Shri Vile Parle Kelavani
Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus

Third Year B.Tech

in

Artificial Intelligence and Machine Learning

(Semester V)

Academic Year 2024-25

Proposed Scheme for Third Year Undergraduate Program in Artificial Intelligence and Machine Learning : Semester V (Autonomous)
Academic Year(2024-25)

Sr No	Course Code	Course	Teaching Scheme(hrs)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					Aggregate (A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th	O	P	O &P	Total SEA (B)		
1	DJS22AMC501	Digital Signal and Image Processing	3	--	--	3	35	--	35	65	--	--	--	65	100	4
	DJS22AML501	Digital Signal and Image Processing Laboratory	--	2	-	1	--	25	25	--	25	--	--	25	50	
2	DJS22AMC502	Machine Learning	3	--	--	3	35	--	35	65	--	--	--	65	100	4
	DJS22AML502	Machine Learning Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
3	DJS22AMC503	Natural Language Processing	3	--	--	3	35	--	35	65	--	--	--	65	100	4
	DJS22AML503	Natural Language Processing Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
4	DS22AML504	Programming Laboratory-III(Full stack development using Python)	--	4	--	2	--	25	25	--	--	_	25	25	50	2
5@	DJS22AMEC5011	Elective1: Computer Network Security	3	--	--	3	35	--	35	65	--	--	--	65	100	4
	DJS22AMEL5011	Elective1: Computer Network Security Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
	DJS22AMEC5012	Elective 2: Advanced Data Structures and Algorithms	3	-	--	3	35	--	35	65	--	--	--	65	100	
	DJS22AMEL5012	Elective 2: Advanced Data Structures and Algorithms Laboratory	_	2	-	1	--	25	25	--	25		--	25	50	
	DJS22AMEC5013	Elective 3: Recommendation Systems	3	--	--	3	35	--	35	65	--	--	--	65	100	
	DJS22AMEL5013	Elective 3: Recommendation Systems Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
6	DJS22A5	Environmental Studies(1 hr)	1	--	--	--	--	--	--	--	--	--	--	--	--	--
7	DJS22ILLL1	Innovative Product Development III(C)	--	2	--	1	--	25	25	--	25	--	--	25	50	1
		Total	19	14	0	19	210	200	410	390	175	0	25	590	1000	19

@Any 1 Elective Course

Th	Theory	T/W	Termwork
P	Practical	O	Oral
T	Tutorial		

Prepared by

Checked by

Head of the Department

Vice Principal

Principal

Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (hrs.)
Theory	One Term test (based on 40 % syllabus)	35	1
	Second Term test (next 40 % syllabus) / presentation / assignment / course project / group discussion / any other.		as applicable
Audit course	Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.	--	
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory & Tutorial	Performance in the laboratory and tutorial.	25	

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.	65	3
	* 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

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: V
Course: Digital Signal and Image Processing (DJS22AMC501)		
Course: Digital Signal and Image Processing Laboratory (DJS22AML501)		

Pre-requisite:

Ability to deal with applied and abstract mathematical concepts.

Course Objective:

1. To introduce students with the basic idea of signals and systems analysis with its characterization in time and frequency domain.
2. To implement algorithms that perform basic image processing- enhancement and filtering
3. To implement algorithms for basic image segmentation

Course Outcomes (CO): On completion of the course, the students will be able to:

1. Classify signals and systems on the basis of their properties and analyze the implications in the context of practical signals and systems.
2. Represent signals in the time and frequency domain using multiple representations and analyze LTI systems using convolution in the frequency domain.
3. Implement image enhancement techniques in spatial and frequency domain.
4. Interpret and apply image segmentation and representation techniques for object recognition.
5.

Digital Signal and Image Processing (DJS22AMC501)		
Unit	**Description**	**Duration**
1	**Discrete-Time Signal and Discrete-Time System:** Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication). Classification of Discrete-Time Signals, Classification of Discrete Systems. Linear Convolution formulation for 1-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. LTI system, Concept of Impulse Response and Step Response, Output of DT system using Time Domain Linear Convolution.	09

2	**Discrete Fourier Transform**: Introduction to DTFT, Relation between DFT and DTFT, DFT of DT signal, Inverse DFT. Properties of the DFT: Scaling and Linearity, Symmetry for real valued signal, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property **Fast Fourier Transform:** Need of FFT, Radix-2 DIT-FFT algorithm. Flow graph for N=4 and 8 using Radix-2 DIT-FFT, Inverse FFT algorithm, Comparison of complex and real, multiplication and additions of DFT and FFT. Overlap Add Algorithm and Overlap Save Algorithm and implementation using FFT.	**10**
3	**Basics of Image Processing**- Image acquisition, Sampling, Quantization, Image Types, and Image formats. Colour models RGB and CMYK models.	**02**
4	**Image Enhancement in spatial domain:** Point processing techniques, Neighborhood processing. Image Smoothing: Spatial Filters-Linear Filters-Averaging filter, Median filter, Sharpening Spatial Filters- The Laplacian, Unsharp Masking and High boost Filtering, Using First-Order Derivatives —The Gradient-Sobel, Prewitt and Roberts operator, Histogram processing (Stretching & Equalization) **Image Enhancement in Frequency domain:** 2D-DFT, Properties of 2D-DFT, Low pass, High pass and Homomorphic filtering.	**10**
5	**Image Restoration:** Overview of Degradation models –Unconstrained and constrained restorations-Inverse Filtering, WienerFilter.	**03**
6	**Image Segmentation**: Basic relationships between pixels -Neighbors, Connectivity, Detection of discontinuities- Point, Line, Edge detection, Region-based segmentation- Region Growing, Region Splitting and merging. Region Identification: chain code, simple geometric border representation, Boundary description using segment sequences. Edge Linking, Hough Transform.	**05**
	TOTAL	**39**

Books Recommended:

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, _Digital Image Processing', Pearson, 4th Edition, 2018.
2. Tarun Rawat, Signals and Systems, Oxford Higher Education, Paperback – 19 July 2010 V. Krishnaveni and A.Rajeshwari, "Signals and Systems", Wiley-India, First Edition 2012

Reference Books:

1. Simon Haykin and Barry Van Veen, "Signals and Sytems", John Wiley and Sons, SecondEdition, 2004.
2. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, "Signals and Systems", Prentice-Hall of India, Second Edition, 2002.
3. Anil K Jain, Fundamentals of digital image processing Paperback, PHI – 1 January 2015
4. Willliam K Pratt, Digital Image Processing John Willey, 2002.
5. Malay K. Pakhira, Digital Image Processing and Pattern Recognition, First Edition, PHILearning Pvt. Ltd., 2011.

Digital Signal and Image Processing Laboratory (DJS22AML501)	
Sr. no.	**Name of Experiment (Any Eight)**
1	Implementation of Linear and Circular Convolution of two discrete time sequences.
2	Implement Overlap and Add method for computing the convolution of two variable length sequences.
3	To understand the effect of Sampling and Quantization on image quality. Study image statistics. (Mean, Variance, Entropy)
4	To perform Spatial Domain Image Enhancement using different Point Processing techniques.
5	To perform Image steganography and retrieve the secret image from the stego image.
6	Implement homomorphic filter
7	To perform frequency domain Image Enhancement techniques.
8	Perform image zooming
9	To perform different Image Segmentation operations using different operators and Canny edge detection.

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Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: V
Course: Machine Learning (DJS22AMC502)		
Course: Machine Learning Laboratory (DJS22AML502)		

Prerequisite: Knowledge of basic probability and statistics, Data Mining and Analytics concepts

Course Objectives:

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: By the end of the course, students should be able to:

1. Analyse model performance using evaluation metrics.
2. Implement and tune regression and classification algorithms.
3. Apply knowledge of Bayesian learning principles.
4. Apply clustering and dimensionality reduction techniques.
5. Understand the fundamentals of Neural Networks.

Machine Learning (DJS22AMC502)		
Unit	**Description**	**Duration**
1	Hypothesis and Inductive Bias, Bias-Variance Trade-off, Performance measures, Data Validation. **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.	5
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).	8
3	**Bayesian Learning:** Bayesian Learning, Naïve Bayes, Bayesian Network: Representation in Bayesian, Belief Network, Inference in Bayesian Network, Applications of Bayesian Network. Classification Model	8
4	**Introduction to Support Vector Machine:** Support Vectors, Kernels: Linear, Polynomial and Radial Basis Function (RBF) Kernel	5

5	**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	8
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: Theory and algorithm, ANN architectures. Hyper-parameter tuning and batch normalization, Machine Learning vs Deep Learning.	5
	Total	39

Books Recommended:

Text books:

1. Practical Statistics for Data Scientists, 2edition by Peter Bruce, Andrew Bruce, Peter Gedeck, O'Reilly Publisher, 2020.
2. Experimental Design and Analysis by Howard J. Seltman, July 11, 2018
3. Tom Mittchell —Machine Learning McGraw Hill,2017.

Reference Books:

1. Data Mining for Business Analytics, (An Indian Adaptation): Concepts, Techniques and Applications in Python, Cambridge University Press, ISBN NO. 978-1108727747, 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. Han Kamber, —Data Mining Concepts & Techniques, Morgann Kaufmann Publishers, 2012.
5. Kevin P. Murphy, Machine Learning — A Probabilistic Perspective, 2012.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2. https://www.datacamp.com/tutorial/tableau-tutorial-for-beginners
3. https://www.kaggle.com/code/ekami66/detailed-exploratory-data-analysis-with-python

Shri Vile Parle Kelavani Mandal's
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NAAC Accredited with "A" Grade (CGPA : 3.18)

Machine Learning Laboratory (DJS22AML502)	
Sr. No	**List of 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 c. Comparision 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	Study a machine learning patent.
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.

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Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: V
Course: Natural Language Processing (DJS22AMC503)		
Course: Natural Language Processing Laboratory (DJS22AML503)		

Pre-requisite: Python Programming

Course Objectives:

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. Understand 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. Check the syntactic and semantic correctness of sentences using grammars and labelling.

Natural Language Processing (DJS22AMC503)		
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.	4
2	**Computational tools for text analysis** Basic Terms: Tokenization, Stemming, 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. Tokenization in the NLTK, Tokenizing text.	6
3	**Word Level Analysis (statistical language model)** Inflectional Morphology, Derivational Morphology, Regular expression with types, Morphological Models: finite state morphology, Morphological parsing with FST (Finite State Transducer)	9

	Lexicon free FST Porter Stemmer algorithm, 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	
4	**Syntax analysis:** Part-Of-Speech tagging (POS): Tag set for English (Upenn Treebank), Difficultics /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 random Field (CRF), CYK.	7
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).	8
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	5
	TOTAL	39

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, 2014.

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 Resources Blogs and Websites:

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 and Tutorials:

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

Suggested List of Experiments:

Natural Language Processing Laboratory (DJS22AML503)	
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

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Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: V
Course: Full Stack Development Laboratory(DS22AML504)		

Pre-requisite:

1. HTML5, CSS3, JavaScript
2. Database Management System

Objectives:

1. To orient students to Basics of REACT along with installation
2. To expose students to Advanced concepts in REACT
3. To orient students to Fundamentals of node.js
4. To expose students to node.js applications using express framework.
5. To gain expertise in a leading document-oriented NoSQL database, designed for speed, scalability, and developer agility using MongoDB

Outcomes: On completion of the course, the learner will be able to:

1. Design front end application using basic React.
2. Design front end applications using functional components of React.
3. Design back-end applications using Node.js.
4. Construct web based Node.js applications using Express.
5. Apply MongoDB for frontend and backend connectivity using REST API.

Full Stack Development Laboratory (DS22AML504)		
Unit	**Description**	**Duration**
1	**React Fundamental** Installation, Installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices, React vs Angular vs Vue.	08
2	**Advance React** Functional components- Refs, Use effects, Hooks, Flow architecture, Model View Controller (MVC) framework, Flux, Bundling the application. Web pack. Self-learning Topics: React Native	08
3	**Database Connectivity** Database Fundamentals, working with Database Schemas, Create-Read-Update-Destroy (CRUD), Database Joins, Querying SQL databases, Serialization, how to model NoSQL data, Document Databases (MongoDB), Create-Read-Update-Destroy (CRUD), NoSQL Best Practices, Mongo Shell and command line use, installing MongoDB, Mapping relationships with MongoDB, using an object-data modelling library (Mongoose)	10

4	**Node.js** Node.js, Setup Development Environment: Installation of Node.js, Working in REPL, Node JS Console, working with an MVC framework, apply concepts like data types, objects, methods, object-oriented programming, and classes in the context of backend development, Server-Side JavaScript Using Node on the command line NPM JavaScript Build Processes, Event Loop and Emitters, File System Interaction, Modules, Native Node drivers.	10
5	**Express.js** Introduction, Installation, Express router, REST API, Generator, Authentication, sessions, Integrating with React, Commercial deployment.	06
6	**Deployment and Building RESTful API** Understand hosting and deployment. Hosting static websites with GitHub Pages. Deploying server-based applications with Heroku. Deploying Databases with Mongo Atlas. Understand REST and guiding principles behind API design. Learn to work with a MongoDB GUI Robo 3T Implementing GET, POST, PUT, PATCH and DELETE by creating a public API from scratch. Understand and use chained route handlers from Express.	10
	Total	**52**

Books Recommended:

Text books:

1. Adam Bretz and Colin J. Ihrig, "Full Stack JavaScript Development with MEAN", SitePoint Pty. Ltd., 2015 Edition
2. Simon Holmes Clive Harber, "Getting MEAN with Mongo, Express, Angular, and Node", Manning Publications, 2015 Edition
3. Venkat Subramaniam, "Rediscovering JavaScript, Master ES6, ES7, and ES8", The Pragmatic Bookshelf, 2018
4. Alex Banks and Eve Porcello, "Learning React Functional Web Development with React and Redux", O'Reilly, 1st Edition, 2017 Edition
5. Andrew Mead, "Learning Node.js Development", Packt Publishing, 2018 Edition
6. Valentin Bojinov, "RESTful Web API Design with Node.js 10", Packt Publication, 2018 Edition

Reference Books:

1. Ethan Brown, "Web Development with Node and Express", O'Reilly, 2019 Edition
2. Shama Hoque "Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js", 2nd Edition Packt Publication, 2020

3. Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications", 2nd Edition, Addison-Wesley Professional, 2017

Suggested List of Experiments:

Full Stack Development Laboratory(DS22AML504)	
S.No	**Title of Experiment**
1	Installation and Configuration of React.
2	Understanding JSX, Components, Props, State in React.
3	Implementing Forms, Events, Routers, Refs, Keys.
4	Implement CRUD operations in MongoDB.
5	Installation and Configuration of Node.js
6	Implementing Callbacks, Event loops in Node.js
7	Create an application to demonstrate use of React hooks and JS.
8	Create an application to demonstrate use of Conditional rendering in React JS.
9	Create an application to demonstrate various Node.js Events.
10	Create an application to demonstrate Node.js Functions
11	Create an application to demonstrate integration of Node JS and MongoDB.
12	Create an application to demonstrate integration of Node JS and React JS.
13	Create an Online Learning application using REST APIs.
14	Deploy the above developed application on any hosting platform of your choice

Prepared by | Checked by Dr. Nilesh Rathy | Head of the Department | Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester:V
Course: Computer Networks and Security (DJS22AMEC5011)		
Course: Computer Networks and Security Laboratory (DJS22AMEL5011)		

Prerequisite: Knowledge of 1. Basic Mathematics 2. Algorithms

Course Objectives:

1. To get familiar with contemporary issues and challenges of various protocol designing in layered architecture and performance analysis of various protocols and security issues.

Course Outcomes: On completion of the course, learner will be able to:

1. Understand the concepts of data communication and functionalities of ISO - OSI model & TCP/IP model.
2. Illustrate the functions of Data link layer and Network Layer
3. Demonstrate the working of transport and application layer protocols
4. Identify security vulnerabilities and explore various monitoring measures.
5. Explore the fundamentals of security algorithms

Computer Networks and Security (DJS22AMEC5011)		
Unit	**Description**	**Duration**
1	Introduction to computer network, Network topology, Networking devices, Reference models: OSI, TCP/IP	04
2	Physical and Data link Layer: Introduction, transmission medium, physical addressing, Error control (Hamming code, CRC), Flow control, Data-Link Layer Protocols: HDLC, Media Access Control: ALOHA, CSMA	08
3	Network Layer: Unicast Routing Algorithms-(DVR, LSR), IPv4 Addressing (Classfull and Classless), Subnetting, Supernetting design problems, IPv4 Protocol, IPV6 protocol	09
4	Transport & Application Layer: Services, Sockets, Transport Layer Protocols - User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Application layer protocols-HTTP, SMTP, DNS	06
5	Introduction to Security: Security Goals, Security threats and attacks, (Spoofing, Phishing, DOS, Virus, Worm, Trojans, Side-Channel Attack), Intrusion Prevention Systems Intrusion Detection System (IDS), Troubleshooting and monitoring tools, Wireshark, Kali Linux, Honeypot, Nmap, Kismet.	04
6	Fundamentals of security algorithms: Cryptography: Symmetric (Substitution Ciphers, Caesar Cipher, Playfair Cipher, Hill Cipher, Block Ciphers, DES and AES), Asymmetric (PKI, RSA, Digital Signature), Key exchange (Diffie-Hellman), Hashing (MD5, SHA)	08
	TOTAL	**39**

Books Recommended:

Textbooks:

1. Andrew S. Tanenbaum, Computer Networks, Sixth Edition, Pearson,2022
2. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2017. 3.Cryptography and Network Security – Atul Kahate, 3rd edition, Tata Mc Graw Hill, 2017.
3. Computer Security Principles and Practice –William Stallings, Seventh Edition, Pearson Education, 2017
4. Security in Computing – Charles P. Pfleeger, Fifth Edition, Pearson Education, 2015
5. Network Security and Cryptography – Bernard Menezes, Cengage Learning, 2014.
6. Network Security Bible – Eric Cole, Second Edition, Wiley, 2011.
7. Mark Stamp's Information Security: Principles and Practice –Deven Shah, Wiley, 2009

Reference Books:

1. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", Seventh Edition, Pearson Education, 2017.
2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013.
3. Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.
4. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, Computer Networks: An Open-Source Approach, McGraw Hill Publisher, 2011.
5. UNIX Network Programming –Richard Steven, Addison Wesley, 2003.
6. TCP/IP Protocol Suite – B. A. Forouzan, 4th Edition, Tata Mc Graw Hill, 2017.
7. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
8. Applied Cryptography, Protocols Algorithms and Source Code in C – Bruce Schneier, 2nd Edition / 20th Anniversary Edition, Wiley, 2015.

Web Links:

1. Nptel Course https://onlinecourses.nptel.ac.in/noc22_cs19/preview
2. Nptel Advanced course https://onlinecourses.nptel.ac.in/noc24_cs11/preview
3. Coursera Course https://www.coursera.org/learn/computer-networking

List of Experiments:

Computer Networks and Security Laboratory (DJS22AMEL5011)	
Sr. No.	**Title of the Experiment**
1	Installation & Configuration of Network Simulator (NS2) in Linux environment. –Study of different topologies and create duplex link in NS2
2	Implementation of an error detection code using CRC.
3	Implementation of Distance Vector/ Link State Routing algorithm.
4	Study of Network simulator (NS) and performance evaluation of Routing protocols using Simulation tool.
5	Applications using TCP sockets like: a) Echo client and echo server b) Chat c) File Transfer
6	Demonstration of security tools.
7	Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture ping and trace route PDUs using a network protocol analyzer.
8	Design and Implement Caesar cipher cryptographic algorithm by considering letter [A...Z] and digits [0...9]. Apply Brute Force Attack to reveal secret.
9	Design and Implement Encryption and Decryption algorithm using Simple Columnar Transposition cipher technique. Study how dictionary attack can be applied on it.
10	Implement RSA Cryptosystem using RSA Algorithm / Implement Elliptical Curve Digital Signature Algorithm (ECDSA)
11	Demonstrate the data integrity using various cryptographic algorithms viz. MD-5, SHA-1 using VLAB, IIT Bombay.

Batch wise laboratory work of 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.

Prepared by Checked by Department Coordinator Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: V
Course: Advanced Data Structures and Algorithm (DJS22AMEC5012)		
Course: Advanced Data Structures and Algorithm Laboratory (DJS22AMEL5012)		

Pre-requisite: Python Programming, Data Structures, Design & Analysis of Algorithms

Course Objectives:

1. To provide conceptual and practical knowledge of Advance Data Structures and Algorithms.
2. To Cultivate algorithmic thinking and problem-solving skills through practice and exposure to diverse problem domains.
3. Develop strategies for breaking down complex problems into manageable sub problems and applying suitable algorithms and data structures.
4. Develop skills to analyze problem complexity and choose appropriate data structures and algorithms for efficient solutions.

Course Outcomes: Students will be able to

1. Understand the concept of time complexity and its importance in analyzing algorithms and to Explore the complexity analysis of popular machine learning algorithms.
2. Explore balanced search tree data structures and spatial data structures used in geometric and spatial applications.
3. Apply graph algorithms to solve real-world problems related to network flows, matching, and optimization.
4. Understand the complexity classes NP, P, NP-complete, and NP-hard and their significance in algorithm classification and to explore the computational geometry algorithms.

Advanced Data Structures and Algorithm (DJS22AMEC5012)		
Unit	**Description**	**Duration**
1	**Analysis of Algorithm Based on Time:** i. **Amortized Analysis:** Aggregate Method, Accounting Method, Potential Method (for Stack data structure) ii. **Probabilistic and Randomized Algorithm:** Probabilisticapproach to algorithm and Randomized Analysis, Indicator Random Variable (IRV), Analysis of Hiring Problem **Complexity Analysis of Machine Learning Algorithms:** i. Training Time Complexity and Testing Time Complexity ii. Train/Test Complexity of Linear Regression iii. Train/Test Complexity of Naïve Bayes Classifier	08
2	**Balanced Search Trees:** Red-Black Tree, Tango Tree,2-3 Tree, B Tree, B+ Tree, Splay Tree	10
3	**Advanced Data Structures:** i. **Spatial Data Structure**: KD Tree, R Tree	06

	ii. **Probabilistic Data Structure**: Bloom filter, LogLog and HyperLogLog, Count Min sketch, MinHash with Machine Learning context (Vector Representation) iii. **Functional Data Structures**: Binomial Tree, Binomial Heap	
4	**Graph Based Algorithms:** i. **Flow Network Introduction**: Residual Network, Augmenting Path, Ford-Fulkerson Method, Edmonds-Karp Method, Push-Relable Algorithm ii. **Bipartite Matching:** Maximum Bipartite Matching	06
5	**Classification of Algorithms:** i. **Algorithm Classes:** P, NP, NP Hardness and NP Completeness ii. **Np Completeness Proofs:** Satisfiability (3 sat), Reducibility, Cook's Theorem, Traveling Salesman Problem iii. **Approximation Algorithms:** Vertex Cover Problem, Travelling Salesman problem.	07
6	**Computational Algorithms – Computational Geometry:** Line Segment Properties, Convex Hull Graham's scan algorithm	02
	TOTAL	39

Books Recommended:

Text Books:

1. Introduction to Algorithms by Thomas H Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, Third Edition, 2009.
2. Design and analysis of algorithms by S. Sridhar Oxford First Edition, 2014
3. Horowitz, Sahani and Rajsekaran, —Fundamentals of Computer Algorithms, Galgotia, 2nd Edition,1998
4. Harsh Bhasin, Algorithms Design and Analysis, Oxford, 1st Edition, 2015.
5. Giuseppe Bonaccorso, Machine Learning Algorithms" by Packt, 2019

Reference Books:

1. Rajeev Motwani, Prabhakar Raghavan, Randomized Algorithm, Cambridge University, 2004
2. Vijay V. Vajirani, Approximation Algorithms, Springer, 2003
3. Computational Complexity, Stanford University, 2010
4. Jason Brownlee, "Master Machine Learning Algorithms", by Machine Learning Mastery, 2020

Web Resources Blogs and Websites:

1. Train/Test Complexity and Space Complexity of Linear Regression | by Writuparna Banerjee | Level Up Coding (gitconnected.com)
2. Computational Complexity of ML Models | by Paritosh Kumar | Analytics Vidhya | Medium
3. Importance of Understanding the Complexity of a Machine Learning Algorithm | by Baran Köseoğlu | Towards Data Science

4. Probabilistic Data Structures Decoded: Enhancing Performance in Modern Computing | by Naman Agrawal | Towards Data Science
5. ML Security Pro Tips: Understanding MinHash in a Security Context | by Melanie Beck | AI/ML at Symantec | Medium.
6. Bloom Filters and when to use them | by Janko Krstic | The Little Bit Ninja | Medium
7. The Power of Bloom Filters: A Comprehensive Guide | by Chiranjeet Baruah | Medium

Suggested List of Experiments:

Advanced Data Structures and Algorithm Laboratory (DJS22AMEL5012)	
Sr. No.	**Title of the Experiment**
1	Experiment on Amortized Analysis.
2	To perform and implement Hiring Problem.
3	Experiment on Randomized Algorithms (Randomized Quick Sort)
4	To implement Red Black Tree creation.
5	To implement Red Black Tree deletion.
6	To implement KD Tree
7	To implement Ford Fulkerson Algorithm
8	To implement Approximation Algorithms (Vertex Cover)
9	Experiment on Computational Geometry Algorithms (Graham Scan)

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.

Prepared by | Checked by | Department Coordinator | Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester:V
Course: Recommendation systems (DJS22AMEC5013)		
Course: Recommendation systems Laboratory (DJS22AMEL5013)		

Prerequisite: Knowledge of Machine Learning

Course Objectives:

1. To provide students with the basic concepts of Recommender Systems, design space, trade-offs and its application in various domain.
2. To have a broad understanding of the field of Recommendation Systems.

Course Outcomes: On completion of the course, learner will be able to:

1. Understanding the architecture and working of Collaborative Filtering, Content based recommendation systems.
2. Understanding the architecture and basics of Knowledge based recommendation systems.
3. Analyzing hybrid and ensembles recommendation systems.
4. Evaluation of recommendation systems by selecting right evaluation parameter.

Recommendation systems (DJS22AMEC5013)		
Unit	**Description**	**Duration**
1	**Introduction to Recommender Systems** 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	**Ensembled- Based and 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.	06
	TOTAL	**39**

Books Recommended:

Textbooks:

1. C.C. Aggarwal, "Recommender Systems: The Textbook", Springer, 1 st Edition, 2016.
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.

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. Kim Falk, "Practical Recommender Systems", Manning, 1st Edition, 2019
6. "Hands-On Recommendation Systems with Python: Start building powerful and personalized, recommendation engines with Python" by Rounak Banik , 2018.

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Web Links:

1. Udemy course on Recommender Systems and Deep Learning in Python:https://realpython.com/build-recommendation-engine-collaborative-filtering.
2. Coursera course on Recommender Systems Specialization: https://www.coursera.org/specializations/recommender-systems
3. http://www.iem.iitkgp.ac.in/eco/Recommender_Systems/
4. https://www.coursera.org/specializations/recommender-systems
5. https://www.udemy.com/course/recommender-systems/
6. https://www.analyticsvidhya.com/blog/2021/08/developing-a-course-recommendersystem- using-python

List of Experiments:

Recommendation systems Laboratory (DJS22AMEL5013)	
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 Neighbors
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 Project.

Batch wise laboratory work of 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.

Prepared by Checked by Department Coordinator Principal

Program: Artificial Intelligence & Machine Learning	T.Y B.Tech	Semester: V
Course: Environmental Studies (DJS22A3)		

Pre-requisite: Interest in Environment and its impact on Human

Objectives:

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarize environment related legislation

Outcomes: On completion of the course, learner will be able to:

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

Environmental Studies (DJ19A5)		
Unit	**Description**	**Duration**
1	**Social Issues and Environment:** Ecological footprint and Carrying Capacity, Depleting nature of Environmental resources such as soil, water minerals and forests, Carbon emissions and Global Warming.	4
2	**Technological Growth for Sustainable Development:** Social, Economical and Environmental aspects of Sustainable Development, Renewable Energy Harvesting, Concept of Carbon credit, Green Building, Power and functions of Central Pollution Control Board and State Pollution Control Board.	4
3	**Green Technology:** History, Agenda, and Challenges Ahead. Sustainable Cloud Computing, and Risk Management, Sustainable Software Design, Data Center Energy Efficiency, Thin-Client and Energy Efficiency.	5

Books Recommended:

Text books:

1. Environmental Studies From Crisis to Cure, R. Rajagopalan, 2012
2. Textbook for Environmental Studies For Undergraduate Courses of all Branches ofHigher Education, Erach Bharucha
3. Green Information Technology A Sustainable Approach, Mohammad Dastbaz, ColinPattinson, Babak Akhgar, Morgan and Kaufman, Elsevier, 2015.

Reference Books:

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

Prepared by checked by Head of the Department Principal

P. G. Talwelkar

Program: Artificial Intelligence & Machine Learning	T.Y B.Tech	Semester: V
Course: Innovative Product Development-III (DJS22ILL1)		

Objectives:

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 conceptualise and create a successful product.

Outcome:

Learner 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 conceptualising 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 theteam or as theleader.
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 tothe 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 the subsequent semester shall be as given below:
  - Marks awarded by the supervisor based on log-book10
  - Marks awarded by review committee 10
  - Quality of the write-up 05

In the last review of the semester VI, the term work marks will be awarded as follows.

- Marks awarded by the supervisor (Considering technical paper writing) 15
- Marks awarded by the review committee 10