॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड - ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण–२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २२ एप्रिल २०२६ रोजी संपन्न झालेल्या मा.विद्यापरिषद बैठकीतील विषय क्र.०८/६४–२०२६ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण–२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यास मा.विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील बी.एस्सी. तृतीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यात येत आहे.

01	B.Sc. III Year Computer Management (Single Major)
02	B.Sc. III Year Artificial Intelligence and Machine Learning (AI & ML) (Single Major)
03	B.Sc. III Year Software Development (Single Major)
04	B.Sc. III Year Data Science (Single Major)
05	B.Sc. III Year Information Technology (Single Major)
06	B.Sc. III Year Network Technology (Single Major)
07	B.Sc. III Year Software Engineering (Single Major)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या www.srtmun.ac.in या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/परिपत्रक/पदवी/बीएस्सी/२०२६–२७/ ११०
दिनांक : २१.०७.२०२६

उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळे) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :–
१) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. प्र.कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ
३) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परिक्षा व मुल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
५) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.

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SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED - 431 606 (MS)

(Credit Framework and Structure of

B. Sc. Data Science (Single Major)

Third Year

with Multiple Entry and Exit Options as per NEP-2020)

Effective From 2026-27

UNDERGRADUATE PROGRAMME OF

SCIENCE & TECHNOLOGY

Major in **DSC** and Minor in **DSM** (Subject)

Under the Faculty of Science & Technology

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science and Technology (Three Optional in the First Year)

Credit Framework for Third Year with Multiple Entry and Exit

Subject: DSC (Major) /DSM (Minor 1)

B.Sc. Data Science (Single Major) Third Year

Year & Level	Semester	Optional 1 (Major) *(From the same Faculty)*	Optional 2 (Minor 1) *(From the same Faculty)*	Optional 3 (Minor 2) *(From the same Faculty)*	Generic Elective (GE) (select from Basket 3 of *Faculties other than Science and Technology*)	Vocational & Skill Enhancement Course	Ability Enhancement Course (AEC) (Basket 4) Value Education Courses (VEC) / Indian Knowledge System (IKS) (Basket 5) *(Common across all faculties)*	Field Work / Project/Internship/ OJT/ Apprenticeship / Case Study Or Co-curricular Courses (CCC) (Basket 6 for CCC) *(Common across all faculties)*	Credits	Total Credits
1	2	3	4	5	6	7	8	9	10	11
2 (5.0)	V	SDSCCT1301 (T 3Cr) SDSCCT1302 (T 3Cr) SDSCIK1303 (T 2Cr) SDSCCP1304 (P 2Cr) SDSCCP1305 (P 2Cr) **12 Credits**	SDSCET1301 (T 3Cr) SDSCEP1301 (P 1Cr) **4 Credits**			SDSCVC1301 **2 Credits**		SDSCFP1301 **4 Credits**	22	44
	VI	SDSCCT1351 (T 3Cr) SDSCCT1352 (T 3Cr) SDSCCT1353 (T 2Cr) SDSCCP1354 (P 2Cr) SDSCCP1355 (P 2Cr) **12 Credits**	SDSCET1351 (T 3Cr) SDSCEP1351 (P 1Cr) **4 Credits**			SDSCVC1351 **2 Credits**		SDSCOJ1351 **4 Credits**	22	
	Cum. Cr.	24	08	00	00	06	00	06	44	

Abbreviations:

1. **DSC:** Department/Discipline Specific Core (Major)
2. **DSE:** Department/Discipline Specific Elective (Major)
3. **DSM:** Discipline Specific Minor
4. **GE/OE:** Generic/Open Elective
5. **VSEC:** Vocational Skill and Skill Enhancement Course
6. **VSC:** Vocational Skill Courses
7. **SEC:** Skill Enhancement Courses
8. **AEC:** Ability Enhancement courses
9. **MIL:** Modern Indian languages
10. **IKS:** Indian Knowledge System
11. **VEC:** Value Education Courses
12. **OJT:** On Job Training: (Internship/Apprenticeship)
13. **FP:** Field Projects
14. **CEP:** Community Engagement and Service
15. **CC:** Co-Curricular Courses
16. **RM:** Research Methodology
17. **RP:** Research Project/Dissertation

B. Sc. DS Third Year Semester V *(Level 5.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs./ week)	
			Theory	Practical	Total	Theory	Practical
Optional 1	SDSCCT1301	Fundamental of ML	03	--	**12**	04	--
	SDSCCT1302	Natural Language Processing	03	--		04	--
	SDSCIK1303	Introduction to super computing	02	--		02	
	SDSCCP1304	Fundamental of ML (P)	--	02		--	02
	SDSCCP1305	Natural Language Processing (P)	--	02		--	02
Optional 2	SDSCET1301	Fundamental of Cloud Computing	03	--	**04**	04	--
	SDSCEP1301	Fundamental of Cloud Computing (P)	--	01		--	02
Vocational & Skill Enhancement Course	SDSCVC1301	Data Warehousing	--	02	**02**	--	02
Field Work / Project/Internship	SDSCFP1301	Project	--	04	**04**	--	04
Total Credits			**11**	**11**	**22**	**14**	**12**

B. Sc. DS Third Year Semester V *(Level 5.5)*

Examination Scheme

[40% Continuous Assessment (CA) and 60% End Semester Assessment (ESA)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Sum of T1 & T2 (6)	Total (7)	CA (8)	ESA (9)	
Optional 1	SDSCCT1301	Fundamental of ML	15	15	30	45	--	--	75
	SDSCCT1302	Natural Language Processing	15	15	30	45	--	--	75
	SDSCIK1303	Introduction to super computing	10	10	20	30	--	--	50
	SDSCCP1304	Fundamental of ML (P)	--	--	--	--	20	30	50
	SDSCCP1305	Natural Language Processing (P)	--	--	--	--	20	30	50
Optional 2	SDSCET1301	Fundamental of Cloud Computing	15	15	30	45	--	--	75
	SDSCEP1301	Fundamental of Cloud Computing (P)	--	--	--	--	10	15	25
Vocational & Skill Enhancement Course	SDSCVC1301	Data Warehousing	--	--	--	--	20	30	50
Field Work / Project/Internship	SDSCFP1301	Project	--	--	--	--	40	60	100

B. Sc. DS Third Year Semester VI *(Level 5.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs./ week)	
			Theory	Practical	Total	Theory	Practical
Optional 1	SDSCCT1351	Computer Vision and Image Analytics	03	--	**12**	04	--
	SDSCCT1352	Deep Learning	03	--		04	--
	SDSCCT1353	Time Series Analysis	02	--		02	
	SDSCCP1354	Computer Vision and Image Analytics (P)	--	02		--	02
	SDSCCP1355	Deep Learning (P)	--	02		--	02
Optional 2	SDSCET1351	Big Data Analytics	03	--	**04**	04	--
	SDSCEP1351	Big Data Analytics (P)	--	01		--	02
Vocational & Skill Enhancement Course	SDSCVC1351	Generative AI	--	02	**02**	--	02
Field Work / Project/Internship	SDSCOJ1351	OJT	--	04	**04**	--	04
Total Credits			**11**	**11**	**22**	**14**	**12**

B. Sc. DS Third Year Semester VI *(Level 5.5)*

Examination Scheme

[40% Continuous Assessment (CA) and 60% End Semester Assessment (ESA)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Sum of T1 & T2 (6)	Total (7)	CA (8)	ESA (9)	
Optional 1	SDSCCT1351	Computer Vision and Image Analytics	15	15	30	45	--	--	75
	SDSCCT1352	Deep Learning	15	15	30	45	--	--	75
	SDSCCT1353	Time Series Analysis	10	10	20	30	--	--	50
	SDSCCP1354	Computer Vision and Image Analytics (P)	--	--	--	--	20	30	50
	SDSCCP1355	Deep Learning (P)	--	--	--	--	20	30	50
Optional 2	SDSCET1351	Big Data Analytics	15	15	30	45	--	--	75
	SDSCEP1351	Big Data Analytics (P)	--	--	--	--	10	15	25
Vocational & Skill Enhancement Course	SDSCVC1351	Generative AI	--	--	--	--	20	30	50
Field Work / Project/Internship	SDSCOJ1351	OJT	--	--	--	--	40	60	100

Detailed Curriculum

Course Structure:

Major 1 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCT1301	Fundamental of ML	45	--	03	--	03

Major 1 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCT1301	Fundamental of ML	15	15	30	45	--	--	75

SDSCCT1301: Fundamental of ML Curriculum Details

Course pre-requisite:

1. Mathematics for AI/ML — Linear Algebra (vectors, matrices, eigenvalues), Probability Theory (Bayes theorem, distributions), Calculus (gradients, chain rule, partial derivatives)
2. Programming in Python — data types, control flow, functions, OOP, file handling, list comprehensions
3. Data Handling — Pandas, NumPy for data wrangling, cleaning, and transformation; Matplotlib/Seaborn for visualization
4. Statistics — descriptive statistics, hypothesis testing, correlation, regression concepts
5. Feature Engineering — data preprocessing, normalization, encoding (completion of AIML-501 or equivalent is advantageous)

Course Objectives:

1. Introduce fundamental concepts, techniques, and applications of Machine Learning
2. Develop the ability to preprocess and analyze data using Python tools
3. Provide knowledge of supervised and unsupervised learning algorithms
4. Enable students to build and evaluate Machine Learning models
5. Expose students to advanced topics and real-world applications of Machine Learning

Course Outcomes:

1. Understand and explain core concepts and types of Machine Learning
2. Apply data preprocessing and visualization techniques using Python libraries
3. Implement supervised learning algorithms for regression and classification problems
4. Apply unsupervised learning techniques such as clustering and dimensionality reduction
5. Analyze model performance and apply advanced ML techniques to real-world problems

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Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction & Data Preprocessing**	10
	1.1	Definition and scope of Machine Learning	
	1.2	Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning	
	1.3	Applications of Machine Learning, Machine Learning pipeline	
	1.4	Introduction to Python for ML: NumPy, Pandas, Matplotlib	
	1.5	Data preprocessing: Handling missing values, Data cleaning Encoding categorical data, Feature scaling (Normalization & Standardization)	
2.0		**Supervised Learning**	12
	2.1	Regression Techniques: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression	
	2.2	Classification Techniques: Logistic Regression, k-Nearest Neighbors (k-NN), Decision Trees, Support Vector Machines (SVM)	
	2.3	Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-score, Cross-validation	
3.0		**Unsupervised Learning**	11
	3.1	Clustering: K-Means Clustering, Hierarchical Clustering	
	3.2	Dimensionality Reduction: Principal Component Analysis (PCA)	
	3.3	Association Rule Learning: Apriori Algorithm	
	3.4	Basics of Anomaly Detection	
4.0		**Advanced Concepts & Applications**	12
	4.1	Ensemble Learning: Random Forest, Boosting (AdaBoost basics)	
	4.2	Basics of Neural Networks	
	4.3	Overfitting and Underfitting	
	4.4	Hyperparameter Tuning (Grid Search basics)	
	4.5	Applications of ML: Image Processing basics, Natural Language Processing basics	
		Total	45

Text Books:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
2. Introduction to Machine Learning with Python – Andreas C. Müller & Sarah Guido
3. Pattern Recognition and Machine Learning – Christopher M. Bishop
4. Machine Learning: A Probabilistic Perspective – Kevin P. Murphy

Course Structure:

Major 2 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCT1302	Natural Language Processing	45	--	03	--	03

Major 2 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCT1302	Natural Language Processing	15	15	30	45	--	--	75

SDSCCT1302: Natural Language Processing Curriculum Details

Course pre-requisite:

1. **Programming Knowledge:** Basic proficiency in programming using Python, including data structures (lists, dictionaries, strings) and file handling.
2. **Mathematics Fundamentals :** Understanding of basic concepts from:Linear Algebra (vectors, matrices) Probability and Statistics (mean, variance, probability concepts)
3. **Basics of Machine Learning:** Familiarity with fundamental concepts of Machine Learning, such as supervised learning, classification, and model evaluation.
4. **Data Handling Skills :** Ability to work with datasets using libraries like Pandas and NumPy.

Course Objectives:

1. This course provides a comprehensive foundation in Natural Language Processing from classical linguistic theories and statistical methods to modern deep learning architectures.
2. large language models. Students will develop practical skills to build intelligent text processing systems for real-world applications including chatbots, machine translation, sentiment analysis, and question answering.
3. Students will implement text preprocessing pipelines including tokenization, stemming, lemmatization, POS tagging, and NER using NLP libraries like NLTK, spaCy, Gensim, Tensorflow etc.

Course Outcomes:

1. Understand and explain fundamental concepts of Natural Language Processing, including its components, challenges, and real-world applications.

2. Apply basic text preprocessing techniques such as tokenization, stemming, lemmatization, and stop-word removal using standard NLP libraries.
3. Represent textual data using methods like Bag of Words, TF-IDF, and word embeddings.
4. Analyze syntactic and semantic structures of language using techniques such as part-of-speech tagging and parsing.
5. Build and evaluate basic NLP models for tasks like text classification, sentiment analysis, and named entity recognition.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction to Natural Language Processing**	12
	1.1	Introduction to NLP and its Importance	
	1.2	Challenges in NLP (Ambiguity, Context, etc.) Steps in NLP: Tokenization, Morphology, Syntax, Semantics, and Pragmatics	
	1.3	Linguistic Concepts: Phonology, morphology, syntax, semantics, pragmatics; levels of language analysis; morphemes, lexemes, phrases, sentences	
	1.4	Text Preprocessing: Tokenization (word, sentence, subword); stopword removal; lowercasing; punctuation and noise removal; sentence segmentation	
	1.5	Stemming & Lemmatization: Porter, Lancaster, Snowball stemmers; WordNet lemmatizer; differences and trade-offs; NLTK and spaCy implementations	
2.0		**Text Pre-processing and Representation**	13
	2.1	Text Cleaning and Preprocessing: Tokenization, Stopword Removal, Stemming, Lemmatization	
	2.2	Bag of Words (BoW) Model and TF-IDF Word Embeddings: Word2Vec, GloVe, FastText	
	2.3	N-gram Language Models 8 Hrs N-Grams, Evaluating Language Models: Training and Test Sets, Evaluating Language Models: Perplexity,	
	2.4	Sampling sentences from a language model, Generalizing vs. overfitting the training set, Smoothing, Interpolation, and Backoff , Advanced: Perplexity's Relation to Entropy	
	2.5	Text Classification, and Sentiment Naive Bayes Classifiers, Training the Naive Bayes Classifier, worked example, optimizing for	

		Sentiment Analysis, Naive Bayes for other text classification tasks, Naive Bayes as a Language	
3.0		**Syntax and Parsing Semantics and Word Sense Disambiguation**	10
	3.1	Part-of-Speech (POS) Tagging: Rule-Based, Statistical, and Neural Approaches	
	3.2	Dependency Parsing and Constituency Parsing, Grammar and Context-Free Grammars, Probabilistic Parsing (CYK Algorithm, Earley's Algorithm)	
	3.3	Lexical Semantics and WordNet Word Sense Disambiguation (WSD) Techniques	
	3.4	Semantic Role Labelling, Distributional Semantics: Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA)	
	3.5	Model, Evaluation: Precision, Recall, F-measure, Test sets and Cross-validation, Statistical Significance Testing, Avoiding Harms in Classification	
4.0		**Large Language Models**	10
	4.1	Large Language Models with Transformers, Sampling for LLM Generation, Pretraining Large Language Models, Evaluating Large Language Models	
	4.2	Recurrent Neural Networks (RNN): Sequence modelling, hidden state, BPTT; vanishing gradient problem; applications in language modelling; one-to-many, many-to-many architectures	
	4.3	LSTM & GRU: Long Short-Term Memory: forget, input, output gates; Gated Recurrent Unit; bidirectional LSTM; stacked LSTMs;	
	4.4	Sequence-to-Sequence Models: Encoder-decoder architecture; teacher forcing; beam search decoding; applications in machine translation, summarization, chatbots	
		Total	45

Text Books:

1. Daniel Jurafsky & James H. Martin Speech and Language Processing (3rd Ed. Draft) Prentice Hall / Online 2023.
2. Steven Bird, Ewan Klein & Edward Loper Natural Language Processing with Python (NLTK Book) O'Reilly Media 2009.
3. Hobson Lane, Hannes Hapke & Cole Howard Natural Language Processing in Action Manning Publications 2019.
4. Lewis Tunstall, Leandro von Werra & Thomas Wolf Natural Language Processing with Transformers O'Reilly Media 2022.

5. Yoav Goldberg Neural Network Methods for Natural Language Processing Morgan & Claypool 2017.
6. Christopher Manning & Hinrich Schütze Foundations of Statistical Natural Language Processing MIT Press 1999.
7. Hugging Face Documentation Transformers Library — Model Hub & Tutorials huggingface.co 2024.

Reference Books:

1. Yoav Goldberg Neural Network Methods for Natural Language Processing Morgan & Claypool 2017.
2. Jacob Devlin et al. BERT: Pre-training of Deep Bidirectional Transformers NAACL 2019 (arXiv:1810.04805) 2019.
3. Ashish Vaswani et al. Attention Is All You Need NeurIPS 2017 (arXiv:1706.03762) 2017.
4. Christopher Manning & Hinrich Schütze Foundations of Statistical Natural Language Processing MIT Press 1999
5. Dipanjan Sarkar Text Analytics with Python (2nd Ed.) Apress / Springer 2019.
6. Hugging Face Documentation Transformers Library — Model Hub & Tutorials huggingface.co 2024.

Course Structure:

Major 3 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCIK1303	Introduction to Super Computing	30	--	2	--	2

Major 3 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCIK1303	Introduction to Super Computing	10	10	20	30	--	--	50

SDSCIK1303: Introduction to Super Computing (Major 3) Curriculum Details

Course pre-requisite:

1. Basic knowledge of computer organization and architecture.
2. Familiarity with programming in C/C++ or Python.
3. Understanding of data structures and algorithms.
4. Introductory knowledge of operating systems and networking.

Course Objectives:

1. To introduce the fundamentals of supercomputing and high-performance computing (HPC), including architecture and evolution.
2. To understand the contributions of Dr. Vijay Bhatkar and India's PARAM supercomputers developed by Centre for Development of Advanced Computing.
3. To develop the ability to design and implement parallel programs using modern programming models (MPI, OpenMP, CUDA).
4. To analyze and evaluate performance metrics and optimization techniques in HPC systems.
5. To explore real-world applications and future trends in supercomputing.

Course Outcomes:

After completing this course, students will be able to:

1. Explain the architecture, evolution, and significance of supercomputers, including systems like PARAM series.
2. Apply parallel computing models and programming paradigms (MPI, OpenMP, CUDA) to solve computational problems.
3. Analyze performance metrics (FLOPS, latency, scalability laws) and optimize parallel programs.
4. Design and implement efficient parallel algorithms for scientific and engineering applications.
5. Evaluate the impact of national initiatives like the National Supercomputing Mission and emerging technologies such as AI-HPC convergence.
6. Demonstrate hands-on skills in executing and analyzing parallel programs on cluster-based systems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Foundations of Supercomputing & Dr. Vijay Bhatkar's Contribution**	7
	1.1	Introduction to Supercomputing: Definition, need, evolution from mainframes to supercomputers	
	1.2	History in India: Role of Dr. Vijay Bhatkar, PARAM series, C-DAC's mission	
	1.3	Supercomputer Architecture Basics: Vector processors, SIMD, MIMD, cluster computing	
	1.4	Performance Metrics: FLOPS, MIPS, latency, bandwidth, Amdahl's Law, Gustafson's Law	
2.0		**Parallel Processing & High Performance Computing Architecture**	8
	2.1	Parallel Computing Models: Shared memory, distributed memory, hybrid models	
	2.2	Interconnection Networks: Topologies – mesh, hypercube, torus, fat tree	
	2.3	Memory Hierarchy: Cache coherence, NUMA, distributed shared memory	

	2.4	Case Study: Architecture of PARAM 8000, PARAM Yuva, PARAM Siddhi-AI	
	2.5	Programming Paradigms: MPI, OpenMP, CUDA basics	
3.0		**Software, Tools & Programming for Supercomputers**	7
	3.1	Operating Systems for HPC: Linux variants for clusters, scheduling	
	3.2	Parallel Algorithms: Matrix multiplication, sorting, graph algorithms	
	3.3	Programming Environments: MPI programming, OpenMP directives, GPU programming	
	3.4	Performance Optimization: Load balancing, profiling tools, debugging parallel code	
4.0		**Applications & Future of Supercomputing**	8
	4.1	Scientific Applications: Weather forecasting, computational fluid dynamics, genomics	
	4.2	National Missions: National Supercomputing Mission, applications in defense, space, disaster management	
	4.3	Emerging Trends: Exascale computing, AI + HPC convergence, quantum computing overview	
	4.4	Ethical & Societal Impact: Digital divide, indigenous tech development, Bhatkar's vision for self-reliance	
		Total	**30**

Text Books:

1. Elements of Parallel Computing – Vijay P. Bhatkar
   Covers fundamentals of parallel computing, architectures, and Indian supercomputing initiatives including PARAM.
2. Introduction to Parallel Processing – M. Sasikumar, D. Shikhare, P. Ravi Prakash
   Provides a clear introduction to parallel algorithms, models, and programming techniques.
3. Parallel Computer Architecture: A Hardware/Software Approach – John L. Hennessy, David A. Patterson
   Detailed coverage of modern parallel architectures, performance, and scalability.

4. Using MPI: Portable Parallel Programming with the Message Passing Interface – William Gropp, Ewing Lusk, Anthony Skjellum
   Comprehensive guide to MPI programming for distributed memory systems.

Reference Books:

1. Elements of Parallel Computing_ by Vijay P. Bhatkar
2. Introduction to Parallel Processing_ by Sasikumar, Shikhare, Ravi Prakash
3. C-DAC whitepapers on PARAM series

Course Structure:

Major 1 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCP1304	Fundamental of ML (P)	--	20	--	02	02

Major 1 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCP1304	Fundamental of ML (P)	--	--	--	--	20	30	50

SDSCCP1304: Fundamental of ML (P) Curriculum Details

Course pre-requisite:

6. Mathematics for AI/ML — Linear Algebra (vectors, matrices, eigenvalues), Probability Theory (Bayes theorem, distributions), Calculus (gradients, chain rule, partial derivatives)
7. Programming in Python — data types, control flow, functions, OOP, file handling, list comprehensions
8. Data Handling — Pandas, NumPy for data wrangling, cleaning, and transformation; Matplotlib/Seaborn for visualization
9. Statistics — descriptive statistics, hypothesis testing, correlation, regression concepts
10. Feature Engineering — data preprocessing, normalization, encoding (completion of AIML-501 or equivalent is advantageous)

Course Objectives:

6. Introduce fundamental concepts, techniques, and applications of Machine Learning
7. Develop the ability to preprocess and analyze data using Python tools
8. Provide knowledge of supervised and unsupervised learning algorithms
9. Enable students to build and evaluate Machine Learning models
10. Expose students to advanced topics and real-world applications of Machine Learning

Course Outcomes:

6. Understand and explain core concepts and types of Machine Learning
7. Apply data preprocessing and visualization techniques using Python libraries
8. Implement supervised learning algorithms for regression and classification problems
9. Apply unsupervised learning techniques such as clustering and dimensionality reduction
10. Analyze model performance and apply advanced ML techniques to real-world problems

.

Curriculum Details:

Lists of Practical

1. Installation of Python, NumPy, Pandas, Matplotlib, Scikit-learn
2. Data preprocessing: handling missing values and encoding
3. Data visualization using Matplotlib/Seaborn
4. Simple Linear Regression implementation
5. Multiple Linear Regression
6. Logistic Regression (classification)
7. k-NN classifier
8. Decision Tree classifier
9. Support Vector Machine (SVM)
10. Model evaluation using confusion matrix and metrics
11. K-Means clustering
12. Hierarchical clustering
13. Principal Component Analysis (PCA)
14. Apriori algorithm implementation
15. Random Forest / Ensemble learning implementation.

Text Books:

5. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
6. Introduction to Machine Learning with Python – Andreas C. Müller & Sarah Guido
7. Pattern Recognition and Machine Learning – Christopher M. Bishop
8. Machine Learning: A Probabilistic Perspective – Kevin P. Murphy

Course Structure:

Major 2 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCP1305	Natural Language Processing (P)	--	20	--	02	02

Major 2 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCP1305	Natural Language Processing (P)	--	--	--	--	20	30	50

SDSCCP1305: Natural Language Processing (P) Curriculum Details

Course pre-requisite:

5. **Programming Knowledge:** Basic proficiency in programming using Python, including data structures (lists, dictionaries, strings) and file handling.
6. **Mathematics Fundamentals :** Understanding of basic concepts from:Linear Algebra (vectors, matrices) Probability and Statistics (mean, variance, probability concepts)
7. **Basics of Machine Learning:** Familiarity with fundamental concepts of Machine Learning, such as supervised learning, classification, and model evaluation.
8. **Data Handling Skills :** Ability to work with datasets using libraries like Pandas and NumPy.

Course Objectives:

4. This course provides a comprehensive foundation in Natural Language Processing from classical linguistic theories and statistical methods to modern deep learning architectures.
5. large language models. Students will develop practical skills to build intelligent text processing systems for real-world applications including chatbots, machine translation, sentiment analysis, and question answering.
6. Students will implement text preprocessing pipelines including tokenization, stemming, lemmatization, POS tagging, and NER using NLP libraries like NLTK, spaCy, Gensim, Tensorflow etc.

Course Outcomes:

6. Understand and explain fundamental concepts of Natural Language Processing,

including its components, challenges, and real-world applications.

7. Apply basic text preprocessing techniques such as tokenization, stemming, lemmatization, and stop-word removal using standard NLP libraries.
8. Represent textual data using methods like Bag of Words, TF-IDF, and word embeddings.
9. Analyze syntactic and semantic structures of language using techniques such as part-of-speech tagging and parsing.
10. Build and evaluate basic NLP models for tasks like text classification, sentiment analysis, and named entity recognition.

Curriculum Details:

List of Practical

1. Practical 1: Basic Text Preprocessing

- Perform tokenization (word & sentence)
- Remove stopwords, punctuation, and convert text to lowercase
- **Tools:** NLTK / spaCy

2. Practical 2: Stemming & Lemmatization

- Implement Porter, Lancaster stemming
- Apply WordNet lemmatization
- Compare outputs

3. Practical 3: Text Cleaning Pipeline

- Create reusable preprocessing pipeline
- Handle noisy text (URLs, emojis, special characters)

4. Practical 4: Bag of Words (BoW)

- Convert text into BoW representation
- Visualize word frequency

5. Practical 5: TF-IDF Implementation

- Compute TF-IDF vectors
- Compare with BoW

6. Practical 6: Word Embeddings

- Generate embeddings using Word2Vec / GloVe
- Visualize similar words

7. Practical 7: N-gram Language Model

- Build unigram, bigram, trigram models
- Generate sample sentences

8. Practical 8: Sentiment Analysis using Naive Bayes

- Train classifier on dataset
- Evaluate accuracy

9. Practical 9: Part-of-Speech (POS) Tagging

- Implement POS tagging
- Analyze tagged sentences

10. Practical 10: Named Entity Recognition (NER)

- Extract entities (Person, Location, Organization)
- Visualize results

11. Practical 11: Parsing Techniques

- Perform dependency parsing
- Visualize parse trees

12. Practical 12: Word Sense Disambiguation

- Use WordNet for sense identification
- Compare meanings in context

13. Practical 13: Topic Modeling

- Implement LDA (Latent Dirichlet Allocation)
- Extract topics from dataset

14. Practical 14: Text Classification using Deep Learning

- Build model using TensorFlow or Keras
- Train on text dataset

15. Practical 15: Transformer-based NLP Application

- Use Hugging Face Transformers
- Perform:
  - Text summarization OR
  - Question answering OR
  - Chatbot implementation

Text Books:

8. Daniel Jurafsky & James H. Martin Speech and Language Processing (3rd Ed. Draft) Prentice Hall / Online 2023.
9. Steven Bird, Ewan Klein & Edward Loper Natural Language Processing with Python (NLTK Book) O'Reilly Media 2009.
10. Hobson Lane, Hannes Hapke & Cole Howard Natural Language Processing in Action Manning Publications 2019.
11. Lewis Tunstall, Leandro von Werra & Thomas Wolf Natural Language Processing with Transformers O'Reilly Media 2022.
12. Yoav Goldberg Neural Network Methods for Natural Language Processing Morgan & Claypool 2017.
13. Christopher Manning & Hinrich Schütze Foundations of Statistical Natural Language Processing MIT Press 1999.
14. Hugging Face Documentation Transformers Library — Model Hub & Tutorials huggingface.co 2024.

Reference Books:

7. Yoav Goldberg Neural Network Methods for Natural Language Processing Morgan & Claypool 2017.
8. Jacob Devlin et al. BERT: Pre-training of Deep Bidirectional Transformers NAACL 2019 (arXiv:1810.04805) 2019.
9. Ashish Vaswani et al. Attention Is All You Need NeurIPS 2017 (arXiv:1706.03762) 2017.
10. Christopher Manning & Hinrich Schütze Foundations of Statistical Natural Language Processing MIT Press 1999
11. Dipanjan Sarkar Text Analytics with Python (2nd Ed.) Apress / Springer 2019.
12. Hugging Face Documentation Transformers Library — Model Hub & Tutorials huggingface.co 2024.

Course Structure:

Minor 1 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCET1301	Fundamental of Cloud Computing	45	--	03	--	03

Minor 1-Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCET1301	Fundamental of Cloud Computing	15	15	30	45	--	--	75

SDSCET1301: Fundamental of Cloud Computing (Minor 1) Curriculum Details

Course pre-requisite:

1. Fundamentals of Computer Systems
2. Operating System Basics
3. Computer Networks (Basic Level)
4. Basic Database Knowledge

Course Objectives:

1. To introduce the fundamental concepts of cloud computing, including cloud models, service types, and the shared responsibility model.
2. To familiarize students with the basics of Microsoft Azure and its core architectural components.
3. To understand various Azure services such as computer, networking, storage, identity, and security.

Course Outcomes:

1. Apply Azure services to create, configure, and manage cloud resources such as virtual machines, storage accounts, and virtual networks.

2. Analyse factors affecting cost in Azure and utilize tools like pricing calculator and cost management for optimization.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	**1**	**Introduction cloud Comuting concepts**	13
	1.1	Introduction to Microsoft Azure Fundamentals	
	1.2	Introduction to cloud computing	
	1.3	What is cloud computing And Define cloud models?	
	1.4	shared responsibility model	
	1.5	Benefits of using cloud services	
	1.6	Cloud service types	
2.0	2	**Describe Azure architecture and services**	12
	2.1	Core Architectural components of Azure	
	2.2	Azure compute services	
	2.3	Azure networking services	
	2.4	Azure storage services	
	2.5	Azure identity, access, and security	
3.0	3	**Azure management and governance**	10
	3.1	Describe factors that can affect costs in Azure, Explore the pricing calculator	
	3.2	Microsoft Cost Management tool	
	3.3	What is purpose of tags?	
	3.4	Cost Optimization options in Azure	
4.0	**4**	**Features and tools for managing and deploying Azure resources**	10
	4.1	Tools for interacting with Azure	
	4.2	Azure Resource Manager and Azure ARM templates	
	4.3	Azure Advisor	
	4.4	Azure Service Health	
	4.5	Concept of Azure Monitor	
		Total	45

Text Books:

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, “Cloud Computing: Concepts, Technology & Architecture”, First Edition, Pearson, 2013.
2. Anthony Puca, Michael Washam,“Exam Ref AZ-900 Microsoft Azure Fundamentals”, Second Edition, Microsoft Press, 2022.
3. Rajkumar Buyya, James Broberg, Andrzej Goscinski, “Cloud Computing: Principles and Paradigms”, First Edition, Wiley, 2011.

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, First Edition, McGraw Hill Education, 2013.

Course Structure:

Minor 1-Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCEP1301	Fundamental of Cloud Computing (P)	--	20	--	01	01

Minor 1-Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCEP1301	Fundamental of Cloud Computing (P)	-	-	-	-	10	15	25

SDSCEP1301: Fundamental of Cloud Computing (P) (Minor 1) Curriculum Details

Course pre-requisite:

1. Fundamentals of Computer Systems
2. Operating System Basics
3. Computer Networks (Basic Level)
4. Basic Database Knowledge

Course Objectives:

4. To introduce the fundamental concepts of cloud computing, including cloud models, service types, and the shared responsibility model.
5. To familiarize students with the basics of Microsoft Azure and its core architectural components.
6. To understand various Azure services such as computer, networking, storage, identity, and security.

Course Outcomes:

1. Apply Azure services to create, configure, and manage cloud resources such as virtual machines, storage accounts, and virtual networks.

2. Analyse factors affecting cost in Azure and utilize tools like pricing calculator and cost management for optimization.

Curriculum Details:

List of Practical

1. Demonstrate the Shared Responsibility Model using a diagram.
2. Create an account on Microsoft Azure portal.
3. Create and manage a Resource Group.
4. Create a Virtual Machine (VM) in Azure.
5. Configure VM (CPU, RAM, OS selection).
6. Create and configure Virtual Network (VNet)
7. Create a Storage Account and upload/download files.
8. Working with Blob Storage (upload images/files).
9. Configure access control using IAM (Identity and Access Management).
10. Implement basic security using Network Security Groups (NSG)
11. Analyze billing using Azure Cost Management tool.
12. Create and apply tags to resources.
13. Azure CLI / PowerShell to create resources
14. Deploy resources using Azure Resource Manager (ARM) templates.
15. Create alerts for resource usage..

Text Books:

4. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", First Edition, Pearson, 2013.
5. Anthony Puca, Michael Washam,"Exam Ref AZ-900 Microsoft Azure Fundamentals", Second Edition, Microsoft Press, 2022.
6. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing: Principles and Paradigms", First Edition, Wiley, 2011.

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", First Edition, McGraw Hill Education, 2013.

Course Structure:

VSC -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCVC1301	Data Warehousing	--	20	--	02	02

VSC -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCVC1301	Data Warehousing	-	-	-	-	20	30	50

SDSCVC1301: Data Warehousing (VSC) Curriculum Details

Course pre-requisite:

1. Basic knowledge of Database Management Systems (DBMS) and SQL
2. Understanding of data structures and basic concepts of data processing

Course Objectives:

1. To introduce the concepts and architecture of data warehousing
2. To understand data modeling techniques such as star and snowflake schemas
3. To develop skills in data extraction, transformation, loading (ETL) and data analysis

Course Outcomes:

1. Understand the fundamental concepts and architecture of data warehousing systems
2. Apply data modeling and ETL techniques for building data warehouses
3. Analyze and utilize data warehouses for decision-making and business intelligence

Curriculum Details:

List of Practical

1. Overview of Data Warehousing.
2. Describe a process for designing a dimensional model for a data warehouse.
3. Design dimension tables for a data warehouse.
4. Design fact tables for a data warehouse.
5. Implement a data flow by using SSIS.
6. Implement control flow with tasks and precedence constraints.
7. Create dynamic packages that include variables and parameters.
8. Use containers in a package control flow.
9. Plan data extraction.
10. Extract modified data2. Handle Activity Lifecycle methods.
11. Design a Snowflake Schema for a Product database.
12. Use any OLAP tool (like Excel Pivot Table) to analyze data.
13. Run analytical queries on warehouse data.
14. Perform ETL process.
15. Design schema (Star/Snowflake).

Text Books:

1. The Data Warehouse Toolkit, by Ralph Kimball

2. Building, Using and Managing the Data Warehouse, by Ramon Barquin, Herb Edelstein.

3. Data Warehousing: Strategies, Technologies and Techniques, by Robert M. Mattison

Reference Books:

1. Data Warehousing (Hb) By Misc, by Misc, 2001.

Course Structure:

Major 1 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCT1351	Computer Vision and Image Analytics	45	--	03	--	03

Major 1 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCT1351	Computer Vision and Image Analytics	15	15	30	45	--	--	75

SDSCCT1351: Computer Vision and Image Analysis (Major 1) Curriculum Details

Course pre-requisite:

1. To understand Image Processing Fundamentals: Knowledge of filtering, color spaces, geometric transformations, and Fourier transforms is critical.

2. To understand Machine Learning (ML): Basic knowledge of supervised learning and neural networks is necessary to understand modern approaches.

3. To understand Libraries and Frameworks: Familiarity with OpenCV (for computer vision tasks) and numerical computing libraries like NumPy or frameworks like PyTorch/TensorFlow is highly recommended.

Course Objectives:

1. To understand digital image processing principles.

2. To apply image processing techniques and to implement image enhancement and restoration.

3. Perform image segmentation and object detection, & To extract features for analysis and classification. To develop Python applications for image processing tasks.

Course Outcomes:

1. Acquire proficiency in digital image processing fundamentals.

2. Demonstrate competence in utilizing Python for image processing
3. Execute techniques for image enhancement and restoration effectively.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction to Digital Image Processing**	12
	1.1	Basics of digital images	
	1.2	Image representation (grayscale, RGB, etc.), Image acquisition and sampling, Histogram Processing and equalization	
	1.3	Spatial domain methods (e.g., filtering)	
	1.4	Frequency domain methods (e.g., Fourier transform)	
2.0		**Image Restoration**	12
	2.1	Image degradation models, Noise reduction techniques	
	2.2	Image Blurring and sharpening, Thresholding techniques	
	2.3	Edge detection of Image, Region-based segmentation	
	2.4	Texture analysis, Shape descriptors, Corner detection	
3.0		**Introduction to Python Libraries for Image Processing**	08
	3.1	Overview of OpenCV	
	3.2	Scikit-image, and NumPy	
	3.3	Installation and setup	
	3.4	Loading and displaying images	
4.0		**Feature Extraction & Applications of Image Processing.**	13
	4.1	Introduction to feature extraction	
	4.2	Texture analysis using gray-level co-occurrence matrix (GLCM	
	4.3	Medical image processing: MRI and CT image analysis	
	4.4	Remote sensing applications: satellite image processing	
		Total	**45**

Text Books:

1. Gonzalez, R.C., Woods, R.E., & Eddins, S.L. (2018). Digital Image Processing Using MATLAB.
2. Szeliski, R. (2010). Computer Vision: Algorithms and Applications

Reference Books:

1. Burger, W., & Burge, M.J. (2016). Digital Image Processing: An Algorithmic Approach with MATLAB.
2. Sonka, M., Hlavac, V., & Boyle, R. (2014). Image Processing, Analysis, and Machine Vision

Course Structure:

Major 2 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCT1352	Deep Learning	45	--	03	--	03

Major 2 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCT1352	Deep Learning	15	15	30	45	--	--	75

SDSCCT1352: Deep Learning (Major 2) Curriculum Details

Course pre-requisite:

1. Programming Skills
2. Mathematics Fundamentals
3. Basics of5 Machine Learning

Course Objectives:

1. To introduce the fundamental concepts of Deep Learning, including its evolution from Artificial Intelligence and Machine Learning.
2. To understand the structure and functioning of artificial neural networks, including perceptron models and their limitations.
3. To study various components of neural networks such as activation functions, loss functions, and optimization techniques.

Course Outcomes:

1. Apply training techniques such as gradient descent and back propagation to build and train neural network models..

2 Analyse issues like over fitting and under fitting and apply regularization and optimization techniques to improve model performance.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	**1**	**Introduction to Deep Learning**	13
	1.1	What is Deep Learning	
	1.2	History and evolution of AI → ML → DL	
	1.3	Applications (Computer Vision, NLP, Speech Recognition)	
	1.4	Biological neuron vs Artificial neuron	
	1.5	Introduction to neural networks	
	1.6	Perceptron model and limitations	
2.0	**2**	**Neural Network Fundamentals**	12
	2.1	Architecture of neural networks	
	2.2	Activation functions (ReLU, Sigmoid, Tanh, Softmax)	
	2.3	Loss functions (MSE, Cross-Entropy).	
	2.4	Gradient Descent and optimization	
	2.5	Backpropagation algorithm And Weight initialization techniques	
3.0	**3**	**Training Deep Neural Networks**	10
	3.1	Over fitting and under fitting And Regularization (L1, L2, Dropout)	
	3.2	Batch normalization and Hyper parameter tuning	
	3.3	Optimization algorithms: and SGD	
	3.4	Momentum	
	3.5	RMSProp and Adam	
4.0	**4**	**Convolutional Neural Networks (CNNs)**	10
	4.1	Image processing basics	
	4.2	Convolution operation	
	4.3	Pooling layers and CNN architectures	
	4.4	LeNet , AlexNet and VGG	
	4.5	ResNet and Transfer learning and fine-tuning	
		Total	45

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2016.2. Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O'Reilly Media, 2015.
2. François Chollet, “Deep Learning with Python”, Second Edition, Manning Publications, 2021.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2016.2. Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O'Reilly Media, 2015.
2. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”, Second Edition, O'Reilly Media, 2019.

Course Structure:

Major 3 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCT1353	Time Series Analysis	30	--	02	--	02

Major 3 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCT1353	Time Series Analysis	10	10	20	30	--	--	50

SDSCCT1353: Time Series Analysis Curriculum Details

Course pre-requisite:

1. Basic Algebra (equations, logarithms, exponentials)
2. Knowledge of Statistics Fundamentals.
3. Data Handling Skills (Understanding datasets and tabular data)

Course Objectives:

1. To introduce students to the fundamental concepts, components, and real-world applications of time series data.
2. To develop the ability to visualize, explore, and interpret time-dependent data using plots, decomposition methods, and seasonal analysis.
3. To provide practical knowledge of form creation, user input handling, validation techniques.
4. To understand the concept of stationarity and apply appropriate transformation techniques such as differencing and logarithmic transformation

Course Outcomes:

1. Analyze and visualize time series datasets using appropriate graphical methods such as line plots, seasonal plots, and decomposition techniques.

2. Distinguish between different forms of stationarity and apply suitable transformation methods to make data stationary.
3. Interpret and utilize ACF and PACF plots for understanding autocorrelation patterns in time series data.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	1	Introduction to Time Series	10
	1.1	Definition and examples of time series	
	1.2	Components of time series	
	1.3	Trend and Seasonality	
	1.4	Types f time series data (discrete, continues)	
	1.5	Applications (finance, weather, sales, healthcare)	
2.0	2	Data Visualization & Exploration	11
	2.1	Line plots and moving averages	
	2.2	Time plots and seasonal plots	
	2.3	Decomposition f time series	
	2.4	Additive model, Multiplicative model	
3.0	3	Stationarity & Transformation	12
	3.1	Concept of stationarity	
	3.2	Why stationarity is important	
	3.3	Types: Strict stationarity, Weak stationarity	
	3.4	Methods to achieve stationarity, Differencing, Log transformation	
4.0	4	Smoothing Techniques	12
	4.1	Weighted Moving Average	
	4.2	Weighted Moving Average	
	4.3	Exponential Smoothing	
	4.4	Exponential Smoothing	
	4.5	Simple Exponential Smoothing, Holt's Linear Trend Method And Holt-Winters Method	
		Total	45

Text Books:

1. Time Series Analysis and Its Applications: With R Examples – Time Series Analysis and Its Applications
2. Introduction to Time Series and Forecasting – Introduction to Time Series and Forecasting

Reference Books:

1. Time Series Analysis and Its Applications: With R Examples – Time Series Analysis and Its Applications

Course Structure:

Major 1 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCP1354	Computer Vision and Image Analysis (P)	--	20	--	02	02

Major 1 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCP1354	Computer Vision and Image Analysis (P)	--	--	--	--	20	30	50

SDSCCP1354: Computer Vision and Image Analysis (P) (Major 2) Curriculum Details

Course pre-requisite:

1. To understand Image Processing Fundamentals: Knowledge of filtering, color spaces, geometric transformations, and Fourier transforms is critical.

2. To understand Machine Learning (ML): Basic knowledge of supervised learning and neural networks is necessary to understand modern approaches.

3. To understand Libraries and Frameworks: Familiarity with OpenCV (for computer vision tasks) and numerical computing libraries like NumPy or frameworks like PyTorch/TensorFlow is highly recommended.

Course Objectives:

1. To understand digital image processing principles.
2. To apply image processing techniques and to implement image enhancement and restoration.
3. Perform image segmentation and object detection, & To extract features for analysis and classification. To develop Python applications for image processing tasks.

Course Outcomes:

1. Acquire proficiency in digital image processing fundamentals.
2. Demonstrate competence in utilizing Python for image processing
3. Execute techniques for image enhancement and restoration effectively.

Curriculum Details:

List of Practical

1. Basics of Digital Images-what a **pixel, resolution** (e.g., 512×512)
2. Image Acquisition & Sampling
3. Draw a histogram for a small set of pixel values
4. Plot histogram and apply histogram equalization
5. Plot Image Degradation Models & Noise
6. Plot Noise Reduction Techniques
7. Show Image Blurring & Sharpening & Thresholding Techniques
8. Region-Based Segmentation
9. Use of python of Libraries
10. Show Loading and Displaying Images (OpenCV)
11. Show Edge Detection
12 Loading Image using scikit-image
13. Show Installation & Setup (OpenCV)
14. Introduction to Feature Extraction
15. Texture Analysis using GLCM

Text Books:

1. Gonzalez, R.C., Woods, R.E., & Eddins, S.L. (2018). Digital Image Processing Using MATLAB.
2. Szeliski, R. (2010). Computer Vision: Algorithms and Applications

Reference Books:

1. Burger, W., & Burge, M.J. (2016). Digital Image Processing: An Algorithmic Approach with MATLAB.
2. Sonka, M., Hlavac, V., & Boyle, R. (2014). Image Processing, Analysis, and Machine Vision.

Course Structure:

Major 2 -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCCP1355	Deep Learning (P)	--	20	--	02	02

Major 2 -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCCP1355	Deep Learning (P)	-	-	-	-	20	30	50

SDSCCP1355: Deep Learning (P) (Major 2) Curriculum Details

Course pre-requisite:

1. Programming Skills
2. Mathematics Fundamentals
3. Basics of Machine Learning

Course Objectives:

4. To introduce the fundamental concepts of Deep Learning, including its evolution from Artificial Intelligence and Machine Learning.
5. To understand the structure and functioning of artificial neural networks, including perceptron models and their limitations.
6. To study various components of neural networks such as activation functions, loss functions, and optimization techniques.

Course Outcomes:

1. Apply training techniques such as gradient descent and back propagation to build and train neural network models..

2 Analyse issues like over fitting and under fitting and apply regularization and optimization techniques to improve model performance.

Curriculum Details:

List of Practical

1. Python & NumPy Refresher.
2. Implement Perceptron from Scratch.
3. Multi-Layer Neural Network using NumPy
4. Neural Network using High-Level Libraries
5. Activation & Loss Functions Analysis.
6. Implementing Optimization Algorithms.
7. Implementing Regularization Techniques
8. CNN for Image Classification.
9. CNN Architecture Comparison.
10. Transfer Learning

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2016.2. Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O'Reilly Media, 2015.
2. François Chollet, “Deep Learning with Python”, Second Edition, Manning Publications, 2021.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2016.2. Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O'Reilly Media, 2015.
2. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”, Second Edition, O'Reilly Media, 2019.

Course Structure:

Minor 1-Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCET1351	Big Data Analytics	45	--	03	--	03

Minor 1-Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCET1351	Big Data Analytics	15	15	30	45	--	--	75

SDSCET1351: Big Data Analytics (Minor 1) Curriculum Details

Course pre-requisite:

1. Basic Programming Knowledge with any one language like:Java / Python
2. Understanding of Variables, loops, functions
3. Understanding of CSV, JSON, XML formats
4. Operating System Basics

Course Objectives:

1. To introduce the fundamental concepts of Big Data, its characteristics, evolution, and challenges in handling large-scale data.
2. To understand the architecture and working of Apache Hadoop, including HDFS, MapReduce, and YARN.
3. To explore various components of the Hadoop ecosystem such as Apache Hive and Apache Pig for data processing and analysis.

Course Outcomes:

1. Analyse different data processing techniques and compare traditional systems (RDBMS) with Big Data technologies.

2. Understand NoSQL databases like MongoDB and Apache Cassandra for handling large-scale and unstructured data.

3. Implement basic data analytics and machine learning techniques such as regression, clustering, and decision trees on datasets.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		Introduction to Big Data	13
	1.1	Types of Digital Data-Characteristics of Data.	
	1.2	Evolution of Big Data, Definition of Big Data, Challenges with Big Data	
	1.3	3Vs of Big Data Non Definitional traits of Big Data.	
	1.4	Business Intelligence vs. Big Data, Data warehouse and Hadoop environment	
	1.5	Big Data Analytics: Classification of analytics.	
	1.6	Data Science ,Terminologies in Big Data, Types of Databases.	
2.0		Introduction to Hadoop	12
	2.1	Features, Advantages,Versions	
	2.2	Overview of Hadoop Eco systems – Hadoop distributions,Hadoop vs. SQL , RDBMS vs. Hadoop	
	2.3	Hadoop Components.	
	2.4	Architecture,HDFS. Map Reduce: Mapper, Reducer, Combiner, Partitioner, Searching,Sorting	
	2.5	Compression. Hadoop (YARN): Architecture, Interacting with Hadoop Eco systems	
3.0		No SQL databases	10
	3.1	Mongo DB: Introduction, Features, Data types.	

	3.2	Mongo DB Query language, CRUD operations, Arrays, Functions: Count – Sort – Limit – Skip – Aggregate – Map Reduce.	
	3.3	Cursors – Indexes – Mongo Import – Mongo Export.	
	3.4	Cassandra: Introduction – Features – Data types – CQLSH – Key spaces – CRUD operations	
	3.5	Collections – Counter – TTL – Alter commands – Import and Export – Querying System tables	
4.0		Hadoop Eco systems	10
	4.1	Hive – Architecture – data type – File format – HQL – SerDe – User defined functions	
	4.2	Pig: Features – Anatomy – Pig on Hadoop – Pig Philosophy – Pig Latin overview – Data types – Running pig – Execution modes of Pig – HDFS commands	
	4.3	– Relational operators – Eval Functions – Complex data type – Piggy Bank – User defined Functions – Parameter substitution – Diagnostic operator.	
	4.4	Introduction to Machine learning: Linear Regression – Clustering	
	4.5	Collaborative filtering – Association rule mining – Decision tree.	
		Total	45

Text Books:

1. V.K. Jain, “Big Data and Hadoop”, First Edition, Khanna Publishing House, 2016.

2. Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O'Reilly Media, 2015.

3. Kristina Chodorow, “MongoDB: The Definitive Guide”, Third Edition, O'Reilly Media, 2019.

Reference Books:

1. Kristina Chodorow, “MongoDB: The Definitive Guide”, Third Edition, O'Reilly Media, 2019.

Course Structure:

Minor 1-Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCEP1351	Big Data Analytics (P)	--	20	--	01	01

Minor 1-Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCEP1351	Big Data Analytics (P)	-	-	-	-	10	15	25

SDSCEP1351: Data Warehousing (Minor 1) Curriculum Details

Course pre-requisite:

1. Basic Programming Knowledge with any one language like:Java / Python
2. Understanding of Variables, loops, functions
3. Understanding of CSV, JSON, XML formats
4. Operating System Basics

Course Objectives:

1. To introduce the fundamental concepts of Big Data, its characteristics, evolution, and challenges in handling large-scale data.
2. To understand the architecture and working of Apache Hadoop, including HDFS, MapReduce, and YARN.
3. To explore various components of the Hadoop ecosystem such as Apache Hive and Apache Pig for data processing and analysis.

Course Outcomes:

1. Analyse different data processing techniques and compare traditional systems (RDBMS) with Big Data technologies.

2. Understand NoSQL databases like MongoDB and Apache Cassandra for handling large-scale and unstructured data.

3. Implement basic data analytics and machine learning techniques such as regression, clustering, and decision trees on datasets.

Curriculum Details:

List of Practical

1. Install Hadoop (Standalone/Local mode) on your system.
2. Practice basic Hadoop commands (start/stop services).
3. Perform file operations in HDFS (put, get, copy, delete).
4. Upload and read files from HDFS
5. Perform HDFS commands for directory management.
6. Write a Word Count program using MapReduce.
7. Perform sorting and searching using MapReduce.
8. Monitor running applications in YARN.
9. Execute MapReduce job using YARN.
10. Interact with Hadoop ecosystem tools via YARN
11. Install MongoDB and create a database.
12. Perform CRUD operations on Collection (Insert, Update, Delete, Find)
13. Install and configure Apache Hive.
14. Create databases and tables in Hive.
15. Implement Linear Regression using sample dataset.

Text Books:

1. The Data Warehouse Toolkit, by Ralph Kimball

2. Building, Using and Managing the Data Warehouse, by Ramon Barquin, Herb Edelstein.

3. Data Warehousing: Strategies, Technologies and Techniques, by Robert M. Mattison

Reference Books:

1. Data Warehousing (Hb) By Misc, by Misc, 2001.

Course Structure:

VSC -Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SDSCVC1351	Generative AI Tools	--	20	--	02	02

VSC -Assessment Scheme

Course Code	Course Name (Paper Title)	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Sum of T1 & T2		CA	ESA	
SDSCVC1351	Generative AI Tools	--	--	--	--	20	30	50

SDSCVC1351: Generative AI Tools Curriculum Details

Course pre-requisite:

1. Machine Learning vs Deep Learning
2. Natural Language Processing (NLP)
3. Generative AI concepts
4. Ethics, bias, hallucination, privacy

Course Objectives:

1. To introduce students to the fundamentals of Generative AI and its real-world applications.
2. To develop practical skills in using AI tools for text, image, audio, video, and code generation.
3. To understand and apply prompt engineering techniques such as zero-shot, few-shot, instruction-based, and role-based promptin

Course Outcomes:

1 Use Generative AI tools for practical tasks such as content creation, summarization, translation, and educational material generation.

2. Generate, analyze, debug, and improve AI-assisted code for basic programming tasks.

3. Evaluate and compare outputs from multiple AI platforms for quality, accuracy, creativity, and domain suitability

List of Practical

Practical 1: Exploring Text Generation

- Use tools like ChatGPT or Google Gemini
- Generate essays, summaries, and explanations
- Compare outputs for the same prompt

Practical 2: Prompt Engineering Basics

- Write different types of prompts:
- Zero-shot
- Few-shot
- Instruction-based
- Analyze how prompt wording affects output

Practical 3: Role-based Prompting

- Assign roles (teacher, coder, doctor, etc.)
- Generate domain-specific responses

Practical 4: Code Generation using AI

- Use GitHub Copilot or ChatGPT
- Generate simple programs (sorting, searching)
- Debug AI-generated code

Practical 5: Content Creation

- Generate:
- Blog posts
- Emails
- Social media content
- Edit for tone and audience

Practical 6: Text Summarization & Translation

- Summarize long articles
- Translate into multiple languages

Practical 7: Image Generation

- Use DALL·E or Midjourney
- Generate images from prompts
- Experiment with styles

Practical 8: Image Editing with AI

- Modify images (background change, object removal)
- Use tools like Canva AI features

Practical 9: Text-to-Video / Audio Generation

- Use tools like Runway ML
- Generate short videos or voice clips

Practical 10: Chatbot Development

- Build a simple chatbot using:
- ChatGPT API or similar tools
- Define conversation flows

Practical 11: Fine-tuning / Customization

- Customize AI outputs using:
- Prompt chaining
- System instructions

Practical 12: Document-based Q&A System

- Upload documents and query them
- Use tools like LangChain

Text Books:

1. Prompt Engineering for Generative AI by James Phoenix, Mike Taylor
2. Prompt engineering for LLMs by John Berryman | Goodreads

Reference Books:

1. Hands-On Large Language Models – Jay Alammar & Maarten Grootendorst

   Covers LLMs, prompt engineering, embeddings, fine-tuning, and practical applications.

Paper Format for 45 Marks

Time: 2:30 Hour **Marks :45**

Note:

I Q.1 is compulsory.

II Solve any 2 Questions from Question number 2 to 5.

III Figures to the Right indicates Full Marks.

IV Assume suitable data whenever necessary.

Q.1 Attempt the following. (on all 4 Units) **15**

a)

b)

c)

d)

e)

Q. 2 Attempt the following. (on First Unit) **15**

a)

b)

c)

Q. 3 Answer the following. (on Second Unit) **15**

a)

b)

c)

Q. 4 Attempt the following. (on Third Unit) **15**

a)

b)

c)

Q .5 Write short note on. (on Forth Unit) **15**

a)

b)

c)

***

Paper Format for 30 Marks

Time: 2:00 Hour **Marks :30**

Note:

I Q.1 is compulsory.

II Solve any 2 Questions from Question number 2 to 5.

III Figures to the Right indicates Full Marks.

IV Assume suitable data whenever necessary.

Q.1 Attempt the following. (on all 4 Units) **10**

a)

b)

c)

d)

Q. 2 Attempt the following. (on First Unit) **10**

a)

b)

Q. 3 Answer the following. (on Second Unit) **10**

a)

b)

Q. 4 Attempt the following. (on Third Unit) **10**

a)

b)

Q .5 Write short note on. (on Forth Unit) **10**

a)

b)

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