Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus (DJ19)

Third Year B.Tech

in

Computer Science and Engineering (Data Science)

(Semester VI)

Scheme for Third Year B.Tech. Program in Computer Science & Engineering (Data Science): Semester VI

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)					Aggregate (A+B)	Credits	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration	Theory	Oral	Pract	Oral & Pract	End Sem Exam Total	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork / Term Work Total	CA Total			
1	DJ19DSC601	Machine Learning - III (Reinforcement Learning)	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	4
	DJ19DSL601	Machine Learning - III Laboratory	–	2	–	1	2	–	–	–	–	–	–	–	–	25	25	25	1	
2	DJ19DSC602	Image Processing and Computer Vision - I	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	4
	DJ19DSL602	Image Processing and Computer Vision - I Laboratory	–	2	–	1	–	–	–	–	25	25	–	–	–	25	25	50	1	
3	DJ19DSC603	Computational Linguistics	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	4
	DJ19DSL603	Computational Linguistics Laboratory	–	2	–	1	2	–		–	25	25	–	–	–	25	25	50	1	
4	DJ19DSL604	Big Data Engineering Laboratory	–	4	–	2	2	–	–	–	25	25	–	–	–	25	25	50	2	2
5@	DJ19DSC6011	Cloud Computing	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	4
	DJ19DSL6011	Cloud Computing Laboratory	–	2	–	1	2	–	–	–	–	–	–	–	–	25	25	25	1	
	DJ19DSC6012	Recommender System	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	
	DJ19DSL6012	Recommender System Laboratory	–	2	–	1	2	–	–	–	–	–	–	–	–	25	25	25	1	
	DJ19DSC6013	Embedded System & RTOS	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	
	DJ19DSL6013	Embedded System & RTOS Laboratory	–	2	–	1	2	–	–	–	–	–	–	–	–	25	25	25	1	
	DJ19DSC6014	Cognitive Neuroscience	3	–	–	3	3	75	–	–	–	75	25	25	25	–	25	100	3	
	DJ19DSL6014	Cognitive Neuroscience Laboratory	–	2	–	1	2	–	–	–	–	–	–	–	–	25	25	25	1	
7	DJ19ILL2	Innovative Product Development -IV	–	2	–	1	–	–	–	–	25	25	–	–	–	25	25	50	1	1
8#	DJ19IHL2	Professional and Business Communication Laboratory	–	4	–	2	–	–	–	–	–	–	–	–	–	50	50	50	2	2
		Total	**21**	**24**	**0**	**33**	**35**	**525**	**0**	**0**	**100**	**625**	**175**	**175**	**175**	**275**	**450**	**1075**	**33**	**21**

@ Any 1 Elective Course
# 2 hrs. of theory (class wise) and 2 hrs of activity based laboratory (batch wise)

Shri Vile Parle Kelavani Mandal's

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Course Structure and Syllabus

of

Third Year (Semester VI)
B. Tech.

Computer Science and
Engineering (Data Science)

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Machine Learning – III (Reinforcement Learning) (DJ19DSC601)

Machine Learning – III Laboratory (DJ19DSL601)

Pre-requisite: Machine Learning-I, Machine Learning-II and Artificial Intelligence.

Course Objectives: To make students learn to build programs that act in a stochastic environment, based on past experience using various Reinforcement Learning methods.

Outcomes: Students will be able to

1. Explain basic and advanced Reinforcement Learning techniques.
2. Identify suitable learning tasks to which Reinforcement learning and Deep Reinforcement Learning techniques can be applied.
3. Apply appropriate Reinforcement Learning method to solve a given problem.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Reinforcement Learning (RL), Elements of Reinforcement Learning, Reinforcement Learning vs Supervised Learning, Approaches of solving Reinforcement Learning: Value based, policy based, model based, Exploration - Exploitation dilemma, Evolutionary methods, Immediate Reinforcement Learning.	**04**
2	**Immediate Reinforcement Learning:** **Bandit Problems:** Bandit problems, Value-action based methods (sample average), Greedy method, Є-greedy method, Incremental Implementation, Non-stationary problem, Optimistic Initial values, UCB algorithm, Thompson Sampling. **Policy Gradient Approaches**: Linear reward Penalty Algorithm, Parameterised policy representation(Θ), Evaluation of policy(η(Θ)), REINFORCE algorithm.	**06**
3	**Full Reinforcement Learning** Difference between Immediate and Full Reinforcement Learning, Agents and Environment, Goals, Rewards, Returns, Policy in Full Reinforcement Learning, Episodic and Continuing Tasks. **Markov Decision Process (MDP)** Markov Property, Finite Markov Decision Process, Value functions, Bellman's equations, optimal value functions, Definition of MDP in Reinforcement Learning, Solution of the Recycling Robot problem	**08**
4	**Dynamic Programing** Policy evaluation, policy improvement, policy iteration, value iteration, Asynchronous Dynamic Programing, Generalized Policy Iteration (GPI), bootstrap, full back up. **Monte Carlo Method** Advantages of Monte Carlo over Dynamic Programing, Monte Carlo Control, on-policy, off-policy, Incremental Monte Carlo, Issues/Assumptions in Monte Carlo Methods, Solution of BlackJack using Monte Carlo Method	**08**

5	**Temporal Difference Learning** What is Temporal Difference learning, Advantages of Temporal Difference methods over Monte Carlo and Dynamic Programming methods, TD(0), On-policy vs off-policy, SARSA, Q learning. **Eligibility traces** N-step Temporal Difference methods, On-line vs Off-line updation, TD(**λ**) : forward view, backward view, Traces: Accumulating trace, Dutch trace, Replacing trace, Equivalence of forward and backward view, SARSA(**λ**)	**08**
6	**Deep Reinforcement Learning:** **Function Approximation** Drawbacks of tabular implementation, Function Approximation, Gradient Descent Methods, Linear parameterization, Policy gradient with function approximation **Deep Reinforcement Learning** Intro of Deep Learning in Reinforcement Learning, Deep learning training workflow, Categories of Deep learning, Deep Q-Network, Ways of improving Deep Q-Network, REINFORCE in Full Reinforcement Learning, Actor-Critic Algorithm, Algorithm Summary, DDPG, Case study on AlphaGo by Google DeepMind	**08**

Books Recommended:

Textbooks

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, 2nd Edition, 2018.
2. Laura Graesser Wah Loon Keng, "Foundations of Deep Reinforcement Learning," Pearson Education, 1st Edition, 2020.

Reference Books

1. Phil Winder, "Reinforcement Learning Industrial Applications of Intelligent Agents", O'Reilly, 1st Edition, 2020.
2. Csaba Szepesvari, "Algorithms for Reinforcement Learning," Morgan & Claypool Publishers, 1st Edition, 2019.
3. Enes Bilgin, "Mastering Reinforcement Learning with Python", Packt publication, 1st Edition, 2020.
4. Brandon Brown, Alexander Zai, "Deep Reinforcement Learning in Action", Manning Publications, 1st Edition, 2020.
5. Micheal Lanham, "Hands-On Reinforcement Learning for Games," Packt Publishing, 1st Edition, 2020
6. Abhishek Nandy, Manisha Biswas, "Reinforcement Learning: With Open AI, TensorFlow and Keras using Python," Apress, 1st Edition, 2018.

Weblinks:

1. NPTEL Course in Reinforcement Learning: https://onlinecourses.nptel.ac.in/noc22_cs75/preview
2. Reinforcement Learning Course (Stanford University): https://www.youtube.com/watch?v=FgzM3zpZ55o

3. AI Games with Deep Reinforcement Learning: https://towardsdatascience.com/how-to-teach-an-ai-to-play-games-deep-reinforcement-learning-28f9b920440a
4. Deep Reinforcement Learning: https://www.v7labs.com/blog/deep-reinforcement-learning-guide

Suggested List of Experiments:

Sr. No.	Title of the Experiments
1.	Bandit Problem: • Implement Greedy and Epsilon greedy methods. • Comparison between Greedy and Epsilon Greedy Policy • UCB: Upper Confidence Bound
2.	Policy Gradient (Convergence) • Implement REINFORCE algorithm on a CartPole/ Lunar Lander.
3.	Dynamic Programming and Monte Carlo Methods • Implementation of GridWorld using Dynamic Programming • Jack's Car Rental using Dynamic Programming • Gamblers Problem using Dynamic Programming • BlackJack using Monte Carlo • Race Track Problem
4.	Temporal Difference • Implement Frozen lake using SARSA • Implement Grid world using Q learning
5.	Deep Reinforcement Learning • Compare the performance of Reinforcement Learning and Deep Reinforcement Learning on a Cartpole problem. • Implementation of Deep Q-Network algorithm • Actor Critic: Find the optimal policy using the Actor Critic method.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus, summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

Oral & Practical examination will be based on the entire syllabus including the practical's performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in the two tests will be considered for final grading.

Laboratory: (Term work)
Laboratory work will be based on **DJ19DSL601** with minimum 08 experiments to be incorporated.

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

1. Laboratory work (Performance of Experiments): 15 Marks
2. Journal Documentation (Write-up and Class Assignments): 10 marks

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

Prepared by Checked by Head of the Department Principal

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Computational Linguistics (DJ19DSC602)

Computational Linguistics Laboratory (DJ19DSL602)

Pre-requisite: Machine Learning-I, Machine Learning-II, Foundations of Data Analysis, Statistics for Data Science

Course Objectives:

To introduce basics of language computation fundamental through morphological computation, syntax, semantic and pragmatic analysis. Apply these concepts to develop Computational Models for Real World Applications

Outcomes: Students will be able to

1. Understand the pre-processing required for linguistic data types.
2. Apply appropriate pre-processing technique on linguistic data.
3. Relate the pre-processing techniques for linguistic data to real world problems
4. Develop applications based on natural language processing.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Generic Natural Language Processing (NLP) system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP Machine Translation, Sentiment Analysis etc. **Text Processing:** Word Tokenization and Segmentation, Lemmatization, Bag of words, N-gram language model, N-gram for spelling correction. Edit distance - Dynamic Programming Approach, Weighted Edit Distance, Finding Dictionary Entries with Small Edit Distances, Noisy Channel Model, Non-word errors Real-word errors. Evaluation of Language Models, Basic Smoothing, Advanced Smoothing Models. Advanced: Perplexity's Relation to Entropy.	**06**
2	**Computational Morphology:** Morphological Processes, Morphological Analysis- Inflectional morphology & Derivational morphology, Regular expression, Finite State Automata, Finite State Transducer, Morphological parsing with FST, Lexicon free FST Porter stemmer, Two - level Morphology.	**06**
3	**Syntax Analysis:** Introduction to POS Tagging, Probabilistic Tagging, Markov Models, Hidden Markov Models (HMM) for POS Tagging, Conditional Random Fields (CRF), Named Entities and Named Entity Tagging, Context-Free Grammars-Derivation, Constituency Parsing, Dependency Parsing.	**09**
4	**Computational Semantics and Semantic Parsing:** Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, Pointwise Mutual Information (PMI), Term Frequency-Inverse Document Frequency (TFIDF), PPMI vector models, Word2vec, Continuous Bag of Words, ELMO, Vector Visualizing Embedding's, Semantic properties of embedding's, Bias and Embedding's Evaluating Vector Models. Word Senses -Relations Between Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation Alternate WSD algorithms and Tasks. Using Thesauruses to	**09**

	Improve Embedding's, Word Sense Induction. Information Extracting: Relation Extraction algorithms, Extracting events and their times, Template filling.	
5	**Discourse Coherence:** Coherence Relation, Discourse Structure Parsing, Centring and Entity-Based Coherence Global Coherence.	**04**
6	**Applications:** Machine Learning Model for Sentiment Analysis, Question Answer in NLP, Deep Learning Architecture for Sequence Processing: Recurrent Neural Network, Managing Context in RNNs: LSTMs, Self – Attention Networks: Transformers.	**08**

Books Recommended:

Textbooks:

1. Jurafsky and Martin, "Speech and Language Processing", Prentice Hall, 3rd Edition, 2020.
2. Uday Kamath, "Deep Learning for NLP and Speech Recognition", 1st Edition, 2019.

Reference Books:

1. Jelinek, F., "Statistical Methods for Speech Recognition", The MIT Press, 2022.
2. Yuli Vasiliev "Natural Language Processing with Python and spaCy - A Practical Introduction", No Starch Press, 2022.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, "Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems", O'Reilly, 1st Edition, 2020.

Web Links

1. Virtual Lab: -https://nlp-iiith.vlabs.ac.in/
2. Virtual Lab:-http://vlabs.iitb.ac.in/vlabs dev/vlab_bootcamp/bootcamp/The_Big_Bang_Nerds/index.html
3. Nptel Course: - https://nptel.ac.in/courses/106105158

Suggested List of Experiments:

Sr. No.	List of Experiment
1	Perform Preprocessing steps in Natural language Processing (Tokenization, Stop Word detaction, Stemming and Lemmatization.
2	Implement Parts of Speech tagging using HMM
3	Implement word-embedding and TF-IDF vectors in Natural language Processing
4	Generate recursive set of sentences using Context Free Grammar Identify the word senses using "synset" in NLTK
5	Implement Spelling Check, Spelling Correction and Auto complete using Language models or CFG.
6	Implement a Spam classifier in Natural Language Processing
7	Implement Fake News Classifier Using LSTM-Deep Learning in NLP

8	Implement a Sentiment Analysis in Natural Language Processing
9	Implement NLP application on Regional Language
10	Implement Question Answering in NLP
11	Implement Catboats in NLP
12	Implement Information Retrieval for extracting Text from Webpages and Images
13	Mini Project

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:
Oral and practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester. Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on **DJ19DSL602** with minimum 08 experiments.

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

1. Laboratory work (Performance of Experiments): 15 marks
2. Journal Documentation (Write-up, Assignments): 10 marks

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

Prepared by Checked by Head of the Department Principal

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Image Processing and Computer Vision - I (DJ19DSC603)

Image Processing and Computer Vision - I Laboratory (DJ19DSL603)

Pre-requisite: Basic co-ordinate geometry, matrix algebra, linear algebra and random process.

Course Objectives: To teach various feature engineering and preprocessing techniques on image and video data types.

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

1. Identify the need of different image and video pre-processing.
2. Apply different image and video corrections.
3. Compare different image and video processing methods.

Detailed Syllabus: (unit) wise

Unit	Description	Duration
1	**Digital Image Fundamentals:** Steps in Digital Image Processing, Components, Image Sampling and Quantization.	04
2	**Image Enhancement** (point processing): Image Negative, Thresholding, Gray-level slicing with and without background, power law and log transform, Contrast Stretching, Histogram equalization and Histogram Specification **Image Enhancement in Spatial Domain** (Neighbourhood processing): Low Pass and High Pass filtering for image enhancement, Basics of Spatial Filtering, Generating Spatial Filter Masks–Smoothing and Sharpening Spatial Filtering **Image Transforms:** 1-D DFT, 2-D Discrete Fourier Transform and Its Inverse, Some Properties of 2D DFT, Walsh -Hadamard, Discrete Cosine Transform, Haar Transform, Slant Transform **Image Enhancement in Frequency Domain:** The Basics of Filtering in the Frequency Domain, Smoothing and Sharpening frequency domain filters	12
3	**Morphology:** Erosion and Dilation, Opening and Closing, The Hit or-Miss Transformation. Restoration: Noise models – Mean Filters – Order Statistics – Adaptive filters –wiener filter. **Corner and Interest Point detection:** The Harris Interest Point Operator: Corner Signals and shifts for various geometric configuration, Performance with crossing point and Junctions, Different forms of Harris Operator, Local Invariant Feature Detectors and Descriptors: Harris scale and Affine- Invariant Detectors and Descriptors, The SIFT operators, The SURF operators.	10
4	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, basic and advance edge detection, Edge linking and boundary detection, Canny's edge detection algorithm **Thresholding:** Foundation, Role of illumination, Basic Global thresholding, Otsu's method Region Based segmentation: Region Growing, Region Splitting and merging, Relationships between pixels, Hough transform **Region Identification:** Chain code, simple geometric border representation,	08

	Fourier Transform of boundaries, Boundary description using segment sequences	
5	**Motion:** Optical Flow, Interpretation of Optical Fields, Using focus of expansion to avoid collision, Time to adjacency analysis, Basic difficulties with optical flow models, Stero from Motion	**08**

Books Recommended:

Textbooks:

1. Rafel C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education Asia, 4th Edition, 2018.
2. Sanjit Mitra, "Digital Signal Processing: A Computer Based Approach", Tata McGraw Hill, 4th Edition, 2013.

Reference Books:

1. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", Tata McGraw Hill Publication 4th Edition, 2019.
2. E. R. Davies, "Computer and Machine Vision: Theory, Algorithms", Academic Press, 4th Edition, 2012.
3. S. Jayaraman, E. Esakkirajan and T. Veerkumar, "Digital Image Processing", Tata McGraw Hill Education Private Ltd, 1st Edition, 2017.
4. Anil K. Jain, "Fundamentals and Digital Image Processing", Pearson Education, 1st Edition, 2015.
5. John G. Proakis, Dimitris and G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson Education, 4th Edition, 2014.
6. A. Anand Kumar, "Digital Signal Processing", Prentice Hall, 2nd Edition, 2015.
7. S. Sridhar, "Digital Image Processing", Oxford University Press, 2nd Edition, 2016.

Web Links:

1. NPTEL Digital Image Processing, By Prof. Prabir Kumar Biswas, IIT Kharagpur: https://nptel.ac.in/courses/117/105/117105135/

Suggested List of Experiments:

Sr. No	Title of the Experiments
1.	To perform basic Image Processing, Geometric, Arithmetic and Logical operations on images
2.	To perform Spatial Domain Image Enhancement using different Point Processing techniques
3.	To perform Spatial Domain Image Enhancement using different Neighbourhood Processing techniques
4.	To perform Histogram equalization
5.	Application of Harr transform in image processing
6.	To perform frequency domain Image Enhancement techniques
7.	To perform region-based segmentation

8.	To perform morphological operations on Image
9.	To perform edge detection using basic and advanced techniques
10.	To perform Image restoration using various filters
11.	To extract the key frames from a video
12.	To perform background subtraction in a video
13.	To perform Steganography operation in a video.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

Oral & Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in the two tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on **DJ19DSL603** with minimum 08 experiments.

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

1. Laboratory work (Performance of Experiments): 15 Marks
2. Journal Documentation (Write-up and Assignments): 10 marks

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

Prepared by Checked by Head of the Department Principal

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Big Data Engineering Laboratory (DJ19DSL604)

Prerequisite: Foundations of Data Analysis, Database Management System, Python Laboratory, Java and Scala Laboratory.

Objectives: The objective of this lab is to provide the basic framework of handling and processing big data.

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

1. Relate to the need of different types of data preprocessing tools/methods.
2. Use appropriate tool/method for a specific Data Engineering task.

Sr. No	Detail of the Experiment	No of Hours
1	Hadoop Ecosystem • Understanding inputs and outputs of Map Reduce Concept of Hadoop • The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of Map Reduce Execution • HDFS file system - Command line • Overview of resource managem ent - YARN	**04**
2	Infrastructure Implementation • Introduction to Kubernetes and Docker • Setting up applications on Kubernetes and Docker • Creating Docker images and deploying them	**04**
3	Messaging Service • Differentiate between different types of connections: Point-to-point, Broadcast/Multicast and Multi point. • Real time messaging using AMPS • Pub / Sub models • Allows subscribers to apply filters on server level	**02**
4	Messaging Service • Need of scalability and concurrency in the messaging services. • Real time messaging, ensuring scalability and concurrency using Kafka • Pub / Sub models • Allows subscribers to apply filters on client side	**02**
5	Data Processing • Need of advance methods for data processing of Big Data • Introduce SPARK • Real time and Batch processing of high volume of data • Write scripts using Java/ Python/Scala • Processing high volume records in-memory	**08**

	• Integration with Hive, HDFS, Kafka, event hub and other messaging and storage system	
6	Data Warehouse • Need of advance methods for data warehousing for storing Big data. • Introduce HIVE • Storage of data on HDFS for high volume data • Perform Analytical queries using Map Reduce	**02**
7	No SQL Data Store • Difference between SQL and NoSQL data stores • Types of NoSQL Data stores • Introduce HBase • Demonstration of Dynamic Scaling	**02**
8	No SQL Data Store • NoSQL Databases for different use cases • DynamoDB - Serverless AWS service for storing data in bytes • MongoDB - Data Storage as documents (Binary JSON -BSon) • Pipeline, query aggregation, complex querying, transaction	**04**
9	ETL Task • Introduce AWS Glue for ETL • Data Integration service from multiple sources • Keeping track of schema in form of catalogue • Data query via Amazon Athena, Amazon EMR, and Amazon Redshift Spectrum.	**04**
10	Data Retrieval • Introduction to Open-Source Indexing Engine Elastic Search for transactional data • Data querying, aggregation, visualization, log extraction and analytics	**04**
11	Cold Data Retrieval AWS S3, Athena and Redshift • Introduction of AWS S3, Athena and RedShift • Storing / Extracting data in S3 in different forms (csv, parquet, text) • Querying the data via Athena / Redshift	**04**

Books Recommended:

Textbooks:

1. Joe Reis and Matt Housley, “Fundamentals of Data Engineering: Plan and Build Robust Data Systems”, O’Reilley, 1st Edition, 2022.
2. Stevan N Brunton and J Nathan Kutz, “Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control”, Cambridge University Press, 1st Edition, 2019.
3. Tom White, "Hadoop: The Definitive Guide", O'Reilley, 3rd Edition, 2012.
4. Eric Sammer, "Hadoop Operations", Reilly, 1st Edition, 2012.

5. Pramod J Sadalge and Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional publications, 1st Edition, 2012.

Reference Books:

1. Paul Zikopoulos, Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, "Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data", The McGraw-Hill Companies, 1st Edition, 2017.
2. Gaurav Vaish, "Getting Started with NoSQL", Packt Publishing, 1st Edition, 2013.
3. Manoj Kukreja, "Data Engineering with Apache Spark, Delta Lake, and Lakehouse", Packt Publishing, 1st Edition, 2021.
4. Scott Haines, "Modern Data Engineering with Apache Spark: A Hands-On Guide for Building Mission-Critical Streaming Applications", Apress Publications, 1st Edition, 2022.

WebLinks:

1. Real-time Bigdata Messaging Services: Built for realtime: Big data messaging with Apache Kafka, Part 1 | InfoWorld
2. Understanding Big data Processing: Understanding Big Data Processing: 2022's Ultimate Guide - Learn | Hevo (hevodata.com)
3. Serverless Databases: What Is Serverless? An Overview | Knowledge Base | Dashbird
4. Kubernet Vs Docker: Kubernetes vs. Docker: Why Not Both? | IBM

Evaluation Scheme:

Practical and Oral(A):

Oral & Practical examination will be based on the practical's performed during laboratory sessions.

1. Implementation/Mini Project Presentation:25 Marks
2. Oral: 25 Marks

   Total: 50 Marks

Continuous Assessment (B):

Term Work:

Laboratory work will be based on syllabus with minimum 10 experiments and a mini project to be incorporated. Experiments should be completed by students in the given time duration.

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

1. Laboratory work (Performance of Experiments and Quiz): 25 Marks
2. Mini Project: 20 Marks
3. Attendance (Practical): 05 Marks

   Total: 50 Marks

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Cloud Computing (DJ19DSC6011)

Cloud Computing Laboratory (DJ19DSL6011)

Pre-requisite: System Fundamentals and Basic Networking

Objectives: The analysis of massive networks which provide many computational, algorithmic modelling challenges, and analysis of large networks.

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

1. Differentiate between different visualization methods and cloud computing technologies.
2. Evaluate the need of cloud migration and available infrastructure for cloud deployment.
3. Deploy secure cloud-based applications.
4. Evaluate the risk in various cloud deployments.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Cloud Computing:** Components of cloud computing, peer-to-peer, client-server, grid computing, NIST Model for cloud, Cloud Types: private, public, community and hybrid, delivery models, **Virtualization:** Benefits, implementation levels of virtualization, Structure: hosted, bare-metal, Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Paravirtualization with Compiler Support, CPY Virtualization, Memory Virtualization.	**08**
2	**Cloud Services and Business Value:** Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Database as a Service, key drivers, types of scalabilities, use of load balancing, levels of business value. **Cloud Deployment:** Network problems and their migration, cloud network topologies, automation for cloud deployments, self-service features and federated cloud deployment, cloud performance monitoring and tuning, impact of memory on cloud performance, improving cloud database performance, Cloud Services Brokerage (CSB).	**08**
3	**Data Security:** Challenges with Cloud Data – Data Redundancy, Disaster Recovery, Data Backup, Data Replication, Data Residency or Location, Data Reliability, Data Fragmentation, Data Integration, Data Transformation, Data Migration, challenges with data security, Data Confidentiality and Encryption – Key Protection, Key Length, Backup Data, Data Availability, Data Integrity, Cloud Data Management Interface, Cloud Storage Gateways (CSGs), Cloud and Virtual Firewall.	**08**
4	**Cloud Programming:**	**08**

	Programming Support for Google Apps Engine – Google File System, BigTable as Google's NoSQL System, Chubby as Google Distributed Lock Service, Programming support from Amazon EC2 – Amazon S3, Elastic Block Store (ESB), Amazon SimpleDB, Identity and Access Management (IAM). **Migrating Applications to the Cloud:** Key aspects, cloud migration techniques, phases during migration, cloud emulators.	
5	**Risks of Cloud Computing and Related Costs:** Various risks and issues, risk assessment and management, issues with cendor lock-in and mitigation mechanism, risk of failure of supply chain, risk of inadequate SLA, malware and internet attacks, risks in the cloud environment and the overall impact on customer business, security and compliance requirement, calculating total cost of ownership (TCO), indirect and indirect costs, chargeback methodology, pricing model, chargeback tools and solution.	**06**
6	**Administration for Clouds:** The AAA model, single sign-on flor clouds, industry implementation for AAA, authentication management – standards for controlling access, SAML, authorization management, accounting for resource utilization.	**04**

Books Recommended:

Textbooks

1. Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah, "Cloud computing Black Book" Dreamtech Publication, 1st Edition, 2014.
2. Rajkumar Buyya, "Mastering Cloud Computing", McGraw Hill Education, 1st Edition, 2017.
3. Ray Rafaels, "Cloud Computing: From Beginning to End," CreateSpace Independent Publishing, 1st Edition, 2015.

Reference Books

1. Temitayo Fagbola, Kamal Kant Hiran, "Cloud Computing: Master the Concepts, Architecture and Applications with Real-World Examples and Case Studies", BPB Publications, 1st Edition, 2019.
2. Dr. Sunilkumar, S. Manvi, "Cloud Computing: Concepts and Technologies", CRC Press, 1st Edition, 2021.
3. Ricardo Puttini, Thomas Erl, and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture," Pearson Publication, 1st Edition, 2014.
4. Michael J Kavis, "Architecting the Cloud", Wiley, 1st Edition, 2014.

Web Links:

1. A course on Cloud Computing: https://onlinecourses.nptel.ac.in/noc22_cs20/preview
2. A comprehensive guide to Social Network Analysis: https://www.analyticsvidhya.com/blog/2021/04/what-is-cloud-computing/
3. AWS Cloud Services: https://docs.aws.amazon.com//?nc2=h_ql_doc_do

Suggested List of Laboratory Experiments:

S No	Name of Experiment
1.	Virtualisation: • Hosted Virtualisation • Bare Metal Virtualisation
2.	Host a Static Website on cloud.
3.	Create and migrate relational database on cloud.
4.	Create a Virtual Private Clouds and establish connections between each other.
5.	Implement user level authentication on your cloud applications.
6.	Implement Load balancing on your created cloud application.
7.	Automate Infrastructure Development.
8.	Implement serverless architecture and configure notification services.
9.	Implement Hybrid storage and Data Migration.
10.	Mini Project

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on **DJ19DSL6011** with minimum 08 experiments.

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

1. Laboratory work (Performance of Experiments and Mini Project): 15 Marks
2. Journal Documentation (Write-up and Assignments): 10 marks

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

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Recommender systems (DJ19DSC6012)

Recommender systems Laboratory (DJ19DSL6012)

Pre-requisite: Statistics for Data Science, and Machine Learning – I.

Course Objectives: To provide students with the basic concepts of Recommender Systems, design space, trade-offs and its application in various domain.

Outcomes: Students will be able to

1. Compare different types of Recommender Systems.
2. Understand various issues related to recommender system development.
3. Design a recommender system for a given problem.
4. Relate data collected from a recommender system to understand user preferences and/or behavior.

Detailed Syllabus: (unit wise)

Unit	Description	Duration
1	**Introduction to Recommender Systems** Recommender Systems Function, Techniques, Application and Evaluation, Recommender Systems and Human Computer Interaction, Trust, Explanations and Persuasiveness, Conversational Systems, Visualization, Biases in Recommender Systems: Statistical, cultural and cognitive, data and algorithm bias and self-selection biases, Issues working with RSs data sets: The cold-start problem. **Recommendation System Properties:** User Preference, Prediction Accuracy, Coverage, Confidence, Trust, Novelty, Serendipity, Diversity, Utility, Risk, Robustness, Privacy, Adaptivity. **Performance evaluation of RSs Experimental settings:** Evaluation metrics: Rating prediction and accuracy, Ranking Measures: NDPM, Spearman's ρ, R-Score, MAP, NDCG, MRR, implicit/explicit. Other metrics: fairness, coverage, diversity, novelty, serendipity.	**09**
2	**Content-based Recommender System** High level Architecture of Content-based Systems, Advantages and Drawbacks of Content-based Filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for Learning User Profiles, Similarity based retrieval, Classification algorithms, Knowledge based recommendation: Knowledge representation and reasoning, Case based recommenders	**05**
3	**Neighborhood-based Recommendation Methods** Advantages of Neighborhood Approaches, Neighborhood-based Recommendation, User-based Rating Prediction, User-based Classification Regression Vs Classification, Item-based Recommendation, User-based Vs Item-based Recommendation, Rating Normalization, Similarity Weight Computation,	**06**

	Neighborhood Selection, Advanced Techniques: Dimensionality Reduction Methods, Graph-based Methods, Feature selection. Item representation, Methods for learning user profiles. Model based and preprocessing based approaches, Attacks on collaborative recommender systems	
4	**Collaborative filtering-based Recommender System** Baseline predictors through least squares, Implicit feedback, Matrix factorization models: SVD, SVD++, Time-aware factor model, Comparison, echo chambers, data drift and concept drift. **Neighborhood models**: Similarity measures, Similarity-based interpolation, jointly derived interpolation weights. Global neighborhood model, Factorized neighborhood model, Temporal models. Step-by-step solution of the RS problem. Temporal dynamics at neighborhood models and Between neighborhood and factorization	**06**
5	**Constraint-based Recommenders** Development of Recommender Knowledge Bases, User Guidance in Recommendation Processes, Calculating Recommendations. **Context-Aware Recommender Systems Trust** Context in Recommender Systems, Modeling Contextual Information in Recommender Systems. Paradigms for Incorporating Context in Recommender Systems: Contextual Pre- Filtering, Contextual Post-Filtering, Contextual Modeling, Combining Multiple Approaches, Additional Issues in Context-Aware Recommender Systems.	**07**
6	**Hybrid approaches** Deep Recommender systems, Multimodal Recommenders, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies, deployment of recommender systems for given timeframe/users/items, Testing and Explainability in recommenders.	**09**

Books Recommended:

Textbooks:

1. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction", Cambridge University Press, 1st Edition, 2011.
2. Kim Falk, "Practical Recommender Systems", Manning, 1st Edition, 2019
3. Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems for Learning", Springer, 1st Edition, 2013.
4. C.C. Aggarwal, "Recommender Systems: The Textbook", Springer, 1st Edition, 2016.

Reference Books:

1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", Now publishers, 1st Edition, 2011.
2. J. Leskovec, A. Rajaraman and J. Ullman, "Mining of massive datasets", Cambridge, 2nd 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: Algorithms and Applications", CRC Press, 1st edition, 2021.

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

Suggested List of Experiments:

Sr. No.	Title of the Experiment
1.	Processing and analysis of public recommender systems datasets, and performance evaluation and comparison / Master spreadsheet-based tools.
2.	Compare and analyze performance of Content-based recommendation engine on different datasets for Book, Movie, Song, product Recommendation.
3.	Implement Recommendation System using K-Nearest Neighbors and evaluate its performance on different dataset.
4.	Build project-association recommenders using association rule mining.
5.	Build a Recommendation Engine with Item-Based Collaborative Filtering.
6.	Implement Context-Aware Recommender Systems Trust.
7.	Build Constraint-based Recommenders to provide valuable support for users searching for products and services in e-commerce environments.
8.	Implement Hacker News algorithm /Subreddit User Recommendation System based on Netflix's Algorithm.
9.	Implement Bayesian personalized ranking using matrix factorization algorithm.
10.	Implement Google PageRank algorithm for recommendation.
11.	Implement unsupervised learning - Autoencoders and Restricted Boltzmann Machines.
12.	Implement recommender systems in 5G wireless networks for optimizing wireless network performance and deploy designed recommender System as Hosted Interactive Web Service on AWS.
13.	Mini Project

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.

2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

Oral and practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester. Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on **DJ19DSL6012** with minimum 08 practicals based on the above list. The distribution of marks for term work shall be as follows:

1. Laboratory work (Performance of Experiments and Mini Project): 15 Marks
2. Journal Documentation (Write-up and Assignments): 10 marks

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

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Embedded Systems & RTOS (DJ19DSC6013)

Embedded Systems & RTOS Laboratory (DJ19DSL6013)

Pre-requisite courses: Microprocessors and Microcontrollers

Objectives: To study concepts involved in embedded hardware and software for system realization.

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

1. Identify and describe various characteristic features and applications of embedded systems.
2. Analyze and identify hardware for embedded system implementations.
3. Analyze and identify various software issues involved in embedded systems for real timerequirements.
4. Analyze and explain the design life-cycle for embedded system implementation.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to embedded systems** Characteristics and Design metrics of Embedded system, Real time systems: Need for Real-time systems, Hard-Soft Real-time systems., Challenges in Embedded System Design: Power, Speed and Code density, Power supply considerations in Embedded systems: Low power features-Idle & Power, down mode, Sleep mode, and Brown-out detection	**05**
2	**Embedded Hardware** Introduction to Embedded Architecture: Embedded cores, Types of memories, Sensor Interface, Communication Interfaces: Comparative study of serial communication interfaces (RS-232,RS-485), SPI, I2C, CAN, USB, Wired LAN (Ethernet) (IEEE 802.3), Wireless LANs & Long Distance Comm. Wireless Fidelity – LoRA Mesh. Selection criteria of above interfaces. ARM Architecture: Comparative study of A, R & M series of processors with introduction to different families and their capabilities- use cases. Understanding the Cortex M0/0+, M3, M4, M33, M55 and M7 in terms of scalability from low performance applications to baseserver applications and moving towards 64-bit architecture. Introducing Pipelining Concepts & basic instruction features such as ARM Mode, Thumb and Thumb 2 mode, Instruction and Data Caches (Cortex-M7 and Cortex-A); FPU & MPU Coprocessors. Introducing the STM 32 F446 RE Nucleo Board and its capabilities with sensor interfacing	**16**
3	**Introduction to RTOS** **Real-time Operating system:** Need of RTOS in Embedded system software and comparison with GPOS, Foreground/Background processes, Interrupt latency, Task, Task-states, Multi-tasking, Context switching, Task scheduling, Scheduling algorithms - Rate Monotonic Scheduling, Earliest Deadline First, Inter-process communication, Semaphore, Mailbox, Message queues, Event timers, Task synchronization- Shared data, Priority inversion, Deadlock. Memory Management, Shared Devices and Mutex (Priority Inversion within it)Critical Code Sections (Disable Scheduler temporarily). **Introduction to FreeRTOS:** Testing above concepts of RTOS on STM 32 F446 Nucleo	**16**

	Board such as task scheduling, context switching, semaphore creations and memory management	
4	**System Integration, Testing and Debugging Methodology** Embedded Product Design Life-Cycle (EDLC), Hardware-Software Co-design **Testing & Debugging:** Boundary-scan/JTAG interface concepts, Black-Box testing, White-Box testing, hardware emulation, logic analyzer.	**05**

Suggested List of Experiments: (Any Six)

Sr. No	Title of the Experiments
1	Introduction to STM 32 446 Nucleo Board & Getting started with Mbed
2	Introduction to the FRDM 64F Platform & Getting Started with Mbed
3	Porting, Compiling, Downloading & Running your first program – Blinky LED
4	Interfacing LCD, Speaker, Temperature Sensor & Accelerometer with Nucleo Board
5	Introduction to FreeRTOS and FreeRTOS Task Creation – Understanding the System Core Clock
6	FreeRTOS Hello World App, Semi hosting & UART Setup
7	FreeRTOS App Debugging using Segger System View Tools
8	FreeRTOS Scheduler, Kernel Interrupts, RTOS Tick and SysTick Timer
9	FreeRTOS Context Switching & Task Notification and Task Deletions
10	FreeRTOS Queue Management, Semaphore for Synchronizations, Mutual Exclusion and Memory Management

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Textbooks:

1. Dr. K. V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, 2014.
2. Perry Xiao, "Designing Embedded Systems & Internet of Things with ARM mbed", Wiley, 1st Edition, 2018.
3. Sriram Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 1st Edition, 2017.

Reference Books:

1. David Simon, "An Embedded Software Primer", Pearson, 1st Edition, 2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems–Real Time Interfacing", Publisher-Cengage Learning, 3rd Edition, 2012.

3. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 1st Edition, 2004
4. Frank Vahid, Tony Givargis, "Embedded System Design–A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 1st Edition, 2002.
5. Shibu K. V., "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 1st Edition, 2009.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will bea compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in the two tests will be considered for final grading.

Term work:

Term work shall consist of minimum 6 experiments, 1 Mini-project and minimum 2 assignments.
The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Mini project and Assignments): 10 Marks

Total: 25 Marks

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

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Cognitive Neuroscience (DJ19DSC6014)

Cognitive Neuroscience Laboratory (DJ19DSL6014)

Pre-requisite: Artificial Intelligence, Machine Learning, Statistics and Programming Skills.

Course Objectives:

This course aims to provide students with a strong foundation in the field of Cognitive Neuroscience, a field that studies the intricate links between the mind, the brain, and behaviour. Students will learn methods to replicate human behaviour of how to sense and perceive the world, act in it, learn and think about it, and remember it.

Outcomes: Students will be able to

1. Analyse the methods of knowledge representation in cognitive processing.
2. Design cognitive architectures.
3. Understand the connection between brain and cognition.
4. Apply neural network models to cognition.
5. Apply reasoning & decision making to design dynamic systems.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Cognitive Science:** The Cognitive view –Some Fundamental Concepts – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation -The Nature of Artificial Intelligence - Knowledge Representation – Artificial Intelligence: Search, Control, and Learning.	**06**
2	**Cognitive Philosophy:** Cognitive Psychology – The Architecture of the Mind - The Nature of Cognitive Psychology- A Global View of The Cognitive Architecture- Propositional Representation- Schematic Representation- Cognitive Processes, Working Memory, and Attention- The Acquisition of Skill- The Connectionist Approach to Cognitive Architecture	**08**
3	**Cognitive Neuroscience:** Brain and Cognition Introduction to the Study of the Nervous System – Neural Representation – Neuropsychology- Computational Neuroscience - The Organization of the mind - Organization of Cognitive systems - Strategies for Brain mapping – A Case study: Exploring mindreading.	**10**
4	**Language Acquisition, Semantics and Processing Models:** Milestones in Acquisition – Theoretical Perspectives- Semantics and Cognitive Science – Meaning and Entailment – Reference – Sense – Cognitive and Computational Models of Semantic Processing – Information Processing Models of the Mind- Physical symbol systems and language of thought- Applying the Symbolic Paradigm- Neural networks and distributed information processing- Neural network models of Cognitive Processes.	**10**
5	**Higher-Level Cognition:** Reasoning – Decision Making – Computer Science and AI: Foundations & Robotics – New Horizons - Dynamical Systems and Situated Cognition-	**08**

	Challenges – Emotions and Consciousness – Physical and Social Environments – Applications.	

Books Recommended:

TextBooks

1. José Luis Bermúdez, "Cognitive Science: An Introduction to the Science of the Mind", Cambridge University Press, New York, 2nd Edition, 2014.
2. Jay Friedenberg, Gordon Silverman and Michael J. Spivey, "Cognitive Science: An Introduction to the Study of Mind", SAGE Publication, 4th Edition, 2021.

Reference Books

1. Michael Gazzaniga, Richard B Ivry, George R Mangun, "Cognitive Neuroscience the Biology of the Mind," W. W. Norton & Company Publication, 5th Edition, 2019.
2. Daniel Kolak, William Hirstein, Peter Mandik, Jonathan Waskan," Cognitive Science: An Introduction to Mind and Brain, Taylor and Francis, 1st Edition, 2006.

Weblinks:

1. Cognitive Science: https://plato.stanford.edu/entries/cognitive-science/
2. Cognitive Neuroscience: https://plato.stanford.edu/entries/cognitive-science/

Suggested List of Experiments:

Sr. No.	Title of the Experiments
1.	Introduction to EEG recordings. Theory, physiology, practical aspects of recording and analysing scalp- recorded brain potentials.
2.	Designing experiments: Control, manipulation, repeated trials, and balanced conditions. Application to studies with brain recordings.
3.	Experimental approach to studying the working human brain and body. How to use Brain Voyager Brain Tutor. How to use the BESA dipole simulator.
4.	Research design and the traditional statistical foundations of experimental research: T-test. Analysis of variance. Evaluate sample data and data from a standard experiment.
5.	Recording dense-array EEG: Practical introduction.
6.	EEG analysis: How to get from the raw recording to brain waves. An example analysis.
7.	Mini Project

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus, summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in the two tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on **DJ19DSL6014** with minimum 06 experiments to be incorporated.

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

1. Laboratory work (Performance of Experiments and Mini Project): 15 Marks
2. Journal Documentation (Write-up and Assignments): 10 marks

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

Prepared by Checked by Head of the Department Principal

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Innovative Product Development-IV (DJ19ILL2)

Course Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuringthat 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 ateam.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at thedesign 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 toconceptualise and create a successful product.

Course Outcome: On completion of the course, student should 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 whileworking 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 proposedmethod 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 eventuallyprepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel inwritten (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

- Students shall convert the solution designed in semester 3 and 4 into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
- The working model 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 the extended 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.
- 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 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.
- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration on their working model
- The distribution of marks for term work shall be as follows:
  1. Marks awarded by the supervisor based on log-book: 10
  2. Marks awarded by review committee: 10
  3. Quality of the write-up : 05

  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.
- The semester reviews (V and VI) may be based on relevant points listed above, as applicable.

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. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the extended technical paper prepared by them during the final review in semester VI.

Prepared by Checked by Head of the Department Principal

Program: Computer Science and Engineering (Data Science) **Semester: VI**

Course: Professional and Business Communication Laboratory (DJ19IHL2)

Pre-requisite: Basic course in Effective Communication Skills.

Objectives:

1. To inculcate professional and ethical attitude at the workplace.
2. To enhance communication and interpersonal skills.
3. To develop effective presentation skills.
4. To hone written skills for technical documentation.

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

1. Plan, organize and write technical documents like reports, proposals and research papers in the prescribed format using appropriate language and style with an understanding of ethics in written communication.
2. Apply techniques of writing resume, participating in a group discussion and facing interviews.
3. Demonstrate interpersonal skills in professional and personal situations
4. Articulate the documentation process of meetings and conduct meetings in a professional manner.
5. Explain communication across cultures and work ethics.
6. Design and deliver effective presentations using Power Point.

Detailed Syllabus: (unit wise)

Unit	Description	Duration
1	**Technical Writing** **Report Writing:** Types of report, parts of formal report, collection of data and survey analysis, pre-writing of report, language and style in reports, formatting of reports, referencing in report **Proposal Writing: Types** of technical proposals, format of proposal, language and style, presentation of proposal **Technical Paper Writing:** Parts of a technical paper, language and formatting, referencing in IEEE format **Plagiarism:** Types of plagiarism, consequences of plagiarism	**08**
2	**Employment Skills** **Group Discussion:** Purpose of a GD, types of GD, criteria for evaluating a GD, Dos and Don'ts of a GD, Tips to be successful in GD **Cover Letter & Resume Writing:** Format and content of cover letter, types of resume, structure, content and formatting of resume **Interview Skills:** Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview	**06**

3	**Introduction to Interpersonal Skills** **Emotional Intelligence:** Definition, difference between IQ and EQ, how to develop EQ **Leadership:** Types of leadership, leadership styles, case studies **Team Building:** Difference between group and team, importance of team work, strategies to be a good team player **Time Management:** Importance of time management, cultural views of time, 80/20 rule, time wasters, setting priorities and goals **Conflict Management:** Types of conflicts, strategies to manage conflict, case studies	**05**
4	**Meetings and Documentation** Planning and preparation for meetings, strategies for conducting effective meetings, notice, agenda and minutes of a meeting, business meeting etiquettes	**02**
5	**Cross-cultural communication and Ethics** Communication across cultures, professional and work ethics, responsible use of social media, introduction to Intellectual Property Rights	**03**
6	**Presentation Skills** Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation	**02**

List of Assignments

1. Business Proposal (PowerPoint presentation)
2. Resume writing
3. Interpersonal Skills (documentation of activity)
4. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
5. Business ethics
6. Presentation Skills

Books Recommended:

Reference Books:

1. Fred Luthans, "Organizational Behavior", McGraw Hill, 12th Edition, 2010.
2. Lesiker and Petit, "Report Writing for Business", McGraw Hill, 10th Edition, 1998.
3. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill, 2nd Edition, 1990.
4. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 10th Edition, 2012.
5. Heta Murphy, "Effective Business Communication", Mc Graw Hill, 7th Edition, 2017.
6. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw-Hill Education, 6th Edition, 2020.
7. Ghosh, B. N., "Managing Soft Skills for Personality Development", Tata McGraw Hill, 2017.
8. Bell, Smith, "Management Communication" Wiley India Edition, 3rd Edition, 1999.
9. Dr. Alex, K., "Soft Skills", S Chand and Company, 3rd Edition, 2009.
10. Subramaniam, R., "Professional Ethics" Oxford University Press, 2nd Edition, 2017.

Evaluation Scheme:

Laboratory: (Term work)

Term work shall consist of 6 assignments, Group Discussion and Power Point Presentation based on the written report

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

Assignments …… (25) Marks

Project Report and Presentation…… (15) Marks

Group Discussion……. (10) Marks

TOTAL: …….. (50) Marks

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

Prepared by Checked by Head of the Department Principal