily tissues: Rasa (lymph), Rakta (blood), Māmsa (muscle), Medas (fat), Asthi (bone), Majjā (marrow), Śukra (reproductive tissue)
4. **Malas:** Waste products, including Mūtra (urine), Śakṛt (feces), Sweda (sweat), etc.
5. **Indriyāṇi:** The five sense organs (eyes, ears, skin, nose, tongue) and the five motor organs (speech, hands, feet, anus, and genitals).
6. **Manas:** The mind plays a crucial role in determining mental and physical health.
7. **Ātma:** The soul, which is the ultimate essence of existence.

2.2.7. The Six Tastes (Rasas)

In Āyurveda, food and its effects on health are understood in terms of six tastes (Rasas), which influence the doshas in different ways:

1. Madhura (Sweet): Balances Vāta and Pitta, increases Kapha.
2. Āmla (Sour): Increases Pitta and Kapha, decreases Vāta.
3. Lavaṇa (Salty): Increases Pitta and Kapha, decreases Vāta.
4. Kaṭu (Pungent): Increases Vāta and Pitta, decreases Kapha.
5. Kaṣāya (Astringent): Decreases Pitta and Kapha, increases Vāta.
6. Tikta (Bitter): Decreases Pitta and Kapha, increases Vāta.

◆ Each season has a predominant dosha

2.2.8. The Seasons and Dosha Dominance

Each season has a predominant dosha, and understanding this helps maintain health:



1. Vāta predominates in winter and fall.
2. Pitta predominates in summer and spring.
3. Kapha predominates in the rainy and autumn seasons.

2.2.9. Causes of Disease (Āyurvedic View)

In Āyurveda, the following factors are considered significant in causing diseases:

1. **Vega (urge suppression):** Suppressing natural urges like urination, defecation, hunger, or sleep.
2. **Environmental factors:** Exposure to extreme climates, pollution, or imbalanced living conditions.
3. **Dietary imbalances:** Eating incompatible foods or excessive indulgence in one taste.
4. **Mental and emotional factors:** Stress, anxiety, and emotional disturbances.
5. **Excessive or insufficient activity:** Lack of exercise or overexertion.

Summarised Overview

Āyurveda is a profound system of medicine that integrates mind, body, and spirit into its healing practices. It is based on the understanding that health results from a balanced interaction between the three doshas: Vāta, Pitta, and Kapha. Each dosha represents a specific combination of the five elements (earth, water, fire, air, and ether), influencing different bodily functions such as movement, digestion, and structure. Health in Āyurveda is not just the absence of disease but the balance of these energies, supported by a well-functioning digestive fire (Agni) and properly nourished bodily tissues (Dhātus).

Imbalances in the doshas, often caused by factors such as improper diet, stress, environmental influences, or suppressed natural urges, can lead to disease. The practice of Āyurveda addresses these imbalances through diet, lifestyle changes, herbal remedies, and other therapeutic methods. Additionally, Āyurveda recognizes the importance of emotional and mental well-being, seeing the mind (Manas) as essential to overall health. Understanding the doshas and their influence on health allows individuals to adopt practices that maintain their Svastha, or balanced state of health.



Assignment

1. Describe the Three Doshas in Āyurveda: Vāta, Pitta, and Kapha
2. Explain the Concept of Svastha in Āyurveda
3. The Role of Diet in Maintaining Dosha Balance
4. How Āyurveda Views the Causes of Disease

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.4.
2. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976
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Kerala Tradition of Ayurveda

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ familiarisation with the literature pertaining to the Indian scientific advancements
- ❖ develop an understanding of specific contributions in the fields of Ayurveda
- ❖ awareness of the major concepts in Ayurveda

Background

Kerala Ayurveda is an ancient system of medicine that focuses on holistic healing by balancing the body, mind, and spirit. Rooted in Kerala's rich cultural and natural heritage, it uses local herbs, specialized therapies, and unique treatments to promote overall well-being. This unit explores the history, key practices, and significance of Kerala Ayurveda, highlighting its enduring relevance in modern healthcare.

Keywords

Uziccil, Marmacikitsā, Bālacikitsā, Netracikitsā, Viṣacikitsā, Bhūtāpasmara Pratividhi, Abhyaṅga, Pañcakarma

Discussion

2.3.1. Kerala Tradition of Ayurveda: A Comprehensive Overview

Ayurveda, the ancient system of medicine that originated in India, holds a special place in the culture and healthcare of Kerala. Kerala, a state located on the southwestern coast of India, has long been renowned for its rich flora, fauna, and diverse climatic conditions, which have greatly influenced the development of Ayurveda. Over

- ◆ Kerala has a rich tradition in Ayurveda



the centuries, various specialized families and communities in Kerala have contributed to this tradition by mastering specific treatments and practices. This write-up will explore the history, specialties, practices, literature, and evolution of Kerala's Ayurvedic tradition.

2.3.1.1. Specialized Practices in Kerala Ayurveda

In Kerala, Ayurveda was practiced not only by learned physicians but also by various communities who specialized in specific forms of treatment. Some of the well-known practices include:

- ◆ **Uziccil (Massage Therapy):** This involves the application of oils and herbs to treat various physical conditions and maintain health. Massage plays a crucial role in improving circulation and rejuvenating the body.
- ◆ **Marmacikitsā (Vital Point Therapy):** This involves treating specific vital points or 'marmas' in the body, which are believed to hold the life force. Specialized practitioners work in these areas to cure diseases related to vital organs or systems.
- ◆ **Bālacikitsā (Pediatrics):** This branch focuses on the health and treatment of children, addressing issues such as growth, nutrition, and immunity.
- ◆ **Netracikitsā (Ophthalmology):** The Ayurvedic treatment of eye diseases has been a significant part of Kerala's medical tradition, with specialized methods to address various eye conditions.
- ◆ **Viśacikitsā (Toxicology):** Given Kerala's natural environment, which includes poisonous plants and reptiles, the treatment of poisonings has been an important focus. Herbal remedies and antidotes have been developed for such conditions.
- ◆ **Bhūtāpasmara Pratividhi (Psychiatric Treatment):** Ayurveda also addresses mental health through spiritual healing, detoxification, and herbal treatments, providing remedies for conditions like depression and anxiety.

- ◆ Uziccil,
Marmacikitsā,
Bālacikitsā,
Netracikitsā,
Viśacikitsā,
Bhūtāpasmara
Pratividhi

Other treatments include remedies for wounds, fractures, and bruises. Kerala's Ayurvedic tradition has also been noted for its success in treating diseases like smallpox and snakebites, which were prevalent in the region.

2.3.1.2. The Role of Kerala's Natural Environment

Kerala's climate, with its abundant rainfall and diverse flora and fauna, has greatly influenced Ayurvedic practices in the region. The state boasts a wide range of medicinal plants, many of which are used in Ayurvedic remedies. Herbs like Kutakappala (Holarrhena Antidysenterica) and Muttanna are often used in medicinal prepa-



rations, such as the special drink “Mukkutti” consumed during the Karkkīṭaka month for health benefits.

The knowledge of local herbs and their medicinal properties was passed down through generations. Villages had their own folk medicine practices, and every housewife possessed basic knowledge of these remedies. In many families, a consultation with an expert was sought only for severe cases, indicating the deep-rooted tradition of self-reliance in health.

2.3.1.3. Ayurvedic Rituals and Practices

In Kerala, Ayurveda was not just a medical system but also intertwined with culture and rituals. One such practice is the offering of the Daśapuṣpa-s (ten sacred flowers), which were believed to have health benefits. The use of herbal remedies and flowers was sometimes part of local religious rituals, and certain days were considered auspicious for worshipping herbs.

- ♦ One of the essential practices in Ayurvedic health management in Kerala

Abhyaṅga (Oil Bath): One of the essential practices in Ayurvedic health management in Kerala is the oil bath. It involves applying medicinal oils to the body to maintain balance, improve skin health, prevent muscle degeneration, and promote relaxation. The oils used depend on the individual’s constitution, and the practice is considered essential for physical and mental well-being.

2.3.1.4. Ayurvedic Literature and Texts

Kerala has a rich tradition of Ayurvedic literature, which is classified into three categories:

1. **Commentaries on Classical Texts:** Early Ayurvedic texts, such as Astanga Samgraha and Astangahrdaya by Vagbhatacarya, were widely studied in Kerala. These works were condensed forms of earlier texts, making them easier to understand and apply.
2. **Compilations of Prescriptions:** Local practitioners often compiled remedies and practical advice in written form. Physicians typically used these texts to treat various ailments.
3. **Modern Works:** As Ayurvedic practices continued to evolve, modern works incorporating scientific principles and findings were also developed. These texts expanded the scope of Ayurveda and adapted it to contemporary needs.

- ♦ Marmacikitsā, Mātaṅgalīlā, Vaidyamanorama, Rasavaiśeṣika-sūtra, and Tantra-yukti -vicāra

Important Ayurvedic Texts: Some famous texts in Kerala include *Marmadarpaṇam* (on *Marmacikitsā*) and *Mātaṅgalīlā* (on elephant treatment). Additionally, *Vaidyamanorama*, *Rasavaiśeṣika-sūtra*, and *Tantra-yukti -vicāra* are important works that have enriched the Ayurvedic literature of Kerala. These texts cover a wide range of topics, from chemotherapy and toxicology to methods of treating specific ailments.



2.3.1.5. The Revival of Ayurveda: The Aṣṭavaidyas

During the period of Ayurveda's decline (1560-1850), the practice of Ayurveda was preserved and promoted by the Aṣṭavaidya-s, Brahmin families and other communities who became specialists in different branches of the system. The term "Aṣṭavaidya-s" refers to physicians who were proficient in eight key branches of Ayurveda. These families were instrumental in the revival of Ayurveda and its widespread practice across Kerala.

- ◆ Aṣṭavaidya-s helped preserve the ancient texts

The Aṣṭavaidya-s helped preserve the ancient texts, ensuring that Ayurvedic knowledge was passed down to subsequent generations. They also played a crucial role in formalizing and systematizing Ayurvedic practices in Kerala.

2.3.1.6. Unique Ayurvedic Specialties in Kerala

Kerala's Ayurvedic tradition is renowned for its specialized branches of medicine, including:

- ◆ **Hastyāyurveda (Elephant Medicine):** Kerala, being home to many elephants, has developed a distinct system of veterinary Ayurveda known as Hastyāyurveda. Specialists in this field treat elephants using herbal remedies and massages. The book Mataṅgalīlā is a notable work on elephant care, outlining various treatments for elephants' health issues.
- ◆ **Vṛkṣāyurveda (Tree Medicine):** Kerala's rich flora also led to the development of Vṛkṣāyurveda, which focuses on the treatment of plants and trees. Texts such as Vṛkṣāyurveda guide the cultivation, nourishment, and protection of plants and even the creation of gardens.

2.3.1.7. Pañcakarma Therapy in Kerala

Pañcakarma, one of the most important aspects of Ayurvedic treatment, involves five methods designed to detoxify and purify the body. These methods include:

1. Vamana: Emesis (induced vomiting) to cleanse the stomach.
2. Virecana: Purgation to clear the bowels.
3. Vasti: Enema with medicinal oils to detoxify the body.
4. Nasyam: Nasal administration of medicinal substances to clear sinus and head-related disorders.
5. Raktamokṣa: Bloodletting to remove toxins from the body.

- ◆ Hastyāyurveda, Vṛkṣāyurveda and Pañcakarma

These therapies aim to restore balance to the body and remove toxins that cause diseases, promoting long-term health and wellness.



2.3.1 8. Contemporary Developments in Kerala Ayurveda

In recent years, Kerala has also embraced modern scientific methods in the study and application of Ayurveda. Institutions like the Ayurveda College in Trivandrum and various research centers are working towards validating and standardizing Ayurvedic treatments with modern scientific principles. There is a growing interest in Ayurvedic tourism, where people from all over the world come to Kerala for rejuvenation therapies and treatments.

Conclusion

Kerala's Ayurveda is a living tradition that has evolved over thousands of years, combining local knowledge with classical Ayurvedic principles. The state's rich natural resources, specialized families, and deep cultural connections to health and healing have made Ayurveda a key aspect of life in Kerala. From folk remedies to advanced therapies like *Pañcakarma*, Ayurveda continues to offer holistic solutions to health problems, ensuring its place as a prominent healing system in the modern world.

The sustained effort of families, scholars, and practitioners has kept this tradition alive, and Kerala remains a global hub for Ayurvedic treatment and education. The state's Ayurvedic heritage serves as a model of how traditional medicine can be integrated into modern healthcare, promoting wellness and longevity for generations to come.

Summarised Overview

Kerala boasts a unique and deeply rooted Ayurvedic tradition shaped by its rich natural environment and a history of dedicated practitioners. Over centuries, specialized communities and families mastered specific therapeutic practices like Uzicil (massage), Marmacikitsā (vital point therapy), Bālacikitsā (pediatrics), Netracikitsā (ophthalmology), Viṣacikitsā (toxicology), and Bhūtāpasmara Pratividhi (psychiatric treatment). The state's abundant medicinal flora, including herbs like Kutakappala and Muttanna, played a crucial role in these remedies, with knowledge passed down through generations and integrated into local rituals such as the offering of Daśapuṣpa-s. Practices like Abhyaṅga (oil bath) further exemplify the holistic approach to health in Kerala's Ayurvedic system.

Kerala also developed a significant body of Ayurvedic literature, encompassing commentaries on classical texts, compilations of local prescriptions, and modern works integrating scientific principles. Notable texts include Marmadarpaṇam, Mātaṅgalīlā, and Vaidyamanorama. During a period of decline, the Aṣṭavaidyas, families specializing in eight key branches of Ayurveda, played a vital role in preserving and reviving the tradition.



Furthermore, Kerala is distinguished by unique branches like Hastyāyurveda (elephant medicine), with texts like Mataṅgalīlā, and Vṛkṣāyurveda (tree medicine). Pañcakarma, a five-fold detoxification therapy, remains a cornerstone of Kerala's Ayurvedic treatments. Today, Kerala continues to be a hub for Ayurveda, integrating modern scientific methods in research and attracting global interest through Ayurvedic tourism.

Assignment

1. Discuss the importance of local plants in Ayurvedic treatments in Kerala.
2. Explain what Panchakarma therapy is and how it helps in healing.
3. Explain how Ayurveda started in Kerala and how it is still practised today.
4. Elaborate on the Ayurvedic philosophy that “health arises from harmony between mind, body, and spirit.”
5. Explain the significance of the eight branches of Āyurveda in providing a comprehensive approach to health and disease management.
6. Discuss the role of the six tastes (Rasas) in Ayurvedic nutrition and their impact on the three doshas.

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.4.
2. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976
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Major Translated Works in Malayalam from Sanskrit on Ayurveda

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ familiarisation with the literature pertaining to the Ayurvedic tradition of Kerala
- ❖ acquainting with the texts on the Ayurvedic tradition of Kerala

Background

Āyurveda, the ancient Indian system of medicine, has evolved through classical Sanskrit texts and regional adaptations. In Kerala, local adaptations of Sanskrit works into Malayalam helped shape the state's unique Āyurvedic practices. These translations and original texts have been crucial in preserving and advancing Kerala's medicinal traditions, blending classical knowledge with local innovations. This unit explores the major Malayalam translations of Sanskrit Āyurvedic texts and their significance in Kerala's medical heritage.

Keywords

Kerala's Ayurveda tradition, *Pañcakarm*, *Vāstīpradīpa*, *Sodhanācikitsā*, *Dhārākālpa*, *Cikitsāsaṅgraham*

Discussion

2.4.1. Introduction to Ayurveda and its Literature

Āyurveda, the ancient system of medicine originating from India, has a textual heritage that spans thousands of years. Its foundational texts, such as the Caraka Saṁhitā, Susruta Saṁhitā, Aṣṭāṅga Saṁgraha, and Aṣṭāṅgaḥṛidaya, are revered not just for their medicinal value but also for their philosophical depth. These texts are the cornerstone of classical Āyurveda, written primarily in Sanskrit. Āyurveda, however, did not remain static over the centuries. It adapted, evolved, and diversified, particularly in regions like Kerala, which is known



for its rich cultural and biological heritage.

- ◆ Kerala is a prominent hub for Ayurveda

Kerala's Ayurvedic tradition is unique in that it developed parallel to, yet distinct from, the classical tradition. This regional tradition is characterized by innovative treatments, specialized therapies, and formulations that evolved over centuries. Many of these contributions were later documented in Malayalam, Kerala's vernacular language, often in the form of translations, commentaries, and original works inspired by Sanskrit texts. These regional texts have had a profound impact on the practice of Āyurveda in Kerala and beyond, making Kerala a prominent hub for Ayurvedic therapies like *Pañcakarma*.

2.4.2. Historical Evolution of Āyurveda in Kerala

Before Sanskrit literature influenced Kerala's Āyurveda, there were Indigenous healing systems practised by the local population. Some historians believe that healing practices existed in Kerala even before the arrival of the Aryans and Sanskrit texts. As Āyurvedic knowledge was disseminated through Sanskrit works, it was adapted by local practitioners who integrated their regional knowledge, cultural practices, and medicinal plants into the tradition.

The fusion of classical Āyurveda and Kerala's indigenous practices led to the development of unique treatment methods, especially in *Pañcakarma* (purification therapies), toxicology, pediatric care, and the use of herbal formulations. Kerala also saw the rise of highly respected families of Aṣṭavāidyans (hereditary Ayurvedic practitioners), who were key to preserving and transmitting this knowledge. The influence of these families was so profound that they contributed significantly to the body of Ayurvedic literature in the region.

2.4.3. Classical Texts and their Influence on Kerala's Regional Āyurveda

- ◆ Classical Texts and their Influence on Kerala's Regional Āyurveda

The classical texts of Āyurveda, written in Sanskrit, form the bedrock of the system. Caraka Saṃhitā, Susruta Saṃhitā, Aṣṭāṅga Saṃgraha, and Aṣṭāṅgaḥṛidaya present a comprehensive overview of Āyurvedic theory, diagnosis, and treatment. These texts are highly structured and provide a deep philosophical and scientific understanding of health and disease.

However, Kerala's regional tradition was shaped by clinical experience and practical application. In this context, many classical works were translated into Malayalam or otherwise reinterpreted for local use. These translations were not merely linguistic conversions but also involved adaptations to fit the local climate, culture, and specific regional health issues.



- ◆ Major Translations and Commentaries in Malayalam

2.4.3.1. Major Translations and Commentaries in Malayalam

Several key works in Malayalam have been instrumental in preserving and disseminating Kerala's unique Ayurvedic traditions. Below are some of the prominent translated works and commentaries that have played a significant role:

1. *Vāsūpradīpa* (1932) by Paṇavalli Kṛṣṇan Vaidyar

This Malayalam text is focused on Vāsti, one of the central therapies in Āyurveda, and provides a detailed examination of its applications, along with other treatments like oleation and sudation. It is considered one of the most authoritative texts on the subject.

2. *Pañcakarmam Athavā Sodhanācikitsā* by Maṇakkōṭam Kēśavan Vaidyar

This work is an extensive guide to the five purificatory procedures (*Pañcakarma*). It offers a structured explanation of the processes, including snehana (oleation), svedana (sudation), and raktamokṣana (bloodletting), with numerous case studies that demonstrate their therapeutic applications.

3. *Āyurvēdic Treatments of Kerala* by Vāyakāra N.S. Mooss

A seminal work that describes the Keraḷīya-*Pañcakarma* techniques, such as Piṇḍasveda, Annalepana, and others. It serves as an important reference for practitioners worldwide.

4. *Dhārākālpa*

This anonymous text elaborates on Takradhārā (buttermilk therapy) and Piḷicil (medicated oil massage), essential therapies in Kerala. The work is often included as an appendix in other classical texts.

5. *Cikitsāsaṅgraham* by Vaidyaratnam P.S. Warriar

A foundational work in Kerala's Ayurvedic literature, *Cikitsāsaṅgraham* provides a collection of *Pañcakarma* therapies and medicinal formulations used by practitioners.

2.4.3.2. Contributions to Specialized Fields: Pediatrics, Toxicology, and Herbal Medicine

Kerala's Ayurvedic texts are especially rich in specialized fields, showcasing the region's unique contributions to traditional medicine.

- ◆ Kerala's Contributions - Pediatrics, Toxicology and Herbal Medicine

1. **Pediatrics:** Kerala has a strong tradition of pediatric care, with texts like *Ārogyakalpadruma* by Kaikkulāṅgara Rāmāvarīar providing detailed treatments for childhood diseases, immunomodulatory therapies, and infant care. This work represents Kerala's distinct approach to Bālācikitsā (Pediatric Āyurveda).



2. **Toxicology:** Kerala's Viṣācikitsā (toxicology) has made significant contributions to the treatment of poisonings, especially those caused by venomous creatures. Works like Viṣajyotsnikā by Kārat Nāmbūtīrī and Prayogasamuccaya by Koṅṭuṇī Tāmpūran are key references in this area.
3. **Herbal Medicine:** Kerala's contribution to medicinal plants is well-documented in texts like Hortus Malabaricus, a Latin botanical work that catalogues the region's flora, many of which are crucial to Ayurvedic therapies. This work is notable not only for its botanical content but also for the collaboration between local and foreign scholars.

2.4.3.3. The Role of Local Communities in Ayurvedic Literature

The development and preservation of Kerala's Ayurvedic literature were significantly influenced by local communities. The Aṣṭavāidyans—hereditary physicians from prominent Nāmbūdirī families—were instrumental in maintaining the oral and written traditions of Kerala Āyurveda. These practitioners not only preserved classical texts but also contributed original works based on their personal clinical experiences.

The influence of other communities, such as the Ezhavas, cannot be overlooked. These communities, while historically marginalized, became key players in the transmission of Ayurvedic knowledge, particularly in the 19th and early 20th centuries.

2.4.3.4. Comparing Classical and Regional Āyurveda

One of the most fascinating aspects of Kerala's Ayurvedic literature is its blend of classical and regional traditions. While the classical Sanskrit texts are known for their theoretical rigor and scientific foundation, the regional works of Kerala focus more on practical application. These texts are structured according to the local needs and clinical practices, and they often integrate innovative therapies specific to the region.

- ◆ The regional Ayurveda works of Kerala focus more on practical application

- ◆ **Language:** Classical texts were written in Sanskrit, while regional texts in Kerala were often written in Maniprāvalam (a mix of Sanskrit and Malayalam) or entirely in Malayalam. This linguistic shift allowed Āyurveda to become more accessible to local practitioners and communities.
- ◆ **Therapeutic Focus:** Classical texts generally cover all eight branches of Āyurveda, whereas Kerala's regional texts tend to focus more on specialized therapies, such as *Pañcakarma*, Viṣācikitsā (toxicology), and Marmācikitsā (treatment of vital points).



- ♦ Structure: Classical texts like the Caraka Saṃhitā are highly structured, presenting diseases, treatments, and therapies in a formalized manner. In contrast, regional texts often organize information according to practical considerations such as clinical symptoms, regional prevalence, and local treatment practices.

2.4.4. Impact of Regional Literature on Contemporary Āyurveda

The influence of Kerala's regional Ayurvedic literature is still felt today. Many of the treatment protocols and therapies developed in Kerala have found their place in modern Ayurvedic practice, especially *Pañcakarma*, which has gained worldwide recognition. Texts like *Vāstīpradīpa* and *Pañcakarmam Athavā Sodhanācikitsā* are still used as reference works by Ayurvedic professionals across the globe.

In recent decades, there has been a growing interest in Kerala Ayurveda in the West, as people seek holistic, natural approaches to health. The preservation of Kerala's Ayurvedic literature has thus played an essential role in ensuring that this ancient knowledge continues to thrive in the modern world.

Conclusion

In conclusion, the contributions of Kerala to the field of Āyurveda are vast, and the region's literature is invaluable for understanding how Ayurveda evolved in this unique locale. The translation of Sanskrit works into Malayalam, along with the development of original regional texts, has allowed Kerala to carve out a distinctive place in the world of traditional medicine. Through these texts, Kerala has not only preserved the ancient wisdom of Āyurveda but has also adapted and expanded upon it in ways that continue to benefit humanity today.

Summarised Overview

The classical tradition of Āyurveda is predominantly based on texts written in Sanskrit, with Caraka Saṃhitā, Śūsruta Saṃhitā, Aṣṭāṅga Saṃgraha, and Aṣṭāṅgahṛidaya being the cornerstones of this system. These texts offer an organized, scientific, and philosophical approach to medicine. Over time, various regions in India developed their own adaptations of these teachings, incorporating local knowledge, resources, and practices. Kerala, with its unique cultural and geographical context, contributed significantly to this body of knowledge.

The literature from Kerala, written in Malayalam and Manipravāla (a blend of Sanskrit and Malayalam), serves as a critical link between the classical Āyurvedic texts and the



regional practices that emerged. Key works include translations of major classical texts like Caraka Saṃhitā and Śūsruta Saṃhitā, as well as original texts focusing on local innovations in *Pañcakarma*, medicinal plants, and toxicology. These works reflect a dynamic interaction between classical Āyurveda and the specific medical needs of the people in Kerala.

Books such as *Vasthipradeepa*, *Pañcakarmam athavā Sodhanācikitsā*, and *Sahasrayogam* illustrate Kerala's contributions to *Pañcakarma* and local medicinal formulations. Not only do these texts describe treatment protocols, but they also offer a practical, case-based approach to diagnosis and therapy. Additionally, texts on paediatrics, toxicology, and general medicine are a testament to Kerala's broad-based contributions to the development of Āyurvedic literature.

In conclusion, the literature from Kerala, through its translations, commentaries, and original works, stands as an essential resource in understanding the deep integration of Āyurvedic knowledge with regional cultural practices. These works continue to influence Ayurvedic practitioners around the world and are crucial in preserving the traditional healing systems that have been passed down through generations.

Assignment

1. Discuss how Kerala's regional Āyurvedic literature has influenced and shaped unique practices such as *Pañcakarma* and the use of local medicinal plants.
2. Analyze the differences between classical Sanskrit texts like Caraka-saṃhitā and Śūsruta-saṃhitā and the regional Malayalam texts from Kerala, focusing on their structure, language, and treatment approaches.
3. Examine how Kerala's unique cultural and geographical characteristics influenced the development of specialized Āyurvedic treatment modalities and the creation of regional texts.
4. Discuss the role of local communities, particularly the Aṣṭavāidyans and other groups like the Ezhavas, in the development and preservation of Kerala's Ayurvedic literature and practices.
5. Evaluate the impact of Kerala's regional Ayurvedic literature on contemporary Ayurvedic practices.
6. Discuss the importance of the Hortus Malabaricus as a resource for understanding Kerala's medicinal flora and its role in Ayurvedic treatments.



Suggested Reading

1. *Sanskrit in Technological age*, P. C. Muraleemadhavan & N.K.Sundareswaran, New-Bharatiya Book Corporation, New Delhi, 2007.
2. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
3. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.

Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K.Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.



BLOCK-03

Indian Architecture, Iconography and Musicology

Block Content

- Unit 1: General Study of the Major Works on Indian Architecture
- Unit 2: Concepts and Studies Relating to Indian Iconography
- Unit 3: General Views on Musicology in India





General Study of the Major Works on Indian Architecture

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ familiarisation with the literature pertaining to the Indian scientific advancements
- ❖ develop an understanding of specific contributions in the field of Architecture

Background

This unit explores the principles of Vāstu, the traditional Indian science of architecture. It outlines the eight key elements of architecture—patron, architect, land, rituals, design, materials, engineering, and decoration—each essential to creating harmonious structures. Ancient Sanskrit texts provide guidelines for aligning architecture with harmony. The unit also highlights Kerala’s unique architectural traditions and the continued relevance of these ancient practices in contemporary architecture.

Keywords

Yajamāna, Śilpin, Bhūmi, Ārādhana, Pādavināsa, Vāstu, Sthāpatyam, Alaṅkāraṇam, Sthāpati, Bhūmimāpana

Discussion

3.1.1. Etymology of Vāstu

The term Vāstu originates from the Sanskrit word vāstu, which means “a place where living beings reside.” This includes a range of spaces such as homes (gr̥ha), fields (kṣetra), gardens (upavana), bridges (setu), and even ponds (sarovara). According to the Arthaśāstra, Vāstu encompasses all locations where beings dwell. Additionally, it is described in the Kāmasūtra as one of the sixty-four arts, emphasizing the essential role of architecture in Indian culture.

- ◆ Vāstu, - a place where living beings reside



Indian architecture reflects the nation's culture, philosophy, and social structures. Over millennia, it has mirrored the evolving political, religious, and cultural landscapes, incorporating advanced knowledge of spatial design, materials, and engineering. Ancient Sanskrit texts on architecture emphasize sophisticated principles that have guided construction practices and urban development throughout India.

3.1.2. The Eight Elements of Architecture

The following eight elements form a holistic approach to traditional Indian architecture, combining material construction with spiritual significance to create buildings that resonate with cosmic and divine forces:

1. **Yajamāna (The Patron):** The individual commissioning the work, ensuring that the structure aligns with architectural norms and cosmic principles.
2. **Śilpin (The Architect and Craftsmen):** The architect, along with their team of artisans, is responsible for the design, construction, and execution.
3. **Bhūmi (Land):** The sacred site chosen for construction, which requires purification to harmonise with cosmic forces before beginning work.
4. **Ārādhana (Rituals):** Spiritual ceremonies that accompany construction, aligning the structure with divine energies.
5. **Pādavyāsa (Design):** The architectural layout and dimensions that ensure harmony with cosmic principles.
6. **Vāstu (Materials):** The selection of materials such as stone, wood, and metal based on their physical properties and alignment with sacred principles.
7. **Sthāpatyam (The Art of Engineering):** Knowledge and skills in creating functional, harmonious buildings, integrating geometry, structure, and aesthetics.
8. **Alaṅkāraṇam (Decoration and Renovations):** The ornamental elements, such as sculptures, carvings, and murals, enhance the structure's spiritual and aesthetic appeal.

◆ The eight elements of *Vāstu*

These eight elements guide the construction of buildings, ensuring they align with cosmic and divine energies.

3.1.3. The Role of the Architect (Sthāpati)

In ancient Indian architecture, the architect, or Sthāpati, was more than just a designer; they were masters of both art and science. The Sthāpati was responsible for planning, material selection, measure-



ments, and construction execution. The architect's team included specialists such as:

9. *Sutragrāhi*: The expert in dimensions and measurements, ensuring the correct proportions and alignment of the structure.
10. *Vardhaki*: The craftsman responsible for assembling the building's components.
11. *Takṣaka*: The sculptor responsible for intricate carvings and artistic embellishments.

As described in the *Śilpāsāstra*:

स्थपतिः सूत्रग्राही तक्षकसंज्ञश्च वर्धकिः क्रमशः ।

स्वोचितकर्मणि दक्षा ग्राह्यास्ते कारवश्चतुर्धति ।

These roles were guided by both practical and symbolic considerations, with architecture seen as a reflection of cosmic harmony.

3.1.4. Land Measurement and Design

Land measurement (*Bhūmimāpana*) and design (*Pādavināsa*) were integral to the planning of any structure. The land was considered sacred and required specific rituals before construction began to ensure purity and alignment with cosmic forces. The design of the building followed strict guidelines to harmonise with natural elements and cosmic energies. The *Vāstuśāstra*, an ancient architectural treatise, outlines these principles, blending the physical with the spiritual.

3.1.5. Materials in Architecture: Vāstu (Materials)

The selection of materials (*Vāstu*) was influenced by both practical and symbolic considerations. Common materials included:

1. Stone (*śila*): Used for monumental structures such as temples and forts, valued for its strength, permanence, and suitability for intricate carvings.
2. Wood (*dāru*): Favored for temples and residential buildings, especially in forest-rich regions, symbolizing life and renewal.
3. Clay and Mud (*mṛttikā*): Ideal for rural architecture, especially in hot and dry climates, due to their thermal insulation properties.

The choice of materials also had cosmological significance. In accordance with Vedic principles, it influenced the flow of energy within space.

3.1.6. The Art of Engineering: Sthāpatya

Sthāpatya refers to the art and practice of architecture, rooted in geometry, engineering, and cosmology. Ancient Indian architects

◆ *Sthāpati*, was more than just a designer; they were masters of both art and science

◆ *Bhūmimāpana* and design *Pādavināsa* were integral to the planning of any structure

- ◆ Sthāpatya refers to the art and practice of architecture, rooted in geometry, engineering, and cosmology

demonstrated exceptional skills in constructing temples, palaces, and fortifications, employing advanced techniques such as interlocking stonework, arches, and domes. The Sthāpatya also involved the creation of mechanical devices (*yantra*-s), such as automata and water fountains, showcasing the integration of artistry with engineering.

3.1.7. Rituals and Renovations

The construction of buildings, especially temples, was often accompanied by rituals performed by the Vāstoṣpati (architect). These ceremonies ensured the sanctity of the structure, aligning it with cosmic forces. Alaṅkāraṇam (decorations) played a vital role, as temples and homes were adorned with sculptures and carvings that had both aesthetic and spiritual significance.

3.1.8. Sanskrit Works on Architecture

Several Sanskrit texts, written over centuries, provide detailed instructions on architecture, from land measurement to temple construction. Notable texts include:

1. *Bṛhat - saṃhitā* (6th century CE), by *Varāhamihira*: Covers various topics, including architecture and town planning, integrating astrology with construction, and emphasizing the importance of auspicious timing (*muhūrta*).
2. *Samarāṅgaṇa - sūtradhāra* (11th century CE), by King Bhoja: A comprehensive guide to building design, from residential structures to temples, with an emphasis on cosmology and sacred rituals.
3. *Mānasāra* (7th century CE), of *Mānasāramuni*: One of the oldest treatises, focusing on temple construction, spatial organization, and measurements governed by cosmic laws.

- ◆ Main works in Vastu - Bṛhat - saṃhitā, Samarāṅgaṇa - sūtradhāra, Mānasāra

3.1.9. Architecture in the Arthaśāstra

The Arthaśāstra, attributed to Kautilya (Chanakya), is a seminal work on statecraft, economics, and governance. Within this treatise, Kautilya discusses the science of architecture, offering valuable insights into construction, urban planning, and fortification. The text defines Vāstu (construction) as encompassing all forms of building, from homes and fields to dams and bridges, underlining the broad scope of architecture in the ancient world.

- ◆ Architecture in the Arthaśāstra

(a) Fortifications and Military Architecture

A significant portion of Kautilya's work is devoted to fortifications, reflecting the importance of security in ancient kingdoms. The Arthaśāstra provides guidelines for building defensive structures, including forts, city walls, moats (*parikhā*), and hidden passages for strategic advantages.



(b) Urban Planning and Town Layout

Kautilya stresses the importance of selecting ideal sites for cities, considering factors like proximity to natural resources, defensibility, and access to trade routes. According to Kautilya, urban planning is not just about functionality but also about ensuring prosperity and security.

3.1.10. Tradition in Kerala Architecture

Kerala's architectural tradition, deeply rooted in its unique cultural and religious heritage, reflects a rich blend of indigenous knowledge and Tantric principles. Several ancient texts and treatises on architecture, both in Sanskrit and Malayalam, provide detailed accounts of the methods, philosophies, and principles guiding the construction of temples, homes, and public structures. These works not only explore the technicalities of design and construction but also reflect the spiritual and philosophical dimensions of architecture.

(a) Important Artisans and Families

Several well-known artisans and families in Kerala have significantly contributed to the development and dissemination of architectural knowledge. Among them, the Kāṇippayūr family stands out for their comprehensive publications on Kerala's architectural tradition. Their works, such as *Tantrasamuccaya*, *Manuṣyālayacandrikā*, *Grhanirmāṇapaddhati*, and *Kettiṭaṅgaḷ*, have played a crucial role in preserving and spreading architectural knowledge in the region.

In recent years, the family has established a Research Institute at Kunnankulam to promote the study of Kerala's Tantra and Vāstuvidyā (the science of construction). The Tantravidyapīṭha at Aluva also contributes significantly to the academic and practical study of Kerala's architectural traditions.

3.1.11. Sanskrit Texts on Kerala Architecture

Several Sanskrit texts offer in-depth knowledge of Kerala's architectural practices, influencing local traditions and continuing to be referenced in contemporary works:

1. *Prayogamañjarī* by Ravi: Written in the 10th–11th century CE by the Namboothiri Brahmin Ravi, this text primarily deals with the consecration of the Liṅga (a symbolic representation of Shiva) but also provides valuable information on temple construction, site selection, and purification rituals.
2. *Mayamata*: Attributed to the celestial architect Maya, this treatise, believed to have been composed in Tamil Nadu or Kerala during the 11th–12th century CE, offers detailed instructions on the construction of houses, villages, palaces, towns, and temples.

- ♦ *Tantrasamuccaya*, *Manuṣyālayacandrikā*, *Grhanirmāṇapaddhati*, and *Kettiṭaṅgaḷ*



◆ Manuṣyālayacandrika as a treatise on domestic architecture

3. Isāṇagurudevapaddhati: Composed in the 11th century by Isāṇagurudeva, this work focuses on Tantra and temple architecture, providing in-depth guidance on temple construction, idol consecration, and religious rituals.
4. Manuṣyālayacandrika of Cennās Narayana: Cennās Narayana, the author of the Tantrasamuccaya, wrote the Manuṣyālayacandrika as a treatise on domestic architecture. It is also known by the title Mānava-vāstu-lakṣanam. An anonymous commentator of the work explains that Narayana composed this text by extracting relevant verses from the Tantrasamuccaya and adding forty-four original verses to address the specific subject matter. In the text itself, the verses from Tantrasamuccaya are integrated seamlessly rather than presented as separate quotations. The Manuṣyālayacandrika covers various topics related to architecture, including the qualifications of land, orientation, vithīkalpana (street planning), vāstumāṇḍala (architectural grid), gṛhalakṣana (design and features of a house), building heights, measurements, different types of dwellings, and the special features of a palace. Given that it is the work of a distinguished author from Kerala, it requires a critical edition and translation for a deeper understanding.
5. Manuṣyālayacandrika of Nilakantha: The Manuṣyālayacandrika by Nilakantha, also known as Tirumaṅgalattu *Nilakanṭhan* Musat, is another significant work on architecture. Nilakantha lived after the period of the Tantrasamuccaya, around the early 15th century CE. His text is still widely referenced by traditional carpenters in Kerala. The work is divided into seven chapters, with each chapter containing between twenty to fifty verses, totalling 225 verses. In verses seven and eight of the first chapter, Nilakantha lists several sources he consulted in compiling his work.

3.1.12. Malayalam Works on Architecture

As mentioned earlier, Kerala has a rich body of Sanskrit literature on architecture. However, there is also a significant amount of work in the regional language, Malayalam, and in Manipravālam. While many Sanskrit texts on architecture have commentaries and translations, independent works in Malayalam also deserve attention. Here are some of the more recent books on the subject, which are written for general readers.

Gṛhanimanapaddhati, written by Parakkal Krishna Warriar, aims to introduce the common reader to Kerala's architectural heritage. This book is a helpful addition to architectural literature, with sketches and plans included where needed to aid the reader's understanding.



- ◆ Two Vastu works in Malayalam -Grhanimanapad-dhati and Kettiṭṭāṇṇal

Kettiṭṭāṇṇal, by the well-known expert on Kerala Tantra and architecture, Kanippayyur Sankaran Namboodiripad, combines traditional architectural ideas with modern trends. This results in innovative approaches that add new energy and creativity to Kerala's architecture. The book includes 77 ground plans of different types of buildings, all designed by the author. Namboodiripad explains in simple yet authoritative language how to construct foundations, walls, doors, ceilings, and roofs. He also discusses important aspects such as ensuring proper ventilation, using natural light, and decorating interiors. Additionally, he shares insights into the beliefs and traditions that have shaped Kerala architecture over time.

These books contribute to the growing collection of Malayalam literature on Kerala's traditional architecture.

Summarised Overview

Indian architecture, guided by the principles of Vāstu, is a holistic blend of design, engineering, and spirituality. Derived from Sanskrit, Vāstu refers to spaces like homes, gardens, and temples, shaped by texts such as the Arthaśāstra and Kāmasūtra, which integrate cosmic and divine elements into construction. Traditional architecture follows eight core elements: the patron (Yajamāna), engineer (Śilpīn), land, rituals, design, materials, engineering, and decoration.

The architect, or Sthāpati, plays a pivotal role in the construction process, supported by specialists like the Sutrāgrāhi (measurer) and Takṣaka (sculptor). Key texts like Bṛhat-saṃhitā, Samarāṅgaṇa-sūtradhāra, and Mānasāra outline essential principles of design, land measurement, and temple construction. Materials were chosen for both their physical properties and symbolic alignment with cosmic principles. Architecture also incorporated advanced engineering, including intricate stonework, arches, and mechanical devices.

In Kerala, traditional architecture is influenced by Sanskrit texts such as Prayogamañ-jarī and Manuṣyālayacandrika, blending Tantric rituals with architectural design. Modern texts continue to preserve and adapt these ancient traditions to contemporary needs, ensuring the continued relevance of India's architectural heritage.

Assignment

1. Comment on the Eight Elements of Traditional Indian Architecture:
2. Analyse the Role of the Architect (*Sthāpati*) in Ancient India:
3. Give an overview of Kerala's Architectural Tradition.
4. Prepare a Chart on Key Sanskrit Texts on Architecture with relevant details.



5. Analyze the significance of land measurement (Bhūmimāpana) and design (Pādavi-nyāsa) in Vāstuśāstra.
6. Discuss Kautilya's perspective on architecture as presented in the Arthaśāstra.
7. Discuss the contributions of prominent artisans and families like the Kāṇippayūr family to the preservation and dissemination of Kerala's architectural knowledge, highlighting specific texts and their significance.

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.
2. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.

Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K. Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.





Concepts and Studies Relating to Indian Iconography

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ familiarisation with the literature pertaining to the Indian scientific advancements
- ❖ develop an understanding of specific contributions in the field of Iconography

Background

This unit explores the significance of Indian iconography in religious practices, focusing on how deities are represented through images and symbols. It examines key terms such as *Pratīmā*, *Bimba*, and *Arcana*, which define different forms of divine representations. The unit also highlights the role of sacred texts, like the *Vedas* and *Śilpaśāstra*-s, in guiding the creation and worship of these images, offering insight into the spiritual, ritual, and cultural importance of icons in Indian religious traditions.

Keywords

Pratīmā, Bimba, Arcana, Agama, Icon, Ritual, Devotion, Shilpa, Symbolism

Discussion

3.2.1. The Art and Meaning of Iconography

Iconography, the study of symbols and images, plays a central role in the religious practices of India. Through the visual representation of the divine, Indian iconography bridges the gap between the material and spiritual worlds, offering devotees a tangible means to approach the ineffable. Central to this study is the understanding of the various terms that define the images of deities, such as *Pratīmā*, *Bimba*, and *Arcana*, as well as the sacred texts that guide the creation and worship of these images. This essay will explore the meanings

- ◆ Iconography, the study of symbols and images



of these terms, the role of Sanskrit texts in shaping iconography, the process of creating divine images, and the significance of these images in the worship and spiritual practices of India.

3.2.2. Understanding Key Terms: The Icon and the Image

The concept of the “icon,” while broadly comparable to its Greek counterpart *eikôn*, carries deeper spiritual and symbolic meanings. In its simplest form, icon is derived from the Greek word *eikôn*, signifying an object of worship associated with the rituals of various divinities. The English word “image,” stemming from the Latin *imago* (meaning “likeness”), was later used synonymously with *eikôn*. The term image takes on nuanced interpretations through several Sanskrit terms, each reflecting different aspects of the divine’s representation.

3.2.2.1. Bimba:

The word *bimba* means “reflection” and is often used to describe the image of a deity. It refers to a reflection or mirrored image, an essential quality that symbolizes the divine’s interaction with the material world. The image, in this sense, is seen as a reflection of the divine essence that is immanent in the world. This concept suggests that although the deity manifests in a physical form, it remains a mere reflection of the transcendent, which cannot be fully captured by any earthly image.

- ◆ Bimba means “reflection” and is often used to describe the image of a deity

3.2.2.2. Pratīmā:

The term *pratīmā* specifically denotes a symbolic representation of a deity in physical form, particularly in the context of idols or statues used in worship. In classical Indian thought, the term eventually evolved to be synonymous with *arca*, which refers to the tangible object of worship. *Pratīmā* conveys the idea of a deity being represented by a physical form—whether stone, metal, clay, or wood—imbued with spiritual significance through rituals. The material form itself is seen as a channel through which the divine presence is invoked, transforming the material object into a sacred entity.

3.2.2.3. Arcana:

The term *arcana* refers to the actual object of regular worship, the physical representation of a god or goddess that is ritually consecrated and revered by devotees. This form serves as the primary medium through which the devotee can express their devotion, offering prayers and offerings and performing rituals that are believed to draw the divine closer to the material world. *Arcana* thus emphasizes the physical and ritualistic aspects of divine worship,

- ◆ Arcana thus emphasizes the physical and ritualistic aspects of divine worship



positioning the image as an active agent in spiritual communion.

3.2.3. The Study of Iconography: A Sacred Methodology

The study of Indian iconography cannot be separated from its deeper spiritual and symbolic meanings. As noted by Richards and Ogden in *The Meaning of Meaning*, “Symbols cannot be studied apart from the references they symbolize.” This statement is particularly relevant in the study of Indian iconography, where the symbolism of images must be understood in the context of the sacred texts from which they derive their meanings. Indian iconography is intimately linked with sacred texts such as the Vedas, Purānas, Āgamas, and Tantras, which provide the theological, mythological, and ritualistic background for the visual representations of the divine.

3.2.4. Sacred Texts and the Iconographic Tradition

Indian iconography is informed by a vast and intricate body of texts that offer detailed guidance on the creation, worship, and symbolism of divine images. These texts are both iconographic—describing the physical appearance of deities—and iconometric, providing rules for the proportions and dimensions of images. Many of these texts are attributed to sages like Bṛhaspati, Atri and *Vasiṣṭha*, and to legendary figures like Viśvakarmā and Maya, who are believed to have been the first divine architects and artists.

- ♦ Viśvakarmā and Maya, who are believed to have been the first divine architects and artists

3.2.4.1. The Śilpaśāstra-s:

The Śilpaśāstra-s (literally “treatises on art”) are specialized texts that focus on the construction of sacred architecture and images. These works provide a detailed framework for creating the images of gods, from their physical proportions to the material to be used in their construction. Prominent texts in this tradition include the *Mayamata*, *Mānasāra*, *Viśvakarmīyaparakāśa*, and *Rūpamañḍana* by Mañḍana. These texts lay down the rules for building temples, crafting statues, and ensuring that every element of the image conforms to sacred standards.

- ♦ *Mayamata*, *Mānasāra*, *Viśvakarmīyaparakāśa*, and *Rūpamañḍana* by Mañḍana

3.2.4.2. The Āgamas and Tantras:

The Āgamas and Tantras are crucial for understanding the ritual and spiritual dimensions of iconography. The Āgamas, specifically the Śaiva and Śākta texts, prescribe rituals related to the worship of images, including the consecration (or *prāṇapratīṣṭhā*) of idols and the methods of invoking divine presence within these forms. The Tantras emphasize the symbolic and ritual aspects of worship, providing instructions for the use of specific materials, mantras, and gestures to invoke the divine.



- ◆ The Agamas and Tantras

The Viṣṇudharmottara, Matsyapurāṇa, Agnipurāṇa, and other Purāṇas also offer detailed descriptions of the gods' appearances, attributes, and mythological stories that influence iconography. These texts often describe the physical and symbolic aspects of the gods' forms, detailing their postures, attributes, and the gestures (or mudrā-s) they perform. Over time, these texts provided the foundation for systematic iconographic conventions that were followed by sculptors and temple builders.

3.2.5. The Technical Construction of Icons: Guidelines and Symbolism

- ◆ The divine image is not simply a representation of a deity's external appearance but an embodiment of their spiritual qualities

Creating a divine image is a sacred task that requires adherence to specific technical guidelines laid out in iconographic texts. These texts detail the ideal proportions, physical characteristics, and symbolic meanings behind each part of the deity's form. The divine image is not simply a representation of a deity's external appearance but an embodiment of their spiritual qualities.

For example, in the iconography of Viṣṇu, specific features are outlined to symbolize his divine attributes:

- ◆ Forehead: The shape of the forehead is likened to the crescent moon, symbolizing calmness and tranquillity. This represents Viṣṇu's role as the preserver of the cosmos, maintaining balance and peace.
- ◆ Eyes: The eyes are compared to the petals of a lotus, symbolizing awakened consciousness and purity.
- ◆ Arms and Hands: The deity's arms are compared to the trunk of an elephant and the tail of a cow, symbolizing both strength and compassion. These features reflect the deity's role as the protector of the world.
- ◆ Feet: The feet are compared to the back of a tortoise, symbolizing stability and the foundation of the universe.

Every part of the image—whether the nose, neck, or body—is carefully designed to embody certain spiritual qualities. These physical characteristics are not merely aesthetic but are metaphysical symbols of the deity's divine attributes.

- ◆ Five sacred substances—Gandha (fragrance), Puspa (flower), Dhūpa (incense), Dīpa (light), and Nivedya (food)

3.2.6. The Role of Iconography in Worship: Ritual and Devotion

The worship of images (arcana) is not seen as idolatry but as an essential means of connecting with the divine. The image serves as a focal point for the devotee's spiritual practice, providing a concrete form through which the formless divine can be approached.



The worship of an image is a ritualistic practice that involves offering five sacred substances—Gandha (fragrance), Puspa (flower), Dhūpa (incense), Dīpa (light), and Nivedya (food)—each symbolizing one of the five elements that constitute the devotee’s body. Through these offerings, the worshipper establishes a connection between their body and the divine presence.

The Tantrasamuccaya offers a prayer that encapsulates the essence of this worship. The deity is described as one who enjoys offerings made with faith and devotion, even though the divine is beyond the limitations of form. The image of the deity becomes a medium for this divine interaction, transforming the material act of offering into a spiritual communion.

3.2.7. Aim and Scope of Iconography

The three principal deities of the Hindu pantheon—Brahmā, Viṣṇu, and Śiva—have been shaped by various philosophical, theological, and cultural elements throughout history. The primary aim of studying Hindu iconography is to interpret and elucidate the original Sanskrit texts that underlie these divine representations. This approach allows us to uncover the mental and spiritual frameworks of the ancient thinkers who crafted these images and rituals. By tracing the evolution of the deities through different stages of literature—starting from the Vedic period through to the Purāṇic era—we can gain deeper insight into the iconographic forms and their meanings.

A thorough journey through this vast literary landscape—examining the gods and goddesses of the pantheon—enriches our understanding of the symbols embedded in their depictions. The study of these texts is invaluable because it sheds light on the complexities of iconography and helps resolve the debates that often arise between scholars, particularly when these symbols are examined alongside archaeological findings. In fact, the study of Sanskrit texts complements the work of archaeologists, offering a rich contextual framework for understanding the material evidence they uncover.

For instance, in the case of Śiva, the iconic Trident (Triśūla) may be seen as a crystallization of the Vedic element of fire, symbolizing the transformative power associated with the god. This is a far cry from the two-horned headdress of the Mohenjo-Daro figure, illustrating how symbolic meanings evolve over time. Furthermore, the shift in the name of Śiva—from the more primal Rudra to Śiva—marks an intellectual and theological development. This transition underscores the complexity of Śiva’s nature, as He embodies both fierce and benevolent qualities, representing the all-encompass-



ing greatness of the divine, transcending opposites to manifest the supreme cosmic force (*Mahādeva*).

- ♦ To understand the deeper philosophical, religious, and cultural concepts

In this way, the study of iconography is not just about understanding the visual representations of deities, but about connecting these forms to the deeper philosophical, religious, and cultural concepts that gave rise to them.

3.2.8. Variety in Iconographic Representations: Reflecting the Divine in Many Forms

One of the most striking aspects of Indian iconography is the vast variety of forms in which the Supreme Reality is represented. While the divine essence is understood to be formless and absolute, it is manifested in many forms to cater to the different temperaments, preferences, and emotional dispositions of devotees. The Tantrasamuccaya mentions various forms of the same Supreme being, such as Śrīśa (Viṣṇu), Iśa (Śiva), and Āmbikeya (Durga), each embodying a different aspect of the divine. These various forms reflect the diversity of human experience and the belief that God can be approached through different paths, whether through the peaceful image of Viṣṇu, the terrifying form of Śiva, or the nurturing aspect of Durga.

- ♦ The Tantrasamuccaya mentions various forms of the same Supreme being

Conclusion: The Spiritual Essence of Indian Iconography

Indian iconography is not merely an aesthetic tradition but a profound spiritual practice. Through the careful study of divine forms and the symbols they carry, Indian iconography enables devotees to understand and connect with the transcendent through the material world. The process of creating, worshipping, and contemplating divine images provides a means for the devotee to experience divine presence in everyday life. In this way, Indian iconography bridges the material and spiritual realms, offering a path to the ultimate realization of the ineffable, formless, and transcendent Absolute.

Summarised Overview

Indian iconography is a profound spiritual practice that uses symbols and images to bridge the material and spiritual realms. Through terms like *Pratīmā*, *Bimba*, and *Arcana*, it represents the divine in physical forms, allowing devotees to connect with the ineffable through tangible mediums. The creation and worship of divine images are guided by sacred texts, including the *Vedas*, *Purāṇas*, *Āgamas*, and *Tantras*, which provide detailed rules for constructing icons, their proportions, and their symbolic meanings. These images are not just aesthetic but embody the spiritual qualities of the deities, and their worship,



through rituals and offerings, facilitates a direct interaction with the divine. Iconography reflects the diverse paths to the divine, illustrating the complexity and evolution of religious thought in India while offering a means for devotees to experience the transcendent in everyday life.

Assignment

1. Discuss the aim and scope of Indian Iconography
2. Discuss the meanings of *Pratīmā*, *Bimba*, and *Arcana* and their roles in understanding the representation of deities
3. Investigate how texts like the *Vedas*, *Purāṇas*, and *Śilpaśāstra-s* guide the construction and worship of divine images in India.
4. Discuss the relationship between sacred Sanskrit texts (*Vedas*, *Purāṇas*, *Āgamas*, *Tantras*, and *Śilpaśāstra-s*) and the Indian iconographic tradition.
5. Explain the significance of image worship (*arcana*) in Indian religious practice
6. Discuss the role of iconography as a bridge between the material and spiritual worlds in Indian religious practices.
7. Synthesize the information from the text to explain how the study of Indian iconography provides insights into the philosophical, religious, and cultural contexts that shaped the visual representations of deities and their worship.

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.
2. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.

Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K. Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.





General Views on Musicology in India

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ acquaint with the significant Indian thought streams of Musicology
- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ develop an understanding of specific contributions in the field of Music

Background

This unit explores the evolution and theoretical foundations of Indian musicology, tracing its roots from the Vedic period to the classical and modern eras. It highlights key texts, such as the *Nāṭyaśāstra*, *Saṅgītaratnākara*, and the works of scholars like Bharata, Sārṅgadeva, and Venkatamakhi, which laid the groundwork for the classification of *rāga*-s, scales, and rhythmic systems in Indian classical music.

Keywords

Udāṭṭa, Anudāṭṭa, Svarita, śruti, jāti, Tāḷa, grāma, mūrccā, Vedic roots, Music Theory, Raga theory, Matyasutra, South Indian Hindustani music

Discussion

3.3.1. Musicology in India: A Historical and Theoretical Overview

The rich tradition of Indian music is deeply rooted in its ancient texts, spiritual practices, and intricate systems of theory. Musicology in India traces its origins back to the Vedic period, when the Vedas themselves embodied musical elements through their distinct tones—*Udāṭṭa*, *Anudāṭṭa*, and *Svarita*. These tones form the foundation of the melodic system in Indian classical music, which continues to influence contemporary practices.



3.3.2. The Vedic Roots of Indian Music

The three Vedic tones—*Udātta* (high tone), *Anudātta* (low tone), and *Svarita* (middle tone)—are foundational in shaping the system of notes in Indian music. According to the *Nāradīya-śikṣā*, the seven notes of classical Indian music can be traced to these tones:

- ◆ *Udātta* corresponds to the modern note *Ga* (with its consonant note) or *Ni*
- ◆ *Anudātta* corresponds to *Ri*, which includes its consonant *Dha*.
- ◆ *Svarita* corresponds to *Sa*, with its consonants *Ma* and *Pa*.

The *Svarita* is described as a note higher than *Udātta*, a concept in agreement with the actual practice in Vedic chant. The *Sāmaveda* further elaborates on the musical system, having a descending scale beginning with *Ma*, with notes named *Kruṣṭa*, *Prathama*, *Dvītīya*, *Trītīya*, *Caturtha*, *Mandra*, and *Atisvārya*. It also differentiates between two parts: the *Ārcika* (single stanzas) and the *Uttarārcika* (three-stanza chants used in sacrifices). These chants, known as stotra-s, are sung in rituals, and several melodies like *Vāruṇa*, *Saubhadra*, and *Vinadri* are applied. The *Puṣpasūtra* provides detailed manuals on the singing of *Sāman*.

- ◆ The three Vedic tones—*Udātta* (high tone), *Anudātta* (low tone), and *Svarita* (middle tone)

3.3.3. The Nāṭyaśāstra and Early Music Theory

Though the Vedic hymns represent an early form of musical notation, it is Bharata's *Nāṭyaśāstra* that stands as one of the first comprehensive texts on musicology in India. Bharata's work, particularly in chapters 28–33, covers the seven notes (*Sa*, *Ri*, *Ga*, *Ma*, *Pa*, *Dha*, *Ni*), the twenty-two *śruti*-s (microtones), and their positions in the system of *śuddha* and *vikṛta* varieties. It also introduces the *Sthāyi* or voice registers, the *Ṣadjaḡrāma* and *Madhyamaḡrāma* scales, and the system of *Jāti*-s (melodic forms) and *Tāla*-s (rhythmic cycles). The text further explores the use of instruments, traditional songs, and the structure of *Dhruva* songs. A critical commentary on the *Nāṭyaśāstra*, the *Abhinavabhāratī* by Abhinavagupta (11th century), has become an important source for understanding ancient Indian music theory.

- ◆ Bharata's *Nāṭyaśāstra* that stands as one of the first comprehensive texts on musicology in India

3.3.4. The Development of Music Theory and Systems

Over time, several texts expanded upon the foundations laid by the *Nāṭyaśāstra*. For instance, Dattilamuni's *Dattilam* focuses on *Śruti*, *Svara*, and *Grāma* (scales), largely following the principles of Bharata's work. Similarly, Mātaṅga's *Bṛhaddeśī* (7th century) provides an analysis of popular music (Desi music) and contrasts it with the sacred music of the *Mārga* tradition. Matanga also introduces the *Mātaṅgamata*, which differs from *Bharatamata* in its inclusion of



twelve notes in a scale rather than the standard seven.

- ◆ *Nāradīya-rāga - nirūpaṇa* describes approximately 140 *rāga*-s

The *Nāradīya* tradition, attributed to Nārada, has several works, including the *Nāradīya-śikṣā*, which discusses the *Gandharagrāma*, a scale that became obsolete in later texts. *Nāradīya-rāga-nirūpaṇa* describes approximately 140 *rāga*-s, and the *Śaṅgītamakaranda* (11th century) categorizes ragas into male, female and neuter forms, a significant development in the classification of ragas by time of day.

3.3.5. Classical Music Texts and Evolution of Rāga Theory

- ◆ The *Śaṅgītamakaranda* (12th century) by Sārṅgadeva is one of the most exhaustive treatises on Indian music.

The *Śaṅgītamakaranda* (12th century) by Sārṅgadeva is one of the most exhaustive treatises on Indian music. It covers a wide range of topics, including *Nāda* (sound), *Śruti*, *Svara*, *Grāma*, *Mūrchanā* (melodic modes), *Jāti*, *Rāga*, *Tāla*, and *Prabandha* (musical compositions). The text provides an in-depth analysis of the components of *rāga*, such as the *Graha* (starting note), *Aśa* (repeating note), *Nyāsa* (resting note), *Mandra* (lowest note), and *Tāra* (highest note). This work is crucial for understanding the development of ragas, modes, and compositions in Indian classical music. It is complemented by two important commentaries: the *Sudhānidhi* of Simhabhūpāla and the *Kalānidhi* of Kallinātha (15th century).

3.3.6. The Influence of Persian Music and the Rise of Hindustani Music

- ◆ The *Śaṅgītamakaranda* (12th century) by Sārṅgadeva is one of the most exhaustive treatises on Indian music.

The influence of Persian music on Indian classical music, particularly in the Hindustani tradition, is documented in works like *Rāga-taraṅgiṇī* (14th century), *Ṣadrāgacandrodaya*, and *Rāgamālā*. These texts describe the evolution of the Janaka-*Janya* system of ragas, replacing the earlier *Grāma-Jāti-Mūrchanā* system. *Puṇḍarīkaviṭ-thala* (16th century) is credited with formalizing Hindustani music as a distinct system. His *Svara-mela-kalānidhi* discusses *Śruti*, *Svara*, *Vīṇā* (lute), and the concept of *Mela* (parent scale), detailing 20 parent scales and 64 derivative ragas.

3.3.7. South Indian Music Theory: The Caturdaṇḍiprakāśika

The development of South Indian music theory is closely associated with Venkatamakhi's *Caturdaṇḍiprakāśika* (17th century). This work introduced the *Mela* system, classifying 72 parent ragas that serve as the foundation for derivative ragas. The text covers *Nāda*, *Śruti*, *Svara*, *Mela*, and *Rāga*, providing a detailed account of the classification of ragas and their relation to specific scales. This system paved the way for further developments in Carnatic music, such



as the classification of ragas into *Grāma* and *Uparāga*, and the formalization of *ālāpana* (improvised elaboration of a raga).

3.3.8. The Modern Era and Contemporary Contributions

In the 18th century, King Tulaja of Tanjore authored the *Saṅgītasārāmṛta*, which presents an extensive catalogue of ragas and their historical development. The *Saṅgrahacūdāmaṇi*, attributed to Govindācārya, also documents the ragas in use at the time. In the modern period, scholars such as Āttūr Kṛṣṇa Piṣāroṭi have contributed significantly to the understanding of music theory, particularly through the *Saṅgītacandrikā*, which presents a unique system of *Meḷakartā* and Raga classification.

3.3.9. The Purpose of Music in Indian Tradition

A distinctive feature of Indian music is its philosophical and spiritual depth. While music serves as entertainment, its ultimate aim is the purification of the self, leading to *mokṣa* (liberation). The concept of *rāga* (melody) is central to this goal, with each *rāga* intended to evoke specific emotional states (*rasa*), facilitating spiritual upliftment. The intricate use of *gamaka-s* (graces), which incorporate microtones and semitones, adds a layer of expressiveness that is unique to Indian classical music. *Tāla-s* (rhythmic cycles) exhibit intricate patterns that challenge the performer to maintain rhythmic precision while expressing the emotional essence of the music.

Folk music, while distinct from classical traditions, is seamlessly absorbed into the classical fold, enriching the broader musical culture. This inclusivity demonstrates the fluid and evolving nature of Indian music, where various regional styles and traditions contribute to a unified musical heritage.

Conclusion

The study of musicology in India offers a window into a rich and complex tradition that spans millennia. From its early roots in the Vedic chants to the sophisticated theoretical frameworks established by Bharata, Sārṅgadeva, and other scholars, Indian music has evolved into a vast system of ragas, talas, and expressive musical forms. At its core, Indian music is not just a tool for entertainment but a profound means of spiritual and emotional expression, with the ultimate aim of achieving liberation. The vast literature and the continuous development of music theory highlight the depth and diversity of this ancient tradition, which remains relevant and vibrant in the contemporary world.

- ♦ The Purpose of Music in Indian Tradition is liberation



Summarised Overview

Indian musicology is a rich and ancient tradition, deeply embedded in spiritual and philosophical practices. Its foundations lie in the Vedic period, where the Vedas themselves incorporated musical tones—*Udāṭṭa*, *Anudāṭṭa*, and *Svarita*—which evolved into the seven notes of Indian classical music. These tones and their relationships are explored in ancient texts like the *Nāradīya-śikṣā*. The *Nāṭyaśāstra* of Bharata (c. 2nd century BCE) is a critical early text on music, laying out the basic theory of *svara* (notes), *śruti* (microtones), *Jāti-s* (melodic forms), and *Tāla-s* (rhythms). Bharata's work significantly influenced later scholars like Dattilamuni and Mātāṅga, who contributed to the development of music theory by exploring scales, modes, and melodies. The *Saṅgītaratnākara* of Śārṅgadeva (12th century) stands as one of the most comprehensive works in Indian musicology. It covers key aspects such as *Nāda*, *Śruti*, *Svara*, *Grāma* (scales), *Rāga*, and *Tāla*, providing an exhaustive framework for the understanding of Indian classical music. Later scholars like Venkatamakhi and King Tulaja contributed to the development of South Indian music theory, particularly through the *Meḷa* system of classification, which formalized 72 parent ragas. Indian music also absorbed influences from Persian music, particularly in the development of Hindustani music, which was codified by Puṇḍarīkaviṭṭhala and others in the 16th century. Over time, the ragas became more systematized, and both Carnatic and Hindustani traditions developed their distinct theoretical systems. Beyond entertainment, Indian music's ultimate purpose is spiritual, aiming for *mokṣa* (liberation) through the emotional depth of *rāga* (melody) and *tāla* (rhythm). The concept of *gamaka-s* (graces) and the fluidity between classical and folk music highlight the inclusivity and richness of the Indian musical tradition, which remains vibrant today.

In sum, Indian musicology offers profound insights into a system that is both artistic and spiritual, built on centuries of scholarship, philosophical depth, and cultural exchange.

Assignment

1. Explain what the *Nāṭyaśāstra* is and how it helped shape the music we hear in India today.
2. Prepare a Chart on Important Sanskrit Texts and Authors in Indian Musicology. (The chart should include brief descriptions of each work, its significance, and the author's contributions to musicology)
3. Comment on your views regarding the concept of Musicology in India.
4. Elaborate on the Vedic roots of Indian music, explaining the correspondence between the Vedic tones (*Udāṭṭa*, *Anudāṭṭa*, *Svarita*) and the seven notes of classical Indian music, and discuss the musical elements found in the *Sāmaveda*.



5. Discuss the influence of Persian music on the development of Hindustani classical music.
6. Discuss the philosophical and spiritual dimensions of Indian music, explaining the concept of rāga and rasa, and how music is believed to lead to the purification of the self and mokṣa.
7. What was the significance of Sārṅgadeva's Saṅgītaratnākara in the development of Indian rāga theory?

Suggested Reading

1. *Technical Literature in Sanskrit*, S. Venkatasubramonia Iyer, University of Kerala, 2009.
2. *A Concise History of Science in India*, D. M. Bose et al., INSA, New Delhi, 1976.

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1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
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BLOCK-04

Jurisprudence and Environmental Studies in India

Block Content

Unit 1: General Study of Jurisprudence Reflected in Sanskrit Literature

Unit 2: Basic Study of Judiciary in Ancient India

Unit 3: General awareness of thoughts on Ecology in Sanskrit works.





General Study of Jurisprudence Reflected in Sanskrit Literature

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an understanding of the governance of critical texts like the *Manusmṛti*, *Yājñavalkyasmṛti*, *Arthaśāstra*, and *Mahābhārata*, and understand their significance in the context of legal theory, social duties and
- ❖ develop a comprehensive understanding of the fundamental concepts of dharma, justice, and law as they are explored in Sanskrit literature.

Background

Jurisprudence, as a field of study, has its roots in various ancient legal traditions, with Sanskrit literature offering one of the earliest and most profound examinations of law and ethics. In ancient India, the *dharmāśāstra*-s - comprising texts like the *Manusmṛti*, *Yājñavalkyasmṛti*, and the *Arthaśāstra* - formed the basis of legal and moral thought. These texts addressed a broad range of legal issues, including civil and criminal law, governance, social duties, and ethical conduct. They were integral in shaping not only the legal framework but also the societal and moral fabric of ancient Indian civilization. The study of these texts reveals a sophisticated understanding of law, where justice, duty, and societal order were intertwined, providing a holistic approach to law and governance that continues to influence contemporary legal thought.

Keywords

Jurisprudence, Dharmasastra, Manusmṛti, Yajnavalkyasmṛiti, Arthasastra, Mahabharata

Discussion

Jurisprudence, or the science of law, is a critical discipline that examines the theory and philosophy of law, its foundations, and its application in society. Historically, legal systems have evolved from ancient traditions and intellectual frameworks, with each civilization developing its own understanding of law and justice. In India, San-



- ◆ The dharmāśāstra-s, provides a deep insight into ancient Indian legal thought

sanskrit literature, particularly the dharmāśāstra-s (texts dealing with duties, law, and ethics), provides a deep insight into ancient Indian legal thought. Through texts such as the Manusmṛti, Yājñavalkyasmṛti, and Arthaśāstra, we can trace the roots of legal theory and practice in India. The study of jurisprudence in Sanskrit literature is not only a historical inquiry into ancient legal systems but also a philosophical exploration of the nature of law, justice, and the role of the state.

4.1.1. The Foundations of Dharmāśāstra-s in Sanskrit Literature

- ◆ The dharmāśāstra-s are more than just legal manuals; they are comprehensive guides to the ethical, social, and political life of the individual and the state.

Sanskrit literature reflects a profound and systematic understanding of law, justice, and governance through the dharmāśāstra-s. The term dharmāśāstra refers to a collection of texts that deal with the principles of righteousness (dharma) and legal norms in ancient Indian society. These texts encompass a wide array of legal subjects, including civil law, criminal law, family law, and even the management of public resources. The dharmāśāstra-s are more than just legal manuals; they are comprehensive guides to the ethical, social, and political life of the individual and the state.

At the heart of these texts is the concept of dharma, often translated as righteousness, moral duty, or law. However, dharma encompasses far more than what is commonly understood as law today; it is an all-encompassing framework that includes ethics, duty, and social order. The dharmāśāstra-s illustrate how law is not just a set of rules but a moral system that dictates the ideal conduct for individuals and rulers alike. The relationship between law and dharma is central to the study of jurisprudence in Sanskrit literature, as these texts aim to align the law with the higher moral order of the universe.

4.1.2. Legal System in Ancient India: Categories and Structure

Jurisprudence in Sanskrit literature revolves around the philosophical and practical aspects of law, as reflected in the Dharmāśāstra-s. The key texts that define ancient Indian legal thought are:

1. Manusmṛti: Often regarded as the first and one of the most authoritative texts on Hindu law, it establishes norms for personal conduct, social duties, marriage, inheritance, and justice. It is attributed to the sage Manu and explores the roles of the king and the individual in maintaining societal order. The Manusmṛti emphasizes the relationship between the ruler and the ruled, with an overarching view of dharma (duty) guiding all actions.
2. Yājñavalkyasmṛti: This text provides a more refined understanding of law, emphasizing judicial procedures, the rights of individ-



uals, and the duties of kings and citizens. It serves as a detailed legal code that also includes provisions for various forms of punishment, civil disputes, and inheritance.

3. Arthaśāstra: Attributed to the ancient Indian statesman and philosopher Kautilya (also known as Chanakya), the Arthaśāstra is primarily a treatise on statecraft, governance, and economics. It also covers aspects of criminal law, legal procedures, and the duties of the king and his ministers. The work discusses the importance of justice, ethical rule, and the balance between power and responsibility in the governance of the state.
4. Mahābhārata: While not a legal treatise in the strict sense, the Mahābhārata includes discussions on justice, law, and the consequences of moral decisions. It provides a philosophical basis for law through its characters, especially in Yudhishtira's dilemmas, thus enriching the discourse on dharma and justice.

- ◆ Dharmāśāstra texts - Manusmṛti, Yājñavalkyasmṛti, Arthaśāstra, and Mahābhārata

The texts make not merely catalogue rules but are deeply embedded in the cultural, social, and moral fabric of ancient Indian society. They reflect a synthesis of ethics, law, politics, and governance, showing how the law was conceived as part of the larger order of the universe (ṛta). This cosmic law governs both natural and social realities.

4.1.3. Key Features of Jurisprudence reflected in Sanskrit literature:

5. Dharma (Moral and Legal Order): The central concept around which Sanskrit jurisprudence revolves is dharma. It signifies not only moral duty but also the legal norms governing social conduct. The texts are based on the belief that law must align with the cosmic order and morality.
6. Justice and the State: Sanskrit literature elaborates on the roles of kings and rulers, not just as lawgivers but as moral guardians of society. Justice is thus deeply intertwined with governance, and the ruler's duty to enforce the law equates to their duty to uphold righteousness.
7. Role of Individuals and Society: The Dharmāśāstra-s emphasize individual responsibilities within society. Legal and ethical duties are delineated according to one's station in life (varṇa) and age (āśrama). The individual's adherence to dharma is crucial to the functioning of the whole society.
8. Legal Categories and Structures: Texts like the Arthaśāstra provide a clear delineation between different categories of law—civil, criminal, constitutional, and administrative. They reflect an understanding of the law's functional role in different aspects of social life.



- ◆ Dharma, Justice etc. Key Features of Jurisprudence reflected in Sanskrit literature

9. Theories of Punishment and Justice: There is a detailed exploration of punishments for various transgressions, ranging from fines and property confiscation to corporal punishment and even capital punishment. The idea of proportional justice and reformatory justice finds a place in ancient Indian jurisprudence.
10. Interpretation and Evidence: The Nyāya school of philosophy, integral to understanding Sanskrit jurisprudence, addresses methods of reasoning and the concept of *pramāṇa* (proof or evidence). The texts advocate for reasoned interpretation of legal texts and the use of evidence in court decisions.

4.1.4. Jurisprudence and Legal Language: Interpretation and Evidence

An often overlooked aspect of Sanskrit jurisprudence is the development of legal language and the theory of interpretation. The *dharmāśāstra*-s contain detailed rules about how legal texts should be interpreted and how legal reasoning should be conducted. The *Mīmāṃsā* school of philosophy, for example, which focuses on the interpretation of texts, provides an essential foundation for understanding how legal texts in Sanskrit literature were meant to be read and understood.

The theory of evidence, or *pramāṇa*, is another area where Sanskrit literature contributes to the study of jurisprudence. In the Nyāya system of philosophy, *pramāṇa* refers to the means by which knowledge is acquired. In the context of law, it relates to the methods by which evidence is used to establish truth and deliver justice. The study of *pramāṇa* in Sanskrit legal texts is vital for understanding how legal reasoning was structured and how decisions were made based on available evidence.

- ◆ In the Nyāya system of philosophy, *pramāṇa* refers to the means by which knowledge is acquired.

4.1.5. Relevance of Ancient Jurisprudence to Contemporary Issues

The study of Sanskrit jurisprudence is not merely an academic exercise; it has profound relevance for contemporary legal issues, particularly in the context of Indian legal reform. Many modern legal challenges—such as the management of natural resources, community rights, and environmental justice—are deeply rooted in ancient practices governed by *dharmāśāstra*-s. For example, the regulation of village forests, water rights, and grazing lands in ancient India was often governed by customary law, which is now being re-examined in light of modern environmental concerns.

- ◆ Relevance of ancient jurisprudence to contemporary issues

The traditional systems of resource management, such as the practice of declaring forests sacred or associating village tanks with temples, represent an early form of sustainable community-based



resource management. Studying these ancient systems can provide valuable insights into contemporary environmental law, particularly in how communities can play an active role in managing and preserving natural resources.

Furthermore, modern legal reforms related to family law, women's rights, and social justice can benefit from a deeper understanding of how these issues were addressed in the dharmāśāstra-s. While the application of these ancient texts must be approached with caution, their historical significance and ethical frameworks can provide a foundation for developing more just and equitable legal systems.

Conclusion

The study of jurisprudence as reflected in Sanskrit literature, particularly through the dharmāśāstra-s, offers a rich and nuanced understanding of the relationship between law, ethics, and governance. These texts not only provide insights into ancient Indian legal systems but also present a unique perspective on the nature of justice and the role of the state. By examining these texts through both historical and contemporary lenses, we can develop a deeper understanding of legal theory and its application in society. Ultimately, the integration of ancient wisdom with modern legal practices can pave the way for a more holistic and just legal system in India and beyond.

Summarised Overview

This unit explores the foundational concepts of jurisprudence as reflected in ancient Sanskrit literature, particularly through the *dharmāśāstra*-s like the *Manusmṛti*, *Yājñavalkyasmṛti*, and *Arthaśāstra*. It delves into the relationship between dharma (moral duty) and law, highlighting how these texts not only offer legal norms but also provide a moral and ethical framework for governance and societal conduct. The essay emphasizes the roles of rulers, individuals, and society in maintaining justice, as well as the importance of legal categories, punishment theories, and the interpretation of evidence. It also reflects on the relevance of ancient legal principles to modern legal challenges, offering valuable insights for contemporary legal reform, particularly in areas like environmental law, family rights, and social justice.

Assignment

1. Discuss the understanding of justice in the *Manusmṛti*. How does it define justice for individuals and rulers, and how are laws linked to moral and ethical duties?



2. Compare the legal principles found in Sanskrit texts such as the *Arthaśāstra* with modern legal frameworks. Discuss similarities and differences in the approach to law and governance.
3. Examine the types of punishments discussed in the *dharmāśāstra*-s and the reasoning behind them. How does the ancient Indian approach to punishment relate to the concepts of justice and reform?
4. Discuss how the *Arthaśāstra* by Kautilya (Chanakya) influenced both political strategy and legal thinking in ancient India. What role did it play in shaping governance and the duties of rulers?
5. Elaborate on the foundations of *dharmāśāstra*-s in Sanskrit literature, explaining the concept of dharma and its all-encompassing nature beyond modern definitions of law.
6. Analyze the significance of the Nyāya and Mīmāṃsā schools of philosophy in understanding Sanskrit jurisprudence, explaining their contributions to the theory of evidence (pramāṇa) and the principles of textual interpretation.
7. Explore the traditional systems of resource management in ancient India, as mentioned in the text.

Suggested Reading

1. Chakrabarti, K Dilip, *Social, Political and Judicial Ideas, Institutions and Practices: History of Ancient India (Vol-6)*, Vivekananda International Foundation & Aryan Books International, New Delhi, 2018.
2. Krishna Rao, Anantha, *Jurisprudence in Ancient Bharath*, Sanskrit Academy, Osmania University, Hyderabad, 2024, pp 1-64.

Reference

1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
2. *Sanskrit in Technological Age*, P. C. Muraleemadhavan & N. K. Sundareswaran, New Bharatiya Book Corporation, New Delhi, 2007.





Basic Study of Judiciary in Ancient India

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ acquainting with the significant Indian thought streams of Jurisprudence
- ❖ recognising Key Judicial Principles and Procedures of Ancient India

Background

This unit delves into the evolution of the judicial system in ancient India, tracing its roots from early Indian jurisprudence to the more structured legal frameworks seen in texts like the *Manusmṛti*, *Yājñavalkya*, and *Nārada*. The relationship between law, morality, religion, and custom in early Indian society is highlighted, with a focus on how these elements shaped the administration of justice. The unit explores how legal principles, procedures, and ethical standards were codified and refined over time, eventually influencing the modern Indian legal system. It also touches upon the impact of British colonialism in shaping contemporary Indian law, demonstrating a synthesis of both Western and indigenous traditions.

Keywords

Āpastamba Sūtra, *Gautama Dharma Sūtra*, *Vasiṣṭha Dharma Sūtra*, *Viṣṇu Smṛti*, Evidence, Legal

Discussion

The judiciary, as a system of resolving disputes and administering justice, has deep historical roots in Indian civilisation, particularly within the framework of ancient Indian jurisprudence. In the early stages, the law was not merely a system of statutes but was deeply interwoven with morality, religion, and custom. Through an analysis of the historical texts and practices, we can trace the evolution of the



judiciary in ancient India, which laid the foundation for modern legal systems. This essay will explore the judicial processes in ancient India, highlighting their development over time, key concepts, and how they influenced modern legal systems, drawing from the contents of the first and second parts of the provided text.

4.2.1. Judicial Foundations in Ancient India: Early Texts and Practices

- ◆ *Āpastamba Sūtra*, *Gautama Dharma Sūtra*, *Vasiṣṭha Dharma Sūtra*, and *Viṣṇu Smṛti*

Ancient Indian jurisprudence is rooted in texts that discuss not only legal principles but also spiritual and moral guidelines for society. The earliest texts, such as the *Āpastamba Sūtra*, *Gautama Dharma Sūtra*, *Vasiṣṭha Dharma Sūtra*, and *Viṣṇu Smṛti*, offer some of the first glimpses into the judicial and procedural framework of the time. These texts, however, contain only a rudimentary system of procedure, which mainly revolves around personal ethics and social conduct, rather than formal legal processes.

For instance, early texts like *Āpastamba* and *Gautama* do not provide comprehensive procedural rules but instead focus on rituals like ordeals and compurgation, a system where a defendant's innocence was proven by the testimonies of others or through divine intervention. The texts of these periods show the reliance on personal integrity and divine forces to resolve disputes with little structure or formality.

However, as Indian society and its governance became more complex, there arose a need for more detailed and formal procedures. The emergence of the *Manusmṛti*, which provided a more extensive code of laws, marks a significant evolution in the development of judicial processes. Though it focused more on ethical behavior and the duties of individuals within society, it did provide a structure for legal issues like inheritance, contracts, and punishments.

4.2.2. The Evolution of Judicial Procedures: From Early Texts to the Code of Yājñavalkya

The development of procedural law in ancient India can be seen in the evolution from rudimentary codes to a more sophisticated legal system as found in the texts of *Yājñavalkya* and *Nārada*. These texts represent the first comprehensive approach to judicial procedure in Indian law. *Yājñavalkya*, in particular, provides a clear classification of legal procedures under categories like "Plaint," "Answer," "Proof," and "Decision." This detailed structure of legal practice in ancient India indicates a shift toward more defined and systematic procedures for resolving disputes.

The judicial process outlined by *Yājñavalkya* had rules that we can recognize in modern legal systems:



1. No recrimination or counterclaim until the complaint is discharged – This demonstrates the focus on clarity and resolution before any counterarguments could be raised.
2. No departure from pleading – This emphasizes the importance of sticking to the issues presented without irrelevant deviation.
3. Counterclaims or recrimination were allowed in certain criminal cases – This points to the recognition of defenses in criminal law.
4. Requirement for sureties for the satisfaction of judgments – A precursor to modern bail systems.
5. Penalties for false claims or losing cases – Where a defendant who loses pays the king, and if a complainant's case is found false, they must pay double the amount. This shows an early understanding of deterrents to false claims.
6. Distinction between cases to be tried immediately or postponed – Establishing urgency in certain cases.
7. Rules for examination of witnesses – The practice of having the plaintiff's witnesses examined first is a form of procedural fairness.

These procedural rules in *Yājñjavalkya* and other texts like *Nārada* reflect the growing sophistication in the judicial process, introducing elements of fairness, structure, and evidence that would be familiar to modern legal practitioners. Moreover, it is essential to highlight the importance of rules regarding fraud, the role of capacity (such as the capacity of children or others in legal matters), and the use of sureties, which are crucial aspects of any modern legal system.

4.2.3. The Role of Evidence and Legal Principles

In ancient India, the role of evidence was given significant importance, and it was meticulously categorized. *Gautama* and subsequent texts classified evidence into different categories such as real evidence, witnesses, and presumptions. This early development of evidence law included distinctions between primary and secondary evidence, qualifications of witnesses, and the burden of proof. Notably, *Yājñjavalkya* dealt with concepts that are central to modern legal proceedings, such as:

1. Cross-examination: This practice, which allows a party to question witnesses presented by the opposing side, can be seen in ancient texts.
2. Res ipsa loquitur: The idea that certain facts speak for themselves was recognized.
3. Hearsay and perjury: Rules against hearsay and the penalty for perjury show the understanding of the value of truthful testimony.

♦ In ancient India, the role of evidence was given significant importance



4. Witness demeanor: The attention to the behavior of witnesses and the credibility of their testimonies in legal settings was well-established.

The early Indian texts' focus on evidence laws, including detailed rules regarding how evidence should be handled, the order of proof, and the responsibilities of witnesses, indicates a high level of sophistication in judicial processes even in ancient times.

4.2.4. Meaning of Law in Ancient India: Lex vs. Jus

A crucial aspect of ancient Indian jurisprudence is its understanding of what constitutes “law.” The debates around the meaning of “law” in ancient texts have influenced modern Indian judicial thought. The distinction between *lex* (laws created by legislation) and *jus* (principles of natural justice) appears in the *Gopalan v. Madras* case (1950), where the Indian Supreme Court debated whether “law” referred to enacted laws or broader principles of justice. This discussion demonstrates the philosophical depth of Indian legal tradition.

While early texts were more concerned with *lex*—rules written by kings and sages—there was also a strong emphasis on the broader ethical and moral considerations underlying law, which aligns with the concept of *jus*. Natural justice principles, which are crucial in modern legal systems, were embedded in the ancient Indian approach to law, though not always as codified rules.

4.2.5. The Synthesis of Western and Indian Legal Traditions in Modern India

The influence of British colonial rule on the development of modern Indian law is undeniable. The introduction of English public law, criminal law, tort law, and legal procedure during British rule significantly shaped the judicial framework of independent India. This Western influence melded with ancient Indian jurisprudence to create a modern, hybrid legal system that retained aspects of both Western and traditional Indian legal thought.

Indian law today reflects this synthesis. While British common law, the principles of *stare decisis*, and constitutional guarantees have shaped the structure of modern Indian courts, the ancient traditions of justice and fairness, as seen in the *Yājñalkya* and *Nārada* texts, continue to influence the system. The modern Indian judiciary's commitment to ensuring justice, even when it means challenging legislative actions or executive decrees, resonates with the ancient

- ◆ The Synthesis of Western and Indian Legal Traditions in Modern India



emphasis on fair procedure and the protection of individual rights.

6. Conclusion

The evolution of the judiciary in ancient India reveals a rich and sophisticated system of law that integrated procedural fairness, moral ethics, and divine principles. From the early days of ordeals and compurgation to the comprehensive legal systems outlined in the texts of *Yājñjavalkya* and *Nārada*, Indian jurisprudence developed complex procedures for resolving disputes. These early systems laid the foundation for modern legal practices, and the integration of Western influences during British rule further refined and codified these systems. Today, the Indian legal system represents a dynamic synthesis of ancient principles and modern legal structures, showcasing India's ability to adapt and synthesize diverse legal traditions into a unified, functional judiciary that serves the needs of its society.

Summarised Overview

The judiciary in ancient India was initially grounded in moral, religious, and customary laws rather than formal statutory systems. Early texts like the *Āpastamba-sūtra* and *Gautama-dharma-sūtra* introduced basic ethical principles and rituals, such as ordeals and compurgation, to resolve disputes. Over time, legal codes like the *Manusmṛti* began to provide more structured frameworks for handling legal matters, including inheritance, contracts, and punishments.

The evolution of judicial procedures became more sophisticated with texts like *Yājñjavalkya* and *Nārada*, which introduced systematic legal processes, such as the classification of legal procedures, the importance of evidence, witness examination, and penalties for false claims. These early practices laid the groundwork for modern legal concepts like cross-examination, the burden of proof, and the role of witnesses.

Moreover, the concept of law in ancient India blended both “lex” (written laws) and “jus” (principles of natural justice), reflecting a deep understanding of fairness and justice. This philosophical approach continued to influence the modern Indian judicial system, especially after British colonial rule introduced Western legal concepts.

Overall, the unit highlights the significant historical developments that contributed to India's legal system, illustrating a blend of ancient traditions and modern legal structures that continue to shape the Indian judiciary today.



Assignment

1. Analyse the contributions of texts like the Āpastamba Sūtra, Gautama Dharma Sūtra, and Manusmṛti to the development of judicial principles in ancient India.
2. Analyze how the judicial processes in ancient India evolved from early texts with basic rules to more comprehensive legal frameworks like those of Yājñavalkya and Nārada.
3. Investigate how ancient Indian legal principles, particularly regarding evidence, cross-examination, and the distinction between lex and jus, continue to influence the modern Indian judiciary.
4. Discuss the meaning of “law” in ancient India.
5. Discuss how modern Indian law represents a synthesis of Western and ancient Indian legal traditions.
6. Discuss the early development of evidence in ancient India, including the categorization of evidence, the distinction between primary and secondary evidence, the qualifications of witnesses, and the concept of the burden of proof, as mentioned in the texts.

Suggested Reading

1. Chakrabarti, K Dilip, *Social, Political and Judicial Ideas, Institutions and Practices: History of Ancient India (Vol-6)*, Vivekananda International Foundation & Aryan Books International, New Delhi, 2018.
2. Krishna Rao, Anantha, *Jurisprudence in Ancient Bharath*, Sanskrit Academy, Osmania University, Hyderabad, 2024, pp 1-64.

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1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
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General awareness of thoughts on Ecology in Sanskrit works

Learning Outcomes

Upon completion of the unit, the learner will be able to:

- ❖ develop an understanding of specific contributions in the fields of familiarisation with the literature pertaining to Ecology
- ❖ develop an appreciation for the contribution of scientific and technical literature in Sanskrit in the context of wider scientific discourse
- ❖ acquainting with the significant Indian thought streams of Environmental and Ecological equilibrium

Background

This unit explores the ecological wisdom found in ancient Sanskrit texts, highlighting the deep connection between humans and nature in Vedic, epic, and classical literature. It examines key concepts such as the Vedic notion of *ṛta*, which emphasizes cosmic harmony, and the medicinal use of plants in the *Atharvaveda* and *Ayurveda*, which advocate for living in balance with nature. The *Mahābhārata* and Kautilya's *Arthaśāstra* further reflect ecological consciousness, promoting the protection of the environment and sustainable practices. The unit underscores how ancient texts offer timeless insights that challenge modern exploitative attitudes and provide a foundation for sustainable living.

Keywords

RTA, Ecology, Rgveda, Pensionofication, Adarvaveda, Ayurvedic texts, RTA carya, Arthasastra

Discussion

Environmental issues have risen to global prominence in recent decades, fueled by the growing realization of the damage wrought by industrialization and unbridled exploitation of natural resources. This environmental awakening reached a crescendo after Rachel Carson's seminal work, *Silent Spring* (1962), which highlighted



the catastrophic effects of pesticides, such as DDT, on ecosystems. Carson's book shattered the illusion of nature as an inexhaustible reservoir for human consumption, pushing the world to reckon with the harsh consequences of human interventions. From pollution to deforestation, and climate change to resource depletion, modern humanity now faces existential threats that stem from the neglect of the environment.

This realization calls for a reassessment of the relationship between man and nature, one that has deep roots in ancient civilizations. India's ancient texts, particularly those in Sanskrit, present a compelling model for ecological consciousness, one that places human beings as an integral part of the cosmic order. In this context, we find that early Indian thought, from the Vedas to later philosophical and literary works, demonstrated an acute awareness of nature and an enduring reverence for the environment.

This essay explores the ecological thoughts embedded in ancient Sanskrit literature, showing how these ancient texts not only reflect a deep ecological awareness but also present a holistic view of the universe in which humans are stewards rather than conquerors of nature.

4.3.1. Vedic Perspectives on Ecology

The Vedic literature, the oldest and most sacred collection of texts in India, provides early glimpses of an environmental consciousness that links humanity with nature. The Vedic worldview is based on the concept of *ṛta*, which denotes both the moral and cosmic order. This order encompasses not only the ethical principles that govern human conduct but also the physical and natural laws that regulate the cycles of the cosmos—day and night, the seasons, and the movements of celestial bodies. The ancient seers believed that the harmony of nature, governed by *ṛta*, required humans to live in balance with the natural world.

- ♦ The Vedic worldview is based on the concept of *ṛta*, which denotes both the moral and cosmic order.

4.3.2. The Concept of Rta and Nature's Cycles

The idea of *ṛta* signifies an innate balance in the universe, mirrored in the natural phenomena that surround human existence. The delicate, cyclical order of nature—such as the rising and setting of the sun, the change of seasons, and the growth and decay of plants—was seen as a fundamental law that humans should not disrupt. In modern scientific terms, this mirrors the ecological concept of homeostasis, where natural systems maintain stability through various feedback mechanisms. The ancient Indian view that all natural forces—sun, water, wind, and earth—are interdependent laid the foundation for an ecological consciousness that has modern resonances.

The Rgveda explicitly personifies natural forces as deities—such



- ◆ Vedic peoples' respect for nature and their belief that these forces must be respected and revered

as Indra (thunder), Varuna (cosmic order), and Agni (fire)—showing the early Vedic peoples' respect for nature and their belief that these forces must be respected and revered. Furthermore, the idea that human beings are an integral part of this cosmic order underscores the ecological consciousness that permeates Vedic thought.

4.3.3. Personification of Natural Elements

The Vedic hymns also personify natural elements like water, trees, and plants, showing their sanctity and the ecological interdependence of life forms. In *Rgveda* (X.97), the goddess of forests is invoked, celebrating the night-time beauty and mystique of the forests, where trees, animals, and other living beings coexist in harmony. The forests are not just physical spaces, but sacred places imbued with life and vitality.

- ◆ Personification of Natural Elements

Similarly, in another hymn, plants, water, rivers, and mountains are venerated as divine entities. Trees are often depicted as having life, feeling pleasure and pain, and capable of growth even when cut. This reverence for trees reflects an intrinsic respect for life forms and the interconnectedness of all creatures, an understanding that resonates with modern ecological science.

4.3.4. The Role of Plants in Ancient Indian Ecology

The awareness of the medicinal properties of plants is another significant aspect of ecological consciousness in ancient Sanskrit texts. The *Atharvaveda* (X.97), a text focused on healing and medicine, contains hymns that praise the powers of medicinal plants (*oṣadhi*). This text highlights the deep knowledge the ancient Indians had about the therapeutic value of plants, including those that treated fevers, jaundice, wounds, and even snake bites. The practice of Ayurveda, India's ancient system of medicine, arose from this rich tradition of plant-based healing and continues to emphasize a holistic approach to health that harmonizes with nature.

- ◆ Ayurvedic texts also underline the seasonal changes in the environment and their impact on human health.

Ayurvedic texts also underline the seasonal changes in the environment and their impact on human health. *Rtucarya*, the practice of adjusting one's lifestyle according to the seasons, reflects an ecological wisdom that recognizes the influence of the environment on human well-being. The descriptions of various seasons in texts like the *Aṣṭāṅgahṛdaya* by Vāgbhaṭa show how the changing environment requires human adaptation through diet, exercise, and lifestyle practices that maintain balance between the body and nature.

4.3.5. Ecological Philosophy in the Mahābhārata and Other Texts

In the *Mahābhārata*, there are numerous references to the ecological balance between man and nature. The epic suggests that na-



- ◆ One of the central themes of the *Mahābhārata* is the idea of *dharma*—righteousness

ture should be respected and preserved, and highlights the destructive consequences of disregarding this principle. One of the central themes of the *Mahābhārata* is the idea of *dharma*—righteousness or moral order—which extends beyond human interactions to encompass the preservation of natural order.

The text recognizes that the exploitation of nature can lead to imbalances, as reflected in the *Aśvamedha* sacrifice, where animals are killed in the pursuit of divine favor. The protest against such sacrifices by the Cārvāka-s, Jains, and Buddhists—who argued that the destruction of life for ritualistic purposes was unethical—can be seen as an early critique of the exploitation of nature.

4.3.6. Kautilya's Arthaśāstra and Environmental Management

- ◆ Kautilya emphasizes the importance of preserving forests and protecting wildlife.

In *Arthaśāstra*, an ancient treatise on statecraft attributed to the philosopher Kautilya (Chanakya), there is an acute awareness of the ecological impacts of urbanization. Kautilya emphasizes the importance of preserving forests and protecting wildlife. He categorizes forests into three types: those used for hunting, those used for timber, and those reserved for elephants. The state was encouraged to protect these forests, and penalties were prescribed for the destruction of trees or harm to animals.

Kautilya's environmental foresight also extended to urban planning, where he recommended the allocation of land for communal use—such as grazing grounds—and prescribed measures for waste management and sanitation. His ecological approach to governance underscores the importance of balancing economic development with environmental sustainability.

4.3.7. Traditional Wisdom and Modern Ecological Movements

In contemporary times, environmental movements such as the Chipko movement in Uttarakhand, which advocated for the protection of forests, have drawn inspiration from India's traditional ecological knowledge. The ancient belief that nature should be protected and preserved resonates strongly in these modern movements, showing that the principles embedded in ancient texts have contemporary relevance.

The Chipko movement, for instance, mirrored the sentiments found in the *Rgveda* and *Mahābhārata*, where nature is seen as sacred and should not be exploited for short-term gains. This traditional wisdom has been crucial in preventing deforestation in many regions, including Himachal Pradesh and Rajasthan.



- ◆ A tree is equal to ten sons

4.3.8. The Role of Trees in Ancient Indian Thought

In ancient texts like the *Matsyapurāna*, trees are described as sacred and essential for the well-being of humanity. The metaphor “A tree is equal to ten sons” reflects the profound reverence for trees. Such sentiments are found throughout Indian literature, where trees are seen not only as life-giving but also as symbols of spiritual and ecological vitality.

The ecological significance of trees is also seen in the Indian practice of tree plantation. In *Manuṣyālayacandrikā*, a house-building manual, the careful selection of tree species for planting around houses is emphasized, reflecting an understanding of how the environment can impact human health and prosperity.

Conclusion

The ecological awareness reflected in ancient Sanskrit literature is profound and multifaceted. From the Vedic concepts of *ṛta* and the personification of nature, to the medicinal practices of Ayurveda and the urban planning ideas of Kautilya, ancient Indian texts offer valuable insights into the sustainable use and preservation of natural resources. These texts recognize the interconnectedness of all life forms and emphasize the need for balance and harmony between humans and nature.

As the modern world grapples with environmental degradation, ancient Indian wisdom offers timeless guidance for building a sustainable future. The ecological thoughts found in Sanskrit works provide a compelling alternative to the exploitative mindset of modern industrial civilization, advocating for a holistic, respectful, and sustainable relationship with nature. In rediscovering these ancient ideas, we may find the solutions to many of today’s pressing environmental problems.

Summarised Overview

This unit delves into the ecological wisdom embedded in ancient Sanskrit texts, exploring the holistic relationship between humans and nature as conceived in Vedic, epic, and classical literature. Key ideas include:

1. **Vedic Concept of *ṛta*:** The notion of *ṛta*, which signifies cosmic and natural order, emphasized the interconnectedness of human life with the environment. The natural world was personified in Vedic hymns, and human actions were seen as part of a larger, harmonious cycle.
2. **Medicinal Value of Plants in the *Atharvaveda* and Ayurveda:** Ancient texts recognized the medicinal properties of plants and promoted a balanced lifestyle in tune with



the seasons to maintain health. The Ayurvedic system encourages living in harmony with nature through diet, lifestyle, and seasonal practices.

3. **Ecological Philosophy in the *Mahābhārata*:** The epic highlights the destructive consequences of human greed and the importance of living in harmony with nature. Ecological consciousness is reflected in the text's teachings on *dharma* and the moral obligation to protect the environment.
4. **Kautilya's *Arthaśāstra* and Environmental Management:** Kautilya, in his treatise on governance, showed remarkable ecological awareness. He advocated for the protection of forests, the establishment of sanctuaries, and the careful planning of urban environments with regard to sanitation, waste disposal, and water supply.
5. **Environmental Movements and Traditional Wisdom:** The Chipko movement and other modern environmental efforts in India draw inspiration from ancient ecological principles, demonstrating the continuing relevance of this ancient wisdom in contemporary environmental protection.

The unit ultimately underscores how ancient Sanskrit texts offer profound ecological insights that challenge the exploitative mindset of modern civilization and provide a blueprint for sustainable living.

Assignment

1. Compare the environmental philosophies found in ancient Sanskrit texts with modern ecological concepts, highlighting their similarities and differences.
2. Discuss the idea of *ṛta* in the Vedas and its ecological implications in modern times.
3. Explore how Ayurveda promotes a lifestyle that aligns with seasonal and environmental changes for better health.
4. Analyze the importance of trees in ancient Indian texts and their ecological and spiritual roles.
5. Discuss the environmental themes in the *Mahābhārata* and how they relate to contemporary ecological issues.

Suggested Reading

1. *Indian Scientific Traditions*, Ed. NVP Unithiri, University of Calicut, 2006.
2. *A Concise History of Science in India*, D. M. Bose et al., INSA, New Delhi, 1976
3. *Sanskrit in Technological age*, P. C. Muraleemadhavan & N.K. Sundareswaran, New-Bharatiya Book Corporation, New Delhi, 2007.



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1. *A Concise History of Science in India*, D. M. Bose et. al., INSA, New Delhi, 1976.
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Model Question Papers





SREENARAYANAGURU OPEN UNIVERSITY

QP CODE:

Reg. No :

Name :

Model Question Paper Set- A

THIRD SEMESTER M.A. SANSKRIT LANGUAGE AND LITERATURE EXAMINATIONS

DISCIPLINE SPECIFIC ELECTIVE COURSE - 02 M23SN02DE - SCIENTIFIC HERITAGE OF SANSKRIT (CBCS- PG)

2023-24 - Admission Onwards

Time: 3 Hours

Max Marks: 70

SECTION-A

I. Answer any *five* of the following questions in one or two sentences each. Each question carries 2 marks. (5× 2=10)

1. What is the primary focus of the Śulbasūtras?
2. What is the significance of the Vedanga Jyothisha and what was its main purpose in relation to Vedic rituals ?
3. What are Bruhatrayi, and why are they considered foundational texts in Ayurveda ?
4. What is Ayurveda?
5. What were the primary responsibilities of the Sthapathi in ancient Indian architecture?
6. What is the primary aim of studying Hindu Iconography ?
7. What is the broad meaning of the term Dharmasastra ?
8. How do Mahabharata and Arthasastra reflect ecological consciousness ?

SECTION –B

II. Answer any *six* of the following questions in half a page each. Each question carries 5 marks. (6 × 5=30)

9. Analyze the groundbreaking contributions of Aryabhata during the Classical Period.
10. Discuss the major contributions of Mādhava of Saṅgama-grāma and the Kerala School of Mathematics to the development of infinite series and calculus.



11. Discuss the significance of the Sūryasiddhānta in the context of Indian astronomy.
12. Analyze the structure and content of the Caraka-saṁhitā,
13. Discuss the role of the six tastes (Rasas) in Ayurvedic nutrition and their impact on the three doshas.
14. Evaluate the impact of Kerala's regional Ayurvedic literature on contemporary Ayurvedic practices, both within India and around the world.
15. Explain the eight elements of traditional Indian architecture.
16. Analyze the unique characteristics of Kerala's architectural tradition.
17. Explain the significance of image worship (arcana) in Indian religious practice.
18. Analyze the contribution of Bharata's Nāṭyaśāstra to the field of Indian musicology.

SECTION – C

III. Answer any two of the following questions in two pages each. Each question carries 15 marks. (2×15=30)

19. Discuss the major texts and authors associated with the Kerala School of Mathematics.
20. Explain the key Features of the Aṣṭāṅgahṛdayam by Vāgbhaṭa
21. Give an overview of Kerala's Architectural Tradition.
22. Analyse the contributions of texts like the Āpastamba Sūtra, Gautama Dharma Sūtra, and Manusmṛti to the development of judicial principles in ancient India.





SREENARAYANAGURU OPEN UNIVERSITY

QP CODE:

Reg. No :

Name :

Model Question Paper Set- B

THIRD SEMESTER M.A. SANSKRIT LANGUAGE AND LITERATURE EXAMINATIONS

DISCIPLINE SPECIFIC ELECTIVE COURSE - 02 M23SN02DE - SCIENTIFIC HERITAGE OF SANSKRIT (CBCS- PG)

2023-24 - Admission Onwards

Time: 3 Hours

Max Marks: 70

SECTION-A

I. Answer any *five* of the following questions in one or two sentences each. Each question carries 2 marks. (5 × 2=10)

1. What revolutionary mathematical concepts did Brahmagupta's *Brāhma-sphuṭa-siddhānta* introduce?
2. How did Jaina cosmography differ from the Vedic systems in its depiction of the Universe and celestial movements?
3. What are the nature of three doshas in Ayurveda?
4. What is *Marmachikitsa*, and what is the underlying principle behind this therapy?
5. What are *gamakas* and *thalas* in Indian classical music?
6. What are some of the key characteristics that define Kerala's architectural tradition?
7. What are the roles of kings and rulers in the context of justice and the law in Sanskrit literature?
8. What is *Rtucharya* in Ayurveda?

SECTION –B

II. Answer any *six* of the following questions in half a page each. Each question carries 5 marks. (6 × 5=30)

9. Describe the role of Varāhamihira's *Pañcasiddhāntikā* in the history of Indian astronomy.
10. Analyze the unique numerical notation systems used in Kerala, namely the *Kaṭapayādi* and *Bhūta-Sāṅkhyā* systems.



11. Evaluate Suśruta's contributions to the field of surgery as described in the *Suśruta-saṁhitā*.
12. Explain the significance of the eight branches of Āyurveda in providing a comprehensive approach to health and disease management.
13. Discuss the role of the architect (*Sthāpati*) in ancient Indian society.
14. Discuss the importance of the Hortus Malabaricus as a resource for understanding Kerala's medicinal flora and its role in Ayurvedic treatments.
15. Discuss the role of iconography as a bridge between the material and spiritual worlds in Indian religious practices.
16. Analyze the significance of the *Nyāya* and *Mīmāṃsā* schools of philosophy in understanding Sanskrit jurisprudence
17. Discuss the ecological wisdom embedded in the Vedic personification of natural elements

SECTION – C

III. Answer any two of the following questions in two pages each. Each question carries 15 marks. (2×15=30)

18. Analyze the major texts and authors associated with the Kerala School of Mathematics
19. Explain what Panchakarma therapy is and how it helps in healing.
20. Discuss the aim and scope of Indian Iconography.
21. Analyze the contributions of texts like the Apastamba Sutra, Gautama Dharma Sutra and Manusmṛiti to the development of judicial principles in ancient India.



സർവ്വകലാശാലാഗീതം

വിദ്യാൽ സ്വതന്ത്രരാകണം
വിശ്വപൗരരായി മാറണം
ഗ്രഹപ്രസാദമായ് വിളങ്ങണം
ഗുരുപ്രകാശമേ നയിക്കണേ

കുതിരുട്ടിൽ നിന്നു ഞങ്ങളെ
സൂര്യവീഥിയിൽ തെളിക്കണം
സ്നേഹദീപ്തിയായ് വിളങ്ങണം
നീതിവൈജയന്തി പറണം

ശാസ്ത്രവ്യാപ്തിയെന്നുമേകണം
ജാതിഭേദമാകെ മാറണം
ബോധരശ്മിയിൽ തിളങ്ങുവാൻ
ജ്ഞാനകേന്ദ്രമേ ജ്വലിക്കണേ

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SCIENTIFIC HERITAGE OF SANSKRIT

COURSE CODE: M23SN02DE

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