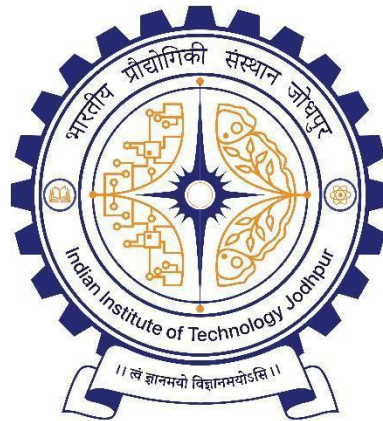


UG Curriculum  
for  
B.Tech. in Computer Science and Engineering  
Department of Computer Science and Engineering (CSE)



**Indian Institute of Technology Jodhpur**

## 1. Introduction

The traditional curriculum in Computer Science and Engineering (CSE) has focused on two major areas, i.e., theory and systems (viz. database, computer hardware, and operating systems). With the advent of the era of Edge Computing, Cloud Computing, Cyber Security, Artificial Intelligence (AI), and Big Data, the discipline has now transformed into one that is instrumental in solving major real-world problems faced by modern society such as healthcare, security, sustainability, and socio-economic challenges. The new B.Tech programme in CSE will prepare its students to tackle problems which are fundamentally multidisciplinary in nature, through the application of core Computer Science skills. Which in turn would enhance IIT Jodhpur's contribution to providing solutions towards an Atma Nirbhar and Viksit Bharat, and global Sustainable Development Goals.

The new curriculum in B.Tech. in CSE at IIT Jodhpur has aimed to be balanced in its theoretical and practical offerings, and is broadly organized around 3 focus areas:

- a) **Theoretical Computer Science** – To provide foundational knowledge in the design and analysis of algorithms for efficient problem solving.
- b) **Systems** – To provide skills (theoretical and hands on) for the comprehension, design and realization of effective computing systems; bridging the gap between software and hardware components.
- c) **AI / ML** – To equip students with expertise in the design and realization of trustworthy systems in a world that is increasingly being driven by AI and machine learning, and their many derivatives across domains.

## 2. Objectives Of The B.Tech. in Computer Science and Engineering (CSE)

The primary objective of the B.Tech. programme in Computer Science and Engineering (CSE) at IIT Jodhpur is to equip students to undertake careers involving challenges of working on real-world problems, while innovating, with their core competency in computer science. The curriculum gives due importance to the foundational aspects of computer science, as well as develops in students the necessary engineering skills for addressing emerging technological challenges. The programme offers flexibility in choosing elective courses for widening the understanding of emerging concepts and processes in different domains.

The programme aims to prepare graduates for the following primary roles:

- a) **Industrial pathway** – Be able to contribute to responsibilities involving application of skills like Software Engineering, Systems Design, and AI-driven technologies across domains (like finance, healthcare, education, security)
- b) **Entrepreneurial pathway** – Be employment providers and effective product designers by bridging Theoretical Computer Science, Systems Realization and AI Methodologies
- c) **Academic and research pathway** – Be capable of pursuing higher education and research in frontier areas like resource-constrained AI, trustworthy system design, high-performance computer architectures, cyber security, pervasive systems, effective human-AI co-creation, and quantum computing.

### 3. Expected Graduate Attributes

After completing this programme, a student is envisioned to develop the ability to:

- Apply appropriate knowledge in Computer Science and Engineering to identify, formulate, analyze, and solve complex engineering problems in order to reach substantive conclusions.
- Self-learn and engage in use of advanced computing tools.
- Develop sustainable computing solutions in broader economic, societal and environmental contexts.
- Think critically, creatively and analytically as a computer scientist, whilst being able to work effectively, independently and collaboratively as part of a team in research, technology development and entrepreneurial ventures.
- Apply evolving ethics and privacy laws across various domains and territories.
- Effectively communicate engineering concepts and ideas to peers in written or oral forms.
- Be motivated to engage in independent and life-long learning in the broadest context of evolving technological challenges.

### 4. Learning Outcomes

The student will have the ability to:

- Abstract computational models based on mathematical rigor.
- Critically analyse and appreciate emerging and applied fields of computer science owing to deeper understanding and strong foundations in theoretical computer science.
- Develop robust, secure, and efficient software systems that would involve software engineering, data structures, and algorithm design paradigms.
- Apply different concepts including digital design, computer architecture, operating systems, databases, networking, and applications for building solutions for real-world problems.
- Design and implement smart, intelligent, and user friendly interfaces for computer applications.
- Analyse, design, develop and deploy computer based systems in collaboration with domain experts for meeting societal needs in areas such as healthcare, safety, environment, law enforcement, transportation, etc., by exploiting tools and techniques of Big data, AI and project management.
- Communicate effectively by comprehending, documenting, making effective presentations and exchanging clear instructions.

### 5. New Skills Targeted

Students are expected to inculcate skills in:

- Designing and synthesizing digital computing systems for solving real world problems
- Designing user-centric human-machine interfaces
- Designing end-to-end efficient cyber-physical systems
- Developing sustainable computing solutions
- Building secure, intelligent, and trustable systems

## 6. Course Categories, Credit Distribution And Structure Of “B.Tech. In Computer Science And Engineering (CSE)” Programme

The regular B.Tech. programme in Computer Science and Engineering (CSE) requires a total of 153 credits for the award of the degree. As is shown in Table I, the UG curriculum structure has four components: Institute Core, Programme Core, Open Electives, and Essential Audit requirements.

**a) Institute Core:** The Institute Core component contributes 39 credits to the total credits that have to be earned for the programme. Courses in this component provide students a broad foundational base in Engineering, Sciences, and Humanities & Social Sciences. These courses are aimed at developing skills – like analytical thinking, scientific understanding, engineering fundamentals, and effective communication abilities – required for all engineers. The Institute Core courses are offered during the 1<sup>st</sup> year, primarily in Semesters I & II, and one course in Semester III.

**b) Programme Core:** The Programme Core constitutes the major discipline-specific part of the curriculum – contributing 90 credits to the total programme-credit requirement – comprising compulsory courses, and program-relevant elective courses and projects. This component aims to inculcate strong expertise in core areas of theoretical computer science (viz. Data Structures and Algorithms, Design and Analysis of Algorithms, etc.), systems (viz. Operating Systems, Computer Organization and Architecture, Database Systems, Software Engineering, Computer Networks, etc.) and AI/ML (viz. Artificial Intelligence, Deep Learning, etc.). The Programme Core courses are offered in the 2<sup>nd</sup> year (Sem III & IV), 3<sup>rd</sup> year (Sem V & VI) and 4<sup>th</sup> year (Sem VII & VIII).

**c) Open Electives:** The Open Elective component contributes 12 credits to the total credit count, and encourages students to pursue interdisciplinary courses, beyond the programme domain, thereby promoting multidisciplinary learning, innovation, and exposure to emerging technologies and allied fields. The credits under this component are available in the 4<sup>th</sup> year (Sem VII & VIII) of the B.Tech. programme.

**d) Essential Audit:** The Essential Audit component includes 12 non-graded credits, comprising Humanities audit courses, Engineering audit courses, Industry-Academia summer internships, and Design credits. This component focuses on professional development, industry readiness, practical exposure, product design skills, and experiential learning – essential for contemporary engineering practices. The credits under this component are spread across the four years of the B.Tech. programme.

**Table I:** Proposed B.Tech-CSE Curriculum Structure

S.No.	Course Type	Course Category	Credits	Total Credits
1	Institute Core (I)	Engineering (IE)	16	39 (27.7%)
		Science (IS)	17	
		Humanities (IH)	06	
2	Programme Core (P)	Programme Compulsory (PC)	66	90 (63.8%)
		Programme Elective (PE)	18	
		(B.Tech.) Project (PP)	06	

3	Open (O)	Open Elective (OE)	12	12 (8.5%)
<b>Total Graded</b>				<b>141 (100%)</b>
4	Compulsory Audit	Humanities (NH)	3	12
		Engineering (NE)	3	
		Industry-Academia Summer Internship outside IIT Jodhpur (two summers, minimum 45 days)	4	
		Design Credit (during regular semester after Semester II)	2	
<b>Total for Award of Degree (Graded + Compulsory Audit)</b>				<b>153</b>

## 7. Course Categories, Credit Distribution And Structure Of “B.Tech. With Minor” Programme

At the Indian Institute of Technology Jodhpur, the B.Tech with Minor programme enables students to pursue their primary B.Tech degree in their parent academic unit while undertaking an interdisciplinary specialization (Minor) in a different academic unit. The Minor is awarded upon completion of the prescribed courses of the parent unit, and an additional (minimum) 18 credits from the academic unit offering the Minor. Consequently, the open elective credit requirement for students pursuing a ‘B.Tech with Minor’ programme is reduced to zero, as is presented in Table II. The remaining course requirements (viz. Institute Core, Programme Core, and Essential Audit) remain the same as those in the institute-wide regular B.Tech curriculum structure.

**Table II:** Proposed “B.Tech with Minor” and “Dual-Degree (B.Tech + Ph.D.)” Curriculum Structure

S.No.	Course Type	Course Category	B.Tech. Regular	Dual Degree (B.Tech. + Ph.D.)	B.Tech with Minor
1	Institute Core (I)	Engineering (IE)	16	16	16
		Science (IS)	17	17	17
		Humanities (IH)	06	06	06
2	Programme (P)	Compulsory (PC)	66	66	66
		Electives (PE)	18	18	18
		B.Tech. Project (PP)	6	6	6
3	Open (O)	Electives (OE)	12	12	0
4	Additional Credits	Programme Compulsory (PC) (Selected courses prescribed by the offering academic unit.)	NA	NA	18
5	Ph.D.	Compulsory (DC)	NA	12	NA
		Electives (DE)		12	
		Ph.D. Thesis (DT)		64	

		<b>Total Graded</b>	<b>141</b>	<b>229</b>	<b>147</b>
6	Essential Audit (Non-taught)	Humanities (NH)	3	3	3
		Engineering (NE)	3	3	3
		Industry-Academia Summer Internship outside IIT Jodhpur (two summers, minimum 45 days - after 2nd and 3rd Year)	4	4	4
		Design/Practical Experience (ND) (during regular semester after 1st Year)	2	2	2
<b>Total Graded + Essential Audit Credits</b>			<b>153</b>	<b>241</b>	<b>159</b>

### 8. List Of Institute-wide Courses For Engineering (IE), Science (IS) And Essential Audit courses In Engineering (NE) And Humanities (NH)

Table III presents the list of all compulsory Institute-wide courses in Engineering and Science, and essential audit courses in Engineering and Humanities. These courses are mostly done during Semester I and II, with a few done in Semester III and V.

**Table III.** List of IE, IS, NE, NH Courses for B.Tech-CSE

<b>Course Category</b>	<b>Course Name</b>	<b>Semester</b>	<b>L-T-P</b>	<b>Contact Hours</b>	<b>Credit</b>
Institute-wide Engineering (IE) Courses (16 credits)	1. Engineering Mechanics	I	3-0-0	3	3
	2. Introduction to Computer Science	I	3-0-2	5	4
	3. Introduction to Machine Learning	II	3-0-2	5	4
	4. Engineering Drawing	II	0-0-2	2	1
	5. Engineering Workshop	I	0-0-2	2	1
	6. Environment and Sustainability	III	3-0-0	3	3
Institute-wide Science (IS) Courses (17 credits)	1. Physics	I	3-0-0	3	3
	2. Physics Lab	I	0-0-2	2	1
	3. Chemistry	II	3-0-0	3	3
	4. Chemistry Lab	II	0-0-2	2	1
	5. Mathematics I	I	2-1-0	3	3
	6. Mathematics II	II	2-1-0	3	3
	7. Introduction to Bioengineering	II	2-0-2	4	3
Institute-wide Humanities & Social Science (IH) Courses (6 credits)	1. HSS I	I	3-0-0	3	3
	2. HSS II	II	3-0-0	3	3
Institute-wide NH courses (3 credits)	1. Communication Skills	I	0-0-2	2	1
	2. Performing Arts /Sports	I	0-0-1	1	0.5
	3. Social Connect and Responsibilities	I	0-0-1	1	0.5
	4. Professional Ethics	V	1-0-0	1	1

Institute-wide NE courses (3 credits)	1. Engineering Design I	I	0-0-2	2	1
	2. Engineering Design II	II	0-0-2	2	1
	3. Introduction to Profession	II	0-0-2	2	1
<b>Total</b>					<b>45</b>

## 9. List Of Programme Compulsory (PC) Courses For B.Tech-CSE

The list of Programme Compulsory (PC) courses for the B.Tech in Computer Science and Engineering is presented in Table IV for the regular programme. Table V presents the list of compulsory courses (equating to 18/19 additional credits) for students aiming to pursue a B.Tech with a Minor in Computer Science and Engineering.

**Table IV.** Programme Compulsory (PC) Courses for B.Tech-CSE

Sr. No.	Course Name	Semester	L-T-P	Contact Hours	Credit
1	Probability Statistics and Stochastic Process	III	3-1-0	4	4
2	Discrete Mathematics	III	3-1-0	4	4
3	Signals and Systems	III	3-1-0	4	4
4	Data Structures and Algorithms	III	3-0-0	3	3
5	CSE Lab 1	III	0-0-2	2	1
6	Computer Organization and Architecture	IV	3-0-0	3	3
7	Software Engineering	IV	3-0-0	3	3
8	Database Systems	IV	3-0-0	3	3
9	Artificial Intelligence	IV	3-0-0	3	3
10	Digital Design	IV	3-0-0	3	3
11	CSE Lab 2	IV	0-0-8	8	4
12	Theory of Computation	V	3-0-0	3	3
13	Design and Analysis of Algorithms	V	3-1-0	4	4
14	Operating Systems	V	3-0-0	3	3
15	Deep Learning	V	3-0-0	3	3
16	CSE Lab 3	V	0-0-4	4	2
17	Cyber Security	VI	3-0-0	3	3
18	Computer Networks	VI	3-0-0	3	3
19	Computer Graphics	VI	3-0-0	3	3
20	Compilers	VI	3-0-0	3	3
21	CSE Lab 4	VI	0-0-8	8	4
<b>Total</b>					<b>66</b>

**Table V.** Ordered list of compulsory courses for B.Tech with Minor in CSE (applicable to UG programs other than B.Tech-CSE). The prescribed order needs to be followed strictly for completing the minimum credit requirements.

Sr. No.	Course Name	Sem for Regular	Sem for Minor	L-T-P	Contact Hours	Credit
M1	Data Structures and Algorithms	III	III/V/VII	3-0-0	3	3
M2	Computer Organization and Architecture	IV	IV/VI/VIII	3-0-0	3	3
M3	Database Systems	IV	IV/VI/VIII	3-0-0	3	3
M4	Operating Systems	V	V/VII	3-0-0	3	3
M5	Design and Analysis of Algorithms	V	V/VII	3-1-0	4	4
M6	Computer Networks	VI	VI/VIII	3-0-0	3	3
<b>Total Additional Credits</b>						<b>19</b>

\* Only when some program already has one or more of the above listed courses as its PC, a student will be required to take other non-overlapping course(s) as in the following ordered list of augmented courses to fulfil the minimum credit requirement of 18 for Minor in CSE. The prescribed order needs to be followed strictly for completing the minimum credit requirements.

Sr. No.	Course Name	Sem for Regular	Sem for Minor	L-T-P	Contact Hours	Credit
A1	Software Engineering	IV	IV/VI/VIII	3-0-0	3	3
A2	Theory of Computation	V	V/VII	3-0-0	3	3
A3	Cyber Security	VI	VI/VIII	3-0-0	3	3
A4	Compilers	VI	VI/VIII	3-0-0	3	3

## 10. List of Programme Elective (PE) Courses For B.Tech-CSE

The program emphasizes on training students in emerging areas through a curated Programme Elective bouquet (presented in Table VI). These courses have taken into consideration national requirements as well as industrial and societal needs.

**Table VI:** Focus area-wise Programme Elective (PE) courses for B.Tech-CSE

Sr. No.	Focus Area	PE Course	Level	L-T-P	Credit
1	Theoretical Computer Science	Graph Theory	400	3-0-0	3
		Computational Social Choice Theory	400	3-0-0	3
		Quantum Computing	400	3-0-0	3
		Complexity Theory	700	3-0-0	3
		Approximation Algorithms	700	3-0-0	3
		Advanced Algorithms	700	3-0-0	3

2	Systems	Computing Systems	400	3-0-0	3
		Embedded Systems	400	3-0-0	3
		Distributed Systems	400	3-0-0	3
		Cryptography and Network Security	400	3-0-0	3
		High Performance Computing Architecture	400	3-0-0	3
		Emerging Network Technologies	700	3-0-0	3
		Distributed Database Systems	700	3-0-0	3
		ML Systems	700	3-0-0	3
		Blockchain Technologies	700	3-0-0	3
		Virtualization and Cloud Computing	700	3-0-0	3
3	AI / ML	Computer Vision	400	3-0-0	3
		Dependable AI / Responsible AI	400	3-0-0	3
		Advanced Machine Learning	700	3-0-0	3
		Foundation Models and Generative AI	700	3-0-0	3
		Autonomous Systems	700	3-0-0	3
		Natural Language Understanding	700	3-0-0	3
<b>Total Number of 400 level PE Courses</b>					<b>10</b>
<b>Total Number of 700 level PE Courses</b>					<b>12</b>

Note: 400 level courses are specific to B.Tech. students, while 700 level courses are open to B.Tech., M.Tech. and Ph.D. students as applicable.

## 11. Open Elective (OE) Courses From Other Academic Units

Open elective courses enable students to explore subjects beyond their core discipline, aiming at broadening their scope - particularly in cross-disciplinary and transdisciplinary generalization.

OE Course	Description
Objective	To encourage interdisciplinary learning and broaden knowledge across different domains
Eligibility	Open to students from different departments, subject to prerequisites of the offered courses from the CSE department or other academic units.
Credit Requirement	Students in the regular B.Tech programme are required to complete 12 credits of open elective courses. For a B.Tech. with Minor route, the OE credits are replaced with 18 credits of selected compulsory courses from the minor department.

## 12. Curriculum Of “Regular B.Tech.” And “B.Tech. With Minor” Programmes In Computer Science and Engineering (CSE)

Tables VII and VIII present the semester-wise placement of Institute-wide courses (IE, IS, IH, NE, NH) and Programme Compulsory (PC) courses for the regular B.Tech programme in CSE and the B.Tech with Minor in CSE, respectively.

**Table VII.** Semester-wise plan for regular B.Tech-CSE

Cat	Course	LTP	CH	NC	GC	Cat	Course	LTP	CH	NC	GC
<b>I Semester</b>						<b>II Semester</b>					
IE	Engineering Mechanics	3-0-0	3	-	3	IE	Introduction to Machine Learning	3-0-2	4	-	4
IE	Introduction to Computer Science	3-0-2	4	-	4	IS	Chemistry	3-0-0	3	-	3
IS	Physics	3-0-0	3	-	3	IS	Introduction to Bioengineering	2-0-2	4	-	3
IH	Humanities I	3-0-0	3		3	IS	Chemistry Lab	0-0-2	2	-	1
IS	Physics Lab	0-0-2	2	-	1	IH	Humanities II	3-0-0	3		3
IS	Mathematics I	2-1-0	3	-	3	IS	Mathematics II	2-1-0	3	-	3
IE	Engineering Drawing	0-0-2	2	-	1	IE	Engineering Workshop	0-0-2	1	-	1
NE	Engineering Design I	0-0-2	2	1	-	NE	Engineering Design II	0-0-2	2	1	-
NH	Communication Skills	0-0-2	2	1	-	NE	Introduction to Profession	0-0-2	2	1	-
NH	Social Connect and responsibilities	0-0-1	1	0.5	-						
NH	Performing Arts / Sports	0-0-1	1	0.5	-						
<b>Total</b>				<b>3</b>	<b>18</b>	<b>Total</b>				<b>2</b>	<b>18</b>
<b>III Semester</b>						<b>IV Semester</b>					
PC	Probability Statistics and Stochastic Process	3-1-0	4	-	4	PC	Computer Organization and Architecture	3-0-0	3	-	3
PC	Discrete Mathematics	3-1-0	4	-	4	PC	Software Engineering	3-0-0	3	-	3
PC	Signals and Systems	3-1-0	4	-	4	PC	Database Systems	3-0-0	3	-	3
PC	Data Structures and Algorithms	3-0-0	3	-	3	PC	Artificial Intelligence	3-0-0	3	-	3
PC	CSE Lab 1	0-0-2	2	-	1	PC	Digital Design	3-0-0	3	-	3
						PC	CSE Lab 2	0-0-8	8	-	4
IE	Environment and Sustainability	3-0-0	3	-	3						
<b>Total</b>					<b>19</b>	<b>Total</b>				-	<b>19</b>
<b>Summer Semester Internship (Minimum 45 days, Outside IIT Jodhpur)</b>											
<b>V Semester</b>						<b>VI Semester</b>					
PC	Theory of Computation	3-0-0	3	-	3	PC	Cyber Security	3-0-0	3	-	3
PC	Design and Analysis of Algorithms	3-1-0	4	-	4	PC	Computer Networks	3-0-0	3	-	3
PC	Operating Systems	3-0-0	3	-	3	PC	Computer Graphics	3-0-0	3	-	3
PC	Deep Learning	3-0-0	3	-	3	PC	Compilers	3-0-0	3	-	3
PC	CSE Lab 3	0-0-4	4	-	2	PC	CSE Lab 4	0-0-8	8	-	4
PE	Programme Elective	3-0-0	3	-	3	PE	Program Elective	3-0-0	3	-	3
NH	Professional Ethics	1-0-0	1	1	-						

<b>Total</b>				<b>1</b>	<b>18</b>	<b>Total</b>					<b>19</b>
<b>Summer Semester Internship (Minimum 45 days, Outside IIT Jodhpur)</b>											
<b>VII Semester</b>						<b>VIII Semester</b>					
PP	B.Tech Project 1	0-0-3		-	3	PP	B.Tech Project 2	0-0-3		-	3
PE	Programme Elective	3-0-0	3	-	3	PE	Program Elective	3-0-0	3	-	3
PE	Programme Elective	3-0-0	3	-	3	PE	Program Elective	3-0-0	3	-	3
OE	Open Elective	3-0-0	3	-	3	OE	Open Elective	3-0-0	3	-	3
OE	Open Elective	3-0-0	3	-	3	OE	Open Elective	3-0-0	3	-	3
<b>Total</b>					<b>15</b>	<b>Total</b>				-	<b>15</b>
<b>Total of graded and Non-Graded Credit</b>										<b>6</b>	<b>141</b>
<b>Non-Graded Design Credits (2) and Summer Internships (4)</b>										<b>6</b>	<b>-</b>
<b>Grand Total</b>										<b>12</b>	<b>153</b>

Note: Design Credit is to be done during regular semesters after 1st Year

**Table VIII.** Semester-wise plan for B.Tech with Minor in CSE

Cat	Course	LTP	CH	NC	GC	Cat	Course	LTP	CH	NC	GC
<b>Semester I - IV: (Same as Table VII) where Programme Compulsory (PC) courses are respective to academic units other than B.Tech-CSE</b>											
<b>2nd Year and 3rd Year: Summer Semester Internship (Minimum 45 days, Outside IIT Jodhpur)</b>											
<b>V Semester</b>						<b>VI Semester</b>					
PC	Programme Compulsory courses offered by academic unit other than CSE				15	PC	Programme Compulsory courses offered by academic unit other than CSE				16
PE/OE	Programme / Open Elective / Minor Compulsory Courses*				3	PE/OE	Programme / Open Elective / Minor Compulsory Courses*				3
NH	Professional Ethics I	1-0-0	1	1	-						
<b>Total</b>				<b>1</b>	<b>18</b>	<b>Total</b>					<b>19</b>
<b>VII Semester</b>						<b>VIII Semester</b>					
PP	B.Tech Project 1	0-0-3			3	PP	B.Tech Project 2	0-0-3		3	3
PE/OE	Programme / Open Elective / Minor Compulsory Courses*				15	PE/OE	Programme / Open Elective / Minor Compulsory Courses*				15
<b>Total</b>					<b>18</b>	<b>Total</b>				-	<b>18</b>
<b>Total</b>										<b>147</b>	
<b>Essential Audit Credits</b>										<b>12</b>	
<b>Grand Total</b>										<b>159</b>	

\* Minor Compulsory Courses will be offered across Semester III-VIII.

### 13. Description And Motivation Underlying Programme Core (PC) And Programme Elective (PE) Courses of B.Tech-CSE

Table IX and X present brief descriptions and general motivation underlying the PC and PE courses, respectively, for the B.Tech in Computer Science and Engineering (CSE) programme.

**Table IX.** Motivation and Description of PC Courses

Sr. No.	Focus Area	Course Name	Description & Motivation
1	Theoretical Computer Science	Probability Statistics and Stochastic Process	Will cover methods dealing with modeling of uncertainty, analysis of data, and system optimization. Topics include: Sample Space And Events, Axioms of Probability, Conditional Probability, Bayes' Theorem, Independent Events And Dependencies, Counting Methods (Combinatorics, Permutations), Random Variables (Discrete, Continuous), Probability Distributions (Binomial, Poisson, Normal/Gaussian), Joint And Marginal Probability, Expected Value And Variance, Measures Of Central Tendency, Measures Of Dispersion, Correlation Analysis, Sampling Distributions, Confidence Intervals, Hypothesis Testing, P-values, Type I And Type II Errors, t-tests, Chi-Squared Tests, Linear Regression Analysis.
2		Discrete Mathematics	Will deal with understanding and effective design of graphs, logic, and algorithms to model, analyze, and solve discrete problems. Topics include: Discrete Structures, Propositional logic and inference, Set theory, Counting and Combinatorics, Basics of graphs and trees.
3		Data Structures and Algorithms	The foundational pillar of the CSE discipline – this course will introduce fundamental techniques focusing on the design and implementation of solutions to problems involving computing systems. Topics include: Abstract Data Types, Linear Data Structures, Non Linear Data Structures, Stack, Queue, Link List, Heap, Sorting, Hashing, Algorithm Analysis, Graph, Tree.
4		Design an Analysis of Algorithms	Will enhance understanding of DSA towards improved solution design for complex problems through analysis of algorithm performance. Topics include: Complexity Analysis, Divide-And-Conquer, Greedy Algorithms, Dynamic Programming, Network-Flow, NP-completeness, Approximation Algorithms, Randomized Algorithms.
5		Theory of Computation	Will complement DSA and DAA through focusing on understanding of solvability and decidability of problems and computational models. Topics include: Languages, Automata, Pumping Lemma, CFG, PDA, Turing Machines, Undecidability, P, NP, NP-completeness, Reductions.
6	Systems	Digital Design	Will focus on fundamentals of design of foundational hardware components and logic circuits of computing systems. Aims to bridge the gap between software and physical system realization. Topics include: Introduction To HDL, Design Flow, Number Representation, Arithmetic Circuits, Design And Analysis Of Synchronous Circuits, Design Of Finite State Machines, CMOS Technology, Programmable Logic Devices, CAD.
7		Signals and Systems	Will cover methodologies underlying mathematical modeling of signals (like real-world multimodal data) and design of efficient computing systems to process signals. Will complement digital design and particularly applies to Systems and AI / ML focus areas of CSE. Topics include: Continuous-Time (CT) Signals, Discrete-Time (DT) Signals, Linearity, Time-Invariance (LTI), Causality, Stability, Memory, Signal Classifications (Energy/Power, Periodic/Aperiodic, Even/Odd, Exponential), Convolution, Impulse Response, Fourier Series, Fourier Transform, Laplace Transform, Z-Transform, Sampling Theorem, Filtering, Feedback Systems, Digital Signal Processing, Control Systems.
8		Computer Organization and Architecture	Will cover fundamentals of computer architecture – providing the necessary foundations for understanding and design of Database Systems, Operating Systems, Computer Networks, Compilers and AI Systems. Topics include: CPU, Memory, Processor, Instruction Set Architecture, RISC, CISC, and ASIC/ASIP

			paradigms, I/O, ALU, Bus Architecture, Cache Management, Performance, Parallel processing, Pipelining, Cache Coherence protocols, Multicore Architecture, Peripherals.
9		Software Engineering	Will focus on best practices of modern software engineering – covering topics like software development life cycles, performance evaluation metrics, agile methodologies, DevOps. Particularly important for graduates aiming to join the industry; will complement all focus areas of CSE. Topics include: Software Development Life Cycle, Software Engineering Process Model, Software Design, Uml, Design Pattern, Project Management, Cost Analysis, UI Design, Service Oriented Architecture, Software Quality, Risk Analysis, Agile Methodologies, Software Architecture.
10		Database Systems	Will cover foundational and contemporary topics underlying the design and handling of database systems for a multitude of application areas. Topics include: Database Architectures, Data Granularity, ER Model, EER Model, Relational Model, Relational Algebra, Relational Calculus, SQL, Schema, Query, Data Definition, Data Manipulation, Data Retrieval, Views, Normalization, Functional Dependency, Transactions, Schedules, ACID Properties, Concurrency Control, Recoverability, Serializability, Deadlock Prevention, Locking Protocols, Timestamp Protocols, Deadlock Detection, Recovery Protocols, Query Optimization, Hashing, Indexing.
11		Operating Systems	The bedrock of all physical computing systems - this course will cover foundational and contemporary topics of operating systems. Topics include: Processes Management, Process Coordination, Deadlock, Memory Management, Storage Management, Protection And Security.
12		Cyber Security	This course covers cryptography, network security, and risk management, providing the foundational principles of securing systems. Topics include: Cyber Security Vulnerabilities And Cyber Security Safeguards, Securing Web Application, Services And Servers, Intrusion Detection And Prevention, Firewalls, Cyberspace And The Law, Cyber Forensics.
13		Computer Networks	Will cover the understanding, design and application of protocols, hardware and software elements of computer networks - particularly relevant to the current era of cloud infrastructure, virtualization and distributed systems. Topics include: OSI Reference Model, Packet Switching Techniques, Performance Metrics, Socket Programming, Email, FTP, TelNet, SSH, DNS, TCP, UDP, Transmission, Flow And Congestion Control, Tunneling, Internet Protocol And Its Operation, Routing Algorithms, ICMP, ARP, RARP, DHCP, Ipv6, RIP, OSPF, Advanced Internetworking, Multicast Routing, Framing, Medium Access Mechanism, Public Key And Private Key Cryptography, Firewalls, SDN Overview.
14		Compilers	Will equip students with critical understanding of how high-level code is translated into machine instructions, and provide foundational knowledge for building optimized complex software systems, languages and tools. Topics include: Abstract Syntax Tree, Control Flow Graphs, Dataflow Graphs, Control Dependence Graphs, Program Dependence Graphs, Call Graphs, Dataflow Analysis, Interprocedural Analysis, Pointer Analysis, Rule Based Analyses, Constraint-based analysis, Scalar Optimizations, Loop Optimizations, Object-oriented Optimizations, Program verification, Bug Finding, Just-in-time Compilation, Memory Management, EDGE architecture compilation, Power-aware Compilation, Machine Specific Optimizations.

15	AI / ML	Artificial Intelligence	This course introduces the principles and techniques behind building intelligent systems, including problem solving, search, knowledge representation, reasoning, machine learning, and decision-making under uncertainty. Students gain a strong foundation in designing systems that can perceive, reason, and act autonomously, with applications spanning robotics, recommendation systems, healthcare, and natural language processing. Topics include: Uninformed Search Strategies, Informed Search Strategies, Local Search Algorithms, Hill Climbing, Constraint Satisfaction Problems, Backtracking, Adversarial Search, Min-Max Algorithms, Propositional Logic, Reasoning Patterns, First-Order Logic, Syntax, Semantics, Q-Value, Policy.
16		Deep Learning	This course covers the theory and practice of deep neural networks, including architectures such as convolutional neural networks, recurrent networks, transformers, and generative models. Students learn how to train, optimize, and evaluate deep models for tasks in computer vision, speech, text, and multimodal learning, preparing them to work on modern AI applications. Topics include: Neural Networks, Gradient Descent, Optimization, Regularization, Autoencoder, Convolutional Neural Network, Recurrent Neural Network, Lstm, Deep Generative Models, Generative Adversarial Network (Gan), Deep Belief Network, Deep Convolutional Gan, Variational Autoencoder, Representation Learning, Unsupervised Pre-Training, Transfer Learning, Distributed Representation, Domain Adaptation, Neural Language Model, Adversarial Learning.
17		Computer Graphics	This course introduces the mathematical and algorithmic foundations of generating and manipulating digital visual content. Topics include geometric transformations, rendering, illumination models, animation, and 3D modeling. The course equips students with the knowledge required to build systems for gaming, simulation, visualization, virtual reality, and interactive media. Topics include: Geometric Primitives, Clipping, Viewing, Rendering, Animation, Shading, Coloring, OpenGL.
18	CSE Lab	CSE Lab 1	(i) Data Structures and Algorithms Lab
19		CSE Lab 2	(i) Computer Organization and Architecture Lab (ii) Software Engineering Lab (iii) Database Systems Lab (iv) Digital Design Lab
20		CSE Lab 3	(i) Operating Systems Lab (ii) Deep Learning Lab
21		CSE Lab 4	(i) Cyber Security Lab (ii) Computer Networks Lab (iii) Compilers Lab (iv) Computer Graphics Lab

**Table X.** Motivation and Description of PE Courses

Sr. No.	Focus Area	PE Course	Description & Motivation
1	Theoretical Computer Science	Graph Theory	This course will provide an understanding of terminologies, concepts and algorithms related to graphs and will equip the students to formulate and solve real-world problems using mathematical foundations of graph theory. Topics include: Graph Search Algorithms, Directed And Undirected Graphs, Cuts and Connectivity, Special Graph Classes (Trees, Bipartite Graphs, Planar Graphs, Line Graphs, Chordal Graphs, Interval Graphs), Graph Coloring, Hamiltonian And Eulerian Graphs, Matroids.
		Quantum Computing	This is an introductory course exploring computation using quantum-mechanical principles. Topics include qubits, superposition, entanglement, quantum gates, algorithms, error correction, cryptography, and emerging quantum computing applications and hardware.
		Computational Social Choice Theory	This course will equip the students to design algorithms for collective decision making problems respecting the preferences of the participants. This will cover fairness and efficiency in voting, matching and resource allocation problems. Topics include: Computational Social Choice: Voting Theory, Multiwinner Elections, One-sided/Two-sided Matchings under Preferences, Stable Matchings, Hospital/Resident Problem, House Allocations, Fair and Efficient Allocation of Divisible and Indivisible Items, Welfare Maximization, Resource Allocation under Constraints, Online Resource Allocation.
		Complexity Theory	This course will present the limitations of computation and challenges thereof. Students will gain insight into what can be computed efficiently, what is believed to be computationally infeasible, and how complexity-theoretic techniques are used to analyze algorithms, optimization problems, and decision-making processes across computer science and mathematics. Topics include: Computational Model And Complexity Classes, NP, NP Completeness, Space Complexity, Hierarchy Theorems, Circuits, Randomised Complexity Theory.
		Advanced Algorithms	This course will provide the students with the tools to deal with computationally hard problems and design approximate, randomized, and parameterized algorithms, leading towards tractability. Topics include: Red-black Trees, Interval Trees, Dynamic Order Statistics, Splay Trees, Network Flows, Amortized Analysis, Aggregate Analysis, Accounting Method, Potential Method, Dynamic Programming, Permutation Problems, Partition Problems, String Matching, NP-completeness And Reductions, Approximation Algorithms, Randomized Algorithms.
		Approximation Algorithms	This course will dive deeper into the understanding of approximation algorithms and provide combinatorial, algebraic, and mathematical tools to deal with intractable optimization problems. Topics include: Combinatorial Techniques, Linear Programming, Cuts, Metrical Relaxations, Embedding, Random Hyperplanes, Dimensionality Reduction, Hashing, Game Theory.
2	Systems	Computing Systems	Computing Systems provides the essential knowledge required for innovation in modern technology and helps students become skilled engineers capable of solving real-world computational challenges. Topics include: advanced processor and memory architectures, including superscalar execution, caching, NUMA, DRAM, and persistent memory, along with kernel, virtualization, and I/O system designs. Explores file systems, distributed systems, consensus, and fault-tolerance models, plus programmable

			networks, high-performance computing, GPU/ML infrastructure, and performance analysis techniques.
		Embedded Systems	The course motivates students to understand real-time computing, microcontrollers, and system optimization, enabling them to build efficient, reliable, and intelligent embedded solutions for modern technological applications. Topics include: Embedded System Design, Architectures Of Embedded Processors, Hardware-Software Co-Design, Arm Cortex M3, Programming For Embedded Systems, Real Time OS, Distributed Embedded Architectures, Real Time Scheduling Algorithms, Multi-Rate Systems.
		Distributed Systems	The course motivates students to understand concepts such as scalability, fault tolerance, synchronization, and cloud computing, which are essential for building reliable and high-performance modern applications and services. Topics include: Concurrency, Events And Ordering, Distributed File Systems, Distributed Disk Management, Fault Tolerance, Microkernel, Operating System Kernel, Virtual Machines, Scalability, Consensus Algorithms (Paxos, Raft), Leader Election, Time Synchronization, Vector Clocks, Gossip Protocols, Load Balancing, Service Discovery, Resource Allocation, Performance Monitoring.
		Cryptography & Network Security	The course motivates students to understand encryption, authentication, digital signatures, and network security protocols, enabling them to design secure and trustworthy computing systems in the modern digital world. Topics include: Symmetric Encryption, Asymmetric Encryption, Cryptographic Hash Functions, Digital Signatures, Key Management, Public Key Infrastructure (PKI), Digital Certificates, Secure Communication Protocols: TLS/SSL, VPNs, Firewalls, Intrusion Detection and Prevention Systems (IDS/IPS), Network Security Protocols: IPSec, SSH, PGP.
		High Performance Computing Architecture	The course motivates students to understand multicore processors, parallel architectures, distributed computing, and performance optimization techniques for applications in scientific computing, artificial intelligence, and big data analytics. Topics include: CPU Optimization, GPU Accelerators, Multi-core Processors, Bare-metal Instances, Low-latency Fabric, Remote Direct Memory Access (RDMA), High-speed Interconnects, Parallel File Systems (Lustre/GPFS), Object Storage, Data Tiering, Burst Buffers, Workflow Orchestration, Resource Scheduling, Containerization, Scalable Infrastructure, Hybrid Cloud, Multi-cloud environments, Edge Computing, Shared Memory, Distributed Memory, Heterogeneous Computing, Optimization, Security.
		Emerging Network Technologies	The course motivates students to understand next-generation networking concepts and develop innovative, scalable, and secure communication solutions for future digital infrastructures. Topics include: Network and Services, Real Internet Architecture, Pattern for Enhanced Network Services, Introducing Network Algorithmics, Network Implementation Models, Router Architectures, Prefix match lookups, Switch design, Scheduling Packets, Measuring Network Traffic, Ideas for better Internet.
		Distributed Database Systems	The course motivates students to understand data distribution, replication, concurrency control, and fault tolerance, enabling the development of scalable, reliable, and high-performance data-driven applications. Topics include: Distributed Systems, Centralized Systems, Data Transparency, Data Fragmentation, Data Allocation, Security, Semantic Integrity, Query Decomposition, Query Localization, Query Ordering, Query Optimization, Transaction Management, Concurrency Control, Deadlock Management, Reliability, Recovery Protocols.

		ML Systems	This course motivates students to large-scale training, distributed inference, hardware acceleration (GPUs/TPUs), and model deployment, preparing students to build efficient, scalable AI infrastructure. Topics include: Basics of Computer Organization and Operating Systems, Basics of high performance computing in the cloud, GPU Architecture, GPU Programming Models, GPU Applications design, TPU architecture, Domain Specific Architectures, ML Training at Scale, Basics of parallel and scalable data processing, parallelism basics, scalable data access, data parallelism, dataflow systems, classical ML training at scale, deep learning systems, feature engineering and model selection systems, techniques in model compression. Frameworks for Parallel and Distributed Training, DL Compilers, Design of ML Pipelines, Scheduling, ML Deployment.
		Blockchain Technologies	The course motivates students to understand how blockchain enables transparency, security, and trust in applications such as cryptocurrencies, supply chain management, healthcare, and digital identity systems. Topics include: Cryptography (Cryptographic Hash, Merkle trees, Commitments, Digital Signatures), Distributed Consensus mechanisms (Paxos, RAFT, BGP, and PBFT), Cryptocurrencies, Bitcoin Blockchain: Architecture, UTXO Transaction Models, Proof of Work (PoW), Bitcoin Scripts, Ethereum Blockchain: Smart Contracts, Ethereum Virtual Machine (EVM), Decentralized Applications (dApps), Proof of Stake (PoS), Hyperledger: Enterprise Blockchain Solution, Chaincode, and its applications (supply chain, healthcare, and finance).
		Virtualization and Cloud Computing	The course motivates students to understand scalable and cost-effective computing solutions, enabling them to design, deploy, and manage cloud-based applications and services efficiently. Topics include: Cloud Computing, Virtualization, Virtual and Physical Networking (vSwitches, virtual NICs, Virtual Networking, virtual LAN), Storage Virtualization, Virtual Machine Management, Containers, Applications (Linux KVM, VirtualBox, Openstack).
3	AI / ML	Computer Vision	This course focuses on enabling machines to interpret and understand visual information from images and videos. Topics include: Image Formation And Transformations, Camera Calibration, Image Restoration, Spatial And Wavelet-Based Processing, Epipolar Geometry, Sfm, Optical Flow, Key-Point Detection, Feature Description And Matching, Deep Learning For Vision, Applications.
		Dependable / Responsible AI	This course covers the principles of building AI systems that are robust, fair, transparent, safe, and accountable. Topics include: Accuracy-Explainability Tradeoff, Interpretability Problem, Predictability, Transparency, Traceability, Causality, Reasoning, Attention And Saliency, Adversarial Attack and Defense, Federated Learning, Robustness, Trustworthy AI, Reproducibility, Accountability, Bias-Free AI, Ethics In AI.
		Advanced Machine Learning	This course explores advanced machine learning methods, from kernel machines and SVM variants to boosting, graphical models, and structured prediction. Students also gain hands-on experience with sparse coding and deep reinforcement learning, while understanding the theoretical foundations of PAC learning. Topics include: Kernel Machines, Variants of Support Vector Machines, PAC Theory, Boosting, Graphical Models, Structural Predictions, Deep Reinforcement Learning, Sparse Coding..
		Foundation Models and Generative AI	This course introduces large-scale pre-trained models and generative techniques that are transforming AI. Students learn how foundation models are trained, adapted, and deployed for applications such as text generation,

			image synthesis, reasoning, and intelligent assistants. Topics include: Transformers & Attention, Diffusion, Language Transformers, Vision Transformers, Dual-Encoder, Fusion, Encoder-Decoder, Adapted LLM, Unified Architectures, Contrastive Learning, Efficient Inference Techniques, Pre-training, Fine-tuning & Parameter Efficient Fine-tuning, Flash Attention, Retrieval Augmented Generation, Evaluation Protocols and Standard Benchmarks, Hallucinations, Bias & Fairness, Privacy, Memorization, Machine Unlearning, Prompt Engineering.
		Autonomous Systems	This course focuses on the design of systems capable of perceiving their environment, making decisions, and acting independently. The course prepares students to work on applications such as self-driving vehicles, drones, industrial automation, and intelligent robotics. Topics include: Abstract Agent Architectures, Environment And Agents, Reactive Agents, Utility-based Agents, Behavior Based Architectures, Concrete Agent Architectures, Logical Agents, Real-time Systems, Distributed Solutions, Fault-tolerance, Autonomous Vehicles, Multi-agent Systems.
		Natural Language Understanding	This course covers computational methods for enabling machines to process, understand, and reason over human language. Students gain the foundations required for building systems such as chatbots, search engines, document intelligence, and language assistants. Topics include: Word Representation, NLP Tasks, Seq2Seq Model, Question Answering, Sentiment Analysis, Dialogue System, Machine Translation, Natural Language Generation Interpretability, Knowledge Graphs.

#### 14. Guidelines for Curriculum Implementation:

- B.Tech project (BTP) 1 and 2 will be done under the same supervisor. Each component will be evaluated in the respective semesters. Since BTPs are part of the program core requirement, the supervisor should be from the department.
- Compulsory Industry-Academia Summer Internship outside IIT Jodhpur: The internship will be after the 4th and 6th semesters during the summer semester break. It is the students' responsibility to complete the internship, which should be for a minimum of 45 days. Students are expected to submit an internship completion certificate, a report, etc., as will be required, to their department.
- B.Tech with Minor: Each academic unit will fix the programme core courses of 18 credits for the minor in its discipline. The departments will circulate the forms to the students at the end of the 2nd, 3rd, and 4th semesters for opting minor. Each department will decide the maximum intake for the minor. Open elective credits will be utilized for completing the minor requirements (12 credits). The students will do (minimum) extra 6 credits to earn a minor in a discipline.
- Design credit will be done during a regular semester after semester-2.