Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and Detailed Syllabus (DJS23)

Third Year B.Tech

in

Artificial Intelligence (AI) and Data Science

(Semester V)

Prepared by:- Board of Studies in Artificial Intelligence (AI) and Data Science

Recommended by:- Academic Council of Dwarkadas. J. Sanghvi College of Engineering

Approved by:- Governing Body of Dwarkadas. J. Sanghvi College of Engineering

With effect from the Academic Year: 2025-2026

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Scheme for Third Year Undergraduate Program in Artificial Intelligence (AI) and Data Science: SEM V (Autonomous)

Academic Year 2025-26

Sr. No.	Course Code	Course	Teaching Scheme			Continuous Assessment (A)						Semester End Examination (B)						Aggregate (A+B)	Credits
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Term Test 1 (TT1) - a	Term Test 2 (TT2) - b	Assg/CP/GD/Presntation/Quiz) - c	Total (a+b+c)	Term work	CA (A)Total	Duration	Theory	Oral	Pract	Oral & Pract	SEE Total		
1	DJS23SCPC501	Machine Learning	3	--	--	15	15	10	40	--	40	2	60	--	--	--	60	100	3
	DJS23SLPC501	Machine Learning Laboratory	--	2	--	--	--	--	--	25	25	2	--	--	--	25	25	50	1
2	DJS23SCPC502	Natural Language Processing	3	--	--	15	15	10	40	--	40	2	60	--	--	--	60	100	3
	DJS23SLPC502	Natural Language Processing Laboratory	--	2	--	--	--	--	--	25	25	2	--	25	--		25	50	1
3	DJS23SCPC503	Image Processing and Computer Vision	3	--	--	15	15	10	40	--	40	2	60	--	--	--	60	100	3
	DJS23SLPC503	Image Processing and Computer Vision Laboratory	--	2	--	--	--	--	--	25	25	2	--	--	--	25	25	50	1
4@	DJS23SCPE511	Recommendation Systems	3	--	--	15	15	10	40	--	40	2	60	--	--	--	60	100	3
	DJS23SLPE511	Recommendation Systems Laboratory	--	2	--	--	--	--	--	25	25	2	--	25	--	--	25	50	1
	DJS23SCPE512	Smart Systems and Applications	3	--	--	15	15	10	40	--	40	2	60	--	--	--	60	100	3
	DJS23SLPE512	Smart Systems and Applications Laboratory	--	2	--	--	--	--	--	25	25	2	--	25	--	--	25	50	1
	DJS23SCPE513	Network and Information Security	3	--	--	15	15	10	40	--	40	2	60	--	--	--	60	100	3
	DJS23SLPE513	Network and Information Security Laboratory	--	2	--	--	--	--	--	25	25	2	--	25	--	--	25	50	1
5	DJS23SLMD501	Cloud Computing Laboratory	--	4	--	--	--	--	--	25	25	2	--	25	--	--	25	50	2
6	DJS23SLMD502	Data Analytics and Visualization Laboratory	--	2	--	--	--	--	--	25	25	2	--	--	--	25	25	50	1
7	DJS23ITHSX10	Environmental Studies	--	--	1	--	--	--	--	25	25	--	--	--	--	--	--	25	1
8	DJS23IPSCX03	Innovative Product Development III	--	2	--	--	--	--	--	25	25	2	--	--	--	25	--	50	1
		Total	**12**	**16**	**1**	**60**	**60**	**40**	**160**	**200**	**360**	**22**	**240**	**75**	**0**	**100**	**415**	**775**	**21**

@Department Electives

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Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (mins)
Theory	a. Term Test 1 (based on 40 % syllabus)	15	45
	b. Term Test 2 (on next 40 % syllabus)	15	45
	c. Assignment / course project / group discussion / presentation / quiz/ any other.	10	--
	Total marks (a + b + c)	40	--
Audit course	Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.	--	As applicable
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory &Tutorial	Performance in the laboratory and tutorial.	50	

The final certification and acceptance of term work will be subject to satisfactory performance upon fulfilling minimum passing criteria in the term work / completion of audit course.

Semester End Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	60	2
	* Computer-based assessment in the college premises.		
Oral	Questions based on the entire syllabus.	25	As applicable
Practical	Performance of the practical assigned during the Examination and the output / results obtained.	25	2
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the Examination and on the entire syllabus.	As per the scheme	2

Prepared by Checked by Head of the Department Vice-Principal Principal

Program: B. Tech in Artificial Intelligence (AI) and Data Science **T.Y B. Tech** **Semester: V**

Course: Machine Learning (DJS23SCPC501)

Course: Machine Learning Laboratory (DJS23SLPC501)

Prerequisite: Knowledge of basic probability and statistics, Python programming

Course Objectives: The Objectives of course are

1. To understand key machine learning concepts: hypothesis formation, bias-variance trade-off, and model evaluation metrics
2. To master regression, classification, and clustering techniques
3. To apply machine learning algorithms to real-world datasets effectively

Course Outcomes: Students will be able to

1. Explain and identify core concepts and challenges in machine learning
2. Evaluate and improve model performance using appropriate metrics and tools
3. Implement and tune various supervised and unsupervised machine learning algorithms
4. Apply advanced techniques in machine learning and data mining

Machine Learning (DJS23SCPC501)		
Unit	**Description**	**Duration**
1	**Introduction to Machine Learning:** Types of Machine Learning, Issues in Machine Learning, Applications of Machine Learning, Steps involved in developing a Machine Learning Application, Hypothesis and Inductive Bias, Bias-Variance Trade-off, Performance measures, Data types and Data Validation, new edge of machine Learning. **Evaluation & Selection**: Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves.	**05**
2	**Regression:** Linear Regression, Least Minimum Slope (LMS) algorithm, Gradient Descent, Lasso and Ridge Regression. Polynomial Regression. Logistic Regression, Maximum Likelihood Function. **Classification:** Introduction to decision tree, Learning Decision tree using ID3 and Gini index; CART, Overfitting. Ensemble methods: Bagging (Random Forest) and Boosting (XG Boost)	**07**
3	**Bayesian Learning:** Bayesian Learning, Naïve Bayes, Bayesian Network: Representation in Bayesian, Belief Network, Inference in Bayesian Network, Applications of Bayesian Network. Classification Model	**07**
4	**Introduction to Support Vector Machine:** Support Vectors, Kernels: Linear, Polynomial and Radial Basis Function (RBF) Kernel	**04**
5	**Association Rule Mining:** Market Basket Analysis, Apriori algorithm and measures of association. **Clustering:** Cluster Analysis and Requirements of Cluster Analysis Partitioning Methods: k-Means, k-Medoids Hierarchical Methods: Agglomerative, Divisive. Dimensionality Reduction: Dimensionality Reduction Techniques: Principal Component Analysis	**08**
6	**Introduction to Neural Networks and Deep Learning:** Deep Learning applications, Association of biological neuron with artificial network, activation functions, weights, bias, threshold, learning rate, momentum factor **McCulloch Pitts Neuron**: Theory and architecture; linear separability; Hebb Network:	**08**

	Theory and algorithm, ANN architectures.Hyper-parameter tuning and batch normalization, Machine Learning vs Deep Learning.	
		Total **39**

Suggested List of Experiments:

Sr. No	Suggested Experiments
1	Perform Linear Regression. a. Perform data cleaning b. EDA c. Data transformation d. Model Training e. Performance evaluation
2	Perform Logistic Regression. a. Perform data cleaning b. EDA c. Data transformation d. Model Training e. Performance evaluation
3	Perform Decision Tree using GINI. a. Data cleaning b. EDA c. Data transformation d. Model Training, Visualize Decision Tree e. Performance evaluation
4	Perform CART decision tree algorithm. a. Data cleaning b. EDA c. Data transformation d. Model Training, Visualize Decision Tree e. Performance evaluation
5	Perform Ensemble methods a. Data cleaning b. EDA c. Data transformation d. Model Training e. Performance evaluation
6	Perform Bayesian Classification a. Data cleaning b. EDA c. Data transformation d. Model Training e. Performance evaluation
7	Compare performance of classification algorithms. a. Model Training b. Performance evaluation Comparison of performance of different classification algorithms
8	Perform Support Vector Machine. a. Data cleaning b. EDA c. Data transformation d. Dimensionality reduction

9 Perform K-means/ K-Medoids clustering.
   a. Data cleaning
   b. EDA
   c. Data transformation
   d. Clustering

10 Perform Market Basket Analysis
   a. Data cleaning
   b. EDA
   c. Data transformation
   d. Market basket analysis

11 Mini project based on any machine learning application

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt

Books Recommended:

Textbooks:

1. Mitchell, T. M., Machine Learning, McGraw Hill, 1st Edition, 2017
2. Ethem Alpaydın, Introduction to Machine Learning, MIT Press, 4th Edition, 2020.
3. Peter Harrington, 'Machine Learning In Action', DreamTech Press, 1st Edition, 2012.
4. Bruce, P., Bruce, A., & Gedeck, P., Practical statistics for data scientists: 50+ essential concepts using R and Python, O'Reilly Media, 2nd Edition, 2020

Reference Books:

1. Galit Shmueli, Peter C. Bruce, Peter Gedeck, Nitin R. Patel, O.P. Wali, Data Mining for Business Analytics, (An Indian Adaptation): Concepts, Techniques and Applications in Python, Cambridge University Press, 2019.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'reilly, 2016
3. Stephen Marsland, Machine Learning an Algorithmic Perspective, CRC Press, 2015
4. P.-N. Tan, M. Steinbach, A. Karpatne, and V. Kumar, Introduction to Data Mining, 2nd ed. Pearson Education Limited, 2019
5. K. P. Murphy, Probabilistic Machine Learning: An Introduction, 1st ed., Cambridge, MA: MIT Press, 2022
6. K. P. Murphy, Probabilistic Machine Learning: Advanced Topics, 1st ed., Cambridge, MA: MIT Press, 2023

Web Links:

1. https://www.datacamp.com/tutorial/tableau-tutorial-for-beginners
2. https://www.kaggle.com/code/ekami66/detailed-exploratory-data-analysis-with-python

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs06/preview

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Program: B. Tech in Artificial Intelligence (AI) and Data Science **T.Y B. Tech** **Semester: V**

Course: Natural Language Processing (DJS23SCPC502)

Course: Natural Language Processing Laboratory (DJS23SLPC502)

Pre-requisite: Python programming

Course Objectives: The Objectives of course are

1. To introduce the fundamental concepts and techniques of Natural Language Processing for analyzing words based on Morphology and CORPUS
2. To examine the NLP models and interpret algorithms for classification of NLP sentences by using both the traditional, symbolic and the more recent statistical approach
3. To get acquainted with the algorithmic description of the main language levels that includes morphology, syntax, semantics, and pragmatics for information retrieval and machine translation applications

Course Outcomes: Students will be able to

1. Explain the Principles and Process of Natural Languages and real-world applications
2. Demonstrate understanding of state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology
3. Perform POS tagging for a given natural language and select a suitable language modelling technique based on the structure of the language
4. Evaluate the syntactic and semantic correctness of sentences using grammars and labelling

Natural Language Processing (DJS23SCPC502)		
Unit	**Description**	**Duration**
1	**Introduction to Natural Language Processing:** Origin & History of NLP, Stages in NLP, Ambiguities and its types in English and Indian Regional Languages; Applications of NLP- Machine Translation, Information Retrieval, Question Answering System, Sentiment Analysis, Text Categorization , Text Summarization, Named Entity Recognition.	**04**
2	**Computational tools for text analysis :** Basic Terms: Tokenization, Tokenization in the NLTK, Tokenizing text, Stemming, Lexicon free FST Porter Stemmer algorithm, Lemmatization, Natural Language Toolkit (NLTK): Corpora and other data resources. Uses of corpora: Lexicography, Grammar and syntax, Stylistics, Training and evaluation. Basic corpus analysis: Frequency distribution building and analyzing a corpus.	**04**
3	**Word Level Analysis (statistical language model):** Inflectional Morphology, Derivational Morphology, Regular expression with types, Finite State Automata, NFA and DFA, Morphological Models: finite state morphology, Morphological parsing with FST (Finite State Transducer) , Grams and its variation: Bigram, Trigram, Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus, Evaluating N-grams: Perplexity, smoothing: Laplace Smoothing, Good-Turing Discounting	**09**
4	**Syntax analysis:** Part-Of-Speech tagging (POS): Tag set for English (Upenn Treebank), Difficulties/Challenges in POS tagging , Rule-based, Stochastic and Transformation-based tagging, Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging; Issues in HMM POS tagging, Discriminative Model: Maximum Entropy model, Conditional	**09**

	random Field (CRF), Syntax tree vs Parse tree, Parsers: Top down and Bottom up parsers, CYK.	
5	**Semantic Analysis:** Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet. Attachment for fragment of English, Relations among lexemes & their senses – Homonymy, Polysemy, Synonymy, Hyponymy, Semantic Ambiguity, Word Sense Disambiguation (WSD), Knowledge based approach (Lesk's Algorithm), Supervised (Naïve Bayes, Decision List).	**08**
6	**Pragmatic & Discourse Processing:** Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence, Anaphora Resolution using Hobbs and Centering Algorithm, Discourse segmentation, Co-reference resolution	**05**
	Total	**39**

Suggested list of Experiments:

Sr. No.	Title of the Experiment
1	Preprocessing steps in NLP: Tokenization, stop word Removal, Lemmatization, stemming using NLTK and SPACY
2	Implement Named Entity Recognition for any given text
3	Perform morphological analysis and word generation for any given text
4	Implement Chunking for the given input text.
5	Build a POS tagger using HMM
6	Similarity Detection in NLP
7	Implement N-Gram model for the given text input
8	Generate word cloud using Python
9	Any application of NLP: Spell Check, Autocorrect, plagiarism detection, sentiment analysis, sarcasm detection or text analytics in any domain

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt

Books Recommended:

Text Books:

1. Raymond S. T. Lee, "Natural Language Processing: A Textbook with Python Implementation", First Edition, 2023.
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers", O'Reilly , 2022.
3. Thushan Ganegedara, Andrei Lopatenko, "Natural Language Processing with TensorFlow: The definitive NLP book to implement the most sought-after machine learning models and tasks", 2nd Edition, 2022.
4. Daniel Jurafsky, James H. and Martin, Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson, 2024.

Reference Books:

1. Masato Hagiwara, "Real-World Natural Language Processing: Practical applications with deep learning", Mnaning,2021.

2. Ashish Bansal, "Advanced Natural Language Processing with TensorFlow 2: Build effective real-world NLP applications using NER, RNNs, seq2seq models, Transformers, and more", Packt Publishing, 2021.

Web Links:

1. POS Tagging Hidden Markov Models (HMM) Viterbi algorithm in NLP maths | Data Science in your pocket (medium.com)
2. Text Generation Using N-Gram Model | by Oleg Borisov | Towards Data Science
3. How to Create Beautiful Word Clouds in Python | by Tia Plagata | Towards Data Science
4. Best NLP Algorithms to get Document Similarity | by Jair Neto | Analytics Vidhya | Medium
5. How to Chunk Text Data — A Comparative Analysis | by Solano Todeschini | Towards Data Science
6. Natural Language Processing. Title :- Morphological Analysis | by Raghvendra Zarkar | Medium

Online Courses:

1. NPTEL Course : Natural Language Processing - Course (nptel.ac.in)
2. Cousera: Natural Language Processing Specialization [4 courses] (DeepLearning.AI) | Coursera
3. Udemy: NLP - Natural Language Processing with Python | Udemy

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Program: B. Tech in Artificial Intelligence (AI) and Data Science T.Y. B.Tech Semester :V

Course: Image Processing and Computer Vision (DJS23SCPC503)

Course: Image Processing and Computer Vision Laboratory (DJS23SLPC503)

Prerequisite: - Basic Mathematics, Python programming

Course Objectives: The Objectives of course are

1. To provide a fundamental understanding of image processing concepts, including image representation, enhancement techniques, and transformation methods
2. To equip students with the knowledge of image segmentation, morphological processing, feature detection, and motion analysis for practical applications in computer vision.
3. To introduce various image compression techniques and their significance in reducing storage and transmission costs while maintaining image quality

Course Outcomes: Students will be able to

1. Apply image enhancement in spatial domain
2. Analyse image in frequency domain through different transforms and enhancement in frequency domain
3. Apply different image segmentation, feature detection techniques on images
4. Examine and apply different morphological operations on an image
5. Apply geometric transformations on an image and Evaluate optical flow algorithms
6. Implement and evaluate image compression techniques

Image Processing and Computer Vision (DJS23SCPC503)		
Unit	**Description**	**Duration**
1	**Image Processing Fundamentals and Image Enhancement:** Image types, Image formats, Sampling & Quantization. **Spatial Domain Techniques:** Point Processing; Digital Negative, Contrast Stretching, Thresholding, Bit Plane Slicing, Power Law Transformation, Dynamic Range Compression. Histogram Modelling; Histogram Stretching & Histogram Equalization. Neighbourhood Processing; Noise, Smoothing (Low Pass Averaging Filter, Low Pass Median Filter), Sharpening Filters (High Pass Filtering & High Boost Filtering). Mean filters, Order statistic filters	**08**
2	**Image Segmentation:** Connectivity of Pixels, Detection of discontinuities (Point, Line, Edge), Detection of Edges (Computing Gradients, 1st order Derivative Filters,2nd order Derivative Filters, Laplacian of Gaussian). Region-based segmentation-Region Growing, Region Splitting, Region Merging, Region Split & Merge	**08**
3	**Image Transforms & Morphological Processing:** Fourier Transform,1D-DFT, Frequency domain techniques - 2D-DFT, Low pass Filter (Ideal, Butterworth, Gaussian), High pass Filter (Ideal, Butterworth, Gaussian). Hadamard Transform, Walsh Transform. **Morphological Operations:** Dilation, Erosion, Opening, Closing	**07**
4	**Geometric Transformations:** Translation, Rotation, Scaling, Shearing **Feature Detection & Description:** Interest or Corner Point Detectors- Harris and Hessian. Histogram of Oriented Gradients, Scale Invariant Feature Transform(SIFT), Speeded up Robust Features(SURF), Scale-Space Analysis- Image Pyramids	**05**
5	**Object Segmentation & Detection:** Canny Edge Detection, Difference of Gaussian (DOG), Graph Technique, Distance Metrics, Global Thresholding, Otsu's Thresholding, Watershed Algorithm **Motion Analysis & Optical Flow:** Introduction to Motion Detection, Lucas-Kanade, Horn-Schunck	**06**
6	**Image Compression:** Run-Length Encoding (RLE), Huffman Coding, LZW (Lempel-Ziv-Welch), Improved Grey Scale coding (IGS)	**05**
	Total	**39**

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Point Processing Techniques (Digital Negative, Thresholding, Intensity Transformation, Contrast Stretching)
2	Sharpening & Smoothing filters
3	Histogram Modelling
4	Frequency Domain Filtering
5	Edge detection
6	Morphological Operations
7	Object Detection
8	Image assessment with NumPy and OpenCV
9	Image Transformation in OpenCV
10	Feature Detection using OpenCV- Corner
11	Image Arithmetic Operations
12	Image Compression
13	Motion analysis and Action detection
14	Project Based Learning
15	Research Article Review

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt

Books Recommended:

Textbooks:

1. Richard Rafael C. Gonzalez, Digital Image Processing, 4th Edition, 2018
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, 1st Edition, 2011
3. Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, 2022

Reference Books:

1. William K. Pratt, Digital Image Processing: PIKS Scientific Inside, 4th Edition, 2007
2. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, 2011
3. E. R. Davies, Computer and Machine Vision: Theory, Algorithms, Practicalities, 4th Edition, 2012
4. S. Jayaraman,S.Esakkirajan,and T.Veerakumar, Digital Image Processing,2nd Edition, 2019
5. Adrian Kaehler and Gary Bradski, Learning OpenCV: Computer Vision with the OpenCV Library, 1st Edition, 2008

Web Links:

1. https://opencv.org/
2. https://staff.fnwi.uva.nl/r.vandenboomgaard/IPCV20162017/index.html
3. https://www.geeksforgeeks.org/computer-vision/
4. https://egyankosh.ac.in/handle/123456789/90205

Online Resources:

1. Computer Vision and Image Processing – Fundamentals and Applications https://onlinecourses.nptel.ac.in/noc22_ee48/preview/

https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

2. Computer Vision
   https://onlinecourses.nptel.ac.in/noc19_cs58/preview
   https://www.coursera.org/specializations/computer-vision
3. Digital Image Processing
   https://onlinecourses.nptel.ac.in/noc20_ee75/preview
   https://www.coursera.org/learn/introduction-image-processing

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Program: B. Tech in Artificial Intelligence (AI) and Data Science **T.Y B. Tech** **Semester: V**

Course: Recommendation Systems (DJS23SCPC511)

Course: Recommendation Systems Laboratory (DJS23SLPC511)

Prerequisite: Statistics for Data Science, and Machine Learning.

Course Objectives: The Objectives of course are

1. To provide a comprehensive understanding of recommendation system techniques, including collaborative, content-based, knowledge-based, and hybrid models.
2. To equip students with the skills to design, implement, and evaluate personalized recommender systems real-world data across various applications.

Course Outcomes: Students will be able to

1. Explain the architecture and functioning of Collaborative Filtering and Content-Based Recommendation Systems
2. Analyze and differentiate various collaborative and content-based filtering techniques, including their algorithms, similarity functions, and limitations
3. Apply knowledge-based and hybrid recommendation models to develop personalized recommendation solutions using constraint-based, case-based, or hybridization strategies
4. Evaluate the performance of different types of recommender systems using offline and online evaluation paradigms and appropriate metrics

Recommendation Systems (DJS23SLPE511)		
Unit	**Description**	**Duration**
1	**Introduction to Recommender System:** Introduction to Recommendation System, Framework of recommendation systems, Eliciting Ratings and other Feedback Contributions, Implicit and Implicit Ratings, Recommender system functions. Applications of recommendation systems, Issues with recommender system	06
2	**Collaborative filtering-based Recommender System:** Architecture of Collaborative Filtering, User-based nearest neighbour recommendation: Similarity Function, User-Based Algorithms, Item-based nearest neighbour recommendation: Similarity Function, Item-Based Algorithms, Comparing User-Based and Item-Based recommendations, data drift and concept drift.	08
3	**Content-based Recommender System:** Architecture of content-based systems, Content representation and content similarity, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, The Role of User Generated Content in the Recommendation Process. Bayes classifier for recommendation, Regression based recommendation system. Advantages and drawbacks of content-based filtering.	07
4	**Knowledge based recommendation:** Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders, Persistent Personalization in Knowledge-Based Systems, Conversational Recommendation. Search based recommendation, Navigation-based recommendation.	06

5	**Hybrid Recommendation System:** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta level, Limitations of hybridization strategies.	06
6	**Evaluating Recommendation System:** Evaluation Paradigms, General Goals of Evaluation Design, Design Issues in Offline Recommender Evaluation, Online Recommender evaluation techniques. Comparison between evaluation design of classification model and recommendation system, Error metrics, Decision-Support metrics, User Centered metrics. Comparative analysis between different types of recommendation systems, NLP based Recommendation systems.	06
	Total	39

Suggested List of Experiments:

Recommendation System Laboratory (DJS23SLPE511)

Sr. No.	Title of the Experiment
1	Build a Recommendation Engine with Item-Based Collaborative Filtering.
2	Build a Recommendation Engine with User-Based Collaborative Filtering.
3	Build Content-based recommendation engine on different datasets
4	Build recommender system using association rule mining.
5	Implement Recommendation System using K-Nearest Neighbours
6	Build Context-Aware Recommender Systems.
7	Build Constraint-based Recommenders.
8	Implement knowledge-based recommender system.
9	Implement a Monolithic hybridization design
10	Evaluate the recommendation system with evaluation matrix.
11	Compare the performance of different recommender systems
12	Mini Projects: 1) Build a recommender system that suggests SDG-related content (articles, actions, or products) based on user preferences or content similarity. 2) Build a recommender system that suggests eco-friendly products or services aligned with specific SDGs. 3) Build a recommender system that suggests books aligned with specific SDGs, helping users find educational or informative literature related to sustainability, equality, or climate action.

Minimum eight experiments from the above-suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. Kim Falk,"Practical Recommender Systems", Manning Publications, 1st Edition, 2019.
2. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction",Cambridge University Press, 1st Edition, 2011
3. Ricci, F., Rokach, L., & Shapira, B., Introduction to Recommender Systems Handbook. Springer, Boston, MA 2011.
4. Frank Kane, "Building Recommender Systems with Machine Learning and AI", Packt Publishing, 1st Edition, 2018.

Reference Books:

1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", Now publishers, 1 st Edition, 2011.
2. J. Leskovec, A. Rajaraman and J. Ullman, "Mining of massive datasets", Cambridge,2 nd Edition, 2012.
3. Rounak Banik, "Hands-On Recommendation Systems with Python: Start building", Ingram short title, 2018.
4. P. Pavan Kumar, S. Vairachilai, Sirisha Potluri, "Recommender Systems: Algorithmsand Applications", CRC Press, 1st edition, 2021.
5. "Hands-On Recommendation Systems with Python: Start building powerful and personalized, recommendation engines with Python" by Rounak Banik , 2018.

Web Links:

1. https://tryolabs.com/blog/introduction-to-recommender-systems
2. https://medium.com/@deepapandithu/recommender-system-user-collaborative-filtering-37613f0c6a9
3. https://www.analyticsvidhya.com/blog/2015/08/beginners-guide-learn-content-based-recommender-systems/
4. https://www.researchgate.net/publication/2378325_Knowledge-Based_Recommender_Systems
5. https://medium.com/analytics-vidhya/7-types-of-hybrid-recommendation-system-3e4f78266ad8

Online Resources:

1. Recommender System Using Collaborative Filtering Algorithm https://scholarworks.gvsu.edu/cgi/viewcontent.cgi?params=/context/cistechlib/article/1157/&path_info=CIS693_Recommender_System_Ala_Alluhaidan.pdf&utm_source=chatgpt.com
2. Content Based Recommender System - Analytics Vidhya https://www.analyticsvidhya.com/blog/2015/08/beginners-guide-learn-content-based-recommender-systems/?utm_source=chatgpt.com
3. (PDF) Content-Based Recommendation Systems https://www.researchgate.net/publication/236895069_Content-Based_Recommendation_Systems
4. Frontiers | Knowledge-based recommender systems: overview and research directions https://www.frontiersin.org/journals/big-data/articles/10.3389/fdata.2024.1304439/full?utm_source=chatgpt.com
5. Umadr13.pdf https://shlomo-berkovsky.github.io/files/pdf/UMADR13.pdf?utm_source=chatgpt.com
6. Recommender Systems | Coursera https://www.coursera.org/specializations/recommender-systems?msockid=13bdb95be1ac64ad3d35ad3ee01e65c8

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Program: B. Tech in Artificial Intelligence (AI) and Data Science T.Y B. Tech Semester: V

Course: Smart Systems and Applications (DJS23SCPC512)

Course: Smart Systems and Applications Laboratory (DJS23SLPC512)

Prerequisite: Basics of Digital Electronics, Networking and programming basics

Course Objectives: The Objectives of course are

1. To provide a comprehensive understanding of the Internet of Things (IoT), including its architecture, smart devices, and enabling technologies
2. It aims to equip students with the knowledge of hardware, software, industrial applications, fog/edge computing models, and security practices essential for developing and deploying intelligent IoT systems

Course Outcomes: Students will be able to

1. Understand the fundamentals of IoT, its architecture, key technologies, and smart environments
2. Analyze and evaluate the hardware, software, and middleware components used in smart systems
3. Demonstrate knowledge of Industrial IoT, Industry 4.0, and smart deployment models
4. Evaluate fog, edge-computing platforms, and address security challenges in smart systems

Smart Systems and Applications (DJS23SCPE512)		
Unit	**Description**	**Duration**
1	**Emergence of IoT, Smart Devices, and Standards:** Background and vision of IoT in smart environments, definition, and key enabling technologies Understanding the need for smart "things" in intelligent systems. Overview of commonly used smart devices. Simplified architecture for smart IoT systems and the core IoT functional stack. Comparison between M2M and IoT. IoT reference frameworks, IoT network layer design. LPWAN and wireless technologies enabling smart applications. Network layer encapsulation techniques for efficient communication	05
2	**Understanding the Building Blocks of Smart Systems – Hardware, Software, and Middleware :** Sensors and Actuators in IoT: Introduction to sensing and actuation within the perception layer. Role and types of actuators in smart applications **Open Hardware in IoT:** Classification of SoC platforms based on functionality. Overview of Arduino, Raspberry Pi, and BeagleBone boards. Comparative analysis of hardware platforms for smart system development **IoT Middleware:** Introduction to middleware for managing IoT devices and data. IoT Software Platforms: Need and characteristics of platforms that enable smart applications. Survey of commercial and open-source IoT software platforms. Guidelines for selecting an appropriate platform for a smart system	07
3	**Industrial IoT and Industry 4.0 in Smart Applications :** Introduction to Industrial IoT and its growing relevance. Why Industrial IoT matters now: current trends and transformations. Use-cases of IIoT in sectors like healthcare, oil and gas, and smart office spaces. Introduction to Industry 4.0 as the next wave of industrial smart systems. Core characteristics and reimagined value chains. Key design principles and technological building blocks enabling Industry 4.0	07

4	**From the Core to the Edge – Smart Deployment Models:** Understanding sensor-cloud integration vs. distributed smart systems using edge/cloud layers. Introduction to fog computing as the next-gen cloud approach. Characteristics, advantages, and practical applications of fog computing. Comprehensive fog architecture framework. Overview of application-agnostic and application-specific fog architectures **Fog Computing for Smart Environments** Exploring the Hadoop philosophy in the context of fog-based systems. Comparative analysis of fog, edge, cloud, and mist computing in smart environments. Study of Open Fog reference architecture. Overview of platforms like EdgeX, Amazon Green grass, and AWS Lambda for smart edge deployments. Common topologies and deployment models in fog-based smart systems	**12**
5	**Securing Smart Systems and IoT :** Introduction to security challenges in smart connected systems. Critical security issues and privacy preservation techniques in IoT. Security requirements based on the CIA principles. Technologies for securing IoT environments. Best practices for securing IoT devices. Addressing misbehavior and anomalies in M2M communication within smart ecosystems.	**08**
	Total	**39**

Suggested List of Experiment

Sr.No.	Title of the Experiment
1	To implement simple data collection using smart IoT devices.
2	To understand, implement, and compare IoT communication protocols like MQTT and CoAP.
3	To set up edge devices and fog/edge servers.
4	To develop an edge computing application for an industrial domain (e.g., healthcare, manufacturing).
5	To implement analytics and decision-making at the edge layer.
6	To explore security issues in IoT and edge environments.
7	To implement encryption and authentication for secure communication in smart systems.
8	To implement an IoT setup for sending data to the cloud.
9	To integrate IoT, edge computing, and cloud platforms in a unified smart system.

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt

Books Recommended:

Text Books:

1. Surya Durbha and Jyoti Joglekar "Internet of Things " Oxford University Press, 2021
2. Sudip Misra, Subhadeep Sarkar and Subarna Chatterjee "Sensors, Cloud and Fog: The Enabling Technologies for the Internet of Things" CRC Press, 2019
3. Alasdair Gilchrist "Industry 4.0: The Industrial Internet of Things" Apress, 2023
4. Perry Lea "IoT and Edge Computing for Architects" Second edition, by Packt, 2020.
5. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, and Jerome Henry "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things "Cisco press, 2017
6. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-On Approach", Universities Press, 1st Edition, 2014.
7. Manuel Domínguez-Morales, Ángel Jesús Varela Vaca, Lourdes Miró Amarante, Internet of Things: New Trends, Challenges and Hurdles, IntechOpen, 1st Edition, 2023.

Reference Books:

1. Yashwant Kanetkar "21 IoT Experiments " BPB Publications, 2018
2. Dimitrios Serpanos and Marilyn Wolf "Internet-of-Things (IoT) Systems: Architectures, Algorithms and Methodologies "Springer,2018
3. Arshdeep Bahga and Vijay Madisetti "Internet of Things: A Hands-on Approach" Universities Press, 2014
4. Raj Kamal "Internet of Things: Architecture and Design Principles" Mc Graw Hill, 2022
5. Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds.), Architecting the Internet of Things, Springer, 1st Edition, 2011
6. Shishir Kumar Shandilya, Internet of Things Security: Fundamentals, Techniques and Applications, River Publishers, 1st Edition, 2023

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Program: B. Tech in Artificial Intelligence (AI) and Data Science **T.Y B. Tech** **Semester: V**

Course Network and Information Security (DJS23SCPC513)

Course: Network and Information Security Laboratory (DJS23SLPC513)

Prerequisite: Computer Networks

Course Objectives: The Objectives of course are

1. To introduce Basics of Network security
2. To perform various attacks on the network security
3. To gain the knowledge of different networking protocols.
4. To understand the firewall and IDS for system security

Course Outcomes: Students will be able to

1. Understand the basics of Network Security
2. Learn the basics of Cryptography
3. Implement different Key Management and Authentication
4. Explore Security at Network and Transport Layer
5. Analyze different Non-Cryptographic Protocol Vulnerabilities
6. Identify the function of an IDS and firewall for the system security

Network and Information Security (DJS23SCPE513)		
Unit	**Description**	**Duration**
1	**Introduction:** Common Attacks and Vulnerabilities, Defence Strategies and Techniques: Access Control, Data Protection, Prevention and Detection, Response, Recovery and Forensics **Basics of Cryptography:** Preliminaries, Elementary Substitution Ciphers, Elementary Transposition Ciphers, Other Cipher Properties, DES construction.	04
2	**Cryptography:** RSA Operations, Why Does RSA Work, Performance, Applications and practical Issues, Public Key Cryptography Standard, Diffie-Hellman Key Exchange **Cryptographic Hash:** Introduction, Properties, Construction, Applications and Performance, The Birthday Attack	07
3	**Key Management and Authentication:** Introduction, Digital Certificates, Public Key Infrastructure, Identity-based Encryption. **Authentication:** One-way Authentication, Mutual Authentication, Dictionary attacks, Centralised Authentication, The Needham-Schroeder Protocol, Kerberos, Biometrics	10
4	**Security at the Network Layer and Transport Layer:** Security at different Layers: Pros and Cons, IPSec, Internet Key Exchange (IKE) Protocol, Security Policy and IPSec, Virtual Private Networks, Introduction to Security at Transport Layer, SSl Handshake Protocol, SSL Record Layer Protocol, Open SSL	05
5	**Non-Cryptographic Protocol Vulnerabilities:** DoS and DDoS, Session Hijacking and Spoofing, Pharming Attacks, Wireless Lan Vulnerabilities	07

	Software Vulnerabilities: Phishing, Buffer Overflow Format String Attacks, Cross-site Scripting (XSS), SQL Injection	
6	**Malwares, Firewalls and Intrusion Prevention and Detection:** Preliminaries: Viruses, Worms and other Malwares, features, Internet Scanning Worms, Topological Worms, Web Worms, Mobile Malware, Botnets **Firewalls:** Basics, Functionalities, Policies and Types, Practical Issues **Intrusion Prevention and Detection:** Introduction, Prevention Versus Detection, Types of Intrution Detection System, DDoS Attack Prevention/Detection, Malware Detection	**06**
	Total	**39**

Suggested List of Experiment:

Sr. No	Experiment
1	Study and Implement OS Security
2	Study and Implement Buffer Overflow
3	Study and Implement SQL Injection
4	Study and Implement Cross Site Scripting
5	Study and Implement DOS Attacks
6	Study and Implement Session Hijacking Attacks
7	Study and Implement VPN
8	Study and Implement PGP/GPG Encryption
9	Study and Implement Firewalls using iptables
10	Study and Implement IDS
11	Study and Implement Network traffic sniffing (Wireshark, Ettercap)
12	Case Study on Cloud Security

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. William Stallings, Cryptography and Network Security, Pearson Publication, 7th Edition, 2017.
2. Charles P. Pfleeger "Security in computing", Pearson Education, 5th Edition, 2018.
3. Behrouz A. Forouzan "Introduction to Cryptography and Network Security", McGraw-Hill, 3rd Edition, 2015.
4. Cryptography, Network Security, and Cyber Laws, CENGAGE Learning, 1st Edition, 2018

Reference Books:

1. Practical Packet Analysis: Using Wireshark to Solve Real-Word Network problems by Chris Sanders. 3rd Editon, 2017.
2. Man Ho Au, Raymond Choo, Mobile Security and Privacy: Advances, Challenges and Future Research Directions, 1st Edition, 2016.
3. Roberta Bragg (Author), Mark Rhodes-Ousley (Author), Keith Strassberg (Author) Network Security: The Complete Reference, 1 July 2017

Web links:

1. https://www.networkworld.com/asia/
2. https://www.coursera.org/professional-certificates/palo-alto-networks-cybersecurity- fundamentals
3. http://www.securitytube.net/
4. https://www.reddit.com/r/netsec/
5. https://www.mygreatlearning.com/academy/learn-for-free/courses/network- security

Online Courses:

1. Prof. Sourav Mukhopadhyay "Cryptography and Network Security " IIT Kharagpur- https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2. Dr.G.padmavathi, Avinashilingam "Cyber Security "Institute for Home Science & Higher Education for Women, Coimbatore, https://onlinecourses.swayam2.ac.in/cec20_cs15/preview
3. Information Security: A Hands-On Approach: https://nptel.ac.in/courses/106/106/106106229/

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Program: B. Tech in Artificial Intelligence (AI) and Data Science T.Y. B. Tech Semester: V

Course: Cloud Computing Laboratory (DJS23SLMD501)

Prerequisite: Knowledge of Computer Networks

Course Objectives: The Objectives of course are

1. To develop a thorough understanding of cloud computing concepts and familiarize students with various cloud deployment models, including private, public, hybrid, and community clouds
2. To introduce students to different cloud service models such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), and Database as a Service (DBaaS)
3. To enable students to apply appropriate cloud service models for designing and implementing real-world applications
4. To introduce students to containerization technologies and tools such as Docker and Kubernetes, and enable them to understand their role in building, deploying, and managing scalable cloud-native applications

Course Outcome: Students will be able to

1. Explain the evolution, principles, architecture, and benefits of Cloud Computing to evaluate existing cloud infrastructures and recommend suitable architectures based on business requirements
2. Explain the foundations of virtualization to demonstrate how cloud service providers ensure elasticity, portability, and resilience
3. Analyze various cloud computing service models and implement appropriate models to solve real-world computing problems
4. Construct containerized applications and services, test them using Docker, and deploy them
5. Kubernetes cluster to achieve scalable and manageable solutions
6. Explore and compare different cloud-based databases and storage services to select the most appropriate ones for given applications

Cloud Computing Laboratory (DJS23SLMD501)		
Unit	**Description**	**Duration**
1	**Introduction to Cloud Computing:** Cloud Computing at a Glance, the vision of Cloud Computing, Defining a Cloud, Cloud Computing reference model, Characteristics and Benefits, Computing platforms and Technologies, principles of Parallel and Distributed Computing, Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel and Distributed Computing, Technologies for Distributed Computing.	07
2	**Virtualization:** Introduction, Characteristics of Virtualization Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples.	09
3	**Cloud Computing Architecture:** Introduction, Cloud Reference model, architecture, Infrastructure / Hardware as a Service. Platform as a Service, Software as a Service, Types of Clouds, public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Economics of the Cloud, Open challenges	09
4	**Cloud Services and Deployment Models:**	07

	Cloud deployment models, Cloud Service Models, Cloud Infrastructure Mechanisms, Cloud service management, Cloud Computing architecture design principles, Cloud Computing life cycle and architecture, load balancing approach.	
5	**Modern application development and deployment:** Dockers, Containers And Kubernetes, Openshift: Introduction to containers, Introduction to Docker, Building container images, Using container registries, Running containers, Understanding container orchestration, Understanding Kubernetes architecture, Introduction to Kubernetes objects, Using basic Kubernetes objects Using the kubectl command, Leveraging Kubernetes, Using ReplicaSets, Using autoscaling Understanding rolling updates Understanding ConfigMaps and secrets Using service bindings The Kubernetes Ecosystem	**10**
6	**Cloud Databases and Storage Services :** Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups. Database and analytics: Introduction to Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non-relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys.	**10**
	Total	**52**

Suggested List of Experiment

Sr. No.	Title of the Experiment
1	Introduction and overview of cloud computing
2	To study and implement Hosted Virtualization with VirtualBox
3	To study and implement Infrastructure as a Service
4	To study and implement Platform as a Service
5	To study and implement Storage as a Service
6	To study and implement Database as a Service on SQL/NOSQL databases
7	To study and implement Security as a Service
8	To study and implement Identity and Access Management (IAM) practices
9	To study and implement Containerization with Docker
10	To study and implement container orchestration with Kubernetes
11	To study and implement AI and Data Science services using cloud platforms

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Text books:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Shivananda Poojara, Satish N. Srirama "Mastering Cloud Computing", McGrawHill, Second Edition, June 2024
2. Kamal Kant Hiran, Ruchi Doshi, Dr. Temitayo Gagbola and Mehul Mahrishi, "Cloud Computing" bpb publication, First Edition 2019
3. Gigi Sayfan, "Mastering Kubernetes", Packt Publishing, Third Edition, 2020.
4. Jamon Camisso, Hanif Jetha, Katherine Juell, "Kubernetes for Full-Stack Developers", DigitalOcean, First Edition, 2019

5. Scott Surovich, Marc Boorshtein, "Kubernetes and Docker - An Enterprise Guide", Packt Publishing, 2020
6. Neal Davis, "AWS Certified Solutions Architect Associate (SAA-C03) Study Guide", Digital Cloud Training, Fourth Edition, March 2023
7. Mark Wilkins, "AWS Certified Solutions Architect Official Study Guide: Associate Exam", Wiley, Second Edition, August 2022

Reference Books:

1. Marinescu, Dan C. Cloud Computing: Theory and Practice. Morgan Kaufmann, 2017.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Mc Graw Hill Education, 1st Edition, 2017.
3. Dr. Sunilkumar, S. Manvi, "Cloud Computing: Concepts and Technologies", CRC Press, 2021
4. Kailash Jayaswal. Jagannath Kallalurchi, Donald J. Houde and Dr. Deven Shah, "Cloud Computing Black Book", First Edition, 2015

Web Links:

1. https://www.nist.gov/system/files/documents/itl/cloud/NIST_SP-500-291_Version2_2013_June18_FINAL.pdf
2. https://phoenixnap.com/kb/ubuntu-installkvm\
   https://docs.citrix.com/en-us/xenserver/7- 1/install.html
3. IaaS, PaaS, STaaS, DbaaS, IAM and Security as a Service on AWS and Azure
   https://docs.aws.amazon.com/
   https://docs.microsoft.com/en-us/azure
4. https://docs.docker.com/get-started/ 6 Kubernetes https://kubernetes.io/docs/home/

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Program: Artificial Intelligence (AI) and Data Science **T.Y. B.Tech.** **Semester: V**

Course: Data Analytics and Visualizations Laboratory (DJS23SLMD502)

Prerequisite: Basic Mathematics and Statistics, Database, Python

Course Objectives: The objective of course is

1. Provide a comprehensive understanding of data analytics concepts, the analytics lifecycle, and different types of analytics used in decision-making
2. Equip students with the skills to collect, clean, and pre-process structured and unstructured data from various sources using tools like Python and Excel.
3. Enable students to perform statistical analysis and exploratory data analysis (EDA) for extracting patterns, trends, and meaningful insights from data.
4. Develop proficiency in creating basic to advanced data visualizations using Python libraries, Tableau, and Power BI.
5. Prepare students for real-world analytics projects by applying data storytelling techniques and building interactive dashboards that support data-driven decisions.

Course Outcomes: Students will be able to

1. Explain fundamental concepts of data analytics and its lifecycle, including types of analytics, data structures, and the role of analysts with hands-on exposure to tools like Python and Excel
2. Apply data collection, cleaning, and integration techniques using Python libraries (Pandas, NumPy) to prepare structured datasets for analysis and visualization.
3. Perform exploratory data analysis (EDA) and create insightful visualizations using Python (Matplotlib, Seaborn, Plotly) to interpret and communicate data-driven findings.
4. Design interactive dashboards and visual storytelling projects using Tableau, Power BI, and Python tools, demonstrating the ability to present real-world insights for decision-making.

Data Analytics and Visualizations Laboratory (DJS23SLMD502)		
Unit	**Description**	**Duration**
1	**Fundamentals of Data Analytics:** Introduction to Data Analytics and its importance, Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive, The Data Analytics Lifecycle Structured vs Unstructured Data, Role of Data Analysts in organizations, Common tools and technologies in Data Analytics, Introduction to Python and Excel for data analysis	**07**
2	**Data Collection and Data Cleaning:** Data types and sources: APIs, databases, web scraping, Data formats: CSV, JSON, Excel, SQL tables, Data cleaning techniques: handling missing and duplicate data, Data transformation: encoding, scaling, parsing Data integration and merging datasets, Python libraries for data handling: Pandas, NumPy. Best practices for clean and usable datasets	**06**
3	**Exploratory Data Analysis (EDA):**Statistical summary: mean, median, mode, std. dev. Grouping and aggregation in data Correlation, covariance, and multivariate analysis, Outlier detection and handling Visualization in EDA: histograms, boxplots, scatter plots, Pandas Profiling and Seaborn pair plots, Data storytelling using insights from EDA	**07**

4	**Data Visualization with Python:** Introduction to Matplotlib and Seaborn, Creating basic charts: bar, line, scatter, pie, Advanced charts: heatmaps, violin plots, pair plots, Interactive dashboards with Plotly and Dash, Theming, color palettes, and annotations, Exporting and sharing visualizations, Best practices in Python data visualization	**06**
5	**Visualization with Tableau and Power BI:** Getting started with Tableau and Power BI interfaces, Connecting to data sources and preparing data, Creating visualizations: bar, line, pie, combo charts, Advanced charts: maps, treemaps, waterfall, funnel, sunburst, Creating dashboards and interactive filters, Using calculated fields, parameters, and DAX in Power BI, Publishing and sharing dashboards with stakeholders	**06**
6	**Projects, Case Studies, and Insights** Capstone project using real-world datasets, Case study in Retail/Finance/Healthcare domain, Building end-to-end dashboards using Tableau/Power BI,Comparative analysis of Python, Tableau, and Power BI visualizations, Creating impactful presentations with visual stories, Evaluation and performance metrics for analytics projects, Final report submission and class presentations	**07**
	Total	**39**

Suggested List of Experiments:

Sr. No.	Title of the Experiment
1	Explore a dataset using Python (Pandas) to calculate mean, median, mode, and standard deviation.
2	Clean a messy dataset by removing duplicates, filling missing values, and converting data types..
3	Use an open API (like COVID-19 or weather) to collect JSON data and convert it to a CSV file.
4	Visualize data using Matplotlib and Seaborn to create bar, line, and scatter plots.
5	Create a heatmap and violin plot in Seaborn to show correlation and distribution of variables.
6	Build an interactive dashboard in Plotly or Streamlit with dropdown filters and live charts.
7	Load a dataset in Tableau and create basic and advanced charts including treemaps and maps.
8	Use Power BI to connect an Excel/CSV file, create visualizations, and apply filters/slicers.
9	Compare visual outputs of one dataset using Python, Tableau, and Power BI to evaluate effectiveness.
10	Create a data storytelling presentation that explores the key drivers of customer churn using visualizations from Power BI, building a compelling narrative from data preparation to actionable insights.

Minimum eight experiments and mini project from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. Wes McKinney "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" 2022 (3rd Edition)
2. Joshua N. Milligan "Learning Tableau: Tools for Business Intelligence, data prep, and visual analytics" 2019 (3rd Edition)
3. Hadley Wickham & Garrett Grolemund "R for Data Science: Import, Tidy, Transform, Visualize, and Model Data" 2023 (2nd Edition)

Reference Books:

1. Dr. Ossama Embarak "Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems" 2018.
2. Daniel G. Murray "Tableau Your Data!: Fast and Easy Visual Analysis with Tableau Software" 2016 (2nd Edition)
3. Thomas Rahlf "Data Visualisation with R: 111 Examples"2020

Web Links:

1. https://github.com/LifnaJos/ADL601-Data-Analytics-and-Visualization-Lab
2. https://ocw.mit.edu/courses/res-6-009-how-to-process-analyze-and-visualize-data-january-iap-2012/
3. https://www.coursera.org/specializations/data-analysis-visualization-foundations
4. https://www.coursera.org/learn/datavisualization?msockid=0fba0991cc8d64af281a1ae9cd3f657a

Online Resources:

1. Data Analytics with Python By Prof. A Ramesh | IIT Roorkee
   https://onlinecourses.nptel.ac.in/noc21_cs45/preview
2. Introduction to Data analytics By Dr. Balaraman RavindranDepartment of Computer Science and Engineering IIT Madra
   https://archive.nptel.ac.in/courses/110/106/110106072/#
3. Data analysis and decision making - by prof.Raghu nandan sengupta Department of Management IIT Kanpur
   https://archive.nptel.ac.in/courses/110/104/110104094/#

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Program: B. Tech in Artificial Intelligence (AI) and Data Science **T.Y B. Tech** **Semester: V**

Course: Environmental Studies (DJS23ITHSX10)

Prerequisite: Interest in Environment and its impact on Human Calculus

Course Objectives: The objectives of the course are

1. Familiarise students with environment related issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Give overview of Green Technology options.

Course Outcomes: Students will be able to

1. Understand how human activities affect environment
2. Understand the various technology options that can make a difference

Unit	Detailed Syllabus:	Duration
1	**Air Pollution** Sources of Air pollution. Definition of Air Quality Index and how it is measured.	1
2	**Water Pollution** Sources of water pollution. Ground water pollution and eutrophication.	1
3	**Noise Pollution** Noise pollution and sources. Decibel limits for hospital, library, silence zone.	1
4	**Biodiversity loss** Value of Biodiversity. Endangered species.	1
5	**Deforestation** Product and services provided by forests. Relationship between forests and climate change.	1
6	**Renewable Energy sources** Our energy needs and global energy crisis. Renewable energy sources.	1
7	**Climate change** Greenhouse gases and climate change.	1
8	**Green Technology** Data Center Energy Efficiency, Thin-Client and Energy Efficiency.	1
	Total	8

List of Tutorials

SN.	Tutorial List
1	Case study on Smog.

2	Presentation on Water Pollution (Industrial, Sewage) explaining any specific case.
3	List effects of noise pollution on human health. Measure decibel level in college library, canteen, classroom
4	Case study on effect of pollution on Biodiversity loss.
5	Debate for and against to promote Economic Growth Deforestation is required.
6	Presentation on different Renewable Energy Technologies.
7	Report on major impact of Global warming on Environment giving real examples.
8	Report on advantages and examples of Green Building for Sustainable development, Sustainable Software Design.

Tutorial: (Term work: 25 marks)

The distribution of marks for term work shall be as follows:

i. Performance in Tutorial: 15 Marks

ii. Write-up/ Report: 10 mark

Text books:

1. Environmental Studies from Crisis to Cure, R. Rajagopalan, Oxford University Press, Second Edition,
2. Textbook of Environmental Studies for Undergraduate Courses, Erach Bharucha for University Grants Commission, New Delhi & Bharti Vidyapeeth Institute of Environment Education and Research.
3. Environmental Pollution: Principles, Analysis and Control; P. Narayanan, CBS Publishers
4. Green Information Technology: A Sustainable Approach, Mohammad Dastbaz, Colin Pattinson, Babak Akhgar, Morgan and Kaufman, Elsevier

Reference Books:

1. Information Technologies in Environmental Engineering: New Trends and Challenges, Paulina Golinska, Marek Fortsch, Jorge Marx-Gómez, Springer, 2011

Weblinks:

1. CITES: **www.cites.org**
2. Convention on Biological Diversity: **www.biodiv.org**
3. Kalpvriksh: **www.kalpvriksh.org**
4. Water pollution: **http://en.wikipedia.org/wiki/Water_polution**
5. Ecosan: **www.eco-solutions.org**

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Program: B. Tech in Artificial Intelligence (AI) and Data Science **T.Y B. Tech** **Semester: V**

Course: Innovative Product Development III (DJS23IPSCX03)

Course Objectives: The objectives of the course are

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value added product
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product

Course Outcome: Students will be able to

1. Identify the requirement for a product based on societal/research needs
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product
4. Draw proper inferences through theoretical/ experimental/simulations and analyse the impact of the proposed method of design and development of the product
5. Develop interpersonal skills, while working as a member of the team or as the leader
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication

Guidelines for the proposed product design and development:

- Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department)
- Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members
- Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor
- Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas
- Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning
- A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis
- The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try

and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department

- The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters, i.e. during the semesters V and VI

Guidelines for Assessment of the work:

- The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester
- In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time
- Distribution of term work marks during semester V shall be as given below:
  - Marks awarded by the supervisor based on performance 10
  - Marks awarded by Review Committee 10
  - Quality of Documentation 05

Review/progress monitoring committee may consider the following points during the assessment.

- In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis
- Two reviews will be conducted based on the presentation given by the student's team

Tentative rubrics for reviews will be as follows:
Review 1:

i. Implementation Details & Status (60% project implementation)
ii. Design & System Specifications
iii. Presentation Quality
iv. Contribution as a team member and Punctuality
v. Project Documentation.

Review 2:

i. Implementation Details & Status (90% project implementation)
ii. Draft copy of research paper.
iii. Draft copy of Copy right or Patent if applicable .

First review is based on readiness of building the working prototype.
Second review shall be based on a presentation as well as the demonstration of the working model. This review will also look at the readiness of the proposed technical paper presentation of the team.

The overall work done by the team shall be assessed based on the following criteria:

1. Quality of survey/ need identification of the product
2. Clarity,of Problem definition (design and development) based on need
3. Innovativeness in the proposed design
4. Feasibility of the proposed design and selection of the best solution

5. Cost effectiveness of the product
6. Societal impact of the product
7. Functioning of the working model as per stated requirements
8. Effective use of standard engineering norms
9. Contribution of each individual as a member or the team leader
10. Clarity on the write-up and the technical paper prepared

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department
- The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organisations having an experience of more than five years, approved by the Head of the Institution. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester V

Prepared by | Checked by | Head of the Department | Vice Principal | Principal