Government College of Engineering
Chhatrapati Sambhajinagar

Department of Computer Science and Engineering

Curriculum

Final Year, B. Tech. (CSE)

Department of Computer Science and Engineering

From Academic Year 2026-27

As per NEP (**Admitted Batch 2023-24**)

Dr. Vikul Pawar
Head CSE

Dr. Anil Karwankar
Dean Academics

B.Tech. Computer Science & Engineering Curriculum
With effect from Academic Year 2026–2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

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Vision of the Institute

To be globally recognized leader in technical education through industry integration and societal wellbeing.

Mission of the Institute

1. To build career-ready graduates through multidisciplinary learning and industry-sync curricula.
2. To promote ecosystem for cutting-edge research, patents, publications, IPR, innovation, technology transfer and entrepreneurship.
3. To be a premier trusted partner of government allied bodies, industries, and society.

Vision of the Department

To nurture technically proficient, socially responsible, and industry-ready computer professionals and researchers.

Mission of the Department

1. To foster strong foundational and advanced knowledge in computer science through industry-driven curricula.
2. To cultivate an ethical, innovative, and research-oriented academic environment that promotes collaboration, leadership, and holistic development.
3. To promote lifelong learning and professional adaptability through industry-relevant skills and experiential learning.

Program Outcomes

Engineering Graduates will be able to:

PO1: Apply knowledge of mathematics, science, and algorithms in solving complex Computer engineering problems.
PO2: Generate solutions by conducting experiments and applying techniques to analyse and interpret data.
PO3: Design components or processes to meet the needs within realistic constraints.
PO4: Identify, formulate, and solve Software Engineering, Networking, and Data Mining problems.
PO5: Comprehend professional and ethical responsibility in the computing profession.
PO6: Express effective communication skills.
PO7: Participate in a global, economic, environmental, and societal context.
PO8: Recognize the need for, and an ability to engage in lifelong learning.
PO9: Knowledge of contemporary issues and emerging developments in the computing profession.
PO10: Utilize the techniques, skills, and modern computer Engineering tools, Software, and techniques necessary for Engineering practice.

PO11: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO12: Design research problems and conduct research in a computing environment.

Program Specific Outcomes

Computer Science and Engineering Graduates will be able to:

PSO1: Ability to apply probability, statistics, programming applications, and science in the development of computing solutions in appropriate areas for system software, database, networking, web development, network security, & Operating systems.

PSO2: Ability to apply standard practices & methods in software project management and development using suitable programming environments & tools to deliver a quality product for the industry.

PSO3: Able to apply ethical, social, and professional fields with proper communication skills & teamwork & pursue lifelong learning

General Course Structure & Theme

A. Definition of Credit

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

B. Total Credits for the completion of B.Tech. in Computer Science & Engineering:
The total number of credits proposed for the four-year B. Tech in Computer Science & Engineering (CSE) with 1 Multidisciplinary minor (Compulsory) degree is 170 as per the structure given below:

C. Semester-wise Credit Distribution Structure for 4-Year UG Program in Computer Science & Engineering with One Multidisciplinary Minor (2023-2024 to 2025-26 Admitted NEP Batch)

Semester		I	II	III	IV		V	VI	VII	VIII	Total
Basic Science Course	BSC/ESC	8	8		--		--	--	--	--	16
Engineering Science Course		8	7		--		--	--	--	--	15
Program Core Course (PCC)	Program Courses	--	2	11	11		6	12	9	0	51
Program Elective Course (PEC)		--	--				4	8	8	0	20
Multidisciplinary Minor (MDM)	Multi-disciplinary Courses		–	4	3		4	3	0	0	14
Open Elective (OE) Other than a particular program		--	--	3	3		2	--	--	--	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2	--	2		--	2	--	--	8
Ability Enhancement Course (AEC01, AEC02)	Humanities Social Science and Management (HSSM)		2		2		--	--	--	--	4
Entrepreneurship/Economics / Management Courses		--		2	2		--	--	--	--	4
Indian Knowledge System (IKS)		2			--		--	--	--	--	2
Value Education Course (VEC)		--	--	2	2		--	--	--	--	4
Research Methodology	Experimental Learning Courses	--	--	--	--		--	--	2	--	2
Comm. Eng. Project (CEP)/Field Project (FP)		--	--	2	--		--	--	-	-	2
Project		--	--	--	--		--	--	4		4
Internship/ OJT		--	---				--	--		12	12
Co-curricular Courses (CC)	Liberal Learning Courses	2	2		--		--	--	--	--	4
Total Credits (Major)		**22**	**23**	**24**	**25**		**16**	**25**	**23**	**12**	**170**

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D. Multidisciplinary Minor

Students can opt for any of the following as per the rules and regulations given by the institute:

1. B. Tech with one Multidisciplinary Minor = Total 170 Credits
2. B. Tech with one Multidisciplinary Minor and Honours in A.I.M.L / programming paradigm = Total 188 Credits
3. B. Tech with one Multidisciplinary Minor and Honours by Research = Total 188 Credits
4. B. Tech with two Multidisciplinary Minors = Total 184 Credits

E. Vocational and Skill Enhancement Course (VSEC)

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	VSEC	Computer Workshop	I	0	0	4	**02**
2	VSEC	Engineering Exploration	II	0	0	4	**02**
3	VSEC	Software Laboratory I (WT)	IV	0	0	4	**02**
4	VSEC	Competitive Programming /SDL-2 (Java Programming)	VI	0	0	4	**02**
Total Credits							**08**

F. Humanities & Social Sciences Courses (HSSM)

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	Indian Knowledge System (IKS)	Indian Knowledge System	I	2	0	0	02
2	Ability Enhancement Course (AEC)	Communicatio n Skills	II	2	0	0	02
3	Entrepreneurship Economics/ Management Courses	Psychology	III	2	0	0	02
4	Value Education Course (VEC)	Universal Human values	III	2	0	0	02
5	Ability Enhancement Course (AEC)	Technical Communicatio n	IV	2	0	2	02
6	Entrepreneurship/ Economics/ Management Courses	Personality Development	IV	2	0	0	02
7	Value Education Course (VEC)	Environmental Studies (EVS)	IV	2	0	0	02
Total Credits							**14**

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G. Experiential Learning Courses (ELC)

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	Comm. Engg. Project (CEP) /Field Project (FP)	Mini Project	III	0	0	4	**02**
2	Project	Project	VII	0	0	8	**04**
3	Research Methodology	Research Methodology	VII	3		0	**02**
4	Internship/ OJT	Internship	VIII	-	-	24	**12**
Total Credits							**20**

H. Liberal Learning Courses (*Co-Curricular Courses (CC)*)

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	CC	Yoga and Meditation	I	1	0	2	**02**
2	CC	NSS/Sports/Clubs Activities	II	0	0	4	**02**
Total Credits							**04**

I. Multidisciplinary Minor (MDM) And Open Elective (OE) Other Than A Particular Program

- List of Multidisciplinary Minor Courses from other faculties: Total 14 Credits as per GR
- Two courses of 4 credits and two courses of 3 credits.
- Open electives of 8 credits can be offered from these other faculties.
- Two courses of 3 credits and 1 course of 02 credits

Specialization	Dramatics	Film Making	Fine Art	Music
Multi-Disciplinary Minor – 01	Dramatic Theory, Literature	Videography + Cinematography	Applied Art (Digital Art)	Theory of Indian Music
Multi-Disciplinary Minor – 02	Acting	Video Editing and Lighting	Painting (Generative Art)	Ancient and Modern Poetry
Multi-Disciplinary Minor – 03	Directing	Story Telling Story Boarding	Sculpture (3D-Space)	The Evolution of Music
Multi-Disciplinary Minor – 04	Playwriting	UI/UX and Animation	Visual Communication (Evolutionary Art)	Music and Film

Multi-Disciplinary Minor – 05	Applied Interactive Theatre	Art of Visual Communication	Graphics Art (Print & Printing Art)	Introduction to Electronic and Computer Music
Multi-Disciplinary Minor – 06	Technical Theatre	Film & TV Directing	Art Culture	Analysis of Tonal Music

Specialization	Management & Finance	Law	Social Science	Journalism
Multi-Disciplinary Minor – 01	Microeconomics	Constitutional Law	Indian Economics	Principles of Communication
Multi-Disciplinary Minor – 02	Corporate Social Responsibility	Human Rights & International Law	Introduction to Sociology	Fundamentals of Journalism
Multi-Disciplinary Minor – 03	Principles of Accounting	Environmental Law	Geo-Informatics	Cyber Journalism
Multi-Disciplinary Minor – 04	Business Intelligence	Civil Procedure Code (CPC)	Introduction to Political Sciences	Basics of Design & Graphics
Multi-Disciplinary Minor – 05	Marketing Research	Land Laws Including Ceiling and other Local Laws	Corporate Sociology	Mass Communication: Concepts and Processes
Multi-Disciplinary Minor – 06	Corporate Governance and Business Ethics	Cyber law	Modern India Political, Economic & Social Ethos	IT and Online Journalism

J. Multidisciplinary Minor

In addition to the above courses following courses are offered as a Multidisciplinary Minor by the Computer Science & Engineering Department

I. Artificial intelligence / Machine learning Group

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	MDM 5001/5002	Introduction to Data Science	III	3	0	1	**04**
2	MDM 5003	Introduction To Machine Learning	IV	3	0	0	**03**
3	MDM 5004/5005	Artificial Intelligence	V	3	0	1	**04**

4	MDM 5006	Neural Network	VI	3	0	0	**03**
Total Credits							**14**

II. Programming Group

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	MDM 6001/6002	C programming	III	3	0	1	**04**
2	MDM 6003	Object Oriented Programming	IV	3	0	0	**03**
3	MDM 6004/6005	Java Programming	V	3	0	1	**04**
4	MDM 6006	Python Programming	VI	3	0	0	**03**
Total Credits							**14**

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E. Open Electives

In addition to the above courses following courses are offered as Open Electives (OE) by the Computer Science & Engineering Department

Sr. No.	Category	Course Title	Sem.	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	OE	Design Thinking/ Critical Thinking	III	3	0	0	**03**
2	OE	PECL/Software Development Cycle	IV	3	0	0	**03**
3	OE	Behavioural Science & Organization	V	2	0	0	**02**
Total Credits							**08**

F. Honours Subject

Students will opt semester wise following courses for Honours degree in AIML. Intelligent System Group:

Sr. No.	Category	Course Code	Course Title	Sem.	Hours per week			Total Credits
					Lecture	Tutorial	Practical	
1	Honours	CSHNC0010	Modern Artificial Intelligence	V	3	1	0	**04**
2	Honours	CSHNC0020	Advanced Computer Vision	VI	3	1	0	**04**
3	Honours	CSHNC0030	Generative AI	VII	3	1	1	**05**
4	Honours	CSHNC0040	Deep Learning for NLP	VIII	3	0	0	**03**
5	Honours	CSHNC0050	Honours Project	VIII	0	0	2	**02**
Total Credits								**18**

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Semester VII

Tentative Teaching and Evaluation Scheme

Third Year B. Tech. Program in Computer Science and Engineering Multidisciplinary Minor

from 2026-27 as per NEP

Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
#	Cate-gory	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total (100)
1	PCC	CSPCC4001	Artificial Intelligence	3	1	-	4	15	15	10	60	100
2	PCC	CSPCC4003	Data Analytics	3	0	-	3	15	15	10	60	100
3	PEC4	CSPEC4001/CSPEC4003	PEC-IV	3	-	-	3	15	15	10	60	100
4	PEC5	CSPEC4005/CSPEC4007	PEC-V	3	-	-	3	15	15	10	60	100
5	PE4	CSPEC4002/CSPEC4004	Lab PEC-IV	-	-	2	1		-	25	25	50
6	PEC5	CSPEC4006/CSPEC4008	Lab PEC-V	-	-	2	1			25	25	50
7	PCC	CSPCC4002	Lab Artificial Intelligence		-	2	1			25	25	50
8	PCC	CSPCC4004	Lab Data Analytics			2	1			25	25	50
9	PR/	CSPRJ4001	Project			8	4			50	50	100
10		CSRMC4001	Research Methodology	2			2	10	10	--	30	50
Total				14	1	16	23	70	70	190	420	750

Professional Elective IV

CSPEC4001 Information Retrieval

CSPEC4003 Internet of Things (IOT)

Lab Professional Elective IV

CSPEC4002 Lab Information Retrieval

CSPEC4004 Lab Internet of things(IOT)

Professional Elective V

CSPEC4005 Recommender Systems

CSPEC4007 Deep Learning

Lab Professional Elective V

CSPEC4006 Lab Recommender Systems

CSPEC4008 Lab Deep Learning

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Semester VIII

Tentative Teaching and Evaluation Scheme

Third Year B. Tech. Program in Computer Science and Engineering Multidisciplinary Minor

from 2026-27 as per NEP

Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
#	Cate-gory	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total (100)
1		CSINT4001	Internship/OJT			24	12			100	100	200
Total				3		24	12	--	--	100	100	200

Note: <u>Credit transfer of NPTEL/SWAYAM courses shall be permitted in line with NEP 2020 regulations, subject to minimum of 80% syllabus equivalence with the institute-designed course and prior approval by the competent academic authority.</u>

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CSPCC4001: Artificial Intelligence

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**1**	ISE II (Marks)	**15**
Credits	**4**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Discrete Mathematics, Probability Theory, Data Structures

Course description

This course provides a comprehensive introduction to Artificial Intelligence, covering foundational concepts, problem-solving paradigms, knowledge representation, reasoning under uncertainty, learning, and intelligent agents. The course balances theoretical foundations with algorithmic techniques and practical applications relevant to modern AI systems.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Explain the fundamental concepts, goals, and historical evolution of Artificial Intelligence.
- **CO2:** Apply problem-solving and search techniques to formulate and solve AI problems.
- **CO3:** Represent knowledge and perform logical inference using symbolic and probabilistic methods.
- **CO4:** Analyze and implement learning and reasoning techniques under uncertainty.
- **CO5:** Design intelligent agents for real-world applications while considering ethical and societal implications.

Detailed Syllabus

UNIT I	**Introduction to Artificial Intelligence and Intelligent Agents** Definition, Scope, and Foundations of Artificial Intelligence; Historical Evolution and Interdisciplinary Nature. Intelligent Agents: Agent Architectures, Rationality, Performance Measures, Environment Types. Applications of AI in Search, Robotics, Vision, Language, Decision Support; Limitations and Current Challenges.
UNIT II	**Problem Solving and Search Techniques** Problem Formulation: State Space, Actions, Transition Models, Goal Tests, Path Cost. Uninformed Search: Breadth-First Search, Depth-First Search, Uniform Cost Search; Completeness and Optimality Analysis. Informed Search: Heuristic Functions, Greedy Best-First Search, A* Algorithms. Game Playing: Minimax Algorithm, Alpha–Beta Pruning, Evaluation Functions.
UNIT III	**Knowledge Representation and Logical Reasoning** Propositional Logic: Syntax, Semantics, Inference Rules, Resolution. First-Order Predicate Logic: Quantifiers, Unification, Forward and Backward Chaining. Knowledge Representation Techniques: Semantic Networks, Frames, Ontologies. Reasoning Systems: Rule-Based Systems, Expert Systems, Knowledge Engineering Process.
UNIT IV	**Reasoning under Uncertainty and Probabilistic Models** Limitations of Deterministic Reasoning; Uncertainty in Real-World AI Systems. Probability Theory Review; Bayesian Inference; Bayes' Rule with Examples. Probabilistic Models: Bayesian Networks, Markov Models, Hidden Markov Models. Decision Theory: Utility Functions, Expected Utility, Decision Networks.

UNIT V	**Learning, Planning, Ethics, and Applications** Introduction to Machine Learning in AI: Supervised, Unsupervised, and Reinforcement Learning Paradigms. Planning: Classical Planning, State-Space Planning, STRIPS Representation. Natural Language Processing and Computer Vision: High-Level Overview and Use Cases. Ethical, Legal, and Social Issues in AI: Bias, Fairness, Transparency, Accountability. Contemporary AI Applications: Healthcare, Finance, Autonomous Systems, Recommendation Engines.

Text Books

- Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education.
- Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence, McGraw-Hill Education.

Additional References

- Patrick Henry Winston, Artificial Intelligence, Addison-Wesley.
- George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson.
- NPTEL: Artificial Intelligence – Prof. Deepak Khemani, IIT Madras.
- NPTEL: Introduction to Artificial Intelligence – IIT Kharagpur.
- CS50's Introduction to Artificial Intelligence with Python – Harvard University.
- MIT 6.034: Artificial Intelligence – MIT Open Course Ware.
- Stanford CS221: Artificial Intelligence – Principles and Techniques.
- Berkeley CS188: Introduction to Artificial Intelligence.
- Oxford: AI Ethics and Society – Open Lectures.
- Research Surveys from IEEE, ACM on Symbolic AI, Probabilistic Reasoning, and Hybrid AI Systems.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1						2	2	1		2	2	1	1
CO2	2	3	2	2	2				2	2		1	3	2	2
CO3	2	2	1	2	2					2		1	3	2	3
CO4	2	1	2	3	3			1		2		1	2	3	2
CO5	2	1	3		2	2	1	3	3	2	2	1	1	1	3
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

Term Assessment of 10 marks is based on one / or a combination of the following

- Tutorials
- Problem Solving
- PowerPoint presentation of case studies
- Question & answer / Numerical solution

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	00	00	00	10
K2	Understand	10	10	05	20
K3	Apply	05	05	05	30
K4	Analyse	00	00	00	00
K5	Evaluate	00	00	00	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3
	CO1	CO2, CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	10	05
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

CSPCC4002: Lab Artificial Intelligence

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Implement classical AI problem-solving and search algorithms, analyze state-space representations, and compare their optimality and completeness.

CO2: Apply knowledge representation and logical reasoning techniques to solve inference-based problems using symbolic AI methods.

CO3: Implement reasoning under uncertainty and learning algorithms, and evaluate their performance using suitable metrics.

CO4: Analyze contemporary AI applications, ethical considerations, and emerging research trends through experimentation and literature study.

List of the Experiments

#	Title of the Experiments	Skill Level	CO	ISE Marks
	Level: Basic			
1	Implementation of State Space Representation and Problem Formulation (e.g., 8-Puzzle).	S1	CO1	2
2	Implementation of Uninformed Search Algorithms (BFS, DFS, UCS) Using A*.	S2	CO1	2
3	Implementation of Informed Search Algorithms (Greedy Best First Search, A*).	S2	CO1	2
4	Implementation of Minimax Algorithm for Game Playing.	S3	CO1	2
	Level: Moderate			
5	Implementation of Propositional Logic Inference using Resolution.	S3	CO2	2
6	Implementation of First Order Logic Inference using Forward/Backward Chaining.	S3	CO2	2
7	Implementation of Bayesian Inference using Bayes' Rule and Bayesian Networks.	S4	CO3	2
8	Implementation of a Simple Machine Learning Algorithm (Naive Bayes / Decision Tree).	S3	CO3	3
	Level: Complex			
9	Case Study and Implementation of an AI Planning Problem (STRIPS-based).	S5	CO3	4
10	Recent Research Paper Study and Presentation in AI (Search, Reasoning, Ethics, or Applications).	S5	CO4	4

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission.

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3					2	2			2	2	
CO2	2	3	2	2						2			2	2	
CO3	2	2	2	3				1		2			3	3	
CO4	2	2	2		1	1	1	2	3	2	2	3	2	2	3
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
55	Naturalization	00	00
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2	S3
	CO1	CO2, CO3	CO4
Term Work (25 Marks)	00	10	15
Practical Examination & Viva Voce (25 Marks)	00	10	15
Total Marks: 50			

CSPCC4003: Data Analytics

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**0**	ISE II (Marks)	**15**
Credits	**3**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Python/R, Databases, Statistics.

Course description

This course is designed to introduce students to principles and practices of data analytics. It covers the complete process of collecting, preparing, analyzing, and interpreting data to support decision-making.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Describe the foundational concepts of data analytics.
- **CO2:** Apply appropriate data cleaning, imputation techniques and statistical analysis to ensure accurate and reliable results
- **CO3:** Apply graph representations and basic graph metrics to analyze social network structures and identify communities using graph clustering techniques
- **CO4:** Visualising the data with the help of Python libraries.
- **CO5:** Apply ethical and security principles to ensure responsible & compliant decision-making.

Detailed Syllabus

UNIT I	**Introduction to data analytics** Importance of data analytics. Role of data analytics in engineering & business. Characteristics of data (volume, variety, velocity, veracity, value – 5vs). Types of data (structured, semi-structured, unstructured data, quantitative vs qualitative data). Types of analytics: descriptive, diagnostic, predictive, prescriptive. Data lifecycle and ETL.
UNIT II	**Data Preparation & Statistical Analysis** Working with Large Datasets. Data cleaning (missing data, duplicates, correcting inaccuracies, outliers). Data transformation (normalisation, standardisation). Imputation techniques (mean, mode, median imputation, forward/backward fill). Feature extraction using PCA. Measures of dispersion (Variance, Standard deviation, IQR). Correlation analysis using Pearson correlation. Cosine similarity. Hypothesis testing (ANOVA and Chi-square).
UNIT III	**Mining Social Network Graphs** Social networks as graphs (nodes, edges, directed and undirected graphs). Representation of social networks (adjacency matrix, adjacency list). Graph properties & metrics (Degree, path length, diameter, Clustering coefficient, Centrality measures: degree, betweenness, closeness, eigenvector centrality). Community Detection and Graph Clustering (Concept of communities in social networks, Graph clustering vs traditional clustering).
UNIT IV	**Data Visualization using Python**Basic Visualization Techniques:Bar charts, line charts, pie charts, histograms,Scatter plots and bubble charts and box plots,CaseStudies:Social media analytics. Scientific literature analysis and News and opinion mining

UNIT V	**Data analytics ethics, privacy & security** Ethical issues in data analytics. Privacy in data analytics. Security issues and how to resolve them. Legal and compliance framework (GDPR, PCI-CSS, HIPAA).

Text Books

- Practical Statistics for Data Scientists, Peter Bruce, Andrew Bruce, and Peter Gedek. Shroff/O'Reilly; Second edition (15 June 2020). ISBN: 8194435005
- Data Visualisation in R and Python, Marco Cremonini. O'Reilly Publishing. ISBN: 9781394289486
- A General Introduction to Data Analytics, João Moreira, André Carvalho, Tomás Horvath. Wiley Publishers. ISBN: 978-1-119-29626-3

Additional References

- NPTEL "Data Science for Engineers" + Stanford's "Mining Massive Datasets"
- Coursera "Applied Data Science with Python" + Kaggle micro-courses
- David Easley and Jon Kleinberg. *Networks, Crowds, and Markets: Reasoning About a Highly Connected World.* Cambridge University Press, ISBN 978-0-521-19533-1.
- Cathy O'Neil. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy.* Crown Publishing Group, ISBN 978-0-553-41881-1.
- Easley, David; Kleinberg, Jon. *Networks, Crowds, and Markets: Reasoning About a Highly Connected World.* Cambridge University Press.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1										2	2	1	1
CO2	2	3		2	2							1	3	2	2
CO3	2	2	1		2							1	3	2	3
CO4	2	1			3					2		1	2	3	2
CO5	2	1				2	1	3				1	1	1	3
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

Term Assessment of 10 marks is based on one / or a combination of the following

- Tutorials
- Problem Solving
- PowerPoint presentation of case studies
- Question & answer / Numerical solution

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	00	00	00	10
K2	Understand	10	10	05	20
K3	Apply	05	05	05	30

K4	Analyse	00	00	00	00
K5	Evaluate	00	00	00	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3
	CO1	CO2, CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	10	05
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

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CSPCC4004: Lab Data Analytics

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Use Python to apply data collection, pre-processing, and exploratory analytic approaches to real-world datasets.

CO2: Create and apply machine learning and statistical models for predictive analytics in the fields of engineering, finance, and healthcare.

CO3: To assist in data-driven decision making, analyse, interpret, and visualise analytical findings.

List of the Experiments

From any of the following Domains: Health Care, Finance, IT for Analytics, Marketing Analytics & Decision & Operations Analytics.

#	Title of the Experiments	Skill Level	CO	ISE Marks
	Level: Basic (all)			
1	Download a real-world dataset (Healthcare / Finance) from an open data repository and detect missing values, duplicate records, and inconsistent entries A healthcare dataset can be obtained using this URL: *https://www.kaggle.com/datasets/prasad22/healthcare-dataset?resource=download*	S1	CO1	05
2	Using a suitable real-world dataset (e.g., PIMA Indians Diabetes), implement **Pearson correlation** in Python to study relationships between variables. PIMA dataset can be obtained using this URL: *https://www.kaggle.com/datasets/uciml/pima-indians-diabetes-database*	S1	CO1, CO3	05
3	Using the Mall customer segmentation data, apply **Principal Component Analysis (PCA)** to reduce the number of features. The dataset can be obtained using this URL: *https://www.kaggle.com/datasets/vjchoudhary7/customer-segmentation-tutorial-in-python*	S1	CO1, CO2	05
	Level: Moderate (all)			
4	Use the **Energy Efficiency Dataset** to analyse the relationship between building design parameters and energy consumption. And apply an appropriate **regression model** to predict the **Heating.** The dataset can be obtained by using this URL: *https://www.kaggle.com/datasets/elikplim/eergy-efficiency-dataset*	S2	CO2	05
5	Using the **Cancer Dataset**, implement a **Support Vector Machine (SVM)** model to predict whether a tumour is **benign or malignant** based on given diagnostic features. The dataset can be obtained by using this URL: *https://www.kaggle.com/datasets/uciml/breast-cancer-wisconsin-data*	S2	CO2	05

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6	Using a real-world finance dataset related to loan applicants. Build a **Logistic Regression model** to classify whether a customer is **likely to default on a loan** based on selected economic and demographic attributes. The dataset can be obtained using this URL: *https://www.kaggle.com/datasets/mlg-ulb/creditcardfraud*	S2	CO2	05
Level: Complex (any two)				
7	Using a real-world finance dataset related to loan default, perform an end-to-end predictive analytics task. The experiment should include: Model building, evaluation and visualization The dataset can be obtained using this URL: *https://www.kaggle.com/datasets/nitindatta/finance-data*	S3	CO1, CO2, CO3	05
8	Using real-world Twitter dataset, perform sentiment analysis to classify tweets based on their sentiment polarity. The dataset can be obtained using this URL: *https://www.kaggle.com/datasets/jp797498e/twitter-entity-sentiment-analysis*	S3	CO1, CO2, CO3	05
9	Using a suitable real-world time series dataset related to transportation traffic (such as road traffic volume, metro passenger count, railway ridership, or air traffic statistics), perform time series analysis (using ARIMA) and forecasting. The dataset can be obtained using this URL: *https://www.kaggle.com/datasets/abdelazizsami/time-series-analysis-for-transportation*	S3	CO2, CO3	05

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission.

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	3							1	2	3	2
CO2	3	3	2	2	3						1	1	2	3	3
CO3	2	2	2	2	3					1	1	2	1	2	2
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	5	2
S2	Manipulation	15	12
S3	Precision	5	11
S4	Articulation	0	0
55	Naturalization	0	0
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2
	CO1	CO2, CO3
Term Work (25 Marks)	5	20
Practical Examination & Viva Voce (25 Marks)	10	15
Total Marks: 50		

CSPEC4001 (PEC-IV): Information Retrieval

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**0**	ISE II (Marks)	**15**
Credits	**3**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Database Management System

Course description

After completing this course, students will gain a good understanding of the foundation concepts of information retrieval (IR) techniques and be able to apply these concepts into practice. The subject covers the basics and important aspects associated with IR, need of retrieval, storage and searching techniques, retrieval performance evaluation and ontology, distributed and multimedia IR and web searching etc.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Understand fundamental concepts and processes of Information Retrieval
- **CO2:** Apply storage, indexing, and retrieval techniques for text and multimedia data
- **CO3:** Evaluate the performance of Information Retrieval systems using standard metrics
- **CO4:** Analyze the working of search engines and web crawlers
- **CO5:** Explore applications of Information Retrieval in multimedia, distributed, and web environments

Detailed Syllabus

UNIT I	**INTRODUCTION** Basic Concepts of IR, Data Retrieval & Information Retrieval, IR system block diagram. Automatic Text Analysis: Luhn's ideas, Conflation Algorithm, Indexing and Index Term Weighing, Probabilistic Indexing, Automatic Classification. Measures of Association, Different Matching Coefficient, Classification Methods, Cluster Hypothesis, Clustering Algorithms, Single Pass Algorithm, Single Link Algorithm
UNIT II	**STORAGE AND SEARCHING TECHNIQUES** Storage: Inverted file, Suffix trees &suffix arrays, Signature Files, Clustered files. IR Models: Basic concepts, Boolean Model, Vector Model Searching strategies: Boolean Search, Serial search, cluster based retrieval, Query languages, Types of queries, Patterns matching, structural queries.
UNIT III	**RETRIEVAL PERFORMANCE EVALUATION AND ONTOLOGY** Performance evaluation: Precision and recall, alternative measures. Ontology: Ontology based information sharing, Ontology languages for semantic web, Ontology creation.
UNIT IV	**DISTRIBUTED AND MULTIMEDIA IR** Distributed IR: Introduction, Collection Partitioning, Source Selection, Query Processing, web issues.

	Multimedia IR: Introduction, Data Modeling, Query languages, Generic multimedia indexing approach, One dimensional time series, two dimensional color images, Automatic feature extraction.
UNIT V	**WEB SEARCHING** Challenges, Characterizing the Web, Search Engines, Browsing, Meta-searchers, Web crawlers, Meta-crawler, Web data mining, Finding needle in the Haystack, Searching using Hyperlinks, Page ranking algorithms.

Text Books

- Yates &Neto, "Modern Information Retrieval", Pearson Education, ISBN 81-297-0274-6.
- C.J.Rijsbergen,"Information Retrieval", (www.dcs.gla.ac.uk).
- HeinerStucken Schmidt, FrankvanHarmelen, "Information Sharing on the Semantic Web", Springer International Edition, ISBN 3-540-20594-2.

Additional References

- Christopher D. Manning, PrabhakarRaghavan and HinrichSchutze "Introduction to Information Retrieval", Cambridge University Press, ISBN 978-0-521-865715
- Mark leven, "Introduction to search engines and web navigation", John Wiley and sons Inc., ISBN 9780-170-52684-2.
- V. S. Subrahamanian, Satish K. Tripathi "Multimedia information System", Kulwer Academic Publisher.
- Chabane Djeraba, "Multimedia mining A highway to intelligent multimedia documents", Kluwer Academic Publisher, ISBN 1-4020-7247-3.
- Ricci,F, Rokach,L.Shapira,B.Kantor, "Recommender Systems Handbook", First Edition,2011
- Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, Information Retrieval Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2010.
- https://nptel.ac.in/courses/106106852

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2										2	3		1
CO2	3	3	2		2							2	3	2	2
CO3	2	3		2	2							2	2	2	2
CO4	2	2	2		3					1		2	2	3	3
CO5	2	2	2		3	1				1		3	2	3	3
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

Term Assessment of 10 marks is based on one / or a combination of the following

- Tutorials
- Problem Solving
- PowerPoint presentation of case studies
- Question & answer / Numerical solution

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	05	00	00	05
K2	Understand	05	05	02	15
K3	Apply	05	05	03	20
K4	Analyse	00	05	03	10
K5	Evaluate	00	00	02	10
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1	K2	K3
	CO1	CO2,CO3	CO4,CO5
ISE I (15 Marks)	05	10	00
ISE II (15 Marks)	00	05	10
ISE III (10 Marks)	02	04	04
ESE Assessment (60 Marks)	15	25	20

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CSPEC4002 (Lab PEC-IV): Lab Information Retrieval

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Implement conflation algorithms and document representation techniques

CO2: Apply clustering techniques using single pass algorithm

CO3: Analyze indexing and searching using inverted file structures

CO4: Explore recent research trends in IR, web crawling, digital libraries, and multimedia IR

List of the Experiments

The student shall perform experiments of the following.

#	Title of the Experiments	Skill Level	CO	ISE Marks
Level: Basic				
1	To implement Conflation Algorithm using File Handling.	S1	CO1	2
2	To implement a single pass algorithm for clustering.	S2	CO2	2
3	To implement a program Retrieval of documents using inverted files.	S2	CO3	2
4	To implement a simple Web Crawler in Java.	S3	CO4	2
Level: Moderate				
5	To implement a program for feature extraction in 2D colour images (any features like color, texture etc.)	S3	CO3	2
6	To study recent papers on IR / search engine / Digital Libraries/ content management system for documents.	S4	CO4	2
7	Assignments based on Multimedia.	S3	CO4	2
8	Assignments based on Digital Libraries.	S3	CO4	3
Level: Complex				
9	Paper presentation on recent work in IR	S5	CO4	8

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2		2							2	3	2	2
CO2	2	3		2	2							2	2	2	2
CO3	2	2	2		3					1		2	2	3	3
CO4	2	2	2		3	1				1		3	2	3	3
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
55	Naturalization	00	00
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2	S3
	CO1	CO2, CO3	CO4
Term Work (25 Marks)	00	10	15
Practical Examination & Viva Voce (25 Marks)	00	10	15
Total Marks: 50			

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CSPEC4003 (PE-IV): Internet of Things

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**0**	ISE II (Marks)	**15**
Credits	**3**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Computer Network and Data Communication.

Course description

This course provides a comprehensive introduction to the Internet of Things (IoT), covering its architecture, physical and logical design, and essential enabling technologies like Fog and Edge computing. Students will gain hands-on experience with hardware platforms like Arduino and Raspberry Pi, interfacing various sensors and actuators using serial and wireless communication protocols such as LoRaWAN, MQTT, and CoAP. The curriculum explores data management through cloud platforms, web development using HTML/PHP, and the implementation of mobile IoT applications. It further addresses advanced networking concepts, including WSNs, 6LoWPAN, and the integration of SDN and NFV for optimized connectivity. Ultimately, the course examines real-world applications across smart cities, healthcare, and industry while tackling the challenges of IoT data analytics and M2M service models.

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Understand the applications of IOT

CO2: Describe the working of different sensors & circuit modules.

CO3: Demonstrate working of different types of connectivity.

CO4: IllustrateIoT device programming.

CO5: Implement IoT in a real time scenario.

Detailed Syllabus

UNIT I	**IOT- Introduction and Applications** Introduction to IoT–Definition, Characteristics, IoTArchitecture ,functional requirements, motivation, Physical design-things in IoT, IoT protocols, Logical Design-functional blocks, communication models, Communication APIs, ,Physical &Logical IoT design Basics , Smart Objects and Connecting Smart Objects. IoT Enabling Technologies ,IoT Stack, Fog ,Edge , Applications–Home Automation, Cities, Environment, Energy, Agriculture, Health, Industry.
UNIT II	**Sensors and Actuators** Sensor working, Sensor Characteristic s , Types of sensors and working principle ,Sensors used in IoT, IoT Hardware platforms, Specifications and interfaces, Serial Communication Protocols, Arduino IDE, Arduino Programming, Interfacing various sensors, modules and devices to Arduino,Raspberry Pi
UNIT III	**Wireless for IOT:** Overview of Wireless Sensor Networks, IEEE standards for IoT ,Overview of Wireless Modems(RF, GSM/GPRS, Bluetooth, RFID, Wi-Fi etc.) ,NodeMCU and ESP32, : Physical

	and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA, Application Layer Protocols: CoAP and MQTT.
UNIT IV	**Cloud Platforms for IOT** IOT dashboards, Introduction to various cloud platforms, Device and data management from Cloud Platforms, Uploading data from hardware platforms to cloud.IoT Graphical user interface and back end Application Design: Web development for IoT, Introduction to HTML and PHP, IoT application development for Mobile
UNIT V	**Data Analytics And Supporting Services** Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, . Introduction-M2M, Difference between M2M and IoT, SDN and NFV for IoT,Organizing in IoT/M2M, Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models

Text Books

- Dr.OvidiuVermesandDr. Peter Fries, Internet of Things: From research and innovation to market development, River Publishers 2014.
- Honbo Zhou, "The Internet Of Things In The Cloud: A Middleware Perspective"- C R C Press 2012
- ArshdeepBahga and Vijay Madisetti. Internet of Things: A Hands-On Approach. VPT Publishers, ISBN 978-0-996-02565-6.

Additional Reference

- Dieter Uckelmann, Mark Harrison, and Florian Michahelles. Architecting the Internet of Things. Springer, ISBN 978-3-642-19156-5.
- PethuruRajandAnupama C. Raman " The Internet of Things: Enabling Technologies and Use Cases". C R C Press

Web References:

- https://onlinecourses.nptel.ac.in/noc19_cs65
- The Internet of Things in the Cloud | A Middleware Perspective | Honbo(taylorfrancis.com)

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1							1							
CO2		2	3					1						1	
CO3		2	3					2					1	1	
CO4	2	2	3					2	3			3	1	1	
CO5		2	3					2	3			3	1		
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

Term Assessment of 10 marks is based on one / or a combination of the following

- Tutorials
- Problem Solving
- PowerPoint presentation of case studies
- Question & answer / Numerical solution

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	00	00	00	10
K2	Understand	10	10	05	20
K3	Apply	05	05	05	30
K4	Analyse	00	00	00	00
K5	Evaluate	00	00	00	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3,K4,K5
	CO1,CO2	CO2,CO3, CO4,CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	00	15
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

CSPEC4004 (Lab PE-IV): Lab Internet of Things

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Design and implement fundamental embedded systems.
CO2: Interface and control sensors and actuators using IoT platforms.
CO3: Implement cloud-based IoT data acquisition and control.
CO4: Develop complete IoT applications integrating hardware and software.

List of the Experiments

The student shall perform a minimum of 5 experiments of the following using Arduino and Mini-Project is essential.

#	Title of the Experiments	Skill Level	CO	ISE Marks
	Level: Basic (all)			
1.	Controlling actuators through Serial Monitor. Creating different led patterns and controlling them use push button switches. Controlling servo motors with the help of a joystick.	S1	CO1	2
2.	Calculate the distance to an object with the help of an ultrasonic sensor and display it on an LCD	S1	CO1	2
3.	a) Controlling relay state based on ambient light levels using LDR sensor. b) Basic Burglar alarm security system with the help of PIR sensor and buzzer. c) Displaying humidity and temperature values on LCD	S2	CO2	2
4.	a) Controlling relay state based on input from IR sensors b) Interfacing stepper motor with R-Pi c) Advanced burglar alarm security system with the help of PIR sensor, buzzer and keypad.(Alarm gets disabled if correct keypad password is entered) d) Automated LED light control based on input from PIR (to detect if people are present) and LDR (ambient light level)	S2	CO2	3
5.	Sense a Finger When it is Placed on Board Using Arduino.	S3	CO3	3
	Level-Moderate			
6.	Controlling LEDs, relay & buzzer using Blynkapp	S3	CO3	3
7.	IntroductiontoHTTP.HostingabasicserverfromtheESP32 To control various digital based actuators (led,buzzer,relay) from a simple web page.	S3	CO3	3
8.	Displaying various sensor readings on a simple webpage	S4	CO4	4

	hostedontheESP32			
9.	Controlling LEDs/Motors from an Android/Webapp, Controlling AC Appliances from an android/web app with the help of relay.	S4	CO4	4
10.	Displaying humidity and temperature data on a web-based application	S4	CO4	4
Level-Complex				
11	Mini-Project	S4	CO4	8

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission.

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes:

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1		3							1		1	2	3	1
CO2		2	2					2		1		1	2	3	1
CO3	1	3	3				3			1		1	2	3	1
CO4		3	3						2	1		1	2	3	1
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	06	06
S2	Manipulation	06	06
S3	Precision	05	05
S4	Articulation	00	00
55	Naturalization	08	08
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2	S3	S4
	CO1	CO2	CO3	CO4
Term Work (25 Marks)	06	06	05	08
Practical Examination & Viva Voce (25 Marks)	06	06	06	07
Total Marks: 50				

CSPEC4005 (PE-V): Recommender Systems

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**0**	ISE II (Marks)	**15**
Credits	**3**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Machine Learning.

Course description

This course introduces foundational and advanced concepts in Recommender Systems. It covers the mathematical, algorithmic, and system-level techniques involved in predicting user preferences, including non-personalized methods, content-based strategies, collaborative filtering models, hybrid recommenders, and domain-specific applications. Emphasis is placed on evaluation metrics, scalability, robustness, and practical deployment.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Explain principles and techniques for generating non-personalized, content-based, and collaborative recommendations.
- **CO2:** Interpret and apply automated decision-support strategies for personalized item suggestions.
- **CO3:** Implement recommendation models using content-based, neighborhood-based, and model-based collaborative filtering.
- **CO4:** Evaluate recommender systems using accuracy, rank-based metrics, diversity, novelty, coverage, and serendipity.
- **CO5:** Design and validate an end-to-end recommender system for a specific application domain.

Detailed Syllabus

UNIT I	**Introduction and Foundations of Recommendation** Overview of Information Retrieval, Retrieval Models, Querying and Matching Techniques, User–Item Interaction Modeling. Search and Filtering: Relevance Feedback, User Profiles, Similarity Models, Rating Prediction Frameworks. Linear Algebra Foundations: Matrix Operations, Norms, Covariance Structures, Vector Similarities, Sparsity Considerations. Applications of Recommender Systems; Challenges such as sparsity, cold-start, bias, popularity effects, fairness, and scalability.
UNIT II	**Content-Based Filtering** High-level Architecture of Content-Based Systems; Semantic and Feature-Driven Recommendation Pipelines. Item Profiles: Feature Extraction, Document Modeling, TF–IDF, Embeddings, Tag-Based Feature Construction. User Profile Learning: Long-term and Short-term Preference Modeling, Adaptive Preference Updating. Similarity-Based Retrieval; Classification Algorithms for Recommendation (Naive Bayes, Logistic Regression, SVMs, Neural Embeddings). Strengths, Limitations, and Domain Suitability of Content-Based Methods.

UNIT III	**Collaborative Filtering** Neighborhood Models: User-Based and Item-Based CF, Similarity Metrics, Neighborhood Construction and Pruning. Model-Based Approaches: Latent Factor Models, Matrix Factorization (SVD, SVD++), Regularization Strategies, Optimization Approaches. Probabilistic and Graph-Based Recommenders; Implicit Feedback Handling; Temporal Dynamics. Attacks on Collaborative Filtering: Shilling Attacks, Poisoning, Bias Injection, and Robustness Measures.
UNIT IV	**Hybrid Recommender Systems** Motivation for Hybridization: Data Completeness, Accuracy Enhancement, Robustness, Cold-Start Alleviation. Monolithic Hybridization: Feature Combination, Feature Augmentation, Joint Modeling Approaches. Parallel Hybridization: Weighted Hybrids, Switching Strategies, Mixed Models. Pipeline Hybridization: Staged Recommendation, Re-Ranking Strategies, Cascaded Architectures. Limitations, Complexity Trade-offs, Deployment Considerations.
UNIT V	**Specialized Recommender System Types and Evaluation** Personalized Web Search; Knowledge-Based Recommenders (constraint-based, case-based). Social Recommenders: Tagging-Based Systems, Trust-Centric Recommenders, Social Graph and Influence Modeling. Group Recommendation: Preference Aggregation, Consensus Modeling. Evaluation of RS: Offline Metrics (RMSE, MAE), Ranking Metrics (Precision@k, Recall@k, MAP, NDCG), Diversity, Novelty, Coverage, Serendipity. Practical Methodology: Dataset Selection, Validation Protocols, Ethical and Privacy Considerations.

Text Books

- Jannach D., Zanker M., Felfernig A., Friedrich G., Recommender Systems: An Introduction, Cambridge University Press.
- Charu C. Aggarwal, Recommender Systems: The Textbook, Springer.
- Francesco Ricci, LiorRokach, BrachaShapira, Paul B. Kantor, Recommender Systems Handbook, Springer.

Additional References

- Robin Burke, Hybrid Recommender Systems (Foundational Chapters in RS Handbook).
- Manning, Raghavan&Schütze, Intro. to Information Retrieval, Cambridge University Press.
- NPTEL: Recommender Systems – IIT Madras / IIT Kharagpur (Full course availability varies).
- NPTEL: Information Retrieval – IIT Kharagpur.
- NPTEL: Machine Learning – IIT Bombay / IIT Madras.
- Coursera: Recommender Systems Specialization – University of Minnesota.
- CS50's Introduction to Artificial Intelligence with Python – Harvard University (contains recommender-related modules).
- Stanford CS246/Mining Massive Data Sets (covers large-scale recommendation topics).
- Google Developers: Recommendation Systems Guides (practical engineering view).

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2		2				1	2	2			2	1	
CO2	2	2	3	2				1	2	2			2	1	
CO3	2	2	3	3				2		3	2		1	1	
CO4	2	2	3	2				2	3	2		3	1	1	
CO5	2	2	3	3	1	1	1	2	3	3	3	3	1	3	3
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

Term Assessment of 10 marks is based on one / or a combination of the following

- Tutorials
- Problem Solving
- PowerPoint presentation of case studies
- Question & answer / Numerical solution

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	00	00	00	10
K2	Understand	10	10	05	20
K3	Apply	05	05	05	30
K4	Analyse	00	00	00	00
K5	Evaluate	00	00	00	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3,K4,K5
	CO1,CO2	CO2,CO3, CO4,CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	00	15
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

Dr. Vikul Pawar
Head CSE

Dr. Anil Karwankar
Dean Academics

B.Tech. Computer Science & Engineering Curriculum
With effect from Academic Year 2026–2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

CSPEC4006 (Lab PE-V): Lab Recommender Systems

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Implement foundational recommendation techniques including non-personalized and content-based filtering using mathematical similarity models.

CO2: Apply collaborative filtering algorithms and matrix factorization techniques for personalized recommendation tasks.

CO3: Evaluate recommender systems using accuracy, ranking, diversity, and coverage-based metrics.

CO4: Analyze real-world recommender systems, scalability challenges, ethical issues, and contemporary research trends.

List of the Experiments

The student shall perform experiments using Python.

#	Title of the Experiments	Skill Level	CO	ISE Marks
	Level: Basic			
1	Implementation of Non-Personalized Recommendation (Top-N / Popularity-Based).	S1	CO1	2
2	Implementation of Similarity Measures (Cosine, Pearson, Jaccard).	S2	CO1	2
3	Implementation of Content-Based Filtering using TF–IDF Features.	S2	CO1	2
4	Implementation of User Profile Learning and Item Ranking.	S3	CO1	2
	Level: Moderate			
5	Implementation of User-Based Collaborative Filtering.	S3	CO2	2
6	Implementation of Item-Based Collaborative Filtering.	S3	CO2	2
7	Implementation of Matrix Factorization using SVD / ALS.	S4	CO2	2
8	Evaluation of Recommender System using RMSE, Precision@K, Recall@K.	S3	CO3	3
	Level: Complex			
9	Design and Implementation of a Hybrid Recommender System.	S5	CO3	4
10	Case Study / Research Paper Presentation on Industrial Recommender Systems (Netflix, Amazon, YouTube).	S5	CO4	4

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission.

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2					2	2			3	2	
CO2	2	3	2	3						2			3	3	
CO3	2	2	2	2				1		2			2	3	
CO4	2	2	2		1	1	1	2	3	2	2	3	2	2	3
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
55	Naturalization	00	00
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2	S3
	CO1	CO2, CO3	CO4
Term Work (25 Marks)	00	10	15
Practical Examination & Viva Voce (25 Marks)	00	10	15
Total Marks: 50			

CSPEC4007 (PEC-V): Deep Learning

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**0**	ISE II (Marks)	**15**
Credits	**3**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Machine Learning.

Course description

This course introduces the foundations of Deep Learning, covering essential mathematical tools, neural network architectures, training strategies, optimization methods, and practical implementations for real-world applications.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Comprehend the fundamental concepts of Deep Learning and interpret key mathematical structures used in deep models.
- **CO2:** Acquire conceptual and algorithmic understanding of modern learning models and identify appropriate applications of deep learning methods.
- **CO3:** Implement and train basic to intermediate Deep Learning architectures.
- **CO4:** Optimize deep learning models through regularization, improved training strategies, and effective hyperparameter tuning.
- **CO5:** Develop and evaluate complete deep learning solutions for domain-specific applications

Detailed Syllabus

UNIT I	**Introduction to Deep Learning, Linear Algebra and Probability Foundations** Scalars, Vectors, Matrices, Tensors; Matrix–Vector Multiplication; Identity and Inverse Matrices; Rank and Linear Transformations. Eigendecomposition, Singular Value Decomposition (SVD), Principal Component Analysis (PCA). Probability Theory: Random Variables, Distributions, Joint/Marginal/Conditional Probabilities, Independence, Expectation, Variance, Covariance. Bayes' Rule, Chain Rule of Probability, Information Measures (entropy, cross-entropy), Useful Mathematical Functions.
UNIT II	**Numerical Computation and Machine Learning Basics** Numerical Stability: Overflow, Underflow, Poor Conditioning, Gradient Computation and Optimization Landscapes. Linear Least Squares, Constrained Optimization, Gradient-Based Optimization Principles. Learning Theory: Capacity, Overfitting/Underfitting, Bias-Variance Trade-off, Hyperparameters and Validation Strategies. Maximum Likelihood Estimation, Bayesian Estimation, Estimators and Consistency. Supervised and Unsupervised Learning Algorithms; Stochastic Gradient Descent; Challenges Motivating Deep Learning.

UNIT III	**Deep Feedforward Networks and Regularization Strategies** Feedforward Networks: XOR Problem, Hidden Units, Activation Functions, Architecture Design. Backpropagation and Computational Graph Differentiation Methods. Regularization: Data Augmentation, Parameter Norm Penalties, Noise Injection, Semi-Supervised Learning. Ensemble Methods: Bagging, Boosting, Dropout. Adversarial Training, Tangent Distance, Tangent Prop, Manifold Tangent Classifiers.
UNIT IV	**Optimization for Deep Models and Convolutional Neural Networks** Distinction Between Learning and Pure Optimization; Loss Landscape Challenges. Optimization Algorithms: SGD Variants, Momentum, RMSProp, Adam, AdaGrad; Parameter Initialization Strategies. Second-Order and Approximate Methods; Meta-Algorithms and Practical Training Heuristics. Convolutional Neural Networks (CNNs): Convolution, Cross-Correlation, Padding, Stride, Pooling, Feature Maps. Variants of Convolutions, Efficient Implementations, Structured Outputs, Neuroscientific Motivation, Historical Development of CNNs.
UNIT V	**Sequence Modeling, Practical Methodology, and Applications** Computational Graph Unfolding; Recurrent and Recursive Neural Networks. RNNs, LSTMs, GRUs, Bidirectional RNNs, Encoder–Decoder Architectures, Seq2Seq Models. Long-Term Dependency Challenges; Echo State Networks; Deep Recurrent Networks. Practical Methodology: Metrics, Baseline Models, Data Requirements, Hyperparameter Selection, Debugging Strategies. Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, NLP, and Cross-Domain Applications.

Text Books

- Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press.
- Christopher Bishop, Pattern Recognition and Machine Learning, Springer.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer.

Additional References

- NPTEL: Deep Learning – Prof.MiteshKhapra (IIT Madras).
- NPTEL: Fundamentals of Deep Learning – IIT Kharagpur / IIT Madras.
- NPTEL: Machine Learning – IIT Bombay / IIT Madras.
- NPTEL: Neural Networks and Applications – IIT Kanpur.
- Michael Nielsen, Neural Networks and Deep Learning (online, free).
- Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley & Sons.
- Sergey Levine, Deep Reinforcement Learning Course Notes (available online).
- MIT 6.S191 – Introduction to Deep Learning, MIT OCW (OpenCourseWare).
- Stanford CS231n: Convolutional Neural Networks for Visual Recognition.
- Stanford CS224n: Natural Language Processing with Deep Learning.
- HarvardX: CS50's Introduction to Computer Science at http://cs50.harvard.edu/x
- HarvardX: CS50's Intro. to Artificial Intelligence with Python at https://cs50.harvard.edu/ai
- Andrew Ng – Deep Learning Specialization, DeepLearning.AI (Coursera).

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1										2	2	1	1
CO2	2	3		2	2							1	3	2	2

CO3	2	2	1		2							1	3	2	3
CO4	2	1			3					2		1	2	3	2
CO5	2	1				2	1	3				1	1	1	3
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

Term Assessment of 10 marks is based on one / or a combination of the following

- Tutorials
- Problem Solving
- PowerPoint presentation of case studies
- Question & answer / Numerical solution

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	00	00	00	10
K2	Understand	10	10	05	20
K3	Apply	05	05	05	30
K4	Analyse	00	00	00	00
K5	Evaluate	00	00	00	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3, K4, K5
	CO1, CO2	CO2. CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	10	05
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

CSPEC4008 (Lab PEC-V): Lab Deep Learning

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Implement core mathematical operations and basic neural network components required for deep learning models and analyze their behavior.

CO2: Design, train, and evaluate deep feedforward and convolutional neural networks using suitable optimization techniques.

CO3: Apply regularization, optimization, and sequence modeling techniques to improve deep learning model performance.

CO4: Analyze advanced deep learning architectures, applications, and recent research trends through experimentation and literature review.

List of the Experiments

The student shall perform ten experiments using Python.

#	Title of the Experiments	Skill Level	CO	ISE Marks
	Level: Basic			
1	Implementation of Vector, Matrix, and Tensor Operations for Deep Learning.	S1	CO1	2
2	Implementation of a Single Neuron Model with Gradient Descent.	S2	CO1	2
3	Implementation of a Multi-Layer Perceptron for Classification.	S2	CO2	2
4	Implementation of Backpropagation Algorithm from Scratch.	S3	CO2	2
	Level: Moderate			
5	Training a Neural Network with Regularization Techniques (L1, L2, Dropout).	S3	CO3	2
6	Implementation of Optimization Algorithms (Momentum, RMSProp, Adam).	S3	CO3	2
7	Design and Training of a Convolutional Neural Network for Image Classification.	S4	CO2	2
8	Implementation of Data Augmentation and Performance Evaluation Techniques.	S3	CO3	3
	Level: Complex			
9	Implementation of Recurrent Neural Network / LSTM for Sequence Modeling.	S5	CO3	4
10	Recent Research Paper Study and Presentation in Deep Learning Applications.	S5	CO4	4

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission.

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3					2	2			2	2	
CO2	2	3	3	3						3	2		3	3	
CO3	2	2	2	3				1		3	2		3	3	
CO4	2	2	2		1	1	1	2	3	2	2	3	2	2	3
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
55	Naturalization	00	00
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2	S3
	CO1	CO2, CO3	CO4
Term Work (25 Marks)	00	10	15
Practical Examination & Viva Voce (25 Marks)	00	10	15
Total Marks: 50			

CSPRJ4001: Project

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**8**	ISE I (Term Work) (Marks)	**50**
Credits	**4**	ESE (Marks)	**50**

Course Description:
This course is to make students acquire thorough knowledge and develop skills to formulate computing requirements for the solution.

Course Outcomes
After successful completion of the course, students will be able to:

CO1: Work efficiently and constructively in a project team
CO2: Review literature to identify gaps and define objectives & scope of the work.
CO3: Get experiences of using obtained knowledge, and learn how to use certain tools used in the IT-community
CO4: Synthesize and integrate information for designing modules
CO5: Design innovative idea for solving the problem

Course Objectives:
The VII Semester Project Work aims to provide students with an opportunity to apply theoretical knowledge to solve real-world problems, develop research and design skills, and gain hands-on experience in software/hardware systems relevant to Computer Science and Engineering.

Project Selection

- The project should address a real-world problem, innovative idea, or research challenge in the field of Computer Science and Engineering.
- Topics may include (but are not limited to): Artificial Intelligence, Machine Learning, Data Science, Cyber Security, Cloud Computing, IoT, Blockchain, Web Technologies, Mobile Applications, and Systems Software.
- The project may be industry-oriented, research-based, or application-oriented.
- Each project must be approved by the assigned Project Guide and the Department Project Review Committee.

Team Formation

- Project work may be carried out individually or in a team (as per university/department norms).
- Each team shall have a maximum of 3–4 students.
- All members must contribute equally and actively throughout the semester.

Project Guide Allocation

- Each project/team will be assigned a faculty guide from the department.
- Students must meet their guide regularly (As per Time-Table) and follow the instructions and feedback provided.

Project Planning and Scheduling

Students are expected to:

- Define the problem statement, objectives, and scope clearly.
- Conduct a literature survey and identify gaps.
- Prepare a project plan with milestones and timelines.
- Follow the project schedule strictly and update progress periodically.

Activities to be performed

During the VII semester, students should complete:

- Problem identification and formulation
- Literature survey and requirement analysis
- System architecture and design
- Selection of tools, technologies, and datasets
- Initial implementation / prototype development
- Documentation of progress

Reviews and Evaluation

- Students must attend periodic project reviews as scheduled by the department.
- Publication of research papers in line with the project work will be considered for additional weightage in the project evaluation.
- Project competitions/Hackathon/Sponsored Project/ Industry Project relevant to the project work will be considered for additional weightage in the evaluation.
- Each review will assess:
    - Understanding of the problem
    - Quality of literature survey
    - Design and methodology
    - Progress of implementation
    - Presentation and communication skills
- Marks will be awarded based on continuous assessment and review performance.

Documentation

Students must maintain:

- Review reports as per department/Institute format
- A Phase-I Project Report at the end of the semester, including:
    - Introduction and objectives
    - Literature survey
    - System design and methodology
    - Preliminary results / implementation details

Ethics and Originality

- The project work must be **original** and free from plagiarism.
- Proper citation of research papers, datasets, and tools must be followed.
- Any form of copying or academic dishonesty will result in strict action as per university norms.

Attendance and Discipline

- Regular attendance in project hours and review meetings is mandatory.
- Students must adhere to departmental and institutional rules and timelines.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1								2		1	1	2			
CO2		1							2			1		1	
CO3				1			3		2						
CO4		1	1											1	1
1 – High, 2 – Medium, 3 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	10	10
S2	Manipulation	20	10
S3	Precision	20	10
S4	Articulation	00	10
55	Naturalization	00	10
Total Marks: 100		**50**	**50**

Level No.	Skill Level	ISE I	ESE
S1	Preparation	10	10
S2	Literature Review	10	10
S2	Observation and Analysis of Results	10	10
S3	Record	10	10
53	Mini-Project / Presentation/ Viva-Voce	10	10
Total Marks: 100		**50**	**50**

Assessment table

Assessment Tool	S1	S2	S3	S4	S5
	CO1	CO2	CO3	CO4	CO5
Term Work (50 Marks)	10	10	10	10	10
Practical Examination & Viva Voce (25 Marks)	05	05	05	05	05

Skill Level	ISE I	ESE
Imitation	10	10
Manipulation	20	10
Precision	20	10
Articulation	00	10
Naturalization	00	10

CSRMC4001: Research Methodology

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**2**	ISE I (Marks)	**10**
Tutorials (Hours/Week)	**0**	ISE II (Marks)	**10**
Credits	**2**	ISE III (Marks)	**0**
		ESE (Marks)	**30**

Course description

This course introduces the fundamental principles of research, covering research design, data collection, scientific writing, ethics, analysis, and dissemination. Students will learn how to conduct systematic investigations, evaluate literature, design experiments, interpret results, and communicate findings effectively.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Understand the core concepts of scientific research, methodologies, and research ethics.
- **CO2:** Conduct literature surveys, formulate research problems, and develop hypotheses.
- **CO3:** Select appropriate research designs and data collection/analysis methods.
- **CO4:** Apply statistical and analytical techniques to interpret research findings.
- **CO5:** Prepare and present technical reports, research papers, and project documentation in standard academic formats.

Detailed Syllabus

UNIT I	**Overview of Research** Defining the Research Cycle, Identifying a Research Problem, Introduction to Research Methodology, The Role of Hypothesis, Literature Survey as a Foundation, Methodology and Execution, Communication and Peer Review. **Technical Writing** Technical Writing, Technical Presentation and Ethics in Research
UNIT II	**Literature Survey** The Purpose of a Literature Survey, Understanding the Context, Sources of Literature, The "Iterative" Nature of Literature Search, Organizing and Critical Thinking, Managing References (BibTeX, LaTeX, EndNote), Using databases (Web of Science, Scopus) **Intellectual Property** Defining Intellectual Property (IP), Why Protect Intellectual Property? Types of Intellectual Property Rights (Patents, Copyright, Trademark, Trade Secrets, Industrial Designs) Ownership and Ethics

UNIT III	**Data Analysis** Purpose of Data Analysis, Types of Data, The Goal of Data Analysis, Accuracy vs. Precision, Significant Figures and Error Bars, Statistical Interpretation, Visualizing Data (Graphing), Correlation vs. Causation Measures of Central Tendency and Variability, Probability Distributions, Correlation and Causality, Hypothesis Testing Introduction, Hypothesis Testing Introduction, Regression Analysis Basics, Regression Analysis Basics, Common Pitfalls in Data Analysis **Modeling Skills** Definition of a Model, First-Principles vs. Empirical Models, Systematic Procedure for Building Models, The "Parsimony" Principle (Occam's Razor)

Text Books

- Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE Publications.
- Wayne C. Booth, Gregory Colomb, Joseph Williams, The Craft of Research, University of Chicago Press.
- C.R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques, New Age International.

Additional References

- John W. Creswell & J. David Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, (6th Edition, 2023).
- Wayne C. Booth, Gregory G. Colomb, & Joseph M. Williams, The Craft of Research, University of Chicago Press, (5th Edition, 2024).
- Robert K. Yin, Qualitative Research from Start to Finish, Guilford Press, (2nd Edition).
- NPTEL: Research Methodology – IIT Madras / IIT Kharagpur.
- NPTEL: Technical Communication for Scientists & Engineers – IIT Bombay
- NPTEL: Quantitative Research Methods – IIT Roorkee.
- Coursera: How to Write and Publish a Scientific Paper – ÉcolePolytechnique.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2					1		1					
CO2	2	2	2	1						2	2				
CO3		2	3	3											
CO4			3	3					3						
CO5	3	2	3	2				2				3			
3 – High, 2 – Medium, 1 - Low															

Term work Assessment:

ISE I and ISE II: In semester evaluations (ISE I and ISE II) of 10 marks, each will be based on Class Test I and Class Test II, respectively.

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ESE
K1	Remember	05	00	05
K2	Understand	05	00	05
K3	Apply	00	05	05
K4	Analyse	00	05	05
K5	Evaluate	00	00	10
Total Marks: 50		10	10	30

Assessment table

Assessment Tool	K1, K2	K3
	CO1,CO2	CO3, CO4,CO5
ISE I (10 Marks)	05	05
ISE II (10 Marks)	05	05
ESE Assessment (30 Marks)	10	20

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B.Tech. Computer Science & Engineering Curriculum
With effect from Academic Year 2026–2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

CSINT4001: Internship/OJT

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**30**	ISE I (Term Work) (Marks)	**00**
Credits	**12**	ESE (Marks)	**00**

Special Instructions:
Credit transfer of Internship/OJT courses shall be permitted as per institute policy in line with NEP 2020, UGC, and AICTE regulations/guidelines.

Guidelines for On-the-Job Training (OJT)/Internship – VIII Semester

1. Objective of On-the-Job Training/Internship

The On-the-Job Training (OJT)/Internship in the VIII semester is designed to provide students with practical exposure to industry practices, professional work culture, and real-time problem-solving in the field of Computer Science and Engineering. It aims to bridge the gap between academic learning and industry requirements.

2. Duration of Training

- The OJT/ internship shall be carried out during the VIII semester as per the academic calendar.
- The duration of training shall be as prescribed by the institute policy.

3. Organization / Industry Selection

- Students may undergo OJT/ internship in IT companies, start-ups, R&D organizations, industries, government organizations, or approved research institutions**.**
- The organization must be relevant to the Computer Science and Engineering domain**.**
- Prior approval from the Department OJT Coordinator is mandatory.

4. Training Area and Scope

The training should be aligned with Computer Science and Engineering domains such as:

- Software Development
- Artificial Intelligence and Machine Learning
- Data Science and Analytics
- Cyber Security
- Cloud Computing and DevOps
- Internet of Things (IoT)
- Web and Mobile Application Development
- Networking and Systems

5. Allocation of Faculty Mentor

- Each student shall be assigned a faculty mentor by the department.
- The student must maintain regular communication with the mentor and follow the guidance provided.

6. Student Responsibilities During OJT/Internship

- Students are expected to:
- Adhere to the rules, regulations, and work culture of the host organization.
- Maintain discipline, punctuality, and professional ethics**.**
- Actively participate in assigned tasks and projects.
- Maintain a daily/weekly logbook or training diary**.**
- Submit periodic progress reports to the faculty mentor.

7. Monitoring and Review

- Periodic reviews shall be conducted by the department/faculty mentor.
- Students may be required to present their progress during review meetings.
- Performance will be assessed based on mentor feedback, reports, and presentations.

8. Documentation and Submission

Students must submit the following documents:

- OJT/ internship joining letter / offer letter or Email
- Training completion certificate or Email from the organization

Final OJT/ internship report in the prescribed format, including:

- Organization profile
- Training objectives
- Work carried out
- Tools and technologies used
- Learning outcomes

9. Evaluation and Assessment

OJT/ internship evaluation shall be based on:

- Performance appraisal by industry supervisor
- Quality of training report
- Presentation / viva-voce
- Feedback from faculty mentor

Marks will be awarded as per the evaluation scheme approved by the BoS/Academic Council based on individual's performance**.**

10. Ethics and Conduct

- Students must follow professional ethics, confidentiality, and data protection policies of the organization.
- Any violation of rules may lead to disciplinary action as per institute norms.

11. Attendance and Completion

- Minimum attendance as prescribed by the organization and institute must be maintained.
- Successful completion of OJT/internship is mandatory for the award of the degree.

12. Outcome of On-the-Job Training/Internship

By the end of the VIII semester OJT/ internship, students should:

- Gain hands-on industry experience
- Develop technical and professional skills
- Understand real-world software development and deployment practices
- Be better prepared for employment or higher studies

Note: Students are advised to plan and complete the OJT/ internship diligently in consultation with the department and assigned faculty mentor.

CSHNC0010: Modern Artificial Intelligence

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**1**	ISE II (Marks)	**15**
Credits	**4**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Course description

To acquaint students with the meaning, purpose, scope, stages, applications, and effects of AI. To share the basic tasks and algorithms in Machine Learning .To provide understanding of how system learns in supervised learning

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Understand the basics of Artificial Intelligence and Intelligent Agents, including the foundations, history, and rational behavior in diverse environments.

CO2: Apply problem-solving strategies using search algorithms, both uninformed and heuristic, for solving real-world AI problems.

CO3: Analyse complex search environments and formulate solutions using local search, partial observability, and constraint satisfaction techniques.

CO4: Demonstrate knowledge representation and reasoning skills using propositional logic, first-order logic, and inference methods.

CO5: Explore uncertainty handling and machine learning techniques, including probabilistic reasoning, Bayesian networks, and foundational supervised learning models.

Detailed Syllabus

UNIT I	**Introduction Artificial Intelligence and Intelligent Agents:** Introduction to AI ,The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Risks and Benefits of AI, Agents and Environments ,Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents .
UNIT II	**Approach for Problem-solving:** Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions. **Search in Complex Environments:** Local Search and Optimization Problems,Local Search in Continuous Spaces, Search with Nondeterministic Actions,Search in Partially Observable Environments,Online Search Agents and Unknown Environments. Constraint Satisfaction Problems: Defining Constraint Satisfaction Problems,Constraint Propagation: Inference in CSPs.

UNIT III	**Knowledge, reasoning, and planning:** Logical Agents ,Knowledge-Based Agents,The Wumpus World,Logic,Propositional Logic: A Very Simple Logic,Propositional Theorem Proving,Effective Propositional Model Checking,Agents Based on Propositional Logic. First-Order Logic:Representation Revisited,Syntax and Semantics of First-Order Logic,Using First-Order Logic,Knowledge Engineering in First-Order Logic. Inference in First-Order Logic:,Propositional vs First-Order Inference,Unification and First-Order Inference,Forward Chaining,Backward Chaining. Knowledge Representation:Ontological Engineering,Categories and Objects,Events,Mental Objects and Modal Logic,Reasoning Systems for Categories,Reasoning with Default Information.
UNIT IV	**Uncertain knowledge and reasoning:** Acting under Uncertainty,Basic Probability Notation, Inference Using Full Joint Distributions,Independence, Bayes' Rule and Its Use,Naive Bayes Models. Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain,The Semantics of Bayesian Networks,Exact Inference in Bayesian Networks, Approximate Inference for Bayesian Networks,Causal Networks. Probabilistic Reasoning over Time: Time and Uncertainty, Inference in Temporal Models, Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks.
UNIT V	**Machine Learning:** Supervised Learning covers Supervised Learning, Learning Decision Trees, Model Selection and Optimization, The Theory of Learning, Linear Regression and Classification, Nonparametric Models, Ensemble Learning, and Developing Machine Learning Systems. Knowledge in Learning explores A Logical Formulation of Learning, Knowledge in Learning, Explanation-Based Learning, Learning Using Relevant Information, and Inductive Logic Programming.

Text Books

- "Artificial Intelligence For Dummies", J.P. Mueller and L. Massaron, Second Edition, For Dummies..
- "Artificial Intelligence: A Modern Approach", S.J. Russell and P. Norvig, Fourth Edition, Pearson Education, 2020.
- "Artificial Intelligence", NPTEL Online Course, https://nptel.ac.in/courses/106102220

Additional References

- John W. Creswell & J. David Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, (6th Edition, 2023).
- Wayne C. Booth, Gregory G. Colomb, & Joseph M. Williams, The Craft of Research, University of Chicago Press, (5th Edition, 2024).
- Robert K. Yin, Qualitative Research from Start to Finish, Guilford Press, (2nd Edition).
- NPTEL: Research Methodology – IIT Madras / IIT Kharagpur.
- NPTEL: Technical Communication for Scientists & Engineers – IIT Bombay
- NPTEL: Quantitative Research Methods – IIT Roorkee.
- Coursera: How to Write and Publish a Scientific Paper – ÉcolePolytechnique.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3											1	3		
CO2	1														
CO3	2	2	1										2		
CO4	3	1	2		1				2	1			1	1	1
CO5	3	1			1				1	1		1	1	1	1
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

ISE I and ISE II: In semester evaluations (ISE I and ISE II) of 15 marks, each will be based on Class Test I and Class Test II, respectively.

ISE III: Term work Assessment of 10 marks is based on one / or a combination of the following:

- Quiz
- Assignments
- Question and answer
- PowerPoint presentation

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	0			10
K2	Understand	10	10	5	20
K3	Apply	5	5	5	30
K4	Analyse				
K5	Evaluate				
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3
	CO1,CO2	CO2, CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	10	05
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

CSHNC0020: Advanced Computer Vision

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**1**	ISE II (Marks)	**15**
Credits	**4**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Course description

The course will provide an overview of the challenges of vision, the common approaches and current techniques. While specific examples and applications may be used to illustrate, the focus will be on fundamental techniques and algorithms. We assume no prior knowledge of computer vision but still aim to study many modern, state-of-art techniques.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Understand the fundamental concepts, applications of computer vision and study principles of image formation through geometric models. photometric properties
- **CO2:** Apply various methods of image segmentation and edge detection for isolate meaningful regions and boundaries in digital images.
- **CO3:** Interpret traditional object recognition techniques by extracting image features and applying classifiers
- **CO4:** Analyze the principles of neural networks and deep learning, including loss functions and optimization strategies of image classification models
- **CO5:** Apply vision transformer models for image classification and object detection, and apply Fully Convolutional Networks (FCNs)

Detailed Syllabus

UNIT I	Introduction Background, requirements and issues, human vision, Image formation: geometry and photometry Geometry, photometry (brightness and color), quantization, camera calibration
UNIT II	Image segmentation and Feature Extraction Various methods of image segmentation, edge detection, SIFT features Multi-view Geometry Shape from stereo and motion,
UNIT III	Object Recognition: Traditional methods Image features, Various classifiers (Nearest Neighbor, Bayes, SVM)
UNIT IV	Introduction to Neural Networks and Deep Learning Neural networks, loss functions, optimization methods, Image Classification and Object Detection LeNet, AlexNet, VGG, ResNet, Efficient Net RCNN, Faster RCNN, YOLO, SSD, FPN
UNIT V	Vision Transformers Transformer architecture, application to image classification and object detection, Fully Convolutional Networks

Text Books & References

- "Computer Vision: A Modern Approach", D. Forsyth and J. Ponce, 2010.

- "Deep Learning: Algorithms and Applications", I. Goodfellow, Y. Bengio and A. Courville, 2017
- "A Guide to Convolutional Neural Networks for Computer Vision", S. Khan, H. Rahmani, S. Shah and M. Bennamoun, 2018
- "Computer Vision: Algorithms and Applications", Richard Szeliski, Second Edition, 2021; https://szeliski.org/Book/
- "Foundations of Computer Vision", A. Torralba, P. Isola and W.T. Freeman, MIT Press, 2024

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3				1	2	3		2		1	
CO2	3	3	1	2				1	2	3		2		1	
CO3	3	3	1	3				1	2	3		2	2	1	3
CO4	2	3	1	3				1	2	3		2	2	1	3
CO5	2	3	1	3				1	2	3		2	2	1	3
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	00	00	00	10
K2	Understand	10	05	02	15
K3	Apply	05	05	02	15
K4	Analyze	00	05	02	15
K5	Evaluate	00	00	02	05
K6	Create	00	00	02	05
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3
	CO1, CO2	CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	00	15
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	30	30

CSHNC0030: Generative AI

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**1**	ISE II (Marks)	**15**
Credits	**4**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Knowledge of Python, linear algebra, and neural network.

Course description

This course provides a comprehensive exploration of Generative AI, beginning with its historical evolution and the fundamental shift from discriminative to generative modeling. This course covers cutting-edge techniques like Prompt Engineering, RLHF, and Retrieval Augmented Generation (RAG), alongside the practical use of open-source frameworks like Hugging Face and LangChain. Beyond technical implementation, the course emphasizes Ethical AI and Responsible AI, addressing critical issues like hallucinations and mode collapse. By the end, you will be equipped to fine-tune, program, and deploy sophisticated AI agents for diverse real-world use cases.

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Understand the concepts of Generative Modeling.
CO2: Apply Gen AI to Generating Texts.
CO3: Apply Gen AI for generating Image.
CO4: Apply Gen AI for generating video.
CO5: Apply Open Source Tools for solving problems using Gen AI.

Detailed Syllabus

UNIT I	**Introduction to GEN AI** Historical Overview of Generative modeling - Difference between Gen AI and Discriminative Modeling, Importance of generative models in AI and Machine Learning Types of Generative models ,GANs,VAEs, autoregressive models and Vector quantized Diffusion models, Understanding if probabilistic, modeling and generative process Challenges of Generative Modeling, Future of Gen AI, Ethical, Aspects of AI, Responsible AI, Use Cases.
UNIT II	**Generative models for Text** Language Models Basics , Building blocks of Language models -,Transformer Architecture , Encoder and Decoder ,Attention mechanisms - Generation of Text , Models like BERT and GPT models ,Generation of Text, Autoencoding, Regression Models, Exploring ChatGPT, Prompt Engineering, Designing Prompts– Revising Prompts using Reinforcement Learning from Human Feedback (RLHF),Retrieval Augmented Generation (RAG) – Multimodal LLM ,Issues of LLM like hallucination.

UNIT III	**Generation of Images** Introduction to Generative Adversarial Networks – Adversarial Training Process – Nash Equilibrium, VariationalAutoencoders – Encoder-Decoder Architectures - Stable Diffusion Models, Introduction toTransformer-based Image Generation, CLIP, Visual Transformers ViT- Dall-E2 and Dall-E3, GPT-4V, Issues of Image Generation models like Mode Collapse and Stability.
UNIT IV	**Generation of Painting, Music, and Play** Variants of GAN – Types of GAN - Cyclic GAN – Using Cyclic GAN to Generate Paintings Neural Style Transfer, Style Transfer - Music Generating RNN, MuseGAN, Autonomous agents, Deep Q Algorithm ,Actor-critic Network.
UNIT V	**Open source models and programming frameworks** Training and Fine tuning of Generative models ,GPT4All - Transfer learning and Pretrained models, Training vision models, Google Copilot - Programming LLM ,LangChain ,Open Source Models ,Llama - Programming for TimeSformer – Deployment – Hugging Face.

Text Books

- Denis Rothman, "Transformers for Natural Language Processing and Computer Vision", Third Edition ,Packt Books, 2024
- Omar Sanseviero" Hands-On Generative AI with Transformers and Diffusion Models"O'Reilly Media
- Valentina Alto" Modern Generative AI with ChatGPT and OpenAIModels"Packt Publishing

Additional References

- David Foster, "Generative Deep Learning", O'Reilly Books, 2024.
- AltafRehmani, "Generative AI for Everyone", BlueRose One, 2024

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2					1		1					
CO2	2	2	2	1						2	2				
CO3		2	3	3											
CO4			3	3					3						
CO5	3	2	3	2				2				3			
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

ISE I and ISE II: In semester evaluations (ISE I and ISE II) of 15 marks, each will be based on Class Test I and Class Test II, respectively.

ISE III: Term work Assessment of 10 marks is based on one / or a combination of the following:

- Quiz
- Assignments
- Question and answer
- PowerPoint presentation

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	05	00	00	10
K2	Understand	05	05	00	10
K3	Apply	05	05	00	10
K4	Analyse	00	05	05	10
K5	Evaluate	00	00	00	20
K6	Create	00	00	05	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3
	CO1,CO2	CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	05	10
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	20	40

CSHNC0031: Lab Generative AI

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**2**	ISE I (Term Work) (Marks)	**25**
Credits	**1**	ESE (Marks)	**25**

Course Outcomes

After successful completion of the course, students will be able to:

- Design and implement basic Generative AI models.
- Develop text, image, and data generation systems using Gen AI frameworks.
- Implement cloud-based training and deployment of Generative AI models.
- Develop end-to-end Generative AI applications integrating data, models, and deployment.

List of the Experiments

The student shall perform experiments of the following.

#	Title of the Experiments	Skill Level	CO	ISE Marks
1	To study the concept of Generative Artificial Intelligence and compare Generative Models with Discriminative Models.	S1	CO1	2
2	To implement probabilistic modeling techniques and generate synthetic data samples.	S2	CO1	2
3	To study the architecture of transformer-based language models and generate text using pretrained models.	S2	CO3	2
4	To design effective prompts and implement Retrieval Augmented Generation to reduce hallucination in large language models.	S3	CO2	3
5	To study the architecture and training process of Generative Adversarial Networks using PyTorch or TensorFlow.	S3	CO3	3
6	To generate images using diffusion-based generative models such as Stable Diffusion.	S4	CO3	3
7	To generate artistic content using neural style transfer and GAN-based models with PyTorch.	S3	CO4	3
8	To train, fine-tune, and deploy open-source generative AI models using a Hugging Face.	S3	CO4	3

Term Work Assessment:

ISEI: In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission

End Semester Evaluation: In ESE of 25 marks Practical conduction and Oral Examination.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2		2							2	3	2	2
CO2	2	3		2	2							2	2	2	2
CO3	2	2	2		3					1		2	2	3	3
CO4	2	2	2		3	1				1		3	2	3	3
3 – High, 2 – Medium, 1 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
55	Naturalization	00	00
Total Marks: 50		25	25

Assessment table

Assessment Tool	S1	S2	S3
	CO1	CO2, CO3	CO4
Term Work (25 Marks)	00	10	15
Practical Examination & Viva Voce (25 Marks)	00	10	15
Total Marks: 50			

Dr. Vikul Pawar
Head CSE

Dr. Anil Karwankar
Dean Academics

B.Tech. Computer Science & Engineering Curriculum
With effect from Academic Year 2026–2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

CSHNC0040: Deep Learning for Natural Language Processing

Teaching Scheme		Examination Scheme	
Lectures (Hours/Week)	**3**	ISE I (Marks)	**15**
Tutorials (Hours/Week)	**1**	ISE II (Marks)	**15**
Credits	**4**	ISE III (Marks)	**10**
		ESE (Marks)	**60**

Prerequisite

Participants should have done a course on Machine Learning, and should know basics of Python Programming

Course description

Natural Language Processing finds its applications nearly everywhere -- be it Machine Translation, Question answering, Text Summarization, Dialogs, etc. In the last decade, Deep Learning based methods have given very good performance across a variety of NLP tasks, and have become a default choice for NLP problems. This course aims to give a thorough understanding of various deep learning architectures along with their specific use-cases in NLP.The course will also introduce the fundamental ideas behind training as well as fine-tuning/prompting the Large Language Models, which include in-context-learning, Parameter-efficient-fine-tuning, Reinforcement Learning through Human Feedback (RLHF). The course will also offer hands-on tutorials to help students master this subject.

Course Outcomes

After successful completion of the course, students will be able to:

- **CO1:** Analyze and Implement Word Embeddings and Sequence Models
- **CO2:** Design and Evaluate Transformer-based Architectures
- **CO3:** Apply Large Language Model (LLM) Optimization Techniques
- **CO4:** Integrate Human Feedback into Model Training.
- **CO5:** Develop and Deploy Practical NLP Solutions.

Detailed Syllabus

UNIT I	**Introduction to NLP** What is Natural Language Processing?, Text Processing Pipeline, Tokenization:, Text Normalization, Stemming and Lemmatization, Sentence Segmentation, N-gram Language Models , The Chain Rule of Probability, Markov Assumption, Maximum Likelihood Estimation (MLE), Calculations & Examples, The Zero Probability Problem, Introduction to Smoothing, NLP Tasks and Paradigms, Generative vs. Discriminative Models The Supervised Learning Framework, The Goal of Training, Optimization, Generalization vs. Overfitting.
UNIT II	**Introduction to deep learning** Shallow and Deep Neural Networks, Representation Learning, Gradient Descent: The Intuition of Gradient Descent, The Gradient Vector, The Update Rule Types of Gradient Descent, Challenges in Optimization ,Backpropagation: The Problem of Credit Assignment, The Computation Graph, The Chain Rule of Calculus, Step-by-Step Derivation, Local Gradients and Upstream Gradients, Multi-Dimensional Backpropagation (Vectorization),Activation Functions and their Gradients, Weight Initialization

UNIT III	**Recurrent Neural Networks** RNN LMs ,GRUs, LSTMs, Bi-LSTMs ,LSTMs for Sequence Labeling,LSTMs for Sequence to Sequence,Attention Mechanism,Sequence to Sequence with Attention,Transformers: Attention is all you need,Self-supervised learning (SSL), Pretraining,Designing SSL objectives ,Pretrained Bi-LSTMs: ELMO ,Pretrained Transformers: BERT, GPT, T5, BART, reinforcement learning from human feedback
UNIT IV	**Prompting Techniques** why does in-context learning work? ,advanced prompting techniques ,tool-aided language models ,automatic prompt engineering ,parameter-efficient fine-tuning, efficient fine-tuning for quantized lms ,other parameter efficient methods: pruning, distillation.
UNIT V	**Scaling laws of LLMs** modern LLMs and architecture variations - i ,:modern LLMs and architecture variations: positional embeddings ,long sequence modeling ,retrieval augmented generation ,model interpretability, model interpretability - multilingual ,model interpretability - iii ,trustworthy LLMs : taxonomy ,trustworthy LLMs: machine unlearning, Analysis and Interpretability, ethical considerations

Text Books

- Mihai Surdeanu& Marco Antonio Valenzuela-Escárcega, Deep Learning for Natural Language Processing: A Gentle Introduction, Cambridge University Press, (2024).
- Yoav Goldberg, Neural Network Methods in Natural Language Processing, Morgan & Claypool Publishers, (2017).
- Daniel Jurafsky& James H. Martin, Speech and Language Processing, Pearson/Prentice Hall, (3rd Edition Draft, 2025).

Additional References

- Lewis Tunstall, Leandro von Werra & Thomas Wolf, Natural Language Processing with Transformers, O'Reilly Media, (Revised Edition, 2022).
- Sebastian Raschka, Build a Large Language Model (From Scratch), Manning Publications, (2024).
- Stephan Raaijmakers, Deep Learning for Natural Language Processing, Manning Publications, (2022).
- https://nptel.ac.in/courses/108105572

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2					1		1					
CO2	2	2	2	1						2	2				
CO3		2	3	3											
CO4			3	3					3						
CO5	3	2	3	2				2				3			
3 – High, 2 – Medium, 1 - Low															

Term Assessment:

ISE I and ISE II: In semester evaluations (ISE I and ISE II) of 15 marks, each will be based on Class Test I and Class Test II, respectively.

ISE III: Term work Assessment of 10 marks is based on one / or a combination of the following:

- Quiz
- Assignments
- Question and answer
- PowerPoint presentation

Assessment Pattern

Level No.	Knowledge Level	ISE I	ISE II	ISE III	ESE
K1	Remember	05	00	00	10
K2	Understand	05	05	00	10
K3	Apply	05	05	00	10
K4	Analyse	00	05	05	10
K5	Evaluate	00	00	00	20
K6	Create	00	00	05	00
Total Marks: 100		15	15	10	60

Assessment table

Assessment Tool	K1, K2	K3
	CO1,CO2	CO3, CO4, CO5
ISE I (15 Marks)	10	05
ISE II (15 Marks)	05	10
ISE III (10 Marks)	05	05
ESE Assessment (60 Marks)	20	40

CSHNC0050: Honours Project

Teaching Scheme		Examination Scheme	
Practical (Hours/Week)	**4**	ISE I (Term Work) (Marks)	**25**
Credits	**2**	ESE (Marks)	**25**

Course Description:
This course develops students' ability to identify small-scale problems, carry out requirement analysis, design feasible solutions, and implement a functional prototype. It emphasizes experiential learning, teamwork, application of modern tools, innovation, documentation, and presentation in line with AICTE–NEP 2020 guidelines.

Course Objectives:

- Identify and formulate a simple technical/problem statement through brief literature/field study
- Work collaboratively in teams to design and implement feasible computing solutions
- Apply appropriate engineering fundamentals, development tools, and testing concepts
- Demonstrate documentation, presentation, ethical responsibility, and readiness for higher-level projects

Course Outcomes
After successful completion of the course, students will be able to:

CO1: Work constructively in a small project team
CO2: Identify problem objectives and define scope through brief literature review
CO3: Apply relevant tools/techniques to design and develop a mini-solution
CO4: Demonstrate testing, validation, documentation and presentation skills

Guidelines for Honours Project Work

1. Objective of the Honours Project

The Honours Project is intended to provide academically motivated students with an opportunity to undertake advanced, in-depth, and research-oriented project work beyond the regular curriculum. It aims to enhance innovation, critical thinking, research aptitude, and professional competency in specialized areas of Computer Science and Engineering.

2. Nature of the Honours Project

- The project shall be research-intensive, innovative, or product-oriented.
- It must be significantly distinct and more advanced than the regular B.Tech project.
- The project may involve:
    - Advanced algorithms and systems
    - Artificial Intelligence / Machine Learning
    - Data Science and Big Data Analytics
    - Cyber Security and Blockchain
    - Cloud Computing, DevOps, and Distributed Systems
    - IoT, Embedded Systems, or Interdisciplinary domains

3. Project Registration and Approval

- Students must submit a detailed project proposal including objectives, methodology, expected outcomes, and timeline.
- The proposal shall be reviewed and approved by the Department Committee.
- Any change in project title or scope requires prior approval.

4. Allocation of Project Guide

- Each Honours Project shall be supervised by a faculty member with relevant expertise.
- Co-supervision by an industry expert or research mentor may be permitted with approval.
- Students must meet the project guide regularly and comply with the guidance provided.

5. Work to Be Accomplished During the Semester

Students undertaking the Honours Project are expected to:

- Clearly define the research problem and objectives
- Perform an extensive literature review using reputed journals and conferences
- Design and validate the methodology / system architecture
- Implement advanced models, algorithms, or systems
- Perform experimentation, testing, and performance analysis
- Document findings systematically

6. Reviews and Progress Evaluation

- Periodic reviews shall be conducted by the Departmental Review Committee in hybrid mode**.**
- Students must present progress reports during each review.
- Evaluation will consider:
    - Depth of research and originality
    - Technical complexity and innovation
    - Quality of implementation and results
    - Documentation and presentation

7. Research Publication and Innovation

- Students are strongly encouraged to publish research papers arising from the Honours Project in reputed journals or conferences.
- Publications, patents, prototypes, or start-up outcomes aligned with the project will carry additional weightage, as per institute norms.

8. Documentation and Submission

Students must submit:

- Periodic progress reports
- A comprehensive Honours Project Report, including:
    - Abstract and introduction

- Literature survey
- Methodology and system design
- Experimental results and analysis
- Conclusion and future work

Source code, datasets, and supporting materials (where applicable)

9. Ethics, Originality, and Compliance

- The Honours Project must be original and free from plagiarism.
- Proper citation of all references, datasets, and tools is mandatory.
- Ethical standards and data confidentiality must be strictly followed.

10. Evaluation and Certification

- The Honours Project shall be evaluated as per the Honours evaluation scheme approved by the Academic Council.
- Successful completion will lead to the award of the Honours degree/recognition as per regulations.

11. Expected Outcomes

By completing the Honours Project, students should:

- Demonstrate advanced technical and research skills
- Gain experience in independent problem-solving
- Be well-prepared for research careers, higher studies, or high-impact industry roles.

Note: Students are advised to plan the Honours Project carefully and maintain continuous interaction in hybrid mode with their project guide and review committee for successful completion.

Mapping of Course Outcomes with Program Outcomes

#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2								2	1	1	2		1	1
CO2	1									2		1	1		2
CO3			1		3							2	1	1	
CO4	1	1											2	1	
1 – High, 2 – Medium, 3 - Low															

Assessment Pattern

Level No.	Skill Level	ISE I	ESE
S1	Imitation	05	10
S2	Manipulation	10	10
S3	Precision	10	05
S4	Articulation	00	00

55	Naturalization	00	00
Total Marks: 100		**50**	**50**

Level No.	Skill Level	ISE I	ESE
S1	Preparation	05	10
S2	Literature Review	05	10
S2	Observation and Analysis of Results	05	05
S3	Record	05	00
53	Honour Project / Presentation/ Viva-Voce	05	00
Total Marks: 100		**25**	**25**

Assessment table

Assessment Tool	S1	S2	S3	S4	S5
	CO1	CO2	CO3	CO4	CO5
Term Work (50 Marks)	05	05	05	05	05
Practical Examination & Viva Voce (25 Marks)	10	10	05	00	00

Skill Level	ISE I	ESE
Imitation	10	10
Manipulation	20	10
Precision	20	10
Articulation	00	10
Naturalization	00	10