

Government College of Engineering, Aurangabad

(An Autonomous Institute)

Teaching and Evaluation Scheme from year 2023-2024

B. Tech. Program in Information Technology with Semester– VII and VIII

SEMESTER-VII												
Sr. No	Category	Course Code	Course Title	Hours per week			Credits	Continuous Evaluation in terms of Marks				Total
				L	T	P		ISE I	ISE II	ISE III	ESE	
1	PEC	ITPEC4031/4033/4035	Professional Elective VI	3	0	0	3	15	15	10	60	100
2	PEC	ITPEC4032/4034/4036	Lab Professional Elective VI	0	0	2	1	-	-	25	-	25
3	PEC	ITPEC4039/4040/4041	Professional Elective VII	2	0	0	2	10	10	-	30	50
4	ELC	ITELC4001	Project-II	0	0	6	3	-	-	100	-	100
5	*ELC	ITELC4004	Project-II	0	0	8	4	-	-	100	-	100
6	ELC	ITELC4002	Research Methodology	2	0	0	2	15	15	10	60	100
Total Credits with MDM				7	0	16	11	40	40	145	250	475
6	Honors	ITHNC7004	Advanced Machine Learning	3	1	0	4	15	15	10	60	100
Total Credits with MDM+Honors				10	1	10	15	55	55	155	310	575
7	Research		Research Project-I	0	0	18	9	-	-	50	50	100
Total Credits with MDM + Research				10	1	28	20	55	55	205	360	675
SEMESTER-VIII												
Sr. No	Category	Course Code	Course Title	Hours per week			Credits	Continuous Evaluation in terms of Marks				Total
				L	T	P		ISEI	ISEII	ISE III	ESE	
1	ELC	ITELC4003	Internship/OJT	0	0	24	12	-	-	100	100	200
Total Credits with MDM				0	0	24	12	-	-	100	100	200
2	Honors	ITHNC7005	Advanced Deep Learning	3	1	0	4	15	15	10	60	100
3	Honors	ITHNC7006	Project	0	0	4	2	-	-	25	25	50
Total Credits with MDM+Honors				3	1	28	18	15	15	135	185	350
4	Research		Research Project-II	0	0	18	9	-	-	50	50	100
Total Credits with MDM + Research				3	1	46	21	15	15	185	235	450

List of Professional Electives:

Professional Elective: VI	Professional Elective: VII
ITPEC4031: Speech and Natural Language Processing ITPEC4032: Lab Speech and Natural Language Processing	ITPEC4039: Soft Computing
ITPEC4033: Distributed Systems ITPEC4034: Lab Distributed Systems	ITPEC4040: Data Science

ITPEC4035: Advanced Computer Architecture ITPEC4036: Lab Advanced Computer Architecture	ITPEC4041: Software Testing and Quality Assurance
ITPEC4037: High Performance Computing ITPEC4038: Lab High Performance Computing	ITPEC4042: Generative Artificial Intelligence
*ITELC4004: Project-II (DSY)	


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ITPEC4031: Speech and Natural Language Processing		
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	ISE I	15 Marks
Tutorial: 0	ISE II	15 Marks
Credits:03	ISE III	10 Marks
	End Semester Examination	60 Marks

Course Description: This course introduces the fundamentals of **Speech and Natural Language Processing (SNLP)**, covering techniques for word-level and syntactic analysis, text classification, information retrieval, lexical resources, and machine translation. It provides students with essential knowledge to understand and develop basic language-based intelligent systems.

Course Outcome: After completing the course, students will be able to	
CO1	Understand basic concepts and applications of NLP and speech processing.
CO2	Apply word-level analysis and part-of-speech tagging techniques.
CO3	Perform syntactic analysis using grammar and parsing methods.
CO4	Use Naive Bayes for text classification and sentiment analysis.
CO5	Explain information retrieval models, lexical resources, and machine translation approaches.

Detailed Syllabus:

Unit 1	Word Level Analysis: Regular Expressions and their role in text processing; Finite-State Automata for lexical analysis; Morphological analysis and morphological parsing; Inflectional and derivational morphology; Spelling error detection and correction techniques; Words and word classes; Part-of-Speech tagging approaches – rule-based and statistical methods.
Unit 2	Syntactic Analysis: Introduction to syntactic structure; Context-Free Grammar (CFG); Constituency and parse trees; Parsing strategies – Top-down parsing and Bottom-up parsing; CYK parsing algorithm and its applications; Limitations of grammar-based parsing.
Unit 3	Text Classification and Sentiment Analysis: Naive Bayes classifiers for text processing; Bayes theorem and independence assumptions; Training the Naive Bayes classifier; Worked example of text classification; Sentiment analysis using Naive Bayes; Optimization techniques for sentiment analysis; Naive Bayes for other text classification tasks; Naive Bayes as a language model.
Unit 4	Information Retrieval: Design features of Information Retrieval (IR) systems; Information Retrieval models – Classical models (Boolean, Vector Space, Probabilistic); Non-classical IR models; Alternative models of information retrieval – Cluster model, Fuzzy model, LSTM-based model; Major issues in information retrieval including indexing, ranking, relevance, and evaluation.
Unit 5	Lexical Resources: Lexical resources for NLP; WordNet – structure and semantic relations; FrameNet; Stemmers and lemmatization techniques; Part-of-Speech taggers; Research corpora – annotated and unannotated corpora; Role of corpora in NLP research. Case study on recent trends in Speech and natural language processing


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Text Books & Reference Books

1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2024
2. Lewis Tunstall, Leandro Von Werra, Thomas Wolf. Natural Language Processing with Transformers, O'Reilly, 2023
3. Sowmya Vajjala, Bodhisattwa Majumder, Anju Gupta, Harshit Surana. Practical Natural Language Processing, O'Reilly, 2021
4. James Allen. Natural language Understanding 2e, Pearson Education, 2007
5. Akshar Bharati, Vineet Chaitanya, Rajeev Sangal. Natural Language Processing: A Paninian Perspective, PHI, 2023
6. Tanveer Siddiqui., U.S. Tiwary. Natural Language Processing and Information Retrieval, OUP, 2008

Web Resources

1. https://archive.nptel.ac.in/content/syllabus_pdf/106105158.pdf

Course outcome	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		2
CO2								1	2	2	2	2	1		1
CO3								1	1	1	2	2	1		2
CO4								1	1	2	2	1	1		1
CO5									1				1		

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

3– High 2 – Medium 1 - Low

Assessment:

ISE I: Class Test-I of Maximum Marks-15

ISE II: Class Test-II of Maximum Marks-15

ISE III: Teacher's Assessment of Maximum Marks-10

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
- 2) Question & answer / Numerical solution
- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-60


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Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	7	7	3	20
K3	Apply	3	3	5	20
K4	Analyze	-	-		10
K5	Evaluate				
K6	Create				
Total Marks 100		15	15	10	60

Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2,CO3	CO4,CO5
ISE I (15 Marks)	3	5	7
ISE II (15 Marks)	5	4	6
ISE III (10 Marks)	2	4	4
ESE Assessment (60 Marks)	10	30	20
Total Marks 100	20	43	37


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ITPEC4033: Distributed Systems		
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	ISE I	15 Marks
Tutorial: 0	ISE II	15 Marks
Credits:03	ISE III	10 Marks
	End Semester Examination	60 Marks

Course Outcome: After completing the course, students will be able to	
CO1	Identify the issues in designing distributed operating system.
CO2	Identify the desirable features of good message passing system and issues in designing inter process communication system by message passing.
CO3	Design and develop distributed programs using RPC.
CO4	Identify the issues of distributed shared memory system.
CO5	Analyze different algorithms and techniques for file systems.

Detailed Syllabus:

Unit 1	Distributed Computing System: DCS models, Distributed systems architecture, Distributed Operating Systems: Definition, Design Issues, Introduction to Distributed Computing Environment, Key characteristics, resource sharing, openness concurrency, scalability, fault tolerance, transparency.
Unit 2	Distributed Systems Models: Client-Server model, Thin Client, Mobile Devices, Software agents. Fundamental models: Interaction, Failure and Security models.
Unit 3	Message passing : Desirable features of a Good Message Passing System, Issue in IPC by message passing Synchronization, Buffering, Multi datagram messages, encoding and decoding of message data, process addressing, failure handling, Remote Procedure Call :RPC Model, Transparency of RPC, Implementing RPC mechanism, RPC messages, Marshaling arguments and results, Server management, Parameter passing semantics, Call semantics, Communication protocols for RPC, Client Server binding, Exception handling, Security, RPC in heterogeneous environments, Optimization for better performance.
Unit 4	Distributed Shared Memory: General architecture of DSM system, Design and Implementation, issues of DSM, Granularity, Structure of shared memory space, Consistency models, Replacement strategy, Thrashing, Other approaches to DSM, Advantages of distributed shared memory. Distributed File System: Desirable features of good Distributed file system, file models, File Accessing, Sharing, Caching methods, File replication, Fault tolerance, atomic transactions, Design principles.
Unit 5	Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms. Resource Management: Features of Global Scheduling Algorithm, Task Assignment Approach, Load Sharing Approach.


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Text Books & Reference Books

1. Distributed Operation System, Concepts and Design, P.K. Sinha, 2nd Edition, IEEE Press, Prentice Hall India, 1998.
2. Distributed Systems Concepts and Design, George Coulouris, Jean Dollimore, and Tim Kindberg, 3rd Edition., Addison Wesley, 2002
3. Distributed Operating System, A. S. Tanenbaum, 2nd Edition, Prentice Hall India, 2002.

Mapping of Course outcome with Program Outcomes and Program Specific Outcome

Course outcome	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		
CO2		1			3									2	
CO3			3			1									2
CO4										2	1	2		1	2
CO5								1	2						1

3– High 2 – Medium 1 – Low**Assessment:**

ISE I: Class Test-I of Maximum Marks-15

ISE II: Class Test-II of Maximum Marks-15

ISE III: Teacher's Assessment of Maximum Marks-10

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
- 2) Question & answer / Numerical solution
- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-60

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	7	7	3	20
K3	Apply	3	3	5	20
K4	Analyze	-	-		10
K5	Evaluate				
K6	Create				
Total Marks 100		15	15	10	60

Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2, CO3	CO4, CO5
ISE I (15 Marks)	3	5	7
ISE II (15 Marks)	5	4	6
ISE III (10 Marks)	2		
ESE Assessment (60 Marks)	10		
Total Marks 100	20		


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ITPEC4035: Advanced Computer Architecture		
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	ISE I	15 Marks
Tutorial: 0	ISE II	15 Marks
Credits:03	ISE III	10 Marks
	End Semester Examination	60 Marks

Course Description:

- To make students know about the Parallelism concepts in Programming
- To give the students an elaborate idea about the different memory systems and buses.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multicomputer.
- To study about data flow computer architectures

Course Outcome: After completing the course, students will be able to	
CO1	Demonstrate concepts of parallelism in hardware/software.
CO2	Discuss memory organization and mapping techniques.
CO3	Describe architectural features of advanced processors.
CO4	Interpret performance of different pipelined processors.
CO5	Development of software to solve computationally intensive problems.

Detailed Syllabus:

Unit 1	PARALLEL COMPUTER MODELS Evolution of Computer architecture, system attributes to performance, Multi processors and multi computers, Multi-vector and SIMD computers, PRAM and VLSI models-Parallelism in Programming, conditions for Parallelism-Program Partitioning and Scheduling-program flow Mechanisms-Speed up performance laws-Amdahl's law, Gustafson's law-Memory bounded speedup Model.
Unit 2	MEMORY SYSTEMS AND BUSES Memory hierarchy-cache and shared memory Concepts-Cache memory organization-cache addressing models, Aliasing problem in cache, cache memory mapping Techniques-Shared Memory Organization-Interleaved memory organization, Lower order interleaving, Higher order interleaving. Backplane bus systems-Bus addressing, arbitration and transaction.
Unit 3	ADVANCED PROCESSORS Instruction set architectures-CISC and RISC scalar processors-Super scalar processors-VLIW architecture- Multivector and SIMD computers-Vector processing principles-Cray Y-MP 816 system-Inter processor communication
Unit 4	MULTI PROCESSOR AND MULTI COMPUTERS Multiprocessor system interconnects- Cross bar switch, Multiport memory-Hot spot problem, Message passing mechanisms-Pipelined processors-Linear pipeline, on linear pipeline- Instruction pipeline design-Arithmetic pipeline design.
Unit 5	DATA FLOW COMPUTERS AND VLSI COMPUTATIONS Data flow computer architectures-Static, Dynamic-VLSI Computing Structures-Systolic array architecture, mapping algorithms into systolic arrays, Reconfigurable processor array-VLSI matrix arithmetic processors-VLSI arithmetic models, partitioned matrix algorithms, matrix arithmetic pipelines.


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Text Books & Reference Books**TEXT BOOKS:**

1. Kai Hwang, Advanced Computer architecture Parallelism, scalability, Programmability, McGraw Hill, N.Y., 2003
2. Kai Hwang and F.A. Briggs, Computer architecture and parallel processors, McGraw Hill, N.Y., 1999
3. David A. Paerson and John L. Hennessey, —Computer organization and design, Elsevier, Fifth edition, 2014.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. <https://www.shiksha.com/online-courses/cloud-computing-basics-by-nptel-course-nptel25>
3. <https://www.linkedin.com/pulse/successfully-completed-nptel-course-cloud-computing-key-ramkumar-j3g3c>

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Course outcome	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		
CO2		1			3									2	
CO3			3			1									2
CO4										2	1	2		1	2
CO5								1	2						1

3– High 2 – Medium 1 - Low**Assessment:****ISE I: Class Test-I of Maximum Marks-15****ISE II: Class Test-II of Maximum Marks-15****ISE III: Teacher's Assessment of Maximum Marks-10**

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
- 2) Question & answer / Numerical solution
- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-60**Assessment Pattern:**

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	7	7	3	20
K3	Apply	3	3	5	20
K4	Analyze	-	-		
K5	Evaluate				
K6	Create				
Total Marks 100		15	15		

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Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2,CO3	CO4,CO5
ISE I (15 Marks)	3	5	7
ISE II (15 Marks)	5	4	6
ISE III (10 Marks)	2	4	4
ESE Assessment (60 Marks)	10	30	20
Total Marks 100	20	43	37


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ITPEC4037: High Performance Computing		
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	ISE I	15 Marks
Tutorial: 0	ISE II	15 Marks
Credits:03	ISE III	10 Marks
	End Semester Examination	60 Marks

Course Outcome: After completing the course, students will be able to	
CO1	Design, formulate, solve and implement high performance versions of standard single threaded algorithms
CO2	Demonstrate the architectural features in the GPU and MIC hardware accelerators.
CO3	Design programs to extract maximum performance in a multicore, shared memory execution environment processor.
CO4	Develop and deploy large scale parallel programs on tightly coupled parallel systems using the message passing paradigm.
CO5	Analyze symmetric and distributed architectures.

Detailed Syllabus:

Unit 1	Introduction to high Performance Computing: Introduction to heterogeneous parallel computing, GPU architecture, thread hierarchy, GPU memory hierarchy. computer organization concepts
Unit 2	Processors & virtual memory: pipelined processors: pipelining, structural, data and control hazards, impact on programming, Use of memory by programs, address translation, basics of GPU programming
Unit 3	Operating systems & cache memory: organization, impact on programming, virtual caches, many integrated cores, introduction to many integrated cores. MIC, Xeon Phi architecture, threads hierarchy, memory hierarchy, memory bandwidth and performance considerations.
Unit 4	Shared memory parallel Programming: Symmetric and distributed architectures, OpenMP Introduction, thread creation, parallel regions. work sharing, Synchronization. program profiling & File systems: disk management, name management, Protection
Unit 5	Parallel architecture: message passing interface, MPI Introduction, collective communication, data grouping for communication. basics of parallel architecture, parallel programming with message passing using MPI

Text Books & Reference Books

- 1 Programming Massively Parallel Processors a Hands-on Approach, 3e, Wen-Mei W Hwu, David B Kirk and Morgan Kaufmann-2019
2. Intel Xeon Phi Coprocessor Architecture and Tools, Rezaur Rahman, Apress Open, 1 st edition-2013
3. Using OpenMP, Barbara Chapman, Gabriele Jost, Rudd Vander Pas, MIT Press, 2008
4. J.L.Hennessy and D.A.Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
5. A.Silberschatz, P.B.Galvin, G.Gagne, Operating System Concepts, John Wiley.
6. R.E.Bryant and D.R.O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall.


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ITPEC4032: Lab Speech and Natural Language Processing		
Teaching Scheme	Examination Scheme	
Practical:2Hrs/Week	ISEIII (Term Work)	25 Marks
Credits:01		

Course Description

This course introduces the fundamentals of Natural Language Processing, focusing on word-level and syntactic analysis, text classification and sentiment analysis, information retrieval models, and the use of lexical resources and corpora for real-world language processing applications.

Course Outcome: After completing the course, students will be able to	
CO1	Apply word-level and morphological analysis techniques, including regular expressions, finite-state automata, and Part-of-Speech tagging.
CO2	Analyze syntactic structures of natural language using context-free grammars and parsing techniques.
CO3	Implement text classification and sentiment analysis models using probabilistic approaches such as Naive Bayes.
CO4	Design and evaluate Information Retrieval systems and utilize lexical resources and corpora for NLP applications.

Suggested list of Practical's

Sr. No.	Title of the Experiments	Skill / Knowledge Level	CO	Marks for ISE
1	Implement text preprocessing tasks using regular expressions for tokenization and pattern matching.	S1	CO1	02
2	Design a Finite-State Automaton (FSA) for lexical analysis of words and symbols	S1	CO1	02
3	Develop a morphological analyzer to identify root words, prefixes, and suffixes.	S1	CO1	02
4	Implement Part-of-Speech tagging using rule-based and statistical approaches.	S2	CO2	02
5	Construct Context-Free Grammar (CFG) and generate parse trees for simple sentences.	S2	CO2	02
6	Implement the CYK parsing algorithm to validate sentence structure.	S2	CO2	03
7	Perform text classification using the Naive Bayes classifier.	S3	CO3	03
8	Implement sentiment analysis on textual data using Naive Bayes.	S3	CO3	03
9	Design a basic Information Retrieval system using TF-IDF and Vector Space Model.	S4	CO4	03
10	Explore lexical resources such as WordNet, stem lemmatization, and NLP corpora.			


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Mapping of Course outcomes with Program Outcomes and Program Specific Outcomes

Course outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	3	2	1	1	1	1	1	3	3	2	1
CO2	3	2	3	1	2	3	2	2	1	2	2	1
CO3	3	2	2	1	3	3	2	2	1	3	2	1
CO4	3	2	3	1	3	3	2	2	1	2	2	1

3 – High 2 – Medium 1 - Low

Assessment Table:

Assessment Tool	S1	S2	S3	S4
	CO1	CO2	CO3	CO4
ISEI(Term Work)	06	07	06	06

Assessment:

ISE III: It shall be based on one of the/combination of few of: Attendance, punctuality, sincerity


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throughout semester, performance of during sessions, timely completion of allotted work, Oral examination, work knowledge etc.

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Course outcome	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											3	
CO2	2						3							2	
CO3			3									2		3	
CO4			3		2						2	2		3	2
CO5									2	2		2			2

3– High 2 – Medium 1 - Low

Assessment:

ISE I: Class Test-I of Maximum Marks-15

ISE II: Class Test-II of Maximum Marks-15

ISE III: Teacher's Assessment of Maximum Marks-10

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
- 2) Question & answer / Numerical solution
- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-60

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	7	7	3	20
K3	Apply	3	3	5	20
K4	Analyze	-	-		10
K5	Evaluate				
K6	Create				
Total Marks 100		15	15	10	60

Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2,CO3	CO4,CO5
ISE I (15 Marks)	3	5	7
ISE II (15 Marks)	5	4	6
ISE III (10 Marks)	2	4	4
ESE Assessment (60 Marks)	10	30	20
Total Marks 100	20	42	27

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ITPEC4034: Lab Distributed Systems		
Teaching Scheme		Examination Scheme
Practical: 2Hrs/Week		ISE III(Term Work)
Credits:01		25 Marks
		End Semester Evaluation
		--
Course Outcome: After completing the course, students will be able to		
CO1	Design and implement client–server architectures using socket programming, including thin client and mobile client models.	
CO2	Apply inter-process communication techniques such as message passing, multi-datagram communication, and remote procedure calls for distributed applications.	
CO3	Analyze and implement RPC mechanisms including parameter marshaling/unmarshaling, client–server binding, and exception handling.	
CO4	Implement and evaluate distributed system coordination mechanisms including logical clocks, event ordering, and consistency models in distributed shared memory.	
CO5	Develop and analyze distributed algorithms for synchronization and resource management, including mutual exclusion, deadlock detection, and leader election.	

List of the Experiments:

The student shall perform minimum ten experiments of the following.

Sr. No.	Title of the Experiments	Skill / Knowledge Level	CO	Marks for ISE
Level: Basic				
1	Implementation of Client–Server Model Using Sockets	S1	CO1	02
2	Simulation of Thin Client and Mobile Client Models	S2	CO1 CO2	02
3	Implementation of Inter-Process Communication Using Message Passing	S2	CO1 CO2	02
Level: Medium				
4	Implementation of Multi-Datagram Message Communication	S2, S3	CO2 CO3	02
5	Implementation of Remote Procedure Call (RPC) Mechanism	S2, S3	CO4	02
6	Marshaling and Unmarshaling of RPC Parameters	S2, S3	CO4 CO5	02
7	Client–Server Binding and Exception Handling in RPC	S2, S4	CO4 CO5	02
8	Implementation of Consistency Models in DSM	S2, S3, S4	CO3 CO4	02
Level: Complex				
9	Implementation of Logical Clock and Event Ordering	S2	CO4	03
10	Implementation of Distributed Mutual Exclusion Algorithm	S4,S5	CO5	03
11	Implementation of Deadlock Detection Algorithm			
12	Implementation of Leader Election Algorithms			


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With effect from Academic Year 2026-2027

Approved in the 32nd Academic Council Meeting, dated 28th July 2026

Assessment:

ISE III (Term Work): In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission

Assessment Table:

Assessment Tool	S1	S2	S3
	CO1 CO2	CO3 CO4	CO5
ISE III(Term Work)	06	06	13
End Semester Evaluation (Practical Examination & Viva Voce)	--	--	--

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE III	End Semester Examination
S1	Imitation	05	-
S2	Manipulation	10	-
S3	Precision	10	-
S4	Articulation	00	-
S5	Naturalization	00	-
Total Marks		25	-

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes:

Course outcome	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			2		3								1	2	
CO2	3		2	1				2					3		3
CO3		3							1				3	1	3
CO4											3	2	3	1	1
CO5				2		3				1			1	1	

3 – High 2 – Medium 1 - Low

ITPEC4036: Lab Advanced Computer Architecture		
Teaching Scheme	Examination Scheme	
Practical: 2Hrs/Week	ISE III(Term Work)	25 Marks
Credits:01	End Semester Evaluation	--

Course Outcome: After completing the course, students will be able to	
CO1	Apply fundamental concepts of parallel computer models and performance laws (Amdahl's and Gustafson's) to analyze system speedup and efficiency.
CO2	Analyze memory hierarchy components, including cache mapping techniques and interleaved memory organization, to evaluate memory performance.
CO3	Compare and interpret architectural features of advanced processors such as RISC, CISC, superscalar, VLIW, SIMD, and multivector architectures.
CO4	Design and evaluate pipelined and multiprocessor systems by analyzing instruction pipelines, interconnection networks, and message passing mechanisms.
CO5	Develop and simulate parallel and dataflow-based solutions for computationally intensive problems using SIMD, systolic arrays, and data flow architectures.

List of the Experiments:

The student shall perform minimum ten experiments of the following.

Sr. No.	Title of the Experiments	Skill / Knowledge Level	CO	Marks for ISE
Level: Basic				
1	Study and compare SISD, SIMD, MISD, and MIMD architectures using diagrams and examples.	S1	CO1	02
2	Write a program or perform numerical analysis to calculate speedup and efficiency using Amdahl's Law	S2	CO1 CO2	02
3	Analyze scalability of parallel systems using Gustafson's Law with suitable problem sizes.	S2	CO1 CO2	02
Level: Medium				
4	Program Partitioning for Parallel Execution Implement a program showing task or data partitioning and analyze parallelism conditions.	S2, S3	CO2 CO3	02
5	Cache Performance Analysis Simulate cache hit/miss ratios for different cache sizes and block sizes.	S2, S3	CO4	02
6	Interleaved Memory Organization Study lower-order and higher-order interleaving and analyze memory access performance.	S2, S3	CO4 CO5	02
7	Design a pipeline for a given instruction set and evaluate hazards and throughput.	S2, S4	CO4 CO5	02
8	Analyze instruction count, CPI, and execution time for RISC vs CISC instruction sequences.	S2, S3, S4	CO3 CO4	02
Level: Complex				
9	Simulation of Superscalar or VLIW Processor Design and analyze instruction-level parallelism in superscalar or VLIW architectures	S2	CO4	03


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10	Parallel Program using SIMD or Multivector Concept Implement vector operations (e.g., matrix or array processing) using SIMD-style parallelism.	S4,S5	CO5	03
11	Message Passing in Multiprocessor Systems Implement and analyze inter-process communication using message passing mechanisms.	S4,S5	CO2 CO5	03
12	Data Flow Architecture Simulation Design and simulate a simple static or dynamic data flow execution model for arithmetic operations.	S5	CO5	03

Assessment:

ISE III (Term Work): In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission

Assessment Table:

Assessment Tool	S1	S2	S3
	CO1 CO2	CO3 CO4	CO5
ISE III(Term Work)	06	07	12
End Semester Evaluation (Practical Examination & Viva Voce)	--	--	--

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	End Semester Examination
S1	Imitation	05	-
S2	Manipulation	10	-
S3	Precision	10	-
S4	Articulation	00	-
S5	Naturalization	00	-
Total Marks		25	-


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ITPEC4038: Lab High Performance computing		
Teaching Scheme	Examination Scheme	
Practical: 2Hrs/Week	ISE I (Term Work)	25 Marks
Credits:01	End Semester Evaluation	

Course Outcome: After completing the course, students will be able to	
CO1	Understand the architecture of modern HPC systems and parallel computing models.
CO2	Implement parallel algorithms using shared memory programming (OpenMP).
CO3	Design and develop distributed memory applications using Message Passing Interface (MPI).
CO4	Implement GPU-accelerated computing using CUDA or OpenCL.
CO5	Analyze and optimize the performance of parallel applications using profiling tools.

List of the Experiments:

The student shall perform minimum ten experiments of the following

Sr. No.	Title of the Experiments	Skill / Knowledge Level	CO	Marks for ISE
Level: Basic (all)				
1	Analyze CPU/GPU specifications and setup the HPC environment (GCC, OpenMP, MPI, CUDA).	S1	CO1	02
2	Implement a parallel version of Bubble Sort / Selection Sort using OpenMP.	S2	CO1 CO2	02
3	Design and implement a parallel program to add two large vectors using OpenMP.			
Level: Medium				
4	Design and implement Parallel Breadth First Search (BFS) and Depth First Search (DFS) using OpenMP.	S2, S3	CO2 CO3	02
5	Implement Matrix-Matrix Multiplication using the Message Passing Interface (MPI).	S2, S3	CO4	03
6	Implement a Basic CUDA program for Vector Addition or Matrix Multiplication on GPU.	S2, S4	CO2 CO3 CO4 CO5	03
Level: Complex				
7	Implement a program to calculate the value of π using the Monte Carlo method with MPI.	S2	CO4	02
8	Case Study: Implementation of a parallel Image Processing filter (e.g., Gaussian Blur) using CUDA.	S4,S5	CO2 CO3 CO4 CO5	03
9	Case Study: Optimization of a Large-scale Linear Equation Solver using Hybrid (MPI + OpenMP).	S4,S5	CO2	02
10	Real-time performance analysis of a parallel application using tools like Gprof or NVVP.			


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Assessment:

ISE I (Term Work): In-Semester Evaluation of 25 marks each will be based on practical assignments completed and timely submission

End Semester Evaluation: The ESE will be based on oral / practical performance of the students

Assessment Table:

Assessment Tool	S1	S2	S3
	CO1 CO2	CO3 CO4	CO5
ISE I (Term Work)	00	15	10
End Semester Evaluation (Practical Examination & Viva Voce)	05	10	10

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	End Semester Examination
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
S5	Naturalization	00	00
Total Marks		25	25

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes:

Course outcome	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		3	3											3	
CO2							3	2					3		2
CO3		3	2	3										2	2
CO4										2	2	3		2	3
CO5								2	2		3	3	2	2	3

3 – High 2 – Medium 1 - Low


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ITPEC4039: Soft Computing		
Teaching Scheme	Examination Scheme	
Lectures: 02hrs/ week	ISE I	10 Marks
Tutorial: 0	ISE II	10 Marks
Credits:02	ISE III	
	End Semester Examination	30 Marks

Course Description:

This course introduces the fundamental concepts and techniques of Soft Computing, which provide intelligent and flexible solutions to complex real-world problems where traditional (hard computing) methods are ineffective. The course covers core components such as fuzzy logic, neural networks, and evolutionary and nature-inspired meta-heuristic algorithms. Emphasis is placed on understanding fuzzy reasoning, genetic algorithms, and hybrid systems such as Neuro-Fuzzy Inference Systems (ANFIS).

Course Outcome: After completing the course, students will be able to	
CO1	Interpret soft computing schemes using knowledge of discrete mathematics, data structures and computer architectures.
CO2	Compare and analyse soft computing schemes.
CO3	Create and evaluate for better schemes using soft computing.

Detailed Syllabus:

Unit 1	Introduction to Soft Computing: Concept of computing systems, Difference between Hard and Soft Computing, Soft Computing Constituents, From Conventional AI to Computational Intelligence, Neural Networks, Fuzzy Set Theory, Evolutionary Computing, Neuro-Fuzzy and Soft Computing Characteristics Fuzzy Logic: Crisp Logic, Fuzzy Logic, Fuzzy Rule base and Approximate Reasoning, Defuzzification Methods, Applications
Unit 2	Nature Inspired Meta-heuristic Algorithms: Ant colony algorithm, Particle search optimization, Artificial Bee colony search, Bat Algorithm Genetic Algorithm: Introduction, Biological Background, Traditional Optimization and Search Techniques, Genetic Algorithm and Search Space, Generic Algorithm vs. Traditional Algorithms, Basic Terminologies in Genetic Algorithm, Simple GA, General Genetic Algorithm, Operators in Generic Algorithm, Stopping Condition, Constrains
Unit 3	Hybrid Systems & Applications of Soft Computing: Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System(ANFIS) Applications of Soft Computing: Optimization of Travelling Salesman Problem using GA,


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Text Books & Reference Books

TEXT BOOKS:

1. JyhShing Roger Jang, Chuen: Tsai Sun, EijiMizutani, "Neuro: Fuzzy and Soft Computing", Prentice Hall of India, 6th Edition, 2003.
2. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley, 2nd Edition, 2011.
3. S. Rajasekaran, G. A. VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 1st Edition, 2003.
4. George J. Klir, Bo Yuan, "Fuzzy Sets and Fuzzy Logic : Theory and Applications", Prentice Hall, 1995.
5. K. Mohan, S. Ranka, K Mehrotra, "Elements of Artificial Neural Networks", MIT Press, 1st Edition 1996.
6. Xin-She Yang, "Nature Inspired Metaheuristic Algorithms", Luniver Press, 2nd Edition, 2010.

Web Resources

1. <http://nptel.ac.in/courses/117105084/>
2. <https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-641j-introduction-to-neural-networks-spring-2005/>
3. https://onlinecourses.nptel.ac.in/noc20_cs17/preview

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Course outcome	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		
CO2		1			3				2	1	2			2	
CO3			3			1									2
CO4														1	2

3– High 2 – Medium 1 - Low

Assessment:

ISE I: Class Test-I of Maximum Marks-10

ISE II: Class Test-II of Maximum Marks-10

ESE: End Semester Examination of Maximum Marks-30

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	3		5
K2	Understand	3	2	10
K3	Apply	4	4	5
K4	Analyze	-	4	10
K5	Evaluate			
K6	Create			
Total Marks 100		10	10	30


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Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2	CO4
ISE I (10 Marks)	3	3	4
ISE II (10 Marks)	2	4	4
ESE Assessment (30 Marks)	10	10	10
Total Marks 50	15	17	18


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ITPEC4040: Data Science		
Teaching Scheme	Examination Scheme	
Lectures: 02 hrs/ week	ISE I	10 Marks
Tutorial: 0	ISE II	10 Marks
Credits:02		
	End Semester Examination	30 Marks

Course Outcome: After completing the course, students will be able to	
CO1	Identify, collect, and manage data from multiple sources using APIs and other methods, and perform data cleaning, exploration, and storage effectively..
CO2	Apply statistical concepts such as central tendency, distributions, variance, sampling, and the Central Limit Theorem to analyze datasets.
CO3	Implement and compare basic machine learning algorithms such as Linear Regression, Support Vector Machines (SVM), and Naive Bayes for data analysis tasks.

This course introduces students to the fundamental principles of machine learning for data science. It focuses on the implementation and comparative evaluation of basic machine learning algorithms, including **Linear Regression, Support Vector Machines (SVM), and Naive Bayes**. Students will learn how these algorithms work, the assumptions behind each method, and their suitability for different types of data and problem domains. The course emphasizes hands-on data analysis, model training, performance evaluation, and interpretation of results, enabling learners to select and apply appropriate machine learning techniques to real-world datasets.

Detailed Syllabus:

Unit 1	Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources.
Unit 2	Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.
Unit 3	Data visualisation: Introduction, Types of data visualisation, Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings, Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Text Books & Reference Books

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.


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Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Course outcome	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		
CO2		1			3									2	
CO3			3			1									2

3– High 2 – Medium 1 - Low

Assessment:

ISE I: Class Test-I of Maximum Marks-10

ISE II: Class Test-II of Maximum Marks-10

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
- 2) Question & answer / Numerical solution
- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-30


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ITPEC4041: Software Testing and Quality Assurance		
Teaching Scheme	Examination Scheme	
Lectures: 02hrs/ week	ISE I	10 Marks
Tutorial: 0	ISE II	10 Marks
Credits:02	ISE III	
	End Semester Examination	30 Marks

Course Description:

This course provides a comprehensive understanding of software testing principles and quality assurance practices essential for developing reliable and high-quality software systems. The course covers software verification techniques, including reviews of requirements, design documents, source code, and user documentation, along with test case generation from SRS and use cases. The course also emphasizes software measurement and metrics, focusing on internal and external product attributes to assess software quality.

Course Outcome: After completing the course, students will be able to	
CO1	Understand various software testing methods and strategies.
CO2	Identify defects and manage those defects for improvement in software quality.
CO3	Design test cases and execute them for software quality control and assurance.

Detailed Syllabus:

Unit 1	Software Verification: Verification Methods, SRS document verification, SDD document verification, Source code reviews, User documentation verification, Software project audit Creating test cases from SRS and Use cases: Use Case Diagram and Use Cases, Generation of test cases from use cases, Guidelines for generating validity checks.
Unit 2	Regression Testing: Regression Test cases selection, Reducing the number of test cases, Code coverage prioritization techniques Testing Web applications: web testing, functional testing, UI testing, usability testing, configurations and compatibility testing, performance testing.
Unit 3	Measurement in software engineering: Scope of software metrics, classifying software measures, Applying the framework, Software measurement validation, Measuring internal product attributes: size, aspects of software size, length, reuse, functionality. Measuring internal product attributes: Structure, Types of structural measures, Control-flow structure, Modularity and information flow attributes, Measuring external product attributes


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Text Books & Reference Books

TEXT BOOKS:

1. Yogesh Singh, "Software Testing", Cambridge University Press, 1st edition, 2013.
2. Ilene Burnstein, "Practical Software Testing", Springer professional computing, 1st edition, ISBN 0-387-95131-8
3. N. E. Fenton, S. L. Pfleeger, "Software Metrics-A Rigorous and Practical Approach", PWS publisher, 2nd edition, ISBN: 0-534-95425-1
4. Aditya P. Mathur, "Foundations of Software Testing", Pearson Education, 2nd edition, 2008.
5. Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill, 1st edition, 2004.
6. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson education, 2006.
7. M. G. Limaye, "Software Testing Principles, Techniques and tools", McGraw Hills, 1st edition, 2009.

Web Resources

1. <http://nptel.ac.in/courses/106105150> Software Testing, Dr. Rajib Mal, Department of CSE, IIT Kharagpur.
2. <http://nptel.ac.in/courses/106101061/18> Software Testing, Prof. R. K. Joshi, Department of CSE, IIT Bombay.
3. <http://www.softwaretestingmentor.com/istqb-videos/> Software Testing, Manish Varma.

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Cour se outc ome	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		
CO2			1	3			1		2	1	2			2	
CO3															2

3– High 2 – Medium 1 - Low

Assessment:

ISE I: Class Test-I of Maximum Marks-10

ISE II: Class Test-II of Maximum Marks-10

ESE: End Semester Examination of Maximum Marks-30


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Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	3	2	5
K2	Understand	3	4	10
K3	Apply	4	4	5
K4	Analyze	-		10
K5	Evaluate			
K6	Create			
Total Marks 100		10	10	30

Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2	CO3
ISE I (10 Marks)	7	3	0
ISE II (10 Marks)	0	4	6
ESE Assessment (30 Marks)	10	10	10
Total Marks 50	17	17	16


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ITPEC4042: Generative Artificial Intelligence		
Teaching Scheme	Examination Scheme	
Lectures: 02hrs/ week	ISE I	10 Marks
Tutorial: 0	ISE II	10 Marks
Credits:02	ISE III	
	End Semester Examination	30 Marks

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, 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 II	Generation of Images Introduction to Generative Adversarial Networks – Adversarial Training Process – Nash Equilibrium ,VariationalAutoencoders – Encoder-Decoder Architectures - Stable Diffusion Models. Variants of GAN – Types of GAN - Cyclic GAN – Using Cyclic GAN to Generate Paintings
UNIT III	Open source models and programming frameworks Neural Style Transfer ,Style Transfer - Music Generating RNN, MuseGAN ,Autonomous agents, Deep Q Algorithm ,Actor-critic Network.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”, 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 OpenAI Models”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

Course 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															

Assessment:

ISE I: Class Test-I of Maximum Marks-10

ISE II: Class Test-II of Maximum Marks-10

ESE: End Semester Examination of Maximum Marks-30


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ITELC4001: Project-II		
Teaching Scheme	Examination Scheme	
Practical: 06 hrs/ week	ISE III	100 Marks
Credits:03	End Semester Examination	

ITELC4004: Project-II		
Teaching Scheme	Examination Scheme	
Practical: 08 hrs/ week	ISE III	100 Marks
Credits:04	End Semester Examination	


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ITHNC7003: Advanced Machine Learning		
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	ISE I	15 Marks
Tutorial: 1	ISE II	15 Marks
Credits:03	ISE III	10 Marks
	End Semester Examination	60 Marks

Course description: The course aims to provide knowledge of various advanced machine learning techniques. It also covers several ensemble methods, Bayesian learning, and deep neural network (DNN) techniques, and prepares students for research or industry applications of machine learning.

Course Outcome: After completing the course, students will be able to	
CO1	Understand ensemble learning, reinforcement learning, Bayesian learning techniques to real-world problems in various domains.
CO2	Build the recommender system for given application scenario.
CO3	Explore and investigate deep learning architectures components.
CO4	Illustrate the technique of Convolution (CNN) and Recurrent Neural Network (RNN) for implementing Deep

Detailed Syllabus:

Unit 1	Ensemble Learning and Reinforcement Learning Classification trees, Regression trees, Regularization and pruning, Gini Index, Gain ratio, ID3, C4.5, CART, Random Forest, Ensemble Learning: Bagging, boosting, Ad boost. Introduction to Reinforcement Learning, Markov Decision Process
Unit 2	Bayesian Learning Classical, Empirical, Subjective methods, Types of events, Types of probabilities, Normal Distribution, Bayes' Theorem, Naïve Bayes' classifier, Bayesian Learning.
Unit 3	Advanced Supervised and Unsupervised Learning Gradient Boosting Machines (XGBoost, LightGBM – overview), Support Vector Machines with kernels, Learning with imbalanced data, Cost-sensitive learning, Performance metrics and model selection, Clustering algorithms (Hierarchical, DBSCAN), Gaussian Mixture Models, Dimensionality reduction (PCA, t-SNE, UMAP – overview)
Unit 4	Recommendation System Machine Learning based Recommendation System, Top recommendation Systems on the Internet, Approaches to recommendation system design: Collaborative Filtering, Content Based Filtering and hybrid approach.
Unit 5	Deep Neural Network Introduction to Neural Networks, Training Neural Networks: Back propagation and Forward propagation Activation Functions, Loss Functions, Hyper-parameters, Gradient-Based Learning.


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Text Books & Reference Books

1. Tom Mitchell, "Machine learning", McGraw-Hill series in Computer Science (Unit 1,2,3)
2. Goodfellow I., Bengio Y. Courville A., "Deep Learning", MIT Press, 2016. (Unit 4,5,6)
3. Parag Kulkarni: Reinforcement and Systematic Machine Learning for Decision Making, Wiley IEEE Press, , July 2012.
4. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd edition-2013.
5. Charu Agarwal, "Neural Networks and deep learning", Springer 2023, ISBN: 978-3-031-29642-3.
6. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", 2nd Edition. MIT Press. ISBN 0262039249
7. Seth Weidman, "Deep Learning from Scratch: Building with Python from First Principles", O'Reilly, ISBN: 978-93-5213-902-6.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc21_cs25/preview, Prof. Balaraman Ravindran IIT Madras.
2. https://onlinecourses.nptel.ac.in/noc23_ee87/preview, Prof. M. K. Bhuyan IIT Guwahati.
3. https://onlinecourses.nptel.ac.in/noc25_cs49/preview, Prof. Balaji Srinivasan, Prof. Ganapathy Krishnamurthi IIT Madras

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Course outcome	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		
CO2		1			3									2	
CO3			3			1									2
CO4										2	1	2		1	2

3– High 2 – Medium 1 - Low**Assessment:****ISE I:** Class Test-I of Maximum Marks-15**ISE II:** Class Test-II of Maximum Marks-15**ISE III:** Teacher's Assessment of Maximum Marks-10

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
- 2) Question & answer / Numerical solution
- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-60**Assessment Pattern:**

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	7	7	3	20
K3	Apply	3	3	5	20
K4	Analyze	-	-		10
K5	Evaluate				
K6	Create				
Total Marks 100		15	15	10	60

Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2,CO3	CO4
ISE I (15 Marks)	3	5	7
ISE II (15 Marks)	5	4	6
ISE III (10 Marks)	2	4	4
ESE Assessment (60 Marks)	10	30	20
Total Marks 100	20	43	37


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ITELC4003: Internship/OJT		
Teaching Scheme	Examination Scheme	
Practical: 24 hrs/ week	ISE I	
Credits:12	ISE II	
	ISE III	100 Marks
	End Semester Examination	100 Marks

ITHNC7004: Advanced Deep Learning		
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	ISE I	15 Marks
Tutorial:1	ISE II	15 Marks
Credits:04	ISE III	10 Marks
	End Semester Examination	60 Marks

Course Outcome: After completing the course, students will be able to	
CO1	Analyze the performance of task of object detection for a given image.
CO2	Apply segmentation techniques in real world problems.
CO3	Apply deep generative model to represent complex data distributions and to generate new data samples that are similar to the training data.
CO4	Use deep learning techniques in natural language processing.
CO5	Use attention model and transformer to enhance the understanding and generation of sequential data for a given real world problem.

Detailed Syllabus:

Unit 1	CNN for object detection: overview, challenges in object detection, region based CNN, single shot multibox detector, YOLO, anchor box and multiscale detection, Evaluation metrics
Unit 2	CNN for segmentation: image segmentation, autoencoder, U-net, segmentation loss function, applications
Unit 3	Deep Generative Models: Introduction of GANs(Generative Modeling) , Different Types of GANs, Components of GANs, Training and Prediction of GANs, Brief on GAN Loss Function, Challenges Faced by GANs, Application of GANs, VariationalAutoencoders and Disentanglement,
Unit 4	Introduction to NLP and Deep Learning: introduction to NLP, Word Vector representation, word2vec model, Continuous Skip-Gram model, Continuous Bag-of-Words model, Language modelling and neural network, Information Retrieval tasks using Neural Networks- Learn to Rank, Understanding Phrases, analogies.
Unit 5	Attention Models and Transformers: Attention in Vision Models: An Introduction, Soft and Hard Attention: Image Captioning, Self-Attention and Transformers, Transformers to Vision Transformers, Transformers for Detection, Transformers for Segmentation, Stable diffusion model: LDM, Latent space, Text to image generation, Large Language Models (LLMs).

Text Books & Reference Books

1. Michael Nielsen, Neural Networks and Deep Learning, 2016

Course outcome	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		
CO2		1			2									2	
CO3			3			1									2
CO4										2	1	2		1	3
CO5								1	2						1

2. Zaccane, G., Karim, M. R., Menshawy, A. "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
3. Ian Goodfellow Yoshua Bengio Aaron Courville, Deep Learning, MIT Press, 2017
4. Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing
5. Jacek M. Zurada, "Introduction to artificial neural systems", West Publishing Co., 1992, ISBN: 0-314-93391 - 3.
6. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2006, ISBN: 978-0-387-31073-2
7. Deep Learning with Python", Francois Chollet, Manning Publications, 2017

Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

3– High 2 – Medium 1 - Low

Assessment:

ISE I: Class Test-I of Maximum Marks-15

ISE II: Class Test-II of Maximum Marks-15

ISE III: Teacher's Assessment of Maximum Marks-10

Teachers Assessment of 10 marks is based on one of the / or combination of few of following

- 1) Power point presentation
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- 3) Surprise test
- 4) Any other activity suggested by course coordinator

ESE: End Semester Examination of Maximum Marks-60

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5	2	10
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K6	Create				
Total Marks 100		15	15	10	60

Assessment table:

Assessment Tool	K1	K2	K3
	CO1	CO2,CO3	CO4,CO5
ISE I (15 Marks)	3	5	7
ISE II (15 Marks)	5	4	6
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ITHNC7005: Project		
Teaching Scheme	Examination Scheme	
Lectures: 04hrs/ week	ISE I	25 Marks
Credits:02	End Semester Examination	25 Marks


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