Introduction to INDIAN KNOWLEDGE SYSTEM

Concepts and Applications

B. Mahadevan
Vinayak Rajat Bhat
Nagendra Pavana R.N.

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B. MAHADEVAN
Professor
Indian Institute of Management Bangalore

VINAYAK RAJAT BHAT
Associate Professor
Center for Indian Knowledge System
Chanakya University
Bengaluru

NAGENDRA PAVANA R.N.
Assistant Professor
School of Vedic Knowledge Systems
Chinmaya Vishwa Vidyapeeth
Ernakulam

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TO

The Great Sages and Saints of Ancient India and the lineage of Gurus who selflessly contributed to the IKS knowledge repository

|| न हि ज्ञानेन सदृशं पवित्रमिह विद्यते ||

There is nothing as purifying as knowledge
Bhagavad-Gita (4.38)

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अखिल भारतीय तकनीकी शिक्षा परिषद्
(भारत सरकार का एक सांविधिक निकाय)
(शिक्षा मंत्रालय, भारत सरकार)
नेल्सन मंडेला मार्ग, वसंत कुञ्ज, नई दिल्ली–110070
दूरभाष : 011–26131498
ई–मेल : chairman@aicte-india.org

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION
(A STATUTORY BODY OF THE GOVT. OF INDIA)
(Ministry of Education, Govt. of India)
Nelson Mandela Marg, Vasant Kunj, New Delhi-110070
Phone : 011-26131498
E-mail : chairman@aicte-india.org

प्रो. अनिल डी. सहस्रबुद्धे
अध्यक्ष
Prof. Anil D. Sahasrabudhe
Chairman

Foreword
by Anil Sahasrabudhe

The formal Indian education system inherited from British policymakers famously known as Macaulian system has kept the Ancient Indian knowledge heritage out of the reach of the budding young students, citing reasons of lack of rigor and scientific value. This is arguably an incorrect perspective. However, truth is otherwise. Ours is one of the only continuing, surviving ancient civilization with huge repository of knowledge created by the forefathers, which can provide great value for any society. It enables the current generation to understand the thought processes and frameworks, analyse the received wisdom in a contemporary context and provide new opportunities to assimilate the accrued wisdom and synthesize new knowledge.

Therefore, All India Council for Technical Education (AICTE), the apex body for technical education spanning the Engineering and Management Education in India while revising the curricula in 2018, introduced a mandatory non-credit course on Indian Knowledge Systems (IKS) along with courses on constitution of India and environment science. While there are several books on the latter courses, unfortunately, there are no textbooks currently available for the subject that will help students understand the various components of IKS. Hence a textbook for the course on Indian Knowledge Systems (IKS) is a timely and valuable contribution to the education system in the country and I am happy to note that this book has been written to address the requirements of this course.

The book has detailed coverage of IKS topics, and the authors have taken the right approach to balancing the concepts with the applications. I notice extensive endnotes for each chapter that points to the depth of research the authors have carried out in culling out relevant ideas to the students. The chapters on Number Systems, Mathematics, and Astronomy truly showcase the scientific rigour and heritage that was existing in the country. Similarly, the chapters on Metal Working and other engineering applications will be true eye openers for the young engineering students. Another interesting feature of this book is the discover IKS exercises at the end of the chapters. This will provide further opportunities for the students to experientially discover the multi-faceted nature of IKS.

Although the authors claim that the book was mainly intended for the lKS course in Engineering institutions, I believe that the book can serve as a useful textbook for any undergraduate or postgraduate degree programs in the country wanting to introduce an elective course on IKS. Incidentally, the NEP 2020 does refer to Indian Knowledge Systems couple of times. The book will therefore be a valuable asset in the context of the New Education Policy (NEP 2020).

I hope the book will motivate professionals and IKS researchers to deep dive into each chapter and write a separate textbook based on each chapter.

(Anil Sahasrabudhe)

Foreword
by Subhash Kak

It is generally recognized that historical accounts of science in India, the world's third-largest economy on a purchasing power parity basis, are woefully inadequate and need to see beyond the colonial lens. Therefore, I am pleased that this book *Introduction to Indian Knowledge System – Concepts and Applications* written by B. Mahadevan, Vinayak Rajat Bhat, and R.N. Nagendra Pavana will provide the students with an excellent introduction to the astonishing breadth and depth of the Indian scientific and knowledge tradition.

Ṣāʿid al-Andalusī, writing in Toledo, Spain in 1068 in the *Tabaqāt al-ʿUmam*, comparing science in different parts of the world declared that India was the most advanced nation: "The first nation to have cultivated science is India. India is known for the wisdom of its people." India appears to have remained ahead of others in science until about the seventeenth century.

India's sciences are based on fundamental principles, axioms, logical inference, and empirical observations and were generally written down in texts called śāstras and sūtras. For example, the Śulba-sūtra geometry includes the so-called "Pythagoras theorem" several centuries prior to its later discovery in Greece; there is also Pāṇini's astonishing grammar that describes the Sanskrit language in 4000 algebraic rules with a structure that is now compared to a computer program. The logic of Navya Nyāya is equivalent to mathematical logic, which is the foundation of analysis by modern machines.

Kaṇāda's physics has its laws of motion, and it speaks of nine classes of substances, some of which are non-atomic and some atomic. Every substance was taken to be composed of four different kinds of atoms, two of which had mass and two did not. A thousand or more years after Kaṇāda, Āryabhaṭa postulated that earth rotated and advanced the basic idea of relativity of motion. It is fascinating that Kaṇāda's ideas were communicated by Swami Vivekananda to Nikola Tesla in connection with the possibility of conversion of mass into energy.
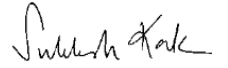
It is generally believed that the discovery of infinite series and calculus by Newton and Leibniz heralded the Scientific Revolution that was to change the world. But new research has shown that the Kerala School of Mathematics had already developed calculus over two centuries prior. Some historians suggest that this advanced astronomical knowledge from Kerala went abroad via the Jesuits and sparked its further development in Europe.

The ancient Āyurveda texts include the notion of germs and inoculation and postulate mind-body connection, which has become an important area of contemporary research. Āyurveda uses tripartite analysis (three *doṣas*, for example), and since modern logic shows that ternary logic is more powerful than binary logic, this fact may prove to be an advantage in the further development of medicine.

There are indirect ways that Indian ideas led to scientific advances. Mendeleev was inspired by the two-dimensional structure of the Sanskrit alphabet to propose a similar two-dimensional structure of chemical elements. Erwin Schrödinger, a founder of quantum theory, credited ideas in the Upanishads for the key notion of superposition that was to bring about the quantum revolution in physics that has transformed modern science. A Vedantic vision guided Jagadish Chandra Bose in his pathbreaking discoveries in several fields, and he is considered the true father of radio science which, as we know, heralded a new age.

Introduction to Indian Knowledge System – Concepts and Applications provides a grand view of the Indian knowledge tradition, and it goes back to the Vedic texts for its overarching unity. The book covers various topics across linguistics, mathematics, astronomy, engineering, town planning, and architecture; it also shows the application of these ideas to health, psychology, and management. Apart from the careful study of motion, vibratory phenomena, acoustics, Indian sages studied the transforming power of fire. It was known that lightning bolts had electricity. Indian technology, which was quite advanced, was used in mechanical devices, engineering, art, and civil projects.

The phenomenon of consciousness is the frontier from the perspectives of biology and physics; it is also central to answering whether machines will become conscious. The Upanishads speak of two kinds of science: one about things and concepts and their mutual relationships (*aparā vidyā*); the other about consciousness (*parā vidyā*). The book will also serve as an excellent foundation for those who wish to investigate how the Indian tradition of consciousness science can be harnessed for further scientific advance and the betterment of the world.

Professor Subhash Kak
Regents Professor
School of Electrical and Computer Engineering
Oklahoma State University–Stillwater
USA

Foreword
by S. Sadagopan

I have gone through this book in detail and it has been an *enriching, fulfilling* and *satisfying* experience. The authors have done an outstanding job covering a whole gamut of things, yet with sufficient depth, to avoid a superficial survey.

The authors have addressed the contributions to Foundational knowledge, Science, Engineering & Technology, and Humanities & Social Sciences through a structured classification. **IKS** (Indian Knowledge System) have evolved over centuries, in fact, over millenniums. It has a wide range, and the well-known among them being **Astronomy**, including planetary movements, solar-centric world, shape and diameter of the Earth; **Health and Well-being**, including plants & herbs, surgical procedures; **Mathematics and Computing**, including the discovery of zero, decimal system of numerals, and approximation algorithms for computation of Pi; **Languages and Linguistics**, including Panini's Sanskrit grammar; **Metallurgy,** including steel-making and zinc-smelting; and **Public Administration**, including Good Governance and Taxation.

Thanks to the Royal patronage over centuries, there was a system where scholars could study IKS throughout their lives without worrying about their daily livelihood. This led to several Schools of thought, often expounded by several principal works, notably, *Brahmasutra Bhashya* by **Sankaracharya**, *Sri Bhashya* by **Ramanujacharya**, *Gita Bhashya* by **Madhwacharya**, *Mulamadhyamakarika* by **Nagarjuna**, and *Pramana Samucchaya* by **Dignaga.** Several cities and towns could house thousands of scholars leading to Centres of learning, for example, **Kasi** in the North and **Kanchi** in the South. Institutions of learning, including **Nalanda** and **Takshashila,** paved the way for graduating generations of scholars.

Particular mention must be made of the many texts in IKS that are referred to in the footnotes at the end of the chapters. For most people, IKS works stop with *Ramayana*, *Mahabharata* and *Srimad Bhagavatam*; Patanjali's *Yogasutras* on **Yoga**, Sayana's *Sayana Bhashya* on **Vedas**, Bharata's *Natyasastra* on **Dance**, Kautilya's *Arthasastra* on **Economics**, Vishnu Sharma's *Pancha Tantra* **Stories,** Sushruta's *Sushruta Samhita* on **Medicine and Surgery,** and more recently Panini's *Ashtadhyayi* on **Sanskrit Grammar** that caught the attention of Computer Scientists. I particularly like the references to the less known and equally impactful works like *Rasa Ratna Samuccaya* that details complex **Metallurgy**, *Aryabhatiya* and Varahamihira's *Brihat Samhita* on **Astronomy**, *Shulba Sutras* on **Geometry,** *Lilavati* of Bhaskaracharya a treatise on **Mathematics**, Gautama's *Nyaya Sutra* on **Logic**, Kanada's *Vaiseshika Sutras* on **Ontology,** Narada's *Shilpasastra* on **Architecture** and **Civil Engineering**, Mayamuni's *Mayamata* (**Architecture**), Bhoja's *Yuktikalpataru* (**Ship-building**), and, Kshemasarma's *Kshemakutuhalam* on **Dietetics and Well-being**.

Most of these works were set in the Sanskrit language widespread across the country. With the higher education system switching completely to the English language over the past two centuries (more so after Indian Independence in 1947 CE), IKS became inaccessible to most Indians. There has been sporadic interest in the IKS, particularly from Western scholars, in specific areas, thanks to pioneering efforts of individuals; for example,

♦ Swami Vivekananda and BKS Iyengar – Indian Philosophical Systems and Yoga
♦ Pandit Ravi Shankar and MS Subbalakshmi – North Indian and South Indian Classical Music

Yet, for most University students in India today, IKS is not in their consideration set!

It is against this backdrop that the study of IKS (Indian Knowledge System) is an idea whose time has come. I am delighted that AICTE & UGC are making efforts to support scholars and textbook creators in the IKS domain.

I had a personal brush with reality when I was looking for an authentic and widely available text of Rig Veda that I realized that the Indian tradition was largely "oral". I ended up creating the first-ever digital edition of Rig Veda through the book *Rig Veda Samhita*, SAKSI, 1998.

This book by Professor Mahadevan et al. is a timely release, particularly in the Post Covid-19 World, when India plays a leading role in the science of discovering vaccines and managing distribution and logistics. It makes IKS accessible to a much larger set of readers, notably University students. The book is interspersed with illustrations and context setting "action points". It provides ample opportunities for further exploration through the pointers for further study that include several authentic works and Websites. I am sure the additional material provided through the companion website will make the book a place that young readers will visit multiple times.

Happy reading!

Professor Sadagopan
Chairman, BoG, IIITDM-Kancheepuram
Founder Director, IIIT-Bangalore

Preface

India is a nation with a long civilizational history with recorded history, cultural artefacts, and evidence pointing to more than five millennia of existence. Not surprisingly, such a society would have discovered enormous knowledge cutting across various dimensions of human life and existence. Despite a continuous onslaught of foreign invasions for more than a millennium, the knowledge practices have more or less remained intact and have been passed on from generation to generation 'orally'. There have also been attempts to record the knowledge and practices in written form in the last millennium. However, during the last 200 years, this knowledge has been relegated to the background and the knowledge paradigm of the West has been imposed on the Indian society. Even after Independence, no concrete efforts were made to introduce indigenous knowledge in the educational curriculum formally.

However, knowing the thinking patterns and the knowledge repository created by the forefathers provides great value for any society. It enables the current generation to understand the thought processes and frameworks, and synthesize new knowledge. Arguably, no society can hope to flourish by simply severing itself from its past and embracing alternative ideas alien to the indigenous thoughts and practices. After some time, the need to revisit will be strongly felt, and the Indian society is currently going through such a phase.

The policymakers and the government have taken cognizance of this and have taken several steps to address this requirement. One of the steps is to introduce a course on the Indian Knowledge System (IKS) in higher educational institutions. Unfortunately, we do not have a textbook to teach this course. This textbook responds to this growing need felt by the Indian society at large and is primarily intended to facilitate offering a one-semester or two-semester course on IKS to undergraduate and graduate-level students. This textbook is a culmination of our efforts to offer a two-semester course on IKS in Chinmaya Vishwavidyapeeth, Ernakulam.

ORGANIZATION OF THE BOOK

This book seeks to fill in the gap for offering a required course on IKS, recently mandated by AICTE. The proposed textbook seeks to introduce the epistemology and ontology of IKS to the Engineering and Science students in a way they can relate, appreciate and explore further should there be a keen interest in the matter. Moreover, the New Education Policy (NEP) has also provided a clear trajectory for imparting IKS in the higher education curriculum, necessitating a book of this kind in several higher education institutions in the country in the days to come.

The book presents the topics in a two-part study of IKS. The first is to develop an overall understanding of some key components of IKS. The second aspect is the application of IKS for some gainful use. Specific areas of applications can be studied in a focused manner by drawing the relevant portions of the IKS showcasing the potential for practical application either in theoretical advancement of concepts or practical use in addressing some issues that we may face either as an individual or at an institutional level. The book presents these aspects in four parts:

- ♦ Part I: Indian Knowledge System: An Introduction
- ♦ Part II: Foundational Concepts relevant for Science, Engineering, and Technology Applications
- ♦ Part III: Specific Concepts related to Science, Engineering, and Technology
- ♦ Part IV: Humanities and Social Sciences Applications

The details of the chapters and the topics discussed in the chapter are schematically presented below.

Part I Indian Knowledge System: An Introduction	Part II Foundational Concepts in IKS for Science, Engineering and Technology	Part III Science, Engineering amd Technology in IKS	Part IV Humanities and Social Sciences in IKS
1. Indian Knowledge System: An Overview	5. Linguistics	8. Mathematics	13. Health, Wellness and Psychology
2. The Vedic Corpus	6. Number System and Units of Measurement	9. Astronomy	14. Governance and Public Administration
3. Philosophical Systems	7. Knowledge: Framework and Classification	10. Engineering and Technology: Metals and Metalworking	
4. Wisdom through the Ages		11. Engineering and Technology: Other Applications	
		12. Town Planning and Architecture	

Although the book has been primarily developed for use by the engineering institutions, the structure and the contents lend itself easily to address the requirement in other University systems (Liberal Arts, Medicine, Science and Management) for such a book. Chapter 1 of the book provides these suggestions.

UNIQUE FEATURES

One approach taken to present IKS has been to lay clear emphasis merely on the 'content' of IKS. Therefore, efforts were made to present the 'what' of IKS rather than the 'why' or 'how' of IKS. The application, implications, and practical relevance of IKS are often left for self-introspection by the students. Another approach is to merely showcase the practical relevance of IKS. However, to impress that IKS has application potential, the material is presented with generous and sweeping extrapolation and innovative interpretations. We have taken a

middle path and have made special efforts to present IKS in a contextually relevant fashion by delicately balancing the 'why' or 'how' of IKS and the 'what' of IKS. Moreover, the textbook follows International best practices by incorporating several pedagogical features that will make learning effective and enjoyable for the students.

Chapter summaries, review questions, and exercises at the end of the chapters help students check their progress in comprehending the subject matter. Besides this, Multiple choice questions are also available at the companion website (https://www.phindia.com/ introduction_to_indian_knowledge_system) for this textbook.

However, following features are also provided to make the process enjoyable for both the teacher and the student:

IKS in Action: This feature enables the students to develop an early appreciation of the subject matter being discussed and provides a context where the ideas discussed in the chapter have application.

IKS IN ACTION 9.1

Astronomical Gifts from the King of Benares to the Prince of Wales in 1876

The Prince of Wales toured India during 1875–76. During this time, the Mahārāja of Benares, Sir Ishwari Prasad Narayan Singh gifted some astronomical instruments to the Prince. The astronomical instruments were prepared according to the descriptions in *Siddhānta-śiromaṇi* (Bhāskarācārya, 1150 CE). Table 9.1 has the details of the instruments presented by the Mahārāja.

The Mahārāja also presented scale models of the masonry astronomical instruments found in the 'Hindu Observatory' at Benares. This observatory was one of the five set up by Sawai Jai Singh II, the king of Jaipur, in the 1720s at Jaipur, Delhi, Mathura, Ujjain and Benares. The model of the observatory of Benares was made in silver and sissoo-wood.

The Mahārāja presented a clock, showing the signs of the Zodiac, phases of the moon, dates of the month, days of the week, hours, and minutes. It is supposed to be a model of a larger clock of the same kind in the inner court of the Ramnagar Fort. This unique clock was made by Mulchand, the State clock maker and it provides several chronological and astronomical information. It shows not only correct time of day but also the position of the sun and phases of the moon together with the signs

TABLE 9.1 List of Instruments Gifted

1	Digaṃśa-Yantra	For finding the degrees of Azimuth of a planet/star
2	Dhruva-Prota-Cakra-Yantra	For finding the degrees of declination of a planet/star.
3	Yantra-Samrāṭ (King of instruments)	For finding the distance (in time) from the meridian and the declination of a planet/ star, and of the Sun.
4	Bhitti-Yantra (A Mural Quadrant)	For finding the Sun's greatest declination and the latitude of the place.
5	Viśuvad-Yantra (Equinoctial Circle)	For ascertaining the distance (in time) of the Sun, or of any star from the meridian.
6	Phalaka-Yantra	An instrument for finding the time after sunrise (invented by Bhāskarācārya).
7	Cakra-Yantra	For finding the altitude and zenith distance of the Sun, the longitude of planets.

Rich Illustrations: The chapters are dotted with several illustrations by way of figures and tables that help concisely summarise complex concepts and facilitate easy understanding and retention by the students.

Source: https://commons.wikimedia.org/wiki/File:Illu01_head_neck.jpg

FIGURE 5.2   Origin of Sound from the Oral Cavity—An Illustration
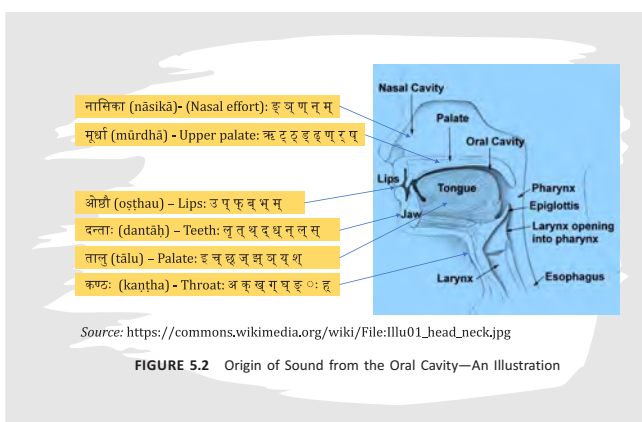
Discover IKS: Every chapter has an end-of-the-chapter feature that points to useful videos on some of the concepts discussed in the chapter. The videos are actual illustrations, existing artefacts, or expert opinions. Students are encouraged to go through the video and prepare a report of their understanding of the ideas presented. Students can develop applied learning, appreciation of concepts, and their relevance to practice.

DISCOVER IKS

1. India's contribution to mathematics has been a subject that has attracted considerable attention in recent times. Several attempts have been made to inquire into this issue. Watch this video produced by BBC, titled, *History of Indian Mathematics, Part-1* by pursuing the link: https://youtu.be/pElvQdcaGXE. After watching the video carefully, prepare a write-up to answer the following questions:
   (a) What are the main contributions of ancient Indians to the number system?
   (b) What is the importance of the number '0'? How does it contribute to science?
   (c) What are the contributions of Brahmagupta in use of numbers in mathematics?

2. It is often mentioned that India's contribution to the world of mathematics is the number zero. This leaves an impression there is not much other than this contribution. On the contrary, there are significant contributions by ancient Indians in a number of areas of mathematics that has led to the development of mathematical thought and applications in a significant way in the West. Watch the talk by Prof. C.K. Raju on the topic, "Not just the Zero – India's gifts of mathematics and science to the world", by pursuing the link: https://youtu.be/22uZ3D5AgaE. After watching the video, prepare a three-page note that covers answers to the following questions:
   (a) Was India's contribution to Mathematics merely the number zero or something more? Enumerate the other salient contributions and their significance.
   (b) What are the salient aspects of Mādhava's sine table (kaṭapayādi)? What is the importance of sine table?
   (c) What is the value of traditional knowledge in mathematics? Do we need it?

Opening Vignette: The beginning of every chapter has an opening vignette, which helps develop a clear set of expectations with respect to the topics discussed in the chapter. It also generates early interest in the topics covered in the chapter.

LEARNING OUTCOMES

After finishing this chapter, you will be able to:
▸ Develop familiarity with the Science, Engineering and Technology (S & T) heritage of ancient and medieval India
▸ Understand the role of archaeological, and other evidence in assessing the S & T heritage of India
▸ Understand about ancient Indian pursuits in the area of metal and metalworking and idol making
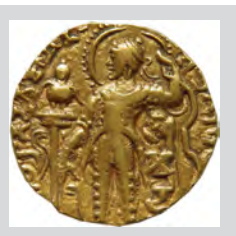
This is a gold coin of the Gupta king Samudragupta (330–376 CE) kept at the British Museum. Samudragupta, with halo, standing facing left, wearing cap, decorated coat and trousers and earrings, holding a spear in left hand and making an offering with right hand over altar. In left field is a Garuda standard with ribbons and crescent above.

Stamping such coins with intricate details requires knowledge of mining, extraction of Gold and further metal forming techniques such as die casting.

Source: https://commons.wikimedia.org/wiki/File:SamudraguptaCoin.jpg

Endnotes: Material for the textbook has been drawn from several original sources and research papers. To establish authenticity and enable the students and the teachers to access the original sources of information, these have been listed at the end of every chapter.

ENDNOTES

1. For a good account of this refer to **Dharampal (2021).** "Indian Science and Technology in the eighteenth century: Some contemporary European Accounts", Dharampal Classic Series 2, Rashtrotthaana Sahitya, Bengaluru.

2. See for example this extract from Chamaka Praśna — ... हिरण्यं च मे ऽयश्च मे सीसं च मे त्रपुश्च मे श्यामं च मे लोहं च मे … hiraṇyaṃ ca me 'yaśca me sīsaṇi ca me trapūśca me śyāmaṃ ca me lohaṃ ca me ...

3. तिग्मं चिदेम महि वर्षो अस्य भसदश्वो न यमसान आसा । विजेहमानः परशुर्न जिह्वां द्रविर्न द्रावयति दारु धक्षत् ॥ tigmaṃ cidema mahi varṣo asya bhasadaśvo na yamasāna āsā | vijehamānaḥ paraśurna jihvāṃ dravirna drāvayati dāru dhakṣat || Ṛgveda Saṃhitā 6.3.4

4. तद्यथा लवणेन सुवर्णं सन्दध्यात्सुवर्णेन रजतं रजतेन त्रपु त्रपुणा सीसं सीसेन लोहं लोहेन दारु दारु चर्मणा ॥ tadyathā lavaṇena suvarṇaṃ sandadhyātsuvarṇena rajatā rajatena trapu trapuṇā sīsa sīsena lohaṃ lohena dāru dāru carmaṇā || **Swami Gambhirananda (2003).** "Chāndogya Upaniṣad", Advaita Ashrama, Kolkata, p. 308.

5. लोहितेन स्वधितिना मिथुनं कर्णयोः कृधि । अकर्तामश्विना लक्ष्म तदस्तु प्रजया बहु ॥ lohitena svadhitinā mithunaṃ karṇayoḥ kṛdhi | akartāmaśvinā lakṣma tadastu prajayā bahu || Atharvaveda 6.141.2

6. को अस्मिन्नापो व्यदधात्विषूवृतः पुरूवृतः सिन्धुसृत्याय जाताः । तीव्रा अरुणा लोहिनीस्ताम्रधूम्रा ऊर्ध्वा अवाचीः पुरुषे तिरश्चीः ॥ ko asminnāpo vyadadhātviṣūvṛtaḥ purūvṛtaḥ sindhusṛtyāya jātāḥ | tīvrā aruṇā lohinīstāmradhūmrā ūrdhvā avācīḥ puruṣe tiraścīḥ || Atharvaveda, 10.2.11

7. For a detailed report on this, please see, **Srinivasan, K.R. (1958).** "The Pallava Architecture of South India", *Ancient India,* **14,** pp. 114–138.

8. For more details on this and issues addressed in this section see, **Deva, K. (1959).** "Temples of Khajuraho in Central India", *Ancient India,* **15,** pp. 43–65.

9. For more details on this and the other issues addressed in this section see, **Singh, P.K., Dey, P., Jaina, S.K. and Mujumdar, P.P. (2020).** "Hydrology and water resources management in ancient India", *Hydrol. Earth Syst. Sci.,* **24,** pp. 4691–4707.

10. https://en.wikipedia.org/wiki/Stepwell Last accessed on Oct. 1, 2021.

11. **Jain—Neubauer, J. (1999).** "The stepwells of Gujarat ", *India International Centre Quarterly,* **26**(2), pp. 75–80.

Suggested Readings: A list of additional readings has been provided at the end of every chapter to help the students pursue further studies in the topics covered in the chapter. It also helps the teachers prepare effectively the topics covered in the chapter.

SUGGESTED READINGS

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Our work in developing a textbook for IKS is perhaps the first of its kind. IKS is a generic phrase that covers practically everything pertaining to India. For a nation with more than 5000 years of recorded history, defining what constitutes IKS is itself a huge challenge. Literature, oral knowledge, societal practices, and knowledge assets in all Indian languages will technically fall under the ambit of IKS. We have taken a certain view on what constitutes IKS to make it manageable for a university-level course. We are aware that alternative views can be taken on this issue. We believe that our work will encourage other authors to bring more textbooks taking alternative perspectives on IKS.

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B. Mahadevan
Vinayak Rajat Bhat
Nagendra Pavana R.N.

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Guide to Transliteration Symbols Used in the Book

All Sanskrit words used in this book are presented using roman scripts as transliteration. The transliteration schema used in this book is based on International Alphabet of Sanskrit Transliteration (**IAST**). IAST is a transliteration scheme that allows a lossless romanization of scripts as employed by the Sanskrit language. The details are given below.

Vowels

अ	a	उ	u	ॡ	ḷ	ओ	o
आ	ā	ऊ	ū	ॡ	ḹ	औ	au
इ	i	ऋ	ṛ	ए	e	०ं/अं	ṃ/aṃ
ई	ī	ॠ	ṝ	ऐ	ai	०ः/अः	ḥ/aḥ

Consonants

क	ka	च	ca	ट	ṭa	त	ta	प	pa
ख	kha	छ	cha	ठ	ṭha	थ	tha	फ	pha
ग	ga	ज	ja	ड	ḍa	द	da	ब	ba
घ	gha	झ	jha	ढ	ḍha	ध	dha	भ	bha
ङ	ṅa	ञ	ña	ण	ṇa	न	na	म	ma

य	ya	र	ra	ल	la	व	va	श	śa
		ष	ṣa	स	sa	ह	ha		

Others

क्ष	kṣa	त्र	tra	ज्ञ	jña	श्र	śra	ऽ	'

Part 1

INDIAN KNOWLEDGE SYSTEM
AN INTRODUCTION

1 Indian Knowledge System: An Overview

After finishing this chapter, you will be able to:

▸ Understand and appreciate the importance of ancient knowledge to a society

▸ Understand the term 'Indian Knowledge System' (IKS)

▸ Familiarise with the key components of the IKS

▸ Develop some appreciation of IKS historicity

Built by Raja Raja Chola I. The construction was completed in 1010. This is one of the earliest granite temples in the world. Around 60,000 tons of granite is said to be used to build the temple. It has one of the tallest vimānam (temple tower) and its kumbham (the structure on the top) weighs approximately 80 tons.

Source: https://upload.wikimedia.org/wikipedia/commons/7/7d/Brihadeeswarar_Temple_Full_View.jpg

IKS IN ACTION 1.1

Do We Need Indian Knowledge System?

There is a question ruminating over our minds, "Why should we bother so much about Indian Knowledge System (IKS)?" IKS is not about merely knowing about some ancestral knowledge. If we closely follow the emerging patenting regime and the economic power arising out of a knowledge society, it becomes clear that the issue merits serious attention. It is about protecting received wisdom, economic security, and national pride.

Efforts by an international coalition of environmentalists to get the US patents on products of the neem tree cancelled did not fructify. We all know that we use neem leaves to keep away insects from our kitchen garden. Every farmer in India knew for time immemorial that it was a good pesticide among other things. Yet, a few years ago, a US company was awarded a patent for neem as a pesticide. The company claimed it had developed an agent that would make the active pesticide agent in neem last for more than the normal two weeks. Although our scientists had been tinkering around with research on neem for years, they had not applied for this specific process and the battle was lost. Nor we were able to bring our vast knowledge system to argue against the case. The patenting of traditional remedies from developing countries became a global issue after patents were granted for neem.

On the other hand, after a legal battle for more than a year India's Council of Scientific and Industrial Research (CSIR), has successfully forced the US Patent and Trademark Office (PTO) to revoke a contentious patent it granted two years ago to researchers in the United States on the use of powdered turmeric (Curcuma longa) for wound healing. The turmeric patent was granted in 1995 to two researchers, Soman K. Das and Harihar Kohli of the University of Mississippi Medical Center. Their six patent claims covered the oral and topical use of turmeric powder to heal surgical wounds and ulcers.

Turmeric is a native Indian plant, and Indians have been using it for centuries for wound healing. With the support of several documents including books on home remedies and Āyurvedic texts, CSIR was able to argue the case. Das and Kohli contested CSIR's objections, but the patent office rejected all their claims. The patenting of indigenous knowledge by foreign corporations is a cultural threat to countries like India as well as an economic one. The case of turmeric is a perfect example since it plays such an extensive role in India's culinary and health practices, among its other uses.

As the turmeric patent case makes it evident, the current patent system seems to allow biopiracy. Patents on Neem, Amla, Jar Amla, Anar, Salai, Dudhi, Gulmendhi, Bagbherenda, Karela, Rangoon-ki-bel, Erand, Vilayetishisham, and Chamkura all need to be revoked based on the logic that these are part of Indian indigenous knowledge and 'prior art'.

India's fight for the turmeric patent was necessary to uphold 'national pride' and to dispel unfounded fears that India was incapable of protecting its traditional knowledge base. The then CSIR's director, Dr. Mashelkar highlighted the importance of documenting traditional knowledge, to provide evidence of prior knowledge. Our scientists and technologists need to wake up and focus their efforts on building scientific data on many of these traditional knowledge treasures that we possess and work towards getting them patented. Knowledge of IKS becomes critical in this journey.

Source: Jayaraman, K.S., US patent office withdraws patent on Indian herb. Nature 389, 6 (1997). https://doi.org/10.1038/37838 and several other reports available on the Internet.

India is a country with a long-surviving civilisational history and practice known to mankind. While the modern western scholars date the civilisation to at least 5000–8000 years, the indigenous sources and belief systems in India date the civilisation to a very ancient period, almost time immemorial. Notwithstanding these differences, a country with such a long history ought to have accumulated some knowledge over its long period of existence. There is an impression in contemporary society that all knowledge that we benefit from has originated from the West. Since the western civilisation is of relatively recent origin compared to Indian

or other civilisations such as the Chinese and the Egyptian, this also implies that all knowledge is of recent origin. This idea is counterintuitive and illogical.

Human beings are inherently knowledge generating in nature endowed with unique capabilities. By using the power of discrimination, reasoning, and rational thinking, human beings constantly process the newly acquired knowledge. Therefore, it is not surprising that a rich repository of knowledge accumulated in the Indian subcontinent and manifested in terms of traditions and practices. One or two examples help us understand this aspect. Indians were good in steel making until the 17th century. The Indian 'wootz' steel was used to manufacture what was famously known as 'Damascus blades' and despite several attempts by the metallurgists in the past, it was not possible to replicate the properties of the wootz steel. Indian's contributions in the fields of Number Systems, Mathematics, and Astronomy in the first millennia of CE contributed to several other developments. These ideas were percolating into the West via the Arabic countries, and they ought to have influenced the scientific developments in the West beginning 15th century CE. Unfortunately, in our current educational system, we do not have an inkling of the nature of the contributions made by the Indians. This raises several questions. Where has all this knowledge gone today? Have we lost this knowledge totally? Is it of no use or interest to us today? Is there a sudden loss of continuity? What has caused this?

As many of us are aware, the ancient knowledge in India was preserved and transmitted 'orally' until a few centuries back. There was an uninterrupted lineage of 'Guru–Śiṣya' that took responsibility for the preservation and transmission of knowledge down the generations. Quite often, the teacher-student was a father-son combination and a group of related family members. These people formed a clan, who preserved the knowledge, practiced it by making a living, and transmitted it to their offsprings. The use of print media in recent history and the palm leaf scripts earlier have served to formally capture this oral knowledge and store it.

♦ Indians were extraordinary in steel making until the 17th century. The Indian 'wootz' steel was used to manufacture what was famously known as 'Damascus blades'.

♦ Due to major changes in the educational system in India introduced about 200 years back, there was a rather abrupt end to the process of knowledge transmission.

Unfortunately, due to major changes in the educational system introduced in India about 200 years back, there was an abrupt end to this process of knowledge transmission and the continuity is mostly lost. The newly introduced educational system demanded the society acquire only such knowledge as made available through the educational system. Those who aligned themselves to the new educational system were assured of jobs and salaries by the ruling class. Arguably, it would have taken about 50 years for most of the population to abandon old ways of doing things and come 'on board' the new system that promises economic prosperity. Once this transition happened, the oral transmission dwindled dramatically, created a sudden void and loss of continuity, thereby confining the knowledge to whatever was available in palm leaf manuscripts and other archives and personal collections.

We have continued with the British system of education in independent India, by keeping the ancient knowledge repository out of consideration. Therefore, today's formal educational system in India has, for historical reasons partly attributable to the British policymakers on education, has kept the ancient Indian knowledge heritage out of the reach of the education system, arguably citing reasons of lack of rigour and scientific value. This textbook is an effort to bring snippets of the Indian knowledge by providing a fresh relook at the corpus and culling out relevant portions that may generate renewed interest in the subject and motivate several to engage in a study of the knowledge repository of interest.

1.1 IMPORTANCE OF ANCIENT KNOWLEDGE

Ancient knowledge is the accrued knowledge over several generations and preserved in formal and informal means. Formal means include documented knowledge and informal means include shared values and practices through oral traditions. Sadly, as explained above, ancient Indian knowledge has been relegated to millions of palm manuscripts lying scattered all over the country and it is gathering dust. While several scholars are engaged in the process of bringing the hidden knowledge out of these manuscripts by researching and republishing such works, it does not match the scale required to make a meaningful impact. It is a herculean proposition to uncover the knowledge and bring it to the attention of modern society. On the other hand, the oral traditions continue in some rural pockets and are at the threat of getting extinct for want of patronage. The question in front of us is, "Does any society need to preserve, protect and pass on the ancient knowledge to the future generations?"

♦ If the underlying knowledge systems are abruptly withdrawn from society, the cultural practices will be rudely jolted.

♦ Ancient knowledge provides a head start to a society to march on the highway of innovation and new knowledge creation.

The thinking patterns and the repository of knowledge created by the forefathers in any society enable the current generation to understand the thought processes and frameworks of the previous generations. It will allow them to analyse the received wisdom in a contemporary context and identify new opportunities to assimilate the accrued wisdom and synthesize new knowledge. Therefore, keeping the current generation in the dark about the contributions of the ancestors is an inefficient, and a short-sighted option for society. Ancient knowledge serves multiple roles for society. Figure 1.1 schematically captures these.

FIGURE 1.1   Importance of Ancient Knowledge

Identity

The quintessential value that ancient knowledge brings to society is the identity it provides to fellow members of the society. Essentially it defines the context for several aspects of the day-to-day living of every individual. The social practices and norms have continuity as most

of them are transmitted from generation to generation through practices and supporting knowledge repositories. Therefore, preserving this knowledge and baton passing them on to the next generation is an important step for contemporary society. In the absence of this continuity, individuals lose their conviction on several living practices. They lose their ability to 'meaning making' of much of the knowledge. Eventually it challenges one's own identity and that of the society.

Culture

Culture has several dimensions. In a direct sense, it is the manifestation of human intellectual achievement regarded collectively by society over time. From a social perspective, culture is nothing but the set of ideas, customs, and behaviour of society. In other words, culture provides a sense of identity at a societal level by providing a common medium for communication and the transaction of ideas. The prevailing knowledge and the literary traditions play a significant role in shaping the culture of the society. If the underlying knowledge systems are abruptly withdrawn from society, the cultural practices will be rudely jolted. It may create distortions and discontinuities in societal progress.

Received Wisdom

Knowledge and innovation are in a continuum. Innovation and new knowledge creation in any society is 'path-dependent'. What it essentially means is that the road travelled so far determines the future path. Without the continuity of thoughts, it is very difficult to make further progress in terms of new ideas. The other equally important issue is the risk of reinventing the wheel. When the benefit of prior knowledge and the thought process is lost by society, it will lead to reinventing the wheel, making innovation and new knowledge creation inefficient. In this context, ancient knowledge plays the valuable role of 'received wisdom' and provides a head start to a society to march on the highway of innovation and new knowledge creation.

Economic Value

One of the compelling arguments in support of the ancient knowledge systems is the huge potential it offers from an economic value standpoint. The emerging world order puts greater emphasis on knowledge society. The prevailing 'military power' will give way for 'knowledge power' and such nations who demonstrate the superiority of knowledge traditions are bound to lead the rest of the world. Transforming knowledge into economic value has been fully formalized with the global intellectual property rights regulations and patent laws. Therefore, the ancient knowledge system will be beneficial to a country like India (see IKS in Action 1.1 at the beginning of the chapter for an illustration of this idea).

Let us see an example to understand this aspect. The US patent and trademark office granted patent rights on knowledge of the usage of pigeon pea extracts for treating diabetes, hypoglycemia, obesity, and arthero-sclerotic cardiovascular disease (clogged arteries) to Insmed Inc, based in Richmond in Virginia. The company claimed its novelty in the invention of pigeon pea extracts for treating these diseases. In the patent applications, Insmed

- ♦ The prevailing 'military power' will give way for 'knowledge power' and such nations who demonstrate the superiority of knowledge traditions are bound to lead the rest of the world.
- ♦ Unless we preserve the ancient knowledge, we will not be able to prevent the spillover of our economic value arising out of our ancient knowledge.

acknowledged only a handful of uses of pigeon peas in traditional medicines by citing some references of journal articles that appeared in 1957 and 1968 that describe the effects of pigeon pea and its extracts on blood sugar. The patent application did not include references to the traditional use of pigeon peas in the treatment of the mentioned diseases.

Pigeon pea (botanical name *Cajanus cajan*) is commonly known as arhar or red gram in India. There are several instances of the use of pigeon pea extracts in traditional medicines in India. A study of plant medicines by researchers in the department of pharmacology at the All-India Institute of Medical Sciences (AIIMS) tested pigeon pea extracts as they are used to treat diabetes in Ayurvedic medicines. The scientists at the Council of Scientific and Industrial Research (CSIR) observed that there is a need to gather strong evidence from our traditional texts to challenge such patent rights. Unless we preserve and be aware of the ancient knowledge, we will not be able to prevent the spill over of our economic value arising out of our ancient knowledge[1].

1.2 DEFINING INDIAN KNOWLEDGE SYSTEM

Indian Knowledge Systems (IKS) is a generic phrase that covers practically everything about India. For a nation with more than 5000 years of recorded history, abundant cultural and archaeological artifacts, literature, and social and community practices defining what constitutes Indian Knowledge is itself a huge challenge. Literature, cultural and social practices, historical evidence, and other such knowledge assets available in all Indian languages, dialects, and geographical regions will all technically fall under the ambit of IKS. The other aspect of the issue is the time dimension. Knowledge is continuously synthesized by any society. Knowledge assets available in India from the pre-historic times to the current day will all qualify to be part of the IKS. Therefore, it requires an unambiguous scope for defining IKS for this book.

Arguably, IKS can evoke different meanings to different stakeholders. The term IKS has three words in it. To better understand what we mean by IKS in the context of this book, we shall analyse each of these words separately.

Indian

By this term, we mean the indigenous sources of knowledge generated by the Indian society. The current political formation called 'India' is of recent origin and it alone does not qualify to be called 'Indian'. The term 'Indian' points to the undivided Indian subcontinent (Akhaṇḍa Bhārata). We mean the geographical area spanning from Burma on the east to modern-day Afghanistan in the west and Himalayas in the North to the Indian Ocean in the south. This region has common cultural, literary, and social practices, and has witnessed a continuous exchange of people, and ideas among them throughout the history of undivided India. Despite several political formations and princely states ruling this entire region for the last several hundred years until the consolidation begun from the 16th century CE, the society was unified under the common umbrella of social practices. Cāṇakya could get educated in Takṣaśilā in the western part of the sub-continent and be instrumental in establishing a powerful Mauryan empire with Pāṭalīputra as the capital in the Eastern part. Similarly, Pāṇini, a Sanskrit Grammarian from Gāndhāra in the North-Western corner of undivided India (now in Pakistan) could influence the thinking of people in the entire country on the Sanskrit language.

A second aspect to this is only such knowledge synthesized, codified, and made available by the 'Indians' is considered Indian knowledge. This implies that they ought to have been part

of the Indian subcontinent, born and lived there, and are part of the knowledge system in an integral fashion. This is especially important because India witnessed several foreign travellers who visited its universities, stayed for some time and wrote about the country, the knowledge, and cultural practices. These have significantly contributed to the export of this knowledge to the west and other parts of the world. For example, some reports have extensively studied the role of such authors in taking mathematical thinking to the west via the Arab world[2]. These are considered as 'about IKS' rather than IKS itself.

Knowledge

The second component of IKS is the 'knowledge', which is always tacit. It primarily arises in the form of the wisdom of the knowledge seekers. It is obtained by the insights gained by personal experiences with life situations, facing problems, and coming up with means of solving them. At other times, one obtains knowledge by means of intense observation of events, experimentation, conjecturing, and analysis. Knowledge may or may not be converted to a literary format. The tacit knowledge can be preserved and transmitted through an oral tradition without loss. India has a rich tradition of folklore practices even to date, that belongs to this category. While both these forms of knowledge are equally important and valuable it is impossible to formally study knowledge transmitted through oral traditions. Therefore, by 'knowledge', we mean in this book, a formal repository of knowledge available in literary sources.

The tacit knowledge gained by a seeker is eventually transmitted systematically in the form of some 'explicit' knowledge. This happens by way of proposing a new theory, framework, or literary work. Furthermore, knowledge pervades all three domains: spiritual, religious, and others addressing social and day-today issues. We can summarise the term 'knowledge' as that emanating from the wisdom and insights arising out of deep experiences, observation, experimentation, and analysis and validated, improved, and augmented further.

System

By 'System' in IKS, we mean a structured methodology and a classification scheme to access the available corpus of knowledge. By its inherent nature, knowledge could be accessed in any manner depending on the interest, purpose, and capacity of the seeker. For an uninitiated, this vastness could throw a challenge as the seeker may be clueless as to where to begin and how to proceed. Therefore, the available knowledge needs to be collected, grouped, and arranged logically. Codification and classification of the available knowledge using a definite framework would constitute one dimension of the word 'System' in IKS. The other important requirement is the interconnection between the part of the knowledge in the classification framework. The framework used to represent should also provide some logical relationships between the different parts of the proposed framework. This helps easy understanding of the overall contribution of the knowledge and how the different components of the knowledge complement each other. We take up this issue for discussion in the next section and present a systematic approach to classifying IKS for this book.

1.3 THE IKS CORPUS — A CLASSIFICATION FRAMEWORK

There are many ways to define and identify what constitutes IKS. For example, one approach is to merely pick the important topics representative of the knowledge corpus such as the Vedas,

Yoga, Vāstu, Śilpa Śāstras, Āyurveda, Buddhism, and Jainism to define IKS. Another approach is to select phrases such as Indian Psychology, Indian Arts, Dance, and Architecture and put together related works into it to construct IKS. These examples bring out the components of IKS. However, whether they will qualify to be a good framework for IKS depends on their ability to meet the requirements of a classification framework for IKS.

The usefulness of a classification framework depends on three factors: completeness, compactness, and inter-connectedness.

- ♦ *Completeness* ensures that all important components of the IKS are included in the proposed framework. If significant omissions are found in the classification, it makes the IKS non-exhaustive and non-representative.
- ♦ *Compactness* indicates the efficacy of the grouping of various topics in IKS in a congruent and logical fashion. This makes the representation simple, concise, and easy to understand and remember.
- ♦ *Inter-connectedness* brings logical relationships among the various sub-classifications. The classification framework will identify how the different components are logically connected. Thus, it presents a unified picture of the entire knowledge.

Closer scrutiny of the IKS knowledge repository provides us the following details:

(a) As already noted, the knowledge is available in both formal literary sources and informal non-literary sources.

(b) Among the literary sources, we can broadly identify three categories. One of the major sources is the Vedic and allied literature, which we shall designate as Sanātana-dharma literature, presented mainly in the Sanskrit language. This comprises the religious and philosophical part consisting of the Vedic and allied corpus, which forms the core and a good repository of other literature spanning areas such as sciences, architecture, and aesthetics. The second major source is the literature on other dharmic traditions. The third group is a large repository of knowledge in other Indian languages and dialectics.

(c) The non-literary source is predominantly available through a rich set of oral traditions found throughout the country.

Figure 1.2 pictorially presents the classification scheme based on the above observations. Let us see some details of these categories.

Sanātana-dharma – Core Literature

This comprises a vast repository of knowledge starting with the Vedas, known as Śruti. Although the Vedic corpus is oral in nature and is still transmitted using oral methods, these have been later systematically documented in written form. The Vedas are considered foundational by the Indian society and several important literary works were developed later, which substantially added to the Vedic corpus by facilitating better understanding and implementation of the ideas presented in the Vedas. This literature owed its allegiance to the Vedas and extracted their cardinal assumptions and principles from the Vedas. For example, six schools of philosophical thought, known as Darśanas developed their basic assumptions from the Vedas while stating their prescriptions. The Vedic and allied repository has several sub-components and divisions and is best understood from a classification methodology adopted, which we will see in the Section 1.4.
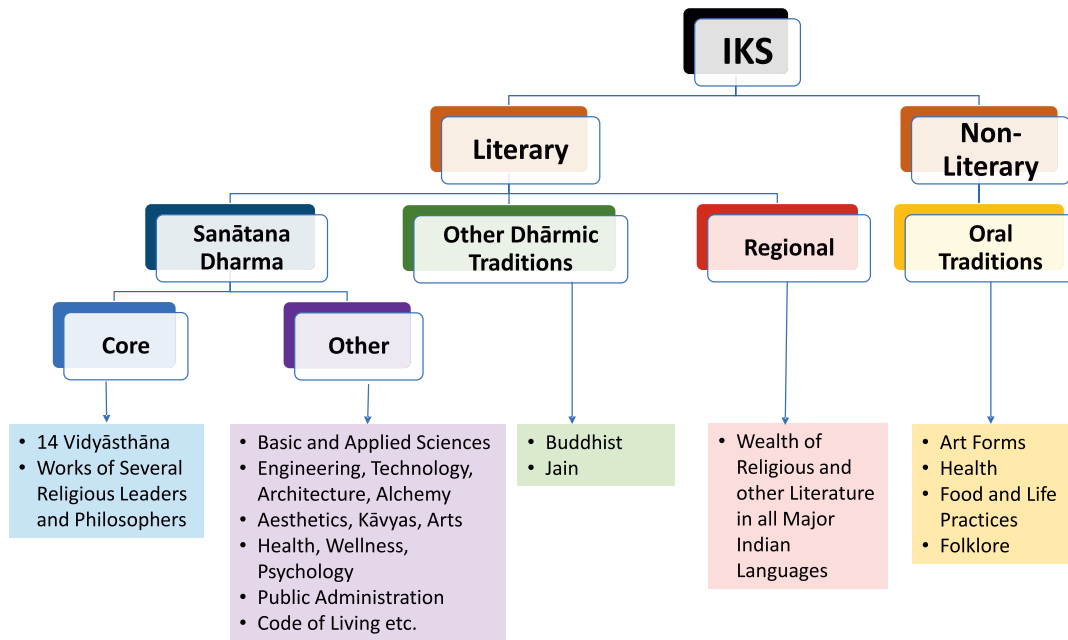
FIGURE 1.2   The IKS Corpus – A Classification Framework

Sanātana-dharma – Other Literature

The other literature consists of works that addressed key issues of day-to-day life such as health, wellness, science, engineering, technology that aided societal progress and development, and aesthetics and art forms. Although they were primarily addressing a variety of issues, they still owed their allegiance to Sanātana-dharma and acknowledged the core assumptions laid out in the Vedas as the ultimate source for valid knowledge and drew relevant ideas wherever it applied to their work. For example, the work on astronomy of Āryabhaṭa recognizes the ideas of what constitutes a year, and the notion of four yugas from the Vedic corpus while proceeding with specific discussions on the mathematical aspects.

   This literature flourished from the first millennia in the BCE and was continuously augmented by multiple works. Several areas were covered in this category, and the following are prominent among them:

♦ *Basic and applied sciences* (Mathematics, Astronomy, Plant Sciences). A series of studies were carried out continuously from the beginning of CE. Later works improved, expanded, and added new components to the existing knowledge repository as evident from the literary sources. We discuss these aspects in Chapters 6, 8, and 9 of the book in some detail.

♦ *Engineering and Technology* (Metalworking Technology, Shipbuilding, Dams and Watershed Management, Alchemy, Cosmetics, Perfumes, Dyes, Town Planning, and Architecture). The literature presents both evidence of these as well as specific ideas and techniques developed in many of these topics. Chapters 10, 11, and 12 look at these aspects of IKS.

♦ *Health, Wellness, and Psychology* addressed the crucial issue that we face in contemporary society. Three important works on Āyurveda (Caraka-saṃhitā, Suśruta-saṃhitā, and Aṣṭāṅga-hṛdaya) provide a wealth of information on health and wellness. Other related works dealing with alchemy such as Rasaratna-samuccaya provide information on āyurvedic formulations. The philosophical systems such as Yoga and Sāṃkhya and the Upaniṣads have discussed the issue of psychology. Chapter 13 of the book discusses the issues related to this theme.

♦ *Nīti-śāstras* is a collection of literature that informs the society of the good code of living through poetic verses and stories. The sāmānya-nīti deals with elements of good living, and the role of ethics and morality in life. Several life situations and wide-ranging topics are addressed through stories, parables, and short poetic works. The famous pañcatantra and the works of Bhartṛhari are some representative examples of this category of literature. An extensive collection of such ideas scattered in the various works is compiled into what is known as subhāṣitas. Chapter 4 of the book introduces glimpses of this literature. Another aspect of nīti-śāstra is the Rāja-nīti, dealing with public administration and governance.

♦ *Public administration* deals with the idea of governance of state and public policy measures required for administration. Manu-smṛti provides rich information on governance and administration. Arthaśāstra compiled during the 3rd century BCE is a seminal work and it triggered further works in the area. Notable among them is the Nīti-sāra of Kāmandaka. Chapter 14 of the book takes up this issue for discussion.

♦ *Aesthetics, Kāvyas, and Performing Arts* is another area with rich contributions. The Sanskrit language is the vehicle through which the entire knowledge corpus of the Sanātana-Dharma (both the core and the other) is presented. Linguistics and phonetics of the Sanskrit language is a fundamental work that sets the stage for rich literature development. Chapter 5 of the book introduces some concepts related to the Sanskrit language. Works of great poets such as Kālidāsa, Daṇḍin, and Bāṇabhaṭṭa, works such as Kāmasūtra of Vātsyāyana, and Nāṭyaśāstra of Bharata are some of the examples.

Other Dharmic Traditions

Other dharmic traditions have stayed out of the Vedic framework but have immensely contributed to IKS in the religious, philosophical, and other domains. Two of them, the Buddhist and the Jain literature are noteworthy, and they have contributed right from 500 BCE to IKS. While the religious and philosophical part of the literature is based on the respective tenets of the school of thought, other literature has applications in areas of science, technology, and other areas.

Buddhist literature has dealt with the religious concepts in its canonical texts. However, there are several Buddhist works in which many issues such as mathematical concepts, maritime activities and alchemy are also discussed. The work of Nāgārjuna, Rasaratnākara in the 1st century CE is an early contribution to alchemy. The Jain sacred literature consists of canonical texts. They considered mathematics as an integral part and have dedicated 'Gaṇitānuyoga', a portion of their literature to mathematics[3]. Tattvārtha-sūtra, composed by Umāsvāti during 2nd–3rd century CE is an important Jain literature. Some popular Jain texts dealing with mathematics include Anuyogadvāra-sūtra, Vyavahāra-sūtra, and Sūrya-prajñapti. Mahāvīrācārya's work, Gaṇita-sāra-saṃgraha (850 CE) is one of the important contributions to the development of mathematics in India.

Regional Literature

The separation of regional languages in this figure is only convenience. Ideally, it could be included under Sanātana-dharma. Indian subcontinent has a rich and diverse mix of cultural and linguistic variations. The 8th schedule of the Indian constitution has listed 22 languages of the country. In each of these languages, there is a huge corpus of religious, philosophical, and other literature. For example, Tamil literature has several contributions in the Sangam period (first millennium BCE). Several of the works in the regional literature have drawn from the Sanskrit resources and have either explained them in detail in the chosen regional language or extrapolated them further with some more ideas. The new literature created broadly follows the Sanātana-dhārmic literature and utilises the basic framework laid in the Sanātana-dharma literature. The sheer volume and vastness of the regional literature introduces constraints in drawing substantially from this corpus for the present book.

> ♦ The Buddhist and the Jain literature have contributed significantly to IKS right from 500 BCE.
> ♦ The 8th schedule of the Indian constitution has listed 22 languages of the country and in each of these there is a huge corpus of sacred and other literature.

Oral Traditions

The diversity of cultural practices and regional preferences have paved the way for oral traditions to preserve and transmit knowledge across generations. These have been primarily in the form of folklore artistic endeavours, skilful jobs, food and life practices, and health. The 64 Kalās mentioned in the IKS literature are mostly skill-based and artistic chores that are orally transmitted.

Sanskrit has been the dominant language for transacting knowledge for a long time in India. Therefore, for the purpose of the book, the main sources of knowledge to discuss various aspects of IKS are drawn from the Sanskrit literature. As we have already seen, the Sanātana-dharma literature, the Jain and some of the Buddhist literature are presented using Sanskrit as the medium of language. The choice of a Sanskrit-based knowledge repository does not imply that similar knowledge was not available in other regional languages in the country. However, as noted earlier, the process becomes complex and unwieldy to present all these in a single book. The other aspect for inclusion is that the knowledge shall be quoted, cross-referenced, and acknowledged by the indigenous people in the domain. This provides internal consistency and validation of the knowledge by the indigenous society.

The other issue that merits attention is, "how recent a history we must include in the definition?" The culture of new knowledge creation is an unhindered process in the country until the early 19th century. However, beginning the 16th century CE, there has been a wave of invasions in the country, introducing newer dimensions and priorities in society. Therefore, there is a greater focus to preserve the existing knowledge repository. Further, beginning the 16th century the ascend of the Western knowledge systems and scientific discoveries had its influence on the native knowledge practices also. Therefore, the knowledge sources dated up to the 16th century CE are mainly considered for the purpose of this book.

1.4   CATURDAŚA-VIDYĀSTHĀNA

A classification framework for the Sanātana-dharma literature as we have defined in the previous section is available within the resources itself[4]. In this framework, the literature

Introduction to
INDIAN KNOWLEDGE SYSTEM
Concepts and Applications

B. Mahadevan || Vinayak Rajat Bhat || Nagendra Pavana R.N.

This textbook is a culmination of multiple efforts of the authors to fill in the gap for offering a required course on Indian Knowledge System (IKS), recently mandated by AICTE. Moreover, the New Education Policy (NEP) has also provided a clear trajectory for imparting IKS in the higher education curriculum, necessitating a book of this kind in several higher education institutions in the country in the days to come.

The book seeks to introduce the epistemology and ontology of IKS to the Engineering and Science students in a way they can relate, appreciate and explore further should there be a keen interest in the matter. After a brief section on the key concepts of IKS, the remaining part of the book traces IKS and brings out the applications. After a formal and concise introduction to IKS, the book provides certain foundational concepts applicable across all domains of Science and Engineering. These form the second part. The Science applications are laid out in Part 3, Engineering applications in Part 4 and other important topics in the final part of the book.

The authors have rich expertise and background in both 'mainstream issues' and 'traditional knowledge' to present IKS in a contextually relevant fashion. They have delicately balanced the 'why' or 'how' of IKS and the 'what' of IKS. Although the book has been primarily developed for use by the Engineering institutions, the structure and the contents also address the requirement in other University systems (Liberal Arts, Medicine, Science and Management). This textbook incorporates several pedagogical features including a companion website **https://www.phindia.com/ introduction_to_indian_knowledge_system** that will make learning effective and enjoyable for the students.

ABOUT THE AUTHORS

B. MAHADEVAN, PhD (IIT Madras), is Professor at IIM Bangalore. As founding Vice-Chancellor of Chinmaya Vishwa Vidyapeeth (University for Sanskrit and Indic Traditions), he created a new generation of academic programs in the higher education space that seamlessly blends Ancient Indian Knowledge traditions with Contemporary Knowledge Systems.

Besides being on the advisory boards of several business schools and management journals in India, Professor Mahadevan has been playing a very significant role in the field of Sanskrit and Samskriti for the past 20 years. These include:

❍ Visioning and execution of Sanskrit promotion activities in India and abroad through a variety of roles in Samskrita Bharti, including being the President of Samskrita Bharati trust

❍ Shaping the trajectory of Sanskrit educational space in the country by providing thought leadership initiatives involving Sanskrit University Vice Chancellors

❍ Helping the Government in policy decision making through membership in Central Sanskrit Board and invited membership in Rashtriya Sanskrit Parishad

❍ Introducing Sanskrit and Samskriti to mainstream audiences such as the Top Management of Corporate and Management graduates at IIMB through seminars, elective courses and lectures

Professor Mahadevan was conferred the 'ICFAI Best Teacher Award' by the Association of Indian Management Schools in 2005. He was one among the 40 nominated globally for the 'Economic Intelligence Unit's (EIU) Business Professor of the Year Award', 2012.

VINAYAK RAJAT BHAT, PhD, is Associate Professor at Center for IKS, Chanakya University, Bengaluru. He has been teaching courses in Indic Knowledge Systems, Vyākarana, Āyurveda, Arthaśāstra for more than eleven years. Dr. Bhat has been honoured with Abhijña, Kovida and Chūdamaṇi in Vyākarana. He was trained under the guidance of the great scholars like Late Prof. R. Devanathan, Prof. B. Mahadevan, IIM Bangalore and Dr. Chandrashekhar Bhat, CSU.

He was appointed as Specialist Sanskrit Advisor for a project on 'Ayurvedic Man: Encounters with Indian Medicine' by Welcome Collections, London. He has written many articles in different areas of Indian Knowledge Systems.

NAGENDRA PAVANA R.N., PhD, is with the School of Vedic Knowledge Systems at Chinmaya Vishwa Vidyapeeth, Ernakulam. Dr. Pavana has been teaching major works of Vyākaraṇa śāstra and allied subjects for more than fifteen years. He has also worked with Vyoma Linguistic Labs and contributed to developing e-learning tools for various topics of Sanskrit.

Besides Sanskrit grammar, his other areas of interest are Sanskrit literature, aesthetics in Sanskrit Poetry, Indian philosophical systems, the Vedas and the Vedāṅgas.