RESEARCH PAPER

Integrating Indian Knowledge Systems (IKS) in Engineering Education: A Five-Layer Pedagogical Framework Aligned With NEP 2020 and Outcome-Based Education

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ABSTRACT
In this research, the feasibility and necessity for incorporating Indian Knowledge Systems (IKS) in modern engineering education are explored. While National Education Policy 2020 and the All India Council for Technical Education initiatives provide guidance, implementation is fragmentary and symbolic. Applying a mixed-method research strategy encompassing curriculum analysis, faculty interviews and student surveys, the research investigates institutional preparedness, infrastructural assistance and stakeholders' attitudes towards IKS implementation. Grounded in constructivist learning theory and Outcome-Based Education, this demonstrates how indigenous knowledge of architectural, hydrological, metallurgical, environmental engineering and mechanical engineering can reinforce current STEM education. The findings indicate a stubborn disconnect between the identification of IKS and sparse academic presence. A Five-Layer Pedagogical Framework is, therefore, advocated: initial exposure, organized electives, integrated case studies, technology-enhanced modules utilising Artificial Intelligence and Augmented Reality/Virtual Reality and project-led innovation. This model offers a flexible track for such meaningful integration without losing rigour. The research ends up situating IKS both as cultural heritage and as a civilisational knowledge base with the potential to render engineering education more ethical, culturally embedded and innovation-focused.
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1. INTRODUCTION

India's engineering and scientific heritage is one of the greatest in the world. Well before the dawn of industrialisation in Europe, Indian architects and engineers evolved sophisticated systems of water management, metallurgy, construction and sustainable living. Throughout the Indian subcontinent, there is an implicit grasp of engineering principles in ancient texts such as *Vaastu Shastra, SamaranganaSutradhara*and*Arthashastra* and in the gravity-based stepwells of Gujarat and sound-engineered temples of Tamil Nadu.

Unlike its rich intellectual past, contemporary engineering education in India is still highly disconnected from its heritage. The current curriculum, greatly influenced by colonialism, leans towards prioritising Western systems of knowledge while neglecting Indian contributions as out-of-date or non-scientific (Kumar, 2005). Technically competent engineers without cultural awareness have appeared, with their sophisticated computational capabilities, but a narrow interest in their cultural heritage.

This disconnection is not only historical but also epistemological. Students are shown to design, model and optimise systems, but seldom are they asked to consider how their historical counterparts came to solve intricate issues without today's tools. Questions of how ancient buildings were made thermally comfortable without air-conditioning or how hydraulic systems were created without electricity are generally dismissed. Such exclusion reduces engineering to systematic know-how rather than a considered and ethical profession, stripping it of the cultural insight and ecological awareness that originally resided inherent in it.

The National Education Policy (NEP) 2020 acknowledges this gap and supports the integration of Indian Knowledge Systems (IKS) into higher education. Its focus on interdisciplinary education, contextual relevance and

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sustainability provides a chance to reconnect engineering education with indigenous thought. But beyond policy intention, actual uptake of IKS in engineering is limited. Institutions are generally without strong frameworks, trained teachers and suitable resources to install these concepts meaningfully.

However, promising initiatives are underway. Various institutions, such as IIT Gandhinagar, the Sanskrit AI Lab at IIT Kharagpur and the Kumaraguru College of Technology, have initiated pilot courses and research initiatives to explore the incorporation of IKS into various technical disciplines. This is proof that knowledge from ancient times can be imparted with academic seriousness and modern applicability, provided it is backed by technology streams such as Artificial Intelligence (AI), Natural Language Processing (NLP) and Augmented Reality (AR).

IKS is not just a cultural artefact; it provides useful lessons for contemporary challenges. When engineering needs to react to global warming, ethical issues and sustainability, there are models in Indian traditions that are economically frugal, socially contextual and ecologically balanced. Gravity-based systems for water, buildings that are ventilated naturally and constructed with local biodegradable materials all come very close to international sustainability targets.

This research aims to fill the gap between Indian engineering education and its native origins. This manuscript looks into how engineering principles are being implemented on existing models, analyses their place in curricula, takes into account the perspectives of teachers and students and proposes a systematic process for integrating IKS, as is aligned with the OBE principles. It is not to idealise the past but to co-create an improved future where traditional knowledge is responsible for and enhances current practice.

2. LITERATURE REVIEW

2.1 Reassessing the Scientific Value of Indian Knowledge Systems

Indian Knowledge Systems (IKS) have often been misunderstood. Many still see them as mystical or mythological, especially in academic spaces shaped by Western thinking. However this view is changing. A growing number of scholars now highlight the scientific depth of IKS. Ancient Indian texts are rich in logic, observation and technology. They stand on equal footing with the knowledge produced in other advanced civilisations of the time.

Masterpiece books such as The Architecture of Manasara (Acharya, 2011), SamaranganaSutradhara (Kak, 2005) and The KautilyaArthashastra (Kangle, 2010) contain elaborate descriptions of load-bearing construction, water supply facilities and infrastructure planning for the masses with extraordinary clarity and accuracy. Physical artefacts also verify intellectual sophistication. The Delhi Iron Pillar (Balasubramaniam, 2000), Gujarat's geometrically optimised stepwells and South India's acoustically crafted temples are examples of a scientific tradition that is well embedded in culture, religion and practice of engineering. These are not just visual manifestations of artistic excellence, but rather careful systems of knowledge worthy of academically interested research.

2.2 Emergence of Academic Interest in IKS

Even two decades later, academic interest in IKS has grown from cultural curiosity to intellectual participation. Inter-disciplinary researchers have begun analysing the classical Indian science from the point of view of environmental sustainability, civil engineering, architecture and system design. Dharampal's (2000) account of pre-colonial systems of learning led the way to a larger vision of indigenous scientific rationality.

Researchers, such as Narayanan (2009), Apte (2020) and Ramasubramanian (2019), have all contributed significantly to translation, interpretation and analysis of engineering, water management and design reasoning in Sanskrit literature. Their studies validate that Indian treatises never offer philosophical constructs but consist of mathematical models, design blueprints and replicable engineering reasoning that aligns with modern STEM principles.

As the literature continues to grow, however, much of the research remains descriptive or archival. Bhatt (2018) and Mishra (2017) argue that the radical potential of this heritage will always remain unrealised unless Indian schools incorporate IKS into their curricula in pedagogically suitable and policy-compliant ways. They called for curriculum design systems, evaluation rubrics and teacher education programmes founded on Indigenous epistemologies.

2.3 Global Movements: Indigenous Systems in Contemporary Curricula

Indian transition towards IKS is only a part of a wider global movement to decolonise education and restore indigenous systems to the mainstream curriculum. Countries such as Australia, Peru, New Zealand and Canada have taken the lead in incorporating indigenous knowledge systems into technical training, not tokens of culture but practicable systems of applied science.

Environmental engineering programmes at Charles Darwin University and the University of Melbourne in Australia incorporate Aboriginal ecological principles (Dei, 2002). In Peru, Incan hydraulic engineering and terraced agriculture innovations are included in sustainable development units, as they express an appreciation of ecosystem patterns, which are context-specific. New Zealand's adoption of Māori values such as *Kaitiakitanga*(the Indigenous concept of environmental stewardship of the world) in architecture and resource management studies further confirms the pedagogical significance of indigenous science (Semali&Kincheloe, 1999). Even Canadian universities are catching on, weaving the Navajo concept of hózhó, think balance, harmony, looking out for your community, right into their engineering ethics. These global case studies are basically shaking up the old Eurocentric playbook and showing that education works way better when it's plugged into local cultures and real-world contexts. They also reassert that indigenous systems, rather than primitive or obsolete ones, can be resilient and regenerative alternatives to paradigms of modern technology.

2.4 Policy Momentum: NEP 2020 and IKS Integration

India's National Education Policy (NEP) 2020 is a watershed on India's education reform agenda and IKS is at its centre. The policy encourages the reinvigoration of Indigenous currents of knowledge, not additive modules but integral scholarly fields at every level of education.

NEP 2020 promotes multidisciplinary holistic education, mother-tongue-based learning and pedagogy that is culturally engaged and globally conscious. Specific mandates are the incorporation of IKS into higher education, the strengthening of Sanskrit and traditional arts and the setting of research agendas on Indian epistemologies (Government of India, 2020).

Consequently, institutional initiatives have indeed taken shape, albeit in a piecemeal fashion. The AICTE IKS Cell, optional courses in IIT Gandhinagar and Sanskrit-based AI research in IIT Kharagpur are all instances of initiatives to implement NEP's vision on the ground. However these are mostly localised, sporadic and subject to individual champions, not institutional drivers. There remains no centralised curricular framework, accreditation cycles and faculty development programmes holding back systemic adoption.

2.5 The Pedagogical Importance of IKS in Engineering

IKS not only offers more than additional content from a pedagogical perspective; it also comes with an entirely new cognitive and philosophical direction. IKS is constructed on the foundations of constructivism and encourages learners to build knowledge through culturally situated, experience-based, storytelling learning environments. Scholars such as Vygotsky and Bruner emphasise the learning of context-based knowledge, a process indigenous to Indian Knowledge Systems and one that often precedes modern educational thought. "Similes, metaphors and analogies drawn from Sanskrit express abstract engineering principles in plain English. Design templates from old Indian systems have a tendency to encompass principles of ecology like symmetry of energy, conservation of water and balance of heat. These characteristics not only add to the pedagogy of engineering but also provide an element of identity, stewardship of the environment and ethical consciousness."

Moreover, the combination of IKS with technologies like augmented reality (AR) and natural language processing (NLP) increases the use value and engagement quotient of age-old wisdom (Mukherjee & Rao, 2020). If one can visualise ancient devises in 3D, simulate temple acoustics, or decipher Sanskrit texts using AI-type tools, IKS goes beyond traditional conceptions into a tangible, experiential learning mode.

2.6 The Role of Technology in Facilitating IKS Learning

The technologies have also ushered in unprecedented opportunities for regenerating and disseminating IKS. Machine learning (ML) and artificial intelligence (AI), particularly natural language processing (NLP) technologies, are now being used to translate and contextualise ancient Sanskrit works of engineering with unprecedented precision. Tools such as SanskritBERT enable high-fidelity parsing of language and for the first time, it becomes feasible to convert ancient treatises into compelling course material.

Virtual reality and augmented reality (AR/VR) software are utilised to simulate ancient architecture as well as ancient systems of engineering. Descriptions of mechanical automata in texts such as *SamaranganaSutradhara* can be simulated by 3D modelling software. The models enable the student to prototype and test technologies of the past in project-based, experiential learning. Rather than fixing IKS in the past, such technologies place it as an interactive, dynamic and ever-evolving living system of knowledge utilising today's tools.

2.7 Gaps in the Literature

Despite growing momentum, several critical gaps continue to limit the full realisation of IKS in engineering education. The majority of investigations provide descriptive narratives or philosophical observations but do not have well-specified pedagogical models for systematic implementation. Second, only limited work traces the mapping of IKS with Bloom's taxonomy or connects IKS with Outcome-Based Education (OBE) principles. Third, few experimental works examined students' and teachers' attitudes, measurable learning outcomes, or IKS module assessment mechanisms.

Lastly, the lack of AICTE-compliant, credit-weighted curriculum templates restricts institutional confidence and scalability. Closing these gaps calls for an integrated effort towards curriculum design, policy assistance and technological facilitation. This study attempts to answer these gaps by outlining a five-layer pedagogical framework and its feasibility through case studies, feedback mechanisms and cross-discipline curriculum mapping.

3. RESEARCH METHODOLOGY

3.1 Research Paradigm and the Founder's Philosophical Foundation

The present study is rooted in the interpretive research paradigm that acknowledges that reality is constructed from social interaction, cultural context and subjective meaning. Since engineering education touches not only scientific ideas but also philosophical heritage, especially when IKS are at stake, a purely positivist or empirical approach would fall short.

The aim was not simply to measure awareness or track engagement levels, but to gain a deeper understanding of perceptions, identify areas of resistance and uncover potential within educational and organisational settings. The research was conducted using a qualitative-dominant mixed-method design, weaving textual analysis, institutional audits and stakeholders' views together into a multi-layered perspective of the research issues.

3.2 Research Design: Mixed-Method Exploratory Model

A three-level research design was used to triangulate data across textual, curricular and human levels. The initial component entailed textual and conceptual examination of seminal ancient Indian engineering and design treatises, with attention to teasing out and interpreting technical lessons latent in Sanskrit texts. The second component consisted of a curriculum audit carried out in five engineering schools, each with varying pedagogical models and levels of interaction with IKS. The third aspect of the design involved perceptual analysis, using data collected from structured surveys and semi-structured interviews among faculty, students and IKS scholars. This integrative approach allowed the study to attain thematic convergence and ensured internal validity at epistemological, practical and experiential axes. The focus throughout was on interpretive correctness, convergence with educational policy and academic viability, to make sure the end outcomes were grounded, scalable and pedagogically valid.

3.3 Data Sources and Sampling

a) Primary Textual Sources

The textual basis of this study is set upon a critical reading of foundational Sanskrit treatises capturing traditional Indian engineering wisdom. The *SamaranganaSutradhara* was examined for its mentions of mechanical machinery, such as self-working automatons *(yantras*), which indicate early concepts of movement, energy transmission and mechanical construction. The Shastra provided detailed insights into spatial direction, environmental degradation and thermodynamic and energy efficiency ideas, which are all very applicable to sustainable building practices today. Additionally, *Kautilya'sArthashastra* yielded design frameworks for urban planning, public infrastructure and civilian systems of governance, reflecting a civic engineering vision centuries before its time. Moreover, local architectural treatises like *Mayamata*and *Manasara* were investigated, resulting in elaborate elevation design rules, material usage and proportional geometry rules. Sanskrit scholars utilised annotated contemporary translations and commentaries to interpret these texts and they verified the technical components by employing engineering cross-mapping, particularly in areas such as airflow dynamics, symmetry, foundation load distribution and passive cooling techniques. During the research phase, the epistemic credibility of IKS as an engineering knowledge repository was established.

b) Institutional Curriculum Review

A curriculum review was implemented in four engineering colleges chosen for pedagogical variability and geographical distribution to study the level of IKS incorporation in modern technical education. The list includes the Indian Institute of Technology (IIT) Gandhinagar, which has been at the forefront of a progressive strategy involving IKS electives based on design thinking and liberal learning; Kumaraguru College of Technology, Coimbatore, which maintains heritage innovation labs that draw upon Tamil civilisational engineering traditions; the Sanskrit-NLP Laboratory in IIT Kharagpur, where computational linguistics research is being carried out to digitise and decrypt ancient texts and Sampurnanand Sanskrit Vishwavidyalaya, Varanasi, which maintains a richness of textual material with limited application in science and technology education. These institutions were chosen to capture the diverse levels of IKS engagement, ranging from non-formal curiosity to nascent integration. Curriculum audit permitted comparative insight into how far traditional knowledge has traversed from archival veneration to academic applicability.

c) Human Respondents

The study consisted of fifty-three participants in three different respondent categories. Eight respondents from the faculty cohort, selected from a variety of disciplines like civil engineering, mechanical engineering, AI and ML and Humanities replied. Their answer indicated different extents of exposure and willingness to incorporate IKS, which largely depended on interest and organisational support.

Three experts with the AICTE IKS Cell and other conventional institutions were approached through in-depth interviews to provide interpretative insights on Sanskrit sources and offer advisory feedback on adaptation. The student sample consisted of 42 third and final-year engineering undergraduates from civil, mechanical and computer science streams. To provide academic diversity and balance the gender distribution, we used stratified random sampling. Collective insights from these groups offered a rich, multidimensional view of IKS awareness, perceived curricular value and technological readiness for its academic implementation.

3.4 Instrumentation

a) Survey Instrument

A 15-item survey was conducted through Google Forms to obtain perceptual information from students. The survey employed a five-point Likert scale to establish the agreement levels in the various thematic areas. The survey covered respondents' general knowledge of IKS, their perceptions about the feasibility and practicability of incorporating IKS into major engineering curricula and their perceptions about the applicability of classical engineering principles to modern technological problems. The study further tested the students' preferences in learning methods, such as AR, VR and CBL models. The questions were designed to test attitudes towards sustainability, the ethical aspects of engineering and how indigenous science might play a role in future developments. Examples provided were: "IKS is of use to contemporary engineering problems", "I would rather learn historical machinery via AR-based pieces," and "IKS plays a part in the typical engineering curriculum." These answers helped identify differential student perceptions of IKS content and delivery modes and shed light on the range of potential current pedagogic conformity.

b) Interview Protocol
A series of semi-structured interviews was conducted among a purposive sample of academic staff and Indian Knowledge Systems (IKS) experts as a supplement to quantitative insights derived from the survey.

These interviews were intended to investigate thematic domains in greater detail and to register the intuitions in response that can not be elicited by structured surveys. The protocol covered five areas of specific attention: the feasibility and value seen in integrating IKS within regular courses in engineering; institutional and pilot study initiatives already in place; obstacles faced during curriculum development, faculty preparation and administrative support; the potential role of upcoming technologies like AI, NLP and AR to render IKS material available; and the aspirations of participants for wider integration of and sustaining IKS in mainstream technical education.

3.5 Data Analysis Tools and Techniques

a) Textual Analysis
Textual material was coded by theme to correlate Sanskrit concepts with their engineering equivalents. Words such as *Yantra*were equated to mechanical assemblies and *Vaastu* diagrams with civil engineering models of load distribution, passive cooling and energy harmonics.

b) Curriculum Mapping
A custom five-parameter scoring rubric was utilised to ascertain the extent of IKS integration in the institutional syllabi. Every parameter was assigned a score of 0 to 2, 10 marks for every curriculum. For systematically assessing the preparedness of the curriculum, a systematic five-parameter scoring rubric was used. The details are provided in the following table:

Table 1: Curriculum Scoring Rubric for Assessing IKS Integration

Sr. No.	Parameter	Scoring Scale
1.	Presence of the IKS content	0–2
2.	Interdisciplinary linkage	0–2
3.	Depth of the content treatment	0–2
4.	Assessment strategy	0–2
5.	Technology-aided delivery	0–2

This mapping presented a quantitative representation of curriculum preparedness and pedagogy richness.

c) Survey analysis
The answers to the survey were processed using embedded Google Forms analysis and exported to Excel for statistical processing. Descriptive statistics such as mean, median, mode and standard deviation were calculated to ascertain general trends and attitudes. Visualisation tools were used to generate charts of preference and frequency distributions.

d) Interview analysis
Nvivo 12 was employed to code the interview transcripts, the thematic categories that had been identified, such as "tech-enablement," "resistance through unfamiliarity," "institutional inertia," "cultural pride," and "visionary integration." Word clouds, co-occurrence charts and sentiment bar graphs were utilised to produce qualitative trends in visual form.

3.6 Validity and Reliability

A variety of methodological approaches were employed to ensure the thoroughness, validity and overall quality of the research outcomes. Data triangulation was first employed to cross-validate textual analysis, institutional curriculum audits, survey and interview results. This comparative approach helped to establish internal reliability and afford rich depth in interpretation for the study.

Three of the principal interviewees were subjected to member checking to ensure the validity of their replies, including the transcribed responses and inferences made from them. This not only guaranteed the qualitative data's validity but also ensured that ethical responsibility was upheld.

The curriculum scoring matrix utilised for gauging the incorporation of IKS between institutions was reviewed and validated by two peer scholars with an engineering education and curriculum development background. Their tweaks made the matrix sharper and way more useful.

Lastly, the student survey instrument's internal consistency was statistically tested with Cronbach's alpha ($\alpha = 0.83$), a standard measure of reliability. The resulting coefficient landed at $\alpha = 0.83$, which is pretty good. Basically, it means the survey questions actually made sense for what they were supposed to measure. The study's design and interpretation continued to be sound and valid.

3.7 Ethical Considerations

Ethical integrity was ensured at every step, sticking to the research process both nationally and within the institution. Everyone involved, faculty, students and experts, signed up with full consent before participating. Participants were explicitly made aware of the purpose of the study, their involvement and their right to withdraw at any time without penalty. The study was completely confidential by ensuring there was no personally identifiable information in the data collection instruments and additional reporting. This was to secure the privacy and anonymity of all the authors.

4. RESULTS

The following reports the main findings drawn from a multi-modal research design that incorporated textual analysis, institutional curriculum audits, faculty interviews and student perception surveys. The results are structured thematically to represent both the empirical trends and interpretive insights available from this triangulated design.

4.1 Engineering Concepts Embedded in Ancient Texts

A detailed reading of the ancient Sanskrit engineering texts uncovered a very high order of technical proficiency and design logic in fields ranging from architecture to hydrology, materials science and mechanical equipment. Not only did each text possess conceptual gravitas, but it also possessed empirical sharpness and systematisation at the level of contemporary engineering practice.

Vaastu Shastra prescribes passive strategies for loading distributions, solar orientation and ventilation, achieving ecological harmony long before scientists focused on sustainability. *SamaranganaSutradhara* refers to early machines and automata (*yantras*), including some exhibiting rotary motion ideas, concealed mechanisms and energy transmission in a forebodingly robotics-like pre-industrial world (Ramasubramanian, 2019).

Kautilya's*Arthashastra* contains recipes for road slopes, canal locks, town drainage and reservoir building, demonstrating high civil and environmental engineering knowledge. *Mayamata* and *Manasara* also outline concepts of proportionate harmony, sacred geometry and foundation making, marrying strength and beauty. These observations support the thesis that ancient Indian books are not a relic of history, but a valid source of engineering pedagogy, ready to be reactivated by contemporary curricula.

4.2 Review of Curriculum: IKS as an Elective but Not Integrated

A five-parameter tailored scoring matrix was employed to review the engineering curricula of the institutions under selection, with the highest achievable score being 10. This simple instrument facilitated assessment not just of the incorporation of IKS content, but also the extent and gravity of its integration into programmes of study.

The review revealed that IKS tends to emerge as bolt-on electives or seminar subjects, as opposed to being genuinely integrated into the mainstream engineering curriculum. Although some increased interest is reflected here, this remains symbolically significant. There is an evident need for a more systematic and reflective integration of IKS, so that it is embraced by mainstream learning and not relegated to the academic periphery.

Indian Institute of Technology (IIT) Gandhinagar scored 6 out of 10. IKS has been incorporated as an elective subject, especially given the integration of design thinking and liberal arts. Kumaraguru College of Technology scored 4 out of 10. Though there are lab facilities with a heritage setting and a facilitation area for casual project activity in the tradition of science, no study stream exists for IKS as yet. The IIT Kharagpur Sanskrit-NLP Lab scored a 5 out of 10. At present, the research at hand is using cutting-edge natural language processing techniques to translate and render Sanskrit texts, but its impacts are still isolated and yet to be incorporated into the engineering students' curriculum. Sampurnan and Sanskrit Vishwavidyalaya, Varanasi, was ranked with the highest 7 out of 10. It has a remarkable treasure house of Sanskrit literature that can be harnessed for innovation of the curriculum in the IKS-led course. Its reach to STEM fields is narrow and underdeveloped at present.

Lack of IKS content in orthodox core mainstream courses like Mechanics of Solids, Environmental Systems and Structural Analysis was a remarkable feature in all five institutions. There are no or negligible traces of the infusion of concepts from traditional Indian engineering ideas in these anchor courses. None of the institutions had introduced formal rubrics, outcomes-based evaluation, or credit-awarded IKS modules in their mainstream technology degrees. This lack of correspondence between policy intentions declared in the NEP 2020 and academic reality on the ground reflects a critical shortfall in operationalising IKS in technical education.

4.3 Faculty Interview Findings

Applying the five-parameter scoring rubric outlined in Table 1 (see Section 3.5), curriculum mapping was conducted to evaluate the level of Indian Knowledge Systems (IKS) integration. Semi-structured interviews of eight engineering and allied faculty members identified five overarching themes, capturing a terrain beset with both genuine enthusiasm and structural resistance towards mainstream IKS incorporation in academic curricula. The first of the recurring themes can be interpreted as "Curiosity meets Caution." Most faculty members indicated that students request discussions on traditional design concepts such as the acoustics in ancient temples or the water harvesting systems in ancient stepwells. These teachers were careful, however, regarding how such subject matter could be integrated into current curricula without a strong scholarly basis or pedagogical framework. Their enthusiasm was often stifled by a lack of clear curricular scaffolding, which resulted in these issues being left unanswered in systematically presented coursework.

The second subject, "Cultural Confidence," emerged with the pedagogic empowerment experienced in teaching ancient systems with modern tools. Some felt teaching *Vaastu Shastra* concepts with design software like AutoCAD to be a measure of intellectual and cultural reclaiming. The faculty viewed this blending of ancient learning and modern technology as a means by which students would be able to reconnect scientifically, philosophically and culturally with their past without compromising academic rigour.

The third theme uncovered a degree of systemic hesitation. “Many of the respondents were hesitant to formally make room for IKS in their curriculum where there are no AICTE-approved modules or template-standardized curricula. They had apprehensions about non-compliance with policy and accreditation requirements, which meant that top-down institutional intervention and explicit sanction through regulation was called for."

The fourth, "Technology as a Bridge," captured the excitement among the faculty to utilise immersive technologies to span engagement gaps. The majority of the instructors were resolute in supporting the utilisation of technologies like AR, VR and AI in contextualising and visualising IKS concepts. These were perfect platforms for realising access to ancient, often esoteric knowledge in a concrete learning environment that was also within the reach of the contemporary engineering student.

Lastly, the fifth and more serious issue was boiled down to the "Faculty Capacity Gap" theme. Members largely agree that although there is increased interest in IKS, a substantial faculty preparedness gap continues, especially in the interpretation of Sanskrit texts, bridging ancient concepts with STEM outcomes and designing related learning activities. This feedback points towards intensive Faculty Development Programmes (FDPs) on mastering content and adapting pedagogy.

The five themes together suggest that the institutional framework is more receptive to IKS than against. It also highlights the fact that implementation, if it has to succeed, will bank very strongly on strategic investment in academic infrastructure, capacity building and technological empowerment.

4.4 Student Survey Findings

A forty-two-strong survey by engineering undergraduates returned a generally positive image of Indian Knowledge Systems attitudes. The survey contained fifteen Likert scale statements and asked students' views on the relevance of IKS, their learning modality preferences and their willingness to see indigenous knowledge included in the core curriculum. Student survey results are presented in the table below, which highlight their perceptions of IKS and preferences for its inclusion in teaching:

Table 2: Student Perceptions of IKS Relevance and Preferred Learning Modes

Sr. No.	Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)
1.	IKS relevance to modern engineering	45%	38%	10%	7%
2.	I prefer AR/VR-based IKS learning	55%	40%	5%	0%
3.	IKS should be included in the mainstream curriculum	48%	35%	12%	5%
4.	Engineering should only focus on Western science	19%	22%	26%	33%
5.	I had never come across the IKS before attending college.	36%	17%	18%	29%

The total scores indicate an average agreement of 4.21 on a 5-point scale regarding the statement that IKS can be used for contemporary engineering problems, with strong agreement emerging as the modal response category. The standard deviation of 0.89 suggests relatively close clustering of opinion regarding the positive mean. When asked how they wanted to be delivered to, a majority of respondents, 52 per cent, selected augmented or virtual reality spaces as the most engaging mode of delivery and a further 27 per cent liked project-based learning. Above all, less than one-tenth of students thought that engineering education should not have indigenous knowledge, which translates to a very high level of pedagogical and cultural receptivity.

These figures together indicate that the present generation of engineers not only embraces but also very much favours Indian Knowledge Systems, especially when offered in an interactive, technology-based mode that suits their online learning habits.

4.5 Curriculum–Perception Gap Matrix

The degree of IKS integration in particular engineering fields on a scale of 0 to 10 and the value of IKS as expressed by key stakeholders, were two significant factors that were taken into account when developing a comparison matrix to examine how well academics and curriculum practice match.

Table 3: Curriculum–Perception Gap Matrix by Discipline

Sr. No.	Discipline	Curriculum Integration (0–10)	Perceived Value (0–10)
1.	Civil Engineering	3	9
2.	Mechanical Engineering	2	8
3.	Computer Science	1	5
4.	Architecture	6	9
5.	Environmental Engineering	4	8

The matrix reveals a paradoxical inconsistency. Civil and mechanical engineering disciplines, in which principles of hydraulics, materials science, spatial geometry and ecological design hold the highest relevance, reflect the lowest grades of curriculum adoption, rating three and two. These are the same disciplines where stakeholder interest and perceived relevance are highest, at ratings of nine and eight.

The curricular vibrancy of IKS in Environmental Engineering and Architecture is relatively strong, but even their scores indicate constrained institutional focus versus stakeholder demand. Computer Science unexpectedly demonstrates constrained IKS presence and lower value perceived; however, interest in topics like AI-aided text interpretation and computational linguistics in Sanskrit is increasing.

4.6 Further Observations

A number of the most insightful cross-cutting comments were an outcome of field observation and free-form participant commentary. The most frequently cited problem is most likely a language problem. Technical vocabulary in technical texts in Sanskrit is challenging for students and teachers alike, mainly because they necessitate specialised linguistic tools and education to comprehend and translate correctly in class.

Another dominant trend observed across all the participating institutions was an extremely high and consistent student demand for technology-based learning experiences. Turns out, students are digging hands-on stuff like AR, VR, AI-powered visualisations, 3D modelling apps, you name it. All these technologies were viewed not only as enhancing engagement but also as rendering abstract or difficult IKS concepts more accessible and experiential.

One of the striking trends was the gap between student curiosity and actual exposure, only 19 per cent of the interviewed students having experienced formal or credit-receiving material related to IKS in their engineering education, whereas 83 per cent indicated a wish to explore it further. This mismatch between access and curiosity calls for curricular change and technological intervention, particularly if IKS is to transition from cultural interest to pedagogic content within technical schools.

Key Takeaways

The findings of this study reveal some extremely significant observations that bring out the challenge as well as the opportunity in integrating Indian knowledge systems in engineering education. Firstly, there is a significant but latent interest in IKS both among the students and faculty. However, the latent potential of such interest is enormous since most of the current initiatives are dispersed and non-credit-bearing. The Institutional support systems have weak strength or are not established at all, making efforts futile in the long term. Second, research determines that technology must be viewed not as a supporting tool but as an integral facilitator of effective IKS pedagogy. Online platforms, like AI, AR, VR and NLP have prime roles in encapsulating indigenous knowledge into forms available to today's students. By and large, the research underscores the importance of having a scientific, results-based framework like the Five-Layer Pedagogical Model that offers a workable and scalable method for placing IKS at the centre stage, thereby making it a part of mainstream engineering curricula as a valid, dependable and innovative element.

5. DISCUSSION

5.1 Redefining IKS as Engineering Pedagogy and Not Nostalgia

The findings of this study categorically disprove the common belief that IKS are mere relics of cultural nostalgia or antiquarian fascination. Rather than leftovers from the past, IKS seems to be a body of science-based paradigms, emanating from empirical rationality, ecological wisdom and systems thinking. These systems, codified in ancient texts and built structures, tend to pre-empt the design principles now promoted under the banners of sustainability, biomimicry and climate-responsive architecture.

Recent policy initiatives, including the National Education Policy (NEP) 2020 and efforts by the All India Council for Technical Education (AICTE), have given an impetus to IKS integration, but its visibility in technical education is more symbolic, sporadic and subservient. In most of the schools of engineering, IKS is only a thematic interest, receiving occasional tokenism through electives or guest lectures, but not integrated into core pedagogy or credited courses.

This study, however, presents a different prospect. The intersection of student eagerness, teacher enthusiasm and technological preparedness presents a timely moment to reimagine IKS as a valid and revolutionary pedagogical material. Instead of promoting an artificial tension between tradition and innovation, IKS can arbitrate a conversation between received knowledge and modern innovation. Reframing this environment relocates engineering education from the mere transmission of technical knowledge to the development of a culturally sensitive, ethically informed and contextually aware subject that can create engineers who innovate with purpose, depth and responsibility.

5.2 Constructivism and Contextual Learning

The pedagogical value of IKS lies squarely in the lines of constructivist learning theories, particularly those constructed by Piaget and Vygotsky. Such theories highlight the requirement of learning that is anchored to past cultural and cognitive frameworks. IKS, as it is rooted in India's civilisational heritage, offers such scaffolding. For instance, while engineering students solve temple acoustics or step-well hydraulics, they engage dormant cultural knowledge that supports better conceptual understanding. Examples also place engineering issues in the context of actual, region-based scenarios and not only improve understanding but also retention and applicability.

5.3 Alignment with Outcome-Based Education

India's initiative towards Outcome-Based Education (OBE) as required by the All India Council for Technical Education (AICTE) is an extremely flexible and strategic window of opportunity for the successful integration of Indian Knowledge Systems (IKS) into engineering education. OBE sets focus on quantifiable outcomes in cognitive (knowledge), affective (attitudes and values) and psychomotor (skills and application) domains, all of which can be handsomely addressed by IKS-illuminated pedagogy. The values embedded in IKS translate point-for-point to the central components of OBE, as shown in the matrix below:

Table 4: Correspondence of IKS to Outcome-Based Education (OBE) Elements

Sr. No.	OBE Component	IKS-Linked Learning Outcomes
1.	Problem solving	Apply IKS concepts to design energy-efficient structures
2.	Ethics	Analyse ecological and moral frameworks within ancient systems
3.	Lifelong learning	Engage with traditional texts and evolving interpretations
4.	Communication	Articulating ancient innovations in modern engineering discourse
5.	Innovation	Rural technology prototypes based on traditional mechanical systems

Each of these areas presents a distinct opportunity for IKS to enhance learning outcomes. For example, problem-solving can be constructed by asking learners to design sustainable buildings from traditional architectural or hydraulic models. Ethical reasoning can be developed by learning about ancient engineering methods' philosophies of environmental consciousness. Besides, lifelong learning is promoted with ongoing reading of interpretive texts using intellectual and historical sensitivity. As the students master communication skills, they are able to communicate ancient innovations in contemporary engineering contexts while at the same time developing innovative mindsets through project-based learning that integrates prototyping technologies borrowed from indigenous systems.

5.4 National Education Policy- NEP 2020: From Policy Desire to Actual Implementation

The National Education Policy (NEP) 2020 offers a historic window of opportunity to universalise IKS in higher education, especially technical streams like engineering. Embracing culturally located, interdisciplinary and mother-tongue-based pedagogy, the policy foresees an Indigenous and inclusive framework of knowledge production, empowered with local relevance. Unlike this utopian imagination, the present study finds a jarring disconnection between policy intent and institutional action.

To bridge this gulf, IKS needs to be integrated beyond tokenistic inclusion into systematic changes in the curriculum. This involves setting clear and measurable learning outcomes from the study of IKS so that traditional knowledge is not reduced to anecdote or the elective.

Second, IKS modules need to be accredited and incorporated into mainstream programmes, not electives or extracurricular. An important part of this translation exercise is to create scalable models of curriculum that can be standardised yet have the flexibility to be applied in several institutions under the AICTE umbrella, right across the nation. Of equal significance is the use of technology to overcome barriers inherent in, most notably, the language and conceptual abstraction which normally come with Sanskrit-based material. The use of technologies such as augmented reality (AR), virtual reality (VR) and artificial intelligence (AI) can assist in overcoming these gaps, making it easy and interactive for digitally native learners to make that vision happen. NEP 2020 needs policies that aren't just pie-in-the-sky but doable, tech-savvy and rooted in real teaching.

5.5 Parallels to the Global Case: An Emerging Wave of Indigenous Integration

India's attempt to revive IKS is merely a component of an international trend to introduce indigenous knowledge into institutional school systems. Across continents, traditional knowledge is coming to be recognised as a viable source of scientific and pedagogical knowledge.

In New Zealand, the Māori principles of *Kaitiakitanga*(Indigenous concept of custodianship of the earth for environmental purposes) have been integrated into architecture and civil courses, emphasising ecological conservation and sustainable design (Smith, 2017).In Peru, Inca hillside agriculture and water engineering are now informing climate-resilient modules of engineering. In Australia, they are integrating Aboriginal eco-ideas into environmental engineering and in Canada, they are developing courses based on First Nations' integrated views of sustainability and ethics. Such international mashups demonstrate that science and culture can completely vibe. Rather than clashing, they enhance learning with local connections and global reach.

5.6 Five-Layer Pedagogical Framework for IKS Integration

From empirical data and institutional readiness estimated in this study, a Five-Layer Pedagogical Framework is proposed to facilitate efficient integration of Indian Knowledge Systems (IKS) into engineering education. This framework is specifically designed to be scalable, flexible and technology-responsive, enabling educational institutions to adjust the pace and scope of integration according to their resources while preserving the distinctiveness of a development plan.

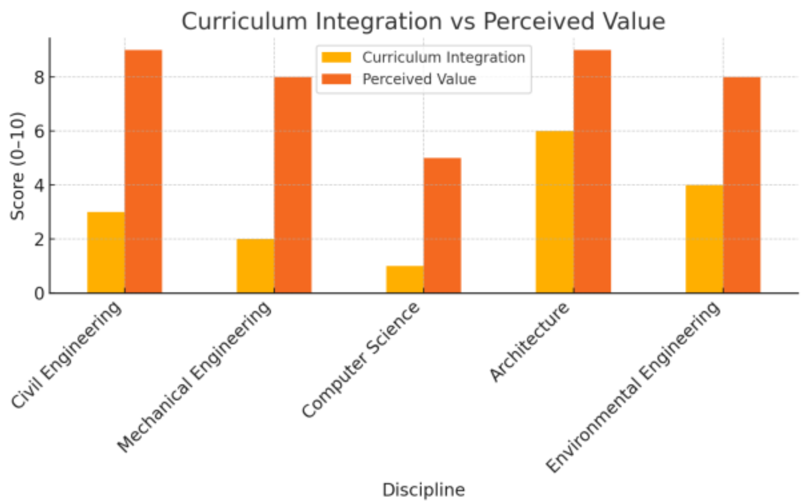

Figure 1: The Five-Layer Pedagogical Framework for Integrating IKS in Engineering Education

Five ladder rungs of a development sequence exploratory, elective, cross-curricular, tech-enhanced and project-based each representing a new threshold of learning. Successive levels deepen the infusion of IKS into engineering pedagogy, reinforcing academic scaffolding and context-bound creativity.

Table 5: Five-Layer Pedagogical Framework for IKS Integration

Sr. No.	Layer	Focus Area	Application in Practice
1.	Exploratory	Awareness and Exposure	Site visits to historical buildings, guest lectures and orientation programmes.
2.	Elective	Formal Credit Modules	Courses such as Ancient Machines, AI Intersections, Vaastu and Structural Logic
3.	Cross-Curricular	Embedded Case Studies	Integration with mainstream subjects (e.g., step-well hydraulics of fluid mechanics)
4.	Tech-Enhanced	AI/AR/NLP Tools	Mobile apps, AR simulations and Sanskrit text translators
5.	Project-Based	Innovation and Application	Final-year projects, inter-disciplinary hackathons and technology scaling frameworks for rural areas

The model begins with an orientation stage, during which students get acquainted with IKS through orientation sessions, guest lectures and site visits to heritage sites. It lays the foundation for the first level of awareness and curiosity regarding culture. The elective phase then consolidates this interface through formal credit courses in Vaastu Shastra, ancient automata, or computational logic from Paninian grammar.

On the cross-curricular level, IKS elements are put directly into technical core subjects, in which they function as contextual case studies. For instance, stepwells as historical hydraulic systems can be covered in Fluid Mechanics, or temple acoustics in Sound Engineering. This tech-rich layer makes them accessible and engaging through digital interventions, such as AI-powered Sanskrit translation apps and AR/VR-based visualisations, which link across learning platforms, bridging intellectual and linguistic gaps.

Finally, the project-based layer steers IKS into applied use and innovation. These include end-of-year engineering projects, rural deployment projects, interdisciplinary hackathons and design challenges that integrate indigenous knowledge with modern tools to create sustainable, locally appropriate technologies.

5.7 Emerging Technologies: From Manuscript to Machine

New technology has a major role in helping to overcome the obstacles that previously prevented the transfer of IKS. Numerous innovations already show how information and communication technologies can provide a bridge between medieval manuscripts and engineering education.

Artificial intelligence technologies such as SanskritBERT can translate Sanskrit shlokas into diagrammatic representations, enabling students to see concepts hidden before by linguistic complexity. AR and VR headsets simulate antique devices and architectural plans for immersive interaction with treatises like *SamaranganaSutradhara*.

NLP tools enable the semantic mapping of IKS vocabularies with existing engineering terminology and 3D printing allows students to create models of historic technology, making IKS both learnable and tangible. Such technologies not only bring the ancient up to date but also revive it, placing IKS at the forefront of interdisciplinary learning.

5.8 Cultural Engineering: Learning with Identity

In addition to technical competence, IKS offers something that engineering education in modern times does not: a cultural and ethical orientation. While curricula today are educating engineers on how to optimise and automate, they rarely educate them to stop and think about why, for whom and at what cost those systems are built.

IKS promotes a sense of respect for nature, principles of community and harmony essential to social justice and sustainability. IKS encourages ethical imagination with the urge to consider consequences, values and wisdom from the past. In so doing, IKS shifts engineering education from mechanistic training towards civilisational mentorship in preparing graduates not just to build machines, but meaning.

5.9 Returning to Research Questions

In reaching the analytical climax of its exploration, it now becomes imperative to revisit the original research questions that guided the inquiry. Leveraging text analysis, curriculum audits, surveys and faculty interviews, evidence, each question is now re-visited in an assessment of how well it has been covered. The table below consolidates findings:

Table 6: Consolidated Framework for IKS Integration in Engineering Education

Sr. No.	Research Question	Key Insight
1.	What are the core IKS engineering concepts?	Material science, hydraulics, energy-saving systems and structural geometry
2.	How are they portrayed in today's curricula?	Only offered as electives; no OBE alignment, rubrics, or official credit
3.	How do important stakeholders see it?	The most enthusiastic students and cautiously optimistic faculty
4.	What are the tools that effectively enable IKS pedagogy?	Mobile apps, 3D modelling software, AI, AR, VR and NLP-based Sanskrit translators
5.	Which model makes scalable integration possible?	The proposed Five-Layer Pedagogical Framework aligns with NEP 2020 and OBE principles

This integration establishes that although the intellectual and technological bases for IKS integration are promising, implementation remains contingent on structural, institutional and pedagogical alignment. Learning from this study reaffirms the worth of IKS as an engine of transformation in engineering education, both as content and as a culturally embedded methodology. This Five-Layer Pedagogical Model is grounded in advanced technology and outcome-based design and appears to be a practical and durable framework that can incorporate past knowledge and current academic goals.

5.10 Towards a New Civilisational Curriculum

The research builds towards a suggestion that stretches from curriculum structure into national academic philosophy: an appeal to move from superficial coverage of content towards true cultural convergence. In an era where global models of scholarship often dominate developing education systems, India is uniquely positioned to not only draw from others' frameworks but also contribute its own. Indian Knowledge Systems, if accompanied by pedagogical integrity and technological facilitation, have the power to transform engineering education as a professional undertaking that is not only technologically challenging but also ethically robust and culturally responsive.

If well implemented, IKS would restore traditional technology, which is inherently sustainable and suitable for the local environment. India could shift from just soaking up global knowledge to actually leading the charge and showing the world how to blend old-school wisdom with fresh, innovative thinking.

This kind of revolution would shift engineering education from a linear path along modernist ideology and towards becoming a spiral of inherited knowledge and ingenuity with a view towards the future. Respect where you came from and you will have a better shot at handling what is ahead and maybe, just maybe, build futures that are not just about concrete and steel, but about values and vision too.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study began with a hypothesis that, while initially sceptical, had not yet been thoroughly investigated: that Indian Knowledge Systems (IKS), typically found in classical texts or symbolic references, hold tangible pedagogical value for engineering. A multi-modal investigation suggests that IKS encompasses more than just cultural sentimentality; it incorporates robust frameworks for structural design, energy conservation, hydrology and materials science, all of which are relevant to contemporary engineering challenges. The issues of today's engineering.

The research results validate that these ancient systems are not esoteric artefacts but are scientifically sound and pedagogically implementable. The examination of root texts like *Vaastu Shastra*, *SamaranganaSutradhara* and *Arthashastra* identifies principles that can be transferred directly to contemporary learning outcomes. These documents enunciate design rationale, efficiency provisions and sustainability trends which match perfectly with contemporary global engineering concerns.

Even so, such potential was revealed to be starkly at variance with curricular and institutional rhetoric by the curriculum audit. IKS integration is still restricted to electives or workshops, albeit without systemic integration into mainstream engineering modules. Faculty responses reveal optimistic caution due to Institutional inertia or the absence of AICTE-approved frameworks. Students, on the other hand, exhibit strong receptivity, particularly when IKS material is presented via immersive, technology-based platforms.

In rebuttal, this research posited a five-layer pedagogical structure that supports IKS involvement through stages of awareness, formal learning, interdisciplinary incorporation, technology facilitation and innovation-led implementation. This framework provides a guideline to make sure that IKS not only gets mainstreamed but also quantifiable, contemporary and significant.

In the end, the research confirms that engineering education in India does not have to be imitative. By adopting IKS, the country can present a model of pedagogy where ethics intersect with engineering and heritage powers innovation.

6.2 Recommendations

To integrate Indian Knowledge Systems (IKS) meaningfully in engineering education, this study proposes a two-pronged strategy, one at the national policy level and the other at the institution-level implementation stage. They are both needed to move from symbolic actions to sustainable, results-based integration.

A. National-Level Policy Recommendations

At the national level, a massive transition from rhetorical support to systemic adoption. The All India Council for Technical Education (AICTE) requires that there should be at least one IKS-based credit-weighted course in every engineering course. For not compromising on academic rigour and pedagogical equilibrium, the course needs to be Bloom-aligned and outcome-based following Outcome-Based Education (OBE) standards. This alignment would also result in standardisation among universities while making learning outcomes measurable.

To steer this transformation, there must be a National IKS Curriculum Council under the AICTE or the University Grants Commission (UGC) umbrella. The council should centralise syllabus designing and standardisation, curriculum preparation, handbooks and create robust assessment rubrics for all fields of engineering. As a policy think tank and pedagogical anchor, the council will be able to facilitate that IKS content keeps pace with academic and technological developments.

Further, IKS curricula deployment must be preceded and followed by massive Faculty Development Programmes (FDPs). These must be implemented on a pan-India basis to make engineering educators familiar with IKS content, interdisciplinary pedagogy and technological applications. A collaborative model involving Sanskrit universities, Indian Institutes of Technology (IITs) and technical education institutions would be in a position to provide linguistic fidelity as well as domain relevance, thus empowering faculty to teach with depth and confidence.

B. Academic Institution Suggestions

Universities and colleges, however, must become the functional nerve centres of IKS integration. All engineering institutions must be equipped with an Institutional IKS Integration Cell with the mandate to spearhead curriculum development, initiate research projects, facilitate community outreach and incubate innovation. Contact with local historians, regional heritage architects and conservation experts will enrich IKS content and add regional context.

Institutions must create and sponsor interdisciplinary elective modules with both ancient knowledge and modern scientific fields. Stuff like Ancient Machines meets Modern Robotics, *Vaastu* for Green Design, or even geeking out over Sanskrit syntax in logic programming, these are not just cool topics; they actually show that ancient smarts can tackle today's challenges.

Secondly, institutions must integrate IKS into project-based curricula, particularly in end-of-year projects and capstone design subjects. Students can be motivated to pursue practical applications like passive cooling systems inspired by temple designs, or village irrigation systems based on step-well hydraulics. These projects will provide experiential learning while divulging the functional beauty and ecological insight inherent in IKS.

C. Technology and Innovation Recommendations

Technology acts as the key link between ancient wisdom and current pedagogy, offering the medium to translate, visualise and realise Indian Knowledge Systems (IKS) in current learning settings. To realise this potential, a series of targeted innovations and infrastructural advances is essential.

In the first place, learning tools tailored to IKS on the basis of cutting-edge technologies must be created at once. The collaboration among public research institutions and educational technology firms must be focused on the creation of AI systems that can comprehend and interpret Sanskrit engineering texts with high fidelity. Augmented reality and virtual reality (AR/VR) platforms must be utilised in an effort to visualise historic technologies described in ancient texts, such as temple acoustics, automata devices and ancient civil engineering designs. Besides, Natural Language Processing systems need to be trained in the creation of cross-language glossaries and semantic concept maps connecting IKS domains and current STEM fields to enable interdisciplinary synthesis and digital access.

To make these resources openly and inclusively available, it is recommended that a National Open Digital Repository be established. It would serve as one centralised point for digitised manuscripts, annotated translations, 3D printable models of historic devices (yantras) and AR-friendly visualisations. Open access commitments would make both teachers and learners capable of accessing and interacting with IKS content in a rigorous, hands-on and intellectually authentic manner.

Finally, to facilitate participation and mass adaptation for digital-native students, institutions can gamify learning the

IKS. Games and mobile applications can be made out of engineering challenges based on time-honoured design principles. Imagine students planning an entire city using Vaastu Shastra, or solving fluid mechanics puzzles inspired by stepwells, learning becomes a game. It keeps things exciting, helps ideas stick and closes the gap between old-school knowledge and next-gen engineering. Tech sits right at the heart of it, turning traditional wisdom into something interactive, alive and ready for the demands of 21stcentury classrooms.

6.3 Vision for the Future

The integration of Indian Knowledge Systems (IKS) into engineering education is not a cultural renaissance; it is a question of civilisational imperative. As India moves towards becoming a technologically dominant world power, sustainable and value-based innovation, its future engineers must inherit not only contemporary tools but also tried-and-tested traditions. This visionary educational method is born out of a meeting between ancient tradition and contemporary scientific understanding and offers an inventive vision instead of being a mere imitation.

The future imagined has engineers applying Vaastu principles to guide intelligent city planning and smart urban planning, reviving drought-stricken rural landscapes with ancient irrigation systems and studying temple acoustics to advance innovation in concert halls and auditoria. Computer scientists of the future can design AI systems based on the structural accuracy and aesthetic beauty of Paninian grammar, borrowing on design ethics founded on dharmic philosophies emphasising balance, responsibility and harmony with nature. These are not utopian imaginations but can be attained with great ease, considering the overlap of sane policies, creative teaching strategies and innovative technological breakthroughs.

The test of tomorrow is not the presence of knowledge, but the strength to institutionalise it, imagination to teach it and integrity to orient it according to world-class academic and industrial requirements. This is how India will be in a position to redefine engineering education as a discipline that solves but sustains civilisations.

6.4 Last Call: From Content to Consciousness

Learning should not just be a transfer of information, but a conversation between science and soul, innovation and tradition, information and dharma. Indian Knowledge Systems cannot continue to be relegated to the fringes of electives, museums, or manuscripts. They must be brought mainstream, institutionalised in teaching and reinterpreted through technology and research. Then alone can we pay them tribute not as leftovers of the past, but as blueprints for the future.

Let the bridges we construct not only bear the physical loads but also the values of civilisation. Let the circuits we develop not only bear electricity but moral intent. Let's not just send out engineers with toolboxes; let's make sure they have got some heart and heritage, a dash of innovation and a real drive to build a world that lasts.

Glossary

- **Indian Knowledge Systems (IKS):** Indigenous science, engineering, philosophy and education traditions embedded in India's civilisational heritage.
- **Vaastu Shastra:** A medieval Indian architectural treatise that aligns built spaces with natural forces, ensuring harmony between human life and the environment.
- **SamaranganaSutradhara:** An 11thcentury Sanskrit text by King Bhoja, covering architecture, town planning and mechanical devices (yantras).
- **Yantra:** Ingenious mechanical contraptions described in ancient texts, often powered by water, gravity, or intricate mechanisms.
- **Kautilya'sArthashastra:** A 4thcentury BCE treatise by Kautilya (Chanakya) on administration, economics and civic planning, still valued as a manual of statecraft.
- **Mayamata:** A Sanskrit text on temple architecture, laying down rules of proportion, design and construction.
- **Manasara:** A comprehensive treatise on town planning and architecture, rich in guidance on elevation, geometry and materials.
- **Paninian Grammar:** The formal and logical system of Sanskrit grammar devised by Panini, foundational for modern linguistics and computational models.
- **Panchakosha:** A philosophical model describing five layers of human existence body, energy, mind, intellect and spirit drawn from Samkhya philosophy.
- **Samkhya:** An ancient Indian school of thought that explains creation as the interplay between consciousness (Purusha) and matter (Prakriti).
- **Guru–ShishyaParampara:** The traditional Indian model of personalised education, where a student learns under close mentorship from a teacher.
- **Constructivism:** A modern learning theory that emphasises knowledge construction through experience, culture and environment.
- **Outcome-Based Education (OBE):** An educational approach that defines and measures learning through clearly stated outcomes in knowledge, skills and values.
- **National Education Policy (NEP) 2020:** India's landmark education reform, encouraging cross-disciplinary learning, rooted in culture and outcome-orientation.
- **AICTE:** The All India Council for Technical Education, India's statutory regulator of technical and engineering education.
- **AR/VR (Augmented/Virtual Reality):** Immersive technologies that recreate or simulate environments for example, modelling ancient engineering marvels.

- **AI (Artificial Intelligence):** Machine intelligence capable of interpreting, simulating and applying knowledge systems to novel problems.
- **NLP (Natural Language Processing):** A branch of AI devoted to analysing and processing human languages, including classical languages like Sanskrit.
- **SanskritBERT:** An AI model trained specifically for Sanskrit translation and interpretation, notable for its precision.
- **Stepwell:** Ingeniously designed Indian water-harvesting structures, using gravity and step-based descent to manage water sustainably.
- **Temple Acoustics:** Acoustic techniques in temple architecture that enhance sound clarity and resonance, especially for chants and music.
- **Kaitiakitanga:** A Māori philosophy of guardianship of the environment, often invoked in comparative studies on sustainability.
- **Hózhó:** A Navajo philosophy centred on harmony and balance, applied to indigenous design and engineering.
- **Bloom's Taxonomy:** A widely used educational framework for categorising learning objectives across cognitive, affective and psychomotor domains.
- **Five-Layer Pedagogical Framework:** A structured model for IKS integration into engineering education, progressing through exploratory, elective, cross-curricular, tech-enhanced and project-based learning.
- **Curriculum Audit:** A systematic review of curricula to identify the presence or absenceof Indian Knowledge Systems.
- **Faculty Development Programme (FDP):** Professional workshops designed to build teachers' capacity to teach IKS-related subjects.
- **Interpretive Research Paradigm:** A qualitative research approach that explores cultural contexts, subjective meanings and depth in pedagogy.

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