Proposed Scheme for Third Year Undergraduate Program in Artificial Intelligence and Machine Learning: Semester VI (Autonomous)
Academic Year(2025-26)

	Sr. No.	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	SEE Total(A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Term Test 3 (TT3)	Term Test Total (TT1 + TT2 + TT3)	Term work	CA Total (B)		
PCC	1	DJS23ACPC601	Deep Learning	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	4
		DJS23ALPC601	Deep Learning Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
	2	DJS23ACPC602	Large Language Models	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	4
		DJS23ALPC602	Large Language Models Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
	3	DJS23ALPC603	Big Data Analytics Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	50	50	75	1
	4	DJS23ALPC604	Advanced Java Laboratory	--	2	--	1	2	--	--	--	25	25	--	--	--	--	50	50	75	1
PCE	5 @	DJS23ACPE611	Advanced System Design	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	4
		DJS23ALPE611	Advanced System Design Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
		DJS23ACPE612	IoT Foundations	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	
		DJS23ALPE612	IoT Foundations Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
		DJS23ACPE613	Cybersecurity and Ethical Hacking	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	
		DJS23ALPE613	Cybersecurity and Ethical Hacking Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
	6@	DJS23ACPE614	Agentic and Explainable AI	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	4
		DJS23ALPE614	Agentic and Explainable AI Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
		DJS23ACPE615	Time Series & Financial Analysis	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	
		DJS23ALPE615	Time Series & Financial Analysis Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
		DJS23ACPE616	Probabilistic Graph Models	3	--	--	3	2	60	--	--	--	60	15	15	10	40	--	40	100	
		DJS23ALPE616	Probabilistic Graph Models Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
MD	7	DJS23ACMD601	DevOps and MLOps	2	--	--	2	2	60	--	--	--	60	15	15	10	40	--	40	100	3
		DJS23ALMD601	DevOps and MLOps Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	50	
	8	DJS23IPSCX04	Innovative Product Development IV	--	2	--	1	2	--	--	--	25	25	--	--	--	--	25	25	50	1
	9	DJS23ICHSX09	Constitution of India	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total				**15**	**16**	**--**	**22**	**26**	**300**	**150**	**--**	**50**	**500**	**75**	**75**	**50**	**200**	**250**	**450**	**950**	**22**

@-Department Elective
CC- Common Courses

Prepared by Checked by HoD Vice Principal Principal

Continuous Assessment (A):

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

Continuous Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	60	02
	* Computer based assessment in the college premises.	--	
Oral	Questions based on the entire syllabus.	--	--
Practical	Performance of the practical assigned during the examination and the output / results obtained.	--	--
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.	25	As applicable

Program: Artificial Intelligence & Machine Learning	B. Tech.	Semester: VI
Course: Deep Learning (DJS23ACPC601)		
Course: Deep Learning Laboratory (DJS23ALPC601)		

Pre-requisite: Natural Language Processing, Machine Learning.

Course Objectives:

1. To introduce fundamental concepts of artificial neural network and different learning algorithms: supervised and unsupervised neural networks
2. Develop in-depth understanding of the key techniques in designing Deep Network and GAN.
3. To expose Deep Network based methods to solve real world complex problems.
4. To explore applications and challenges in deep learning

Course Outcomes: Students will be able to

1. Understand the fundamentals of deep neural networks and their training mechanisms.
2. Apply optimization and regularization techniques to improve model performance.
3. Design and implement CNN models for supervised learning tasks.
4. Develop solutions for sequence learning applications using recurrent networks.
5. Analyze unsupervised learning techniques for dimensionality reduction and data reconstruction.
6. Evaluate recent trends in adversarial networks and generative models.

Deep Learning (DJS23ACPC601)		
Unit	**Description**	**Duration**
1	**Supervised Learning Networks** **Feedforward DNN** Perceptron: Representational power of Perceptron, The Perceptron Training Rule, Multilayer perceptron: Delta training rule; Multilayer Networks: A differentiable Threshold Unit (Sigmoid Neurons), Representational Power of Feedforward Networks; Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	7
2	**Optimization** Learning with backpropagation: EBPTA, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp, Convergence and local minima, stopping criteria. **Regularization:** Regularization for Deep Learning: Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stooping, Sparse Representation, Dropout.	6

3	**Convolutional Neural Networks:** Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function, 2D Convolution **ConvNet Architectures:** LeNet: Architecture, AlexNET: Architecture, ResNet : Architecture, ConvNeXt, EfficientNET, **Applications:** object detection and recognition tasks, medical image analysis, image classification	6
4	**Sequence Modelling:** Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Limitation of "vanilla RNN", Vanishing and Exploding Gradients, The Long Short-Term Memory, GRU, Deep recurrent Networks. **Applications:** Sentiment analysis, stock prices or market trends	7
5	**Unsupervised Learning Networks:** Kohonen Self-Organizing Feature Maps – architecture, training algorithm **Autoencoders:** Introduction, comparison with PCA, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders, Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders, Variational Autoencoders (VAEs) **Applications:** image compression, feature extraction, risk assessment and fraud detection	8
6	**Adversarial Networks** Generative Vs Discriminative Modeling, Generative Adversarial Networks (GAN) Architecture, GAN challenges: Oscillation Loss, Mode Collapse, Uninformative Loss, Hyperparameters, Tackling GAN challenges, Wasserstein GAN, Cycle GAN, Neural Style Transfer **Diffusion Models:** Introduction, Comparison with GANs **Applications**: Image synthesis or style transfer, Data Augmentation	8
	TOTAL	42

Books Recommended:

Text Books:

1. Dive into Deep Learning: Asaton Zhang, Zhacary Lipton, Mu Li and Alex Smola, December 2023
2. Understanding Deep Learning, Simon Prince, MIT Press, Dec2023
3. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition, 2010.
4. S. N. Sivanandam and S. N. Deepa, "Introduction to Soft Computing", Wiley India Publications, 3rd Edition, 2018.
5. M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, IT Press.
6. David Foster, "Generative Deep Learning", O'Reilly Media, 2019.

7. Denis Rothman, "Hands-On Explainable AI (XAI) with python", Packt, 2020.

Reference Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", An MIT Press, 2016
2. François Chollet, "Deep Learning with Python", Manning Publication, 2017.
3. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Publication, 2017.
4. Andrew W. Trask, Grokking, "Deep Learning", Manning Publication, 2019.
5. John D. Kelleher, "Deep Learning", MIT Press Essential Knowledge series, 2019.
6. Douwe Osinga. ―Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi

Web Resources Blogs and Websites:

1. Deep Learning: https://vlab.spit.ac.in/ai/#/experiments
2. Deep learning book https://www.deeplearningbook.org/
3. Deep learning all videos: https://www.cse.iitm.ac.in/~miteshk/CS6910.html
4. Deep Learning Specialization: https://www.coursera.org/specializations/deep-learning

Online Resources

1. Deep Learning, IIT Ropar NPTEL course by Prof. Sudarshan Iyengar,Dr. Padmavati https://nptel.ac.in/courses/106106184

Suggested List of Experiments:

Deep Learning Laboratory(DJS23ALPC601)	
Sr. No.	**Title of the Experiment**
1	Implement Boolean gates using perceptron.
2	Implement representation power of perceptron.
3	Implement backpropagation algorithm from scratch.
4	Train CNN Models for Image Classification Tasks.
5	Evaluate the Effect of Optimizer SGD on Model Performance.
6	Evaluate the Effect of Optimizer Adam on Model Performance.
7	Compare the Performance of PCA and Autoencoders on Dimensionality Reduction
8	Sequence Classification Using RNN or GRU (e.g., Sentiment Analysis or Activity Recognition).
9	Anomaly detection using Self-Organizing Network.
10	Compare the performance of PCA and Autoencoders on a given dataset.
11	Train Variational Autoencoders (VAEs) for Image Reconstruction.
12	Build Generative adversarial model for fake (news/image/audio/video) prediction.
13	Generate Synthetic Data Using Diffusion Models and Evaluate Results.
14	Mini Project

Minimum ten 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 HoD Vice-Principal Principal

Program: Artificial Intelligence & Machine Learning	TY.B. Tech.	Semester: VI
Course: Large Language Models (DJS23ACPC602)		
Course: Large Language Models Laboratory (DJS23ALPC602)		

Pre-requisite: Natural Language Processing, Deep Learning.

Course Objectives:

1. Introduce the fundamental concepts and applications of Generative AI.
2. Provide in-depth understanding of Transformer architecture, the core building block of most Large Language Models (LLMs).
3. Explore various LLM architectures and techniques like BERT, prompt engineering, and fine-tuning.
4. Introduce students to Multimodal LLMs that can process and understand different data modalities.

Course Outcomes: Students will be able to

1. Introduce the fundamental concepts and applications of Generative AI and to provide in-depth understanding of Transformer architecture, the core building block of Large Language Models (LLMs).
2. Explore various LLM architectures and techniques like BERT, GPT-3, T5 and Large Reasoning Models.
3. Apply prompt engineering techniques for effective LLM interaction and understand the concept of Retrieval Augmented Generation (RAG) and its role in LLMs.
4. Understand the different data modalities using Multimodal Architectures.

Large Language Models (DJS23ACPC602)		
Unit	**Description**	**Duration**
1	**Module 1: Introduction to Generative AI &Transformer Architecture** Domains of Generative AI, Text Generation, Image Generation, Music Generation, Video Generation. Limitations of RNN & LSTM, Tokenization, Transformer Architecture : encoders, decoders, attention mechanisms - types, Self-attention vs Flash Attention, feed-forward layer, RETRO Transformer, Reinforcement Learning with AI Feedback (RLAIF), Reinforcement Learning from Human Feedback (RLHF)	7
2	**Module 2: Language Models - Unveiling the Power of Words** BERT (Bidirectional Encoder Representations from Transformers) and its applications, exploring other notable LLM architectures (e.g.GPT-3, T5), Mixture of Experts (MoE), various benchmarks to evaluate LLMs – perplexity, BLEU score, Needle in a Haystack	6
3	**Module 3: Large Reasoning Models** Deep seek- v2: Multi head Latent Attention, Deep seek MoE, Knowledge	6

	Distillation, Mistral 7-B Architecture: sliding Window attention, Grouped Query Attention, Titans: Learning to memorize at test time, Knowledge Distillation, QWQ models.	
4	**Module 4: Prompt Engineering &Agentic AI** Introduction to prompt, examples of prompt, prompt engineering, prompt techniques, zero shot, one shot, few-shot learning, Agentic AI- a chain of thought , ReAct , self-consistency, Tree of thought, Multimodal CoT, Graph prompting, Large Action Models(LAMs), LLM based Agents, Auto Gen	7
5	**Module 5: Retrieval Augmentation & Generation (RAG) and Fine-tuning for LLMs** Understanding Retrieval and vector, vector storage: vector indexing and retrieval Algorithms: Annoy, HSNV, Inverted File System, LSH, vector quantization techniques: Scalar, Product, Binary, vector libraries, vector databases, Loading and retrieving in Lang Chain, Document loaders, Retrievers in Lang Chain. Fine-tuning: Quantization, PEFT, Full-Fine-tuning vs LoRA vs QLoRA, Fine-Tuning LLMs for different downstream tasks.	8
6	**Module 6: Multimodal Architectures - Beyond Text** Introduction to Multimodal LLMs, Exploring architectures for Multimodal LLMs: Vision Transformer, Next GPT, GPT-4V, **Vision-Language Fusion Models** – BLIP-2, Flamingo, LLaVA, MiniGPT-4,**Temporal & Cross-Modal Models** – VideoLLaMA, ImageBind, Empowering Time Series Analysis with Large Language Models	8
	TOTAL	42

Books Recommended:

Text Books:

1. Ben Auffarth, "Generative AI with LangChain: Build large language model (LLM) apps with Python, ChatGPT, and other LLMs" by Packt Publishing, 2023.
2. Valentina Alto, "Modern Generative AI with ChatGPT and OpenAI Models", by Packt Publishing, 2023.
3. Jay Alammar, Maarten Grootendorst, "Hands-On Large Language Models", by O'Reilly, 2023
4. Thushan Ganegedara, "Natural Language Processing with TensorFlow", by Packt Publishing, Second Edition, 2022.

Reference Books:

1. David Foster, "Generative Deep Learning", O'Reilly, 2020.
2. Lewis Tunstall, Leandro von Werra & Thomas Wolf," Natural Language Processing with Transformers", 2022.
3. Sebastian Raschka, "Build a Large Language Model (From Scratch)", ISBN 9781633437166

Web Resources Blogs and Websites:

1. Mixture of Experts: Mixture of Experts Explained (huggingface.co)
2. PEFT:Efficient Model Fine-Tuning for LLMs: Understanding PEFT by Implementation | by Shivansh Kaushik | Medium
3. Various benchmarks to evaluate LLMs: LLM Benchmarks: Understanding Language Model Performance (humanloop.com)
4. Types of attention mechanism: Understanding and Coding the Self-Attention Mechanism of Large Language Models From Scratch (sebastianraschka.com)
5. Agents| RAG: Intro to LLM Agents with Langchain: When RAG is Not Enough | by Alex Honchar | Mar, 2024 | Towards Data Science
6. React| Agent: Teaching LLMs to Think and Act: ReAct Prompt Engineering | by Bryan McKenney | Medium
7. LLM based Agents : Superpower LLMs with Conversational Agents | Pinecone
8. RAGAS: Evaluating RAG pipelines with Ragas + LangSmith (langchain.dev)
9. Model distillation: LLM distillation demystified: a complete guide | Snorkel AI
10. Sentence classifier |BERT: Classify text with BERT | Text | TensorFlow

Suggested List of Experiments:

Large Language Models Laboratory(DJS23ALPC602)	
Sr. No.	**Title of the Experiment**
1	Case study on Applications of Generative AI
2	Case study on role of Artificial Intelligence in achieving the Sustainable Development Goals
3	Fine Tuning Pre-trained Model On Custom Dataset (synthetic data) Using Transformer
4	Build your own LLM from scratch.
5	Query PDF using Lang Chain and Pine cone
6	Fine Tune Mistral7-B With Custom Dataset Using LoRA And QLoRA Techniques
7	Using in-built tools and creating custom tools for ReAct agent in Langchain.
8	Question Answering Application using LLM based agents.
9	Understanding various retrievers in Langchain.
10	Case study on comparison of Large Reasoning Models
11	Understanding multimodal models like Gemini vision
12	Build a simple multimodal generative model that combines text and image inputs to generate captions
13	Fine-tune or evaluate open-source BLIP-2, LLaVA, or MiniGPT-4 on image captioning, visual question answering (VQA), and instruction-following.
14	Mini project

Minimum ten 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.

Program: Artificial Intelligence & Machine Learning	TY.BTech	Semester: VI
Course: Big Data Analytics Laboratory (DJS23ALPC603)		

Pre-requisite: **Java**, **Python, SQL.**

Course Objectives:

To equip students with the necessary theoretical knowledge and practical expertise to design, implement, and manage scalable data solutions using both traditional and modern data technologies. Students will learn to leverage the Hadoop ecosystem (HDFS, MapReduce, Hive, Pig) for large-scale data processing, utilize specialized databases like PostgreSQL and MongoDB, and master the high-speed processing capabilities of Apache Spark for real-time analytics and machine learning applications, culminating in data visualization for business insights.

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

1. Analyze and apply the MapReduce paradigm using Hadoop and Spark for efficient distributed processing of large datasets.
2. Differentiate and utilize structured (PostgreSQL) and various NoSQL databases (Document, Column-family, Graph) based on data model requirements.
3. Design and implement Big Data ingestion, cleaning, and modeling pipelines for analytical purposes.
4. Evaluate and select appropriate Big Data tools and cloud services for real-world application case studies.

Big Data Analytics (DJS23ALPC603)		
Unit	**Description**	**Duration**
1	**Hadoop & MapReduce Programming**: Big Data Characteristics (4 V's), Big Data vs. Traditional Databases. Hadoop: Architecture, HDFS (Design, File Operations, NameNode/DataNode Monitoring). Hadoop Ecosystem overview (YARN, Pig, Hive, HBase). **MapReduce Programming:** Job Run Anatomy, Mapper, Reducer, Combiner, Partitioner, Shuffle & Sort. Programming Examples: Word Count, Set Operations, Matrix Multiplication.	**04**
2	**Relational & NoSQL Systems:** PostgreSQL (Relational): pgAdmin - Schemas, Basic and Advanced Queries, Joins, Views. **NoSQL Introduction:** Types, CAP Theorem. **MongoDB:** Database and Collection creation. CRUD Operations - Document structure, Insert, Query, Update, and Delete documents, MongoDB Compass.	**04**
3	**Apache Spark**: Introduction to Spark: Architecture, Components (Spark Core, SQL, Streaming, MLlib, GraphX). Resilient Distributed Datasets (RDDs): Creation, Transformations (Narrow & Wide), Actions. Spark DataFrames and Spark SQL basics.	**04**
4	**Advanced NoSQL Databases: Cassandra (Column-Family):** Architecture, Data Model (Keyspace, Column Family, Row, Column), CQL (Cassandra	**04**

	Query Language) basics, CRUD operations. **Neo4j (Graph):** Introduction to Graph Databases, Nodes, Relationships, Properties, Cypher Query Language fundamentals.	
5	**Data Ingestion & Processing Pipeline**: ETL/ELT Concepts for Big Data. Introduction to Data Ingestion tools (e.g., Flume, Sqoop). Data Cleaning and Filtering techniques in Big Data context. Data modeling for Analytical processing.	**07**
6	**Visualization & Cloud Services:** Introduction to Data Visualization for Big Data (e.g., Tableau, Power BI, or Python Libraries). Overview of Cloud Big Data Services (e.g., AWS EMR, Google Cloud Dataproc, Azure HDInsight). Case Studies on Big Data Applications.	**05**
	TOTAL	**28**

Books Recommended:

Textbooks:

1. Mayank Bhushan "Big Data and Hadoop: Fundamentals, tools, and techniques for data-driven success", Edition 2nd ed. ISBN-13978-9355516664, 2024.
2. Jugnesh Kumar, Anubhav Kumar, Rinku Kumar "Big Data and Analytics: The key concepts and practical applications of big data analytics", ISBN-13978-9355516176, 2024.
3. Greyson Chesterfield "Mastering Apache Spark: Real-Time Big Data Analytics: Build Large-Scale Data Processing Pipelines with Apache Spark", 2024
4. Mrs A S R Sulthana & Mr Micheal Yeboah Frimpong "Demystifying the NoSQL", 2021.
5. Kristina Chodorow, Michael Dirolf, "MongoDB: The Definitive Guide Paperback", O'Reilly Publications, 2020.
6. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications, 2019.

Reference Books:

1. Simhadri Govindappa "Ultimate Big Data Analytics with Apache Hadoop: Master Big Data Analytics with Apache Hadoop Using Apache Spark Hive, and Python", 2024.
2. Dr Sudhakar Ranjan, Dr Anurag Bharatwal, Dr Amit Kumar Goel, "Hadoop in Action: Real World Applications and Best Practices for Big Data Processing Kindle" Edition,), 2024.
3. Ali Soofastaei, "Advanced Analytics in Mining Engineering: Leverage Advanced Analytics in Mining Industry to Make Better Business Decisions", 2023.
4. Herbert Jones, "Data Analytics: The Ultimate Guide to Big Data Analytics for Business, Data Mining Techniques, Data Collection, and Business Intelligence Concepts", 2020.

Online References:

1. NPTEL Course: https://onlinecourses.nptel.ac.in/noc20_cs92
2. MongoDB:https://www.mongodb.com/developer/products/mongodb/learn-mongodb-university-online-free-mooc/?msockid=07258624254b619719bf95cb24b36065
3. https://www.youtube.com/watch?v=S2MUhGA3lEw
4. https://www.youtube.com/watch?v=XhjIJGsAMsQ&list=PL6UwySlcwEYKiC-EjEmN4f33c5fVpbzha

Suggested List of Laboratory Experiments:

Big Data Analytics Laboratory (DJS23ALPC603)	
Sr No	**Title of Experiment**
1	Implement the following HDFS File Operations in Hadoop: • Adding files and directories • Retrieving files • Deleting file Use the Hadoop Web UI (50070) to check the NameNode status, view DataNode health, and observe file blocks and replication factors for a file uploaded.
2	i. Implement word count/frequency programs using MapReduce using a large text file (e.g., a novel) in Java or Python. ii. Implementing algorithm in MapReduce Matrix multiplication, Aggregates, joins, sort.
3	Install MongoDB/Compass. Practice CRUD operations. Create various types of indexes to optimize query performance.
4	Use the MongoDB Aggregation Framework to perform complex data analysis (e.g., grouping, counting, and calculating averages).
5	Install Cassandra. Design a keyspace, and create tables adhering to Cassandra's data denormalized model. Execute basic CQL commands.
6	Design a Cassandra schema suitable for time-series data and demonstrate insertion and querying based on time ranges.
7	Write a PySpark/Scala program to create RDDs and apply various Transformations (e.g., groupByKey, reduceByKey) and Actions.
8	Load data into a Spark DataFrame. Perform analytical queries and joining operations using Spark SQL
9	Implement a Natural Join using Spark DataFrames or RDDs on two large related datasets.
10	Install Neo4j. Model a real-world scenario (e.g., a supply chain). Use Cypher for basic pattern matching.
11	Execute built-in graph algorithms in Neo4j (e.g., Shortest Path or PageRank) on your modeled data.
12	Experiment with Sqoop to transfer data between HDFS/Hive and a relational database (PostgreSQL/MySQL), or use Flume for log data collection.
13	Use a visualization tool (e.g., Tableau, Power BI, or Matplotlib/Seaborn in Python) to load and visualize analytical results obtained from Spark or MongoDB.
14	A major e-commerce platform needs to shift from legacy RDBMS to a Big Data architecture to handle billions of daily clickstream events. The objective is to design a hybrid analytics pipeline using Hadoop for storage, MapReduce/Spark for calculating key metrics (e.g., top products, page views), and a mix of PostgreSQL,

	MongoDB, Cassandra, and Neo4j to store diverse results. This system must ultimately identify complex user-to-user purchase relationships and generate personalized product recommendations efficiently.
15	Mini Project: SDG 13: Climate Change Impact Analysis • Analyse temperature and air quality data to identify trends and patterns. • Use social media data to assess public sentiment towards climate change. • Visualize the impact of climate change on specific regions. SDG 3: Healthcare Access Analysis • Analyze data on healthcare access, disease prevalence, and mortality rates. • Identify disparities in healthcare access across different populations. • Visualize the impact of healthcare interventions. SDG 4: Student Dropout Prediction • Analyze large datasets of student records, attendance, test scores, and socio-economic background. • Use a Spark ML classification model to predict which students are at high risk of dropping out. SDG 13: Greenhouse Gas (GHG) Emissions Tracking • Load historical industry, transport, and energy consumption data into Hive. • Use HiveQL to calculate and trend total **GHG emissions** per capita and per sector, visualized on a dashboard.

Minimum ten 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.

Program: Artificial Intelligence & Machine Learning	TY.B.Tech.	Semester:VI
Course: Advanced Java Programming Laboratory (DJS23ALPC604)		

Prerequisite: Object Oriented Programming using Java.

Course Objectives:

1. Build advanced Java programming and enterprise application development skills aligned with current industry practices.
2. Apply modern frameworks and APIs, especially Spring Boot, for secure and scalable software solutions.
3. Design and implement multi-tier applications with database integration, web services, and concurrency handling.
4. Gain practical exposure to DevOps tools and workflows for real-world software development and deployment.

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

1. Apply advanced Java programming concepts—including Generics, Streams, concurrency utilities, and modern Java (21+) features—to design efficient and parallel data processing applications.
2. Develop and deploy enterprise-level applications using Spring Boot, incorporating RESTful APIs, dependency injection, and microservice-based architecture.
3. Design interactive and responsive web applications by integrating Spring MVC with frontend frameworks and ensuring effective database management using JDBC and ORM tools like Hibernate/JPA.
4. Implement software engineering best practices using design patterns, unit testing, version control, and DevOps tools to build secure, scalable, and high-performance Java solutions.

Advanced Java Programming Laboratory (DJS23ALPC604)		
Unit	**Description**	**Duration**
1	**Core Java Essentials & Data Handling:** Java Collections Framework (ArrayList, HashMap, etc.); Generics with type parameters, wildcards, and erasure; Lambda Expressions and Functional Interfaces; Stream API (filtering, mapping, reducing, parallel streams); Introduction to Java 21+ features (records, sealed classes, pattern matching).	06
2	**Database Integration & ORM**: JDBC Architecture (drivers, connections, Statements, PreparedStatements, ResultSets); Transaction management, batch processing, connection pooling; Introduction to ORM with Hibernate/JPA (entities, mappings, queries); Spring Data JPA basics; Practical examples with MySQL/PostgreSQL, including CRUD operations and metadata handling.	04

3	**Web Development Fundamentals:** HTTP Protocol and web architecture; RESTful APIs design principles; JSON processing (parsing, serialization); Introduction to Spring Boot (auto-configuration, starters); Creating REST controllers, handling requests/responses, error management; Basic frontend integration (e.g., with Thymeleaf or API calls to React).	06
4	**Enterprise Frameworks & Architecture:** Spring Framework core (IoC, Dependency Injection, Application Context); Spring MVC patterns; Advanced Spring Boot (microservices basics, actuators, profiles); Security fundamentals (Spring Security, JWT, OAuth); File handling, internationalization, and session management in web apps.	06
5	**Concurrency & Advanced Concepts:** Multithreading (threads, synchronization, executors); Java Concurrency utilities (Locks, Semaphores, Completable Future); Virtual threads (Project Loom); Reflection API (dynamic invocation, annotations); Performance optimization (garbage collection tuning, profiling). Design, Testing and DevOps	06
	TOTAL	**28**

Books Recommended:

Textbooks:

1. Java: The Complete Reference (13th Edition): Herbert Schildt & Danny Coward, McGraw-Hill. Year: 2024 (Jan).
2. Core Java Volume I – Fundamentals: Cay S. Horstmann, Pearson / Oracle Press. For example, the 11th edition 2019.
3. Effective Java (3rd Edition): Joshua Bloch, Addison-Wesley Professional. Year: 2017.

Reference Books:

1. Mark Heckler, Spring Boot: Up and Running – Building Cloud-Native Java and Kotlin Applications, O'Reilly Media / Shroff Publishers (Indian edition), 2021.
2. Christian Ullenboom, Spring Boot 3 and Spring Framework 6, Rheinwerk / SAP Press, 2024.
3. K. Siva Prasad Reddy & Sai Upadhyayula, Beginning Spring Boot 3: Build Dynamic Cloud-Native Java Applications and Microservices (2nd Edition), Apress, 2023.
4. Marten Deinum, Spring Boot 3 Recipes: A Problem-Solution Approach for Java Microservices and Cloud-Native Applications (2nd Edition), Apress, 2024.

Web Links:

1. Getting started with Spring MVC + Thymeleaf: Tutorial Point – Spring Boot Thymeleaf
2. Spring Boot CRUD application with Thymeleaf: Baeldung – Spring Boot CRUD Thymeleaf
3. Official Thymeleaf + Spring tutorial: Thymeleaf.org – Thymeleaf + Spring

Suggested List of Experiments:

Advanced Java Programming Laboratory (DJS23ALPC604)	
Sr. No.	**Title of the Experiment**
1	Implement ArrayList, HashMap, and basic file I/O to create a console-based student record management system with search and sort functionality.
2	Create generic classes and methods to handle different data types, implement custom comparators, and use wildcards for flexible data processing.
3	Process CSV files using Stream API for filtering, mapping, and collecting data. Generate reports with statistical analysis using lambda expressions.
4	Build a console application using JDBC to manage books, members, and transactions with MySQL database. Implement CRUD operations with proper exception handling.
5	Develop RESTful web services using Spring Boot for employee management. Implement GET, POST, PUT, DELETE operations with JSON request/response handling.
6	Create a web application using Spring Boot and Thymeleaf to display products with search, filter, and pagination features. Include responsive web design.
7	Implement complete user registration, login, and session management system with password encryption and form validation using Spring Security basics.
8	Build a web-based file upload/download system with file type validation, storage management, and user access control. Include progress indicators.
9	Enterprise Report Generation using JasperReports and Spring Boot
10	Real-Time Event Processing using Apache Kafka
11	Use Java multithreading and Completable Future to simulate a task scheduler (e.g., email notifications), ensuring proper synchronization and error handling.
12	Implement Singleton and Factory patterns for a simple calculator app. Write JUnit tests to verify functionality and deploy using Maven to a local server.
13	Full-Stack Application with Spring Boot and React
14	Mini Project

Batch wise laboratory work of minimum ten 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.

Continuous Assessment:

15 Marks- Journal completion
5 Marks- Attendance
Term Test 1 (based on 40% syllabus) of 15 marks for the duration of 45 mins
Term Test 2 (based on the next 40% syllabus) of 15 marks for the duration of 45 mins

Program: Artificial Intelligence & Machine Learning	TY.B.Tech.	Semester :VI
Course: Advanced System Design (DJS23ACPE611)		
Course: Advanced System Design Laboratory (DJS23ALPE611)		

Prerequisite:

1. Operating Systems, DBMS, Computer Networking & Protocols

Course Objectives (At the end of course, student will be able to):

1. Design and justify high-level distributed architectures based on requirements.
2. Master low-level techniques for data distribution, caching, and performance optimization.
3. Design highly available and observable systems using SRE principles and asynchronous patterns.
4. Synthesize all knowledge to solve common industry design problems under interview pressure.

Course Outcomes:

1. Accurately estimate scale and propose a resilient HLD (High-Level Design) with justified core components.
2. Implement Consistent Hashing and justify caching policies (LRU/LFU) to optimize system latency and throughput.
3. Design a decoupled system using Message Queues and implement fault-tolerance patterns (e.g., Circuit Breakers).
4. Solve complex design problems (e.g., News Feed) by articulating trade-offs and low-level choices using the interview blueprint.

Advanced System Design (DJS23ACPE611)		
Unit	**Description**	**Duration**
1.	**System Design Fundamentals & Core Concepts** Introduction to System Design, Core Architectural Patterns, Back-of-the-Envelope Estimation, Availability & Scalability Metrics	4
2.	**Data Modeling and Storage Systems** Relational Databases (SQL), NoSQL Databases, Data Partitioning and Sharding, Storage Technologies & Filesystems, Parallel Database design & query evaluation.	6
3.	**Performance, Caching, and Load Balancing** Caching at Scale: **Low-Level Concepts:** Cache eviction policies (LRU, LFU), Write-through, Write-back, Cache-Aside patterns. Distributed Caching (e.g., Redis Cluster). **Cache Invalidation,** Load Balancing Techniques: Layer 4 vs. Layer 7, Algorithms: Round Robin, Least Connections, Weighted. Proxy servers (Forward/Reverse), Performance Optimization: Connection pooling, compression (Gzip), reducing I/O, and database query optimization. Throttling and rate limiting	8
4.	**Asynchronous Processing and Communication**	8

	Message Queues & Brokers, **Kafka** vs. **RabbitMQ** concepts, **Publish-Subscribe vs. Point-to-Point** models., Data Ingestion and Stream Processing, Kafka Streams or Flink, Communication Protocols: REST vs. gRPC (Protocol Buffers),WebSockets for real-time applications, Polling, Long Polling, and Server-Sent Events (SSE).	
5.	**Security, Monitoring, and Reliability** System Monitoring and Logging, Telemetry, Metrics (Prometheus), Logging (ELK/Graylog), and Alerting. Tracing (Jaeger/Zipkin) for microservices. **SRE (Site Reliability Engineering) Basics,** Security Fundamentals, Authentication (OAuth 2.0, JWT), Authorization, Transport Layer Security (TLS/SSL). Defenses against common attacks (DDoS, SQL Injection, XSS), Fault Tolerance and Disaster Recovery.	10
6.	**Scaling Real-World Systems** Designing a URL Shortener (TinyURL), Distributed Shopping Cart Design, Designing a News Feed or Twitter Timeline, Designing a Distributed Key-Value Store	6
	TOTAL	42

Books Recommended:

Textbooks:

1. Martin Kleppmann, "Designing Data-Intensive Applications (DDIA)", O'Reilly 2017.
2. Alex Xu, "System Design Interview – An Insider's Guide (Volumes 1 & 2)", Independently published 2020/2021.
3. Mark Richards, Neal Ford, "Fundamentals of Software Architecture", O'Reilly 2020.

Reference Books:

1. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, John Friday, "Distributed Systems: Concepts and Design", Addison-Wesley 2021.
2. Google (Various Authors), "Site Reliability Engineering (SRE)", O'Reilly 2016.

NPTEL Courses:

1. Cloud Computing and Distributed Systems Cloud Computing - Course
2. Distributed Systems Cloud Computing and Distributed Systems - Course
3. Introduction to Database Systems Introduction to Database Systems - Course

Suggested Experiments:

Advanced System Design Laboratory (DJS23ALPE611)	
1.	**Back-of-the-Envelope Calculator:** Create a spreadsheet or simple program to quickly calculate storage (TB/year) and QPS for a given user base (e.g., 100M Daily Active Users).
2.	**SQL vs. NoSQL Schema Modeling:** Design the schema for a simple E-commerce cart: one using a normalized SQL model and one using a de-normalized Document/NoSQL model.
3.	**Consistent Hashing Simulation:** Implement a small simulation of Consistent Hashing (using a language of choice, e.g., Python) to observe key redistribution when 1 node is added and 1 node is removed from an initial 3-node cluster.
4.	**Data Sharding Design:** Propose 3 different sharding keys (e.g., `user_id`, `geolocation`, `date`) for a highly-used logging service and analyze the pros/cons of each (e.g., data skew, query access pattern).

5.	**LRU Cache Implementation:** Implement a simple in-memory LRU (Least Recently Used) Cache using a standard library (like a linked hash map or equivalent structure).
6.	**Cache-Aside vs. Write-Through Analysis:** Document the read/write steps and potential consistency issues for the Cache-Aside and Write-Through patterns for a user profile service.
7.	**Load Balancer Algorithm Selection:** Given a scenario (e.g., homogenous servers, stateful sessions, high heterogeneity), recommend and justify a Load Balancing algorithm (Round Robin, Least Connections, Weighted).
8.	**API Rate Limiter Logic:** Design the logic (using a Leaky Bucket or Token Bucket algorithm concept) to limit a user to 5 requests per second on a login API.
9.	**Asynchronous Task Design:** Design the interaction flow between a Web App, a Message Queue (MQ), and a Worker Service to process a video upload and encoding task.
10.	**Observability Stack Design:** Propose a 3-tool monitoring stack (Metrics, Logs, Tracing) for a microservices architecture and explain how it helps debug a P99 latency spike.
11.	**Circuit Breaker Implementation:** Design a component (pseudocode) that wraps a remote service call and implements the Circuit Breaker pattern (Closed, Open, Half-Open states).
12.	**JWT vs. Session Design:** Compare and contrast the Authentication workflow using traditional session cookies versus using JSON Web Tokens (JWT) for a mobile-first application.
13.	**URL Key Generation Algorithm:** Implement the logic (Base-62 or a simple Hash with collision handling) for generating and ensuring uniqueness for a 7-character short key.
14.	**Fan-out on Write vs. Read Cost Analysis:** Calculate the estimated write and read cost (in simple units) for a News Feed system with 1M users, comparing the Fan-out on Write vs. Fan-out on Read model assumptions.
15.	**Distributed Key-Value Store API:** Design the API (interfaces and methods) for a simple distributed K-V store, including methods for replication and failure handling (e.g., `put(key, value, quorum)`, `get(key, quorum)`).

Batch wise laboratory work of minimum ten experiments from the above suggested list or any other experiment based on syllabus will be include, which would help the learner to apply the concept learnt.

Prepared by Checked by HoD Vice Principal Principal

Program: Artificial Intelligence & Machine Learning	TY.B.Tech	Semester: VI
Course: IoT Foundations (DJS23ACPE612)		
Course: IoT Foundations Laboratory (DJS23ALPE612)		

Prerequisite: Microcontrollers and Sensor Fundamentals.

Course Objectives:

1. To learn concepts of sensors and their interfacing.
2. To introduce different architectures used for connected smart devices.
3. To study integration of AI with IoT and various protocols used in the IoT environment.

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

1. Understand the fundamentals and architecture of IoT and IIoT and interface sensors, actuators, and embedded devices for IoT applications.
2. Use IoT communication protocols and integrate data with cloud platforms.
3. Apply IoT analytics and visualization techniques for smart solutions.
4. Analyze industrial IoT frameworks, standards, and security mechanisms.

Detailed Syllabus: IoT Foundations (DJS23ACPE612)		
Unit	**Description**	**Duration**
1	**Introduction to IoT:** Definition, evolution, and characteristics of IoT. Components: Things, Internet, Data, Cloud. IoT Ecosystem and Reference Architectures (3-layer, 5-layer). IoT Communication Models: Device-to-Device, Device-to-Cloud, Cloud-to-Cloud. Applications: Smart Home, Smart City, Healthcare, Agriculture, Energy.	05
2	**IoT Hardware and Software Components:** Sensors, actuators, and embedded platforms (Arduino, Raspberry Pi, ESP32). Communication Modules: Wi-Fi, Bluetooth, ZigBee, LoRa, RFID, NFC. Edge devices and gateways. IoT Operating Systems: Contiki, RIOT, FreeRTOS.	07
3	**IoT Communication Protocols:** IPv6, 6LoWPAN, MQTT, CoAP, HTTP/HTTPS, AMQP. Shared memory vs. message passing. Cloud Integration: AWS IoT, Azure IoT Hub, Google Cloud IoT. Case Studies: Smart Home, Smart Agriculture.	07
4	**IoT Data Management and Analytics:** IoT data lifecycle and characteristics. IoT cloud storage (ThingSpeak, Firebase). Edge and Fog Computing concepts. IoT Analytics – real-time dashboards, anomaly detection, data visualization. Case Study: Smart Energy Management.	07
5	**Industrial Internet of Things (IIoT):** Introduction to IIoT and Industry 4.0. IIoT Architecture and Reference Models (IIRA, RAMI 4.0). Industrial Connectivity: OPC-UA, Modbus, PROFINET. M2M Communication. Use Cases: Manufacturing, Energy, Transportation, Robotics. **IoT Security, Standards and Governance:** IoT Security challenges,	10

	Authentication, Authorization, and Encryption. Privacy and data protection mechanisms. IoT Standards and Frameworks: IEEE, IETF, ITU, ISO, NIST. Ethical and Governance aspects in IoT.	
6	**Emerging Trends and Case Studies:** Digital Twins, Cyber-Physical Systems, AI and ML in IoT, 5G and IoT, Sustainable IoT, and Green Computing. Case Studies: Smart Manufacturing, Smart Grid, Connected Vehicles.	07
	TOTAL	**42**

Books Recommended:

Textbooks:

1. Arshdeep Bahga & Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, ISBN 9788173719547.
2. Raj Kamal, *Internet of Things: Architecture and Design Principles*, McGraw Hill, ISBN 9789352605224.
3. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress, ISBN 9781484220467.
4. Olivier Hersent et al., *The Internet of Things: Key Applications and Protocols*, Wiley, ISBN 9781119958352.
5. NPTEL Course: *IoT and Applications* by Prof. Sudip Misra, IIT Kharagpur.

Reference Books:

1. Pethuru Raj, Anupama C. Raman, *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press.
2. Dirk Slama et al., *Enterprise IoT: Strategies and Best Practices for Connected Products and Services*, O'Reilly Media.
3. Jan Holler et al., *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, Academic Press.
4. Aloknath De, *Industrial Internet of Things (IIoT): Applications, Challenges and Standards*, McGraw Hill.

Web Links:

1. Cisco Networking Academy – Introduction to IoT - https://www.netacad.com/courses/iot/introduction-iot
2. ThingSpeak IoT Analytics Platform (MathWorks) - https://thingspeak.com/
3. AWS IoT Core Developer Guide - https://docs.aws.amazon.com/iot/latest/developerguide/what-is-aws-iot.html
4. IBM: What is Industrial IoT (IIoT)? - https://www.ibm.com/topics/iiot
5. NIST Cybersecurity for IoT Program - https://www.nist.gov/programs-projects/cybersecurity-iot-program

Suggested Experiments:

IoT Foundations Laboratory (DJS23ALPE612)	
Sr. No.	**Title of Experiment**
1	Introduction to Arduino/Raspberry Pi – setup and environment configuration.
2	Interfacing temperature and motion sensors with Arduino/Raspberry Pi.

3	IoT-based LED control using MQTT protocol (Node-RED or Mosquitto).
4	Real-time data acquisition and visualization using ThingSpeak
5	Smart Home automation using Wi-Fi and cloud dashboard
6	Implementation of MQTT and CoAP communication protocols.
7	Edge computing demo using ESP32 and local data processing.
8	Industrial data communication using Modbus protocol (simulation).
9	IoT security demonstration using SSL/TLS in MQTT communication.
10	Implement Cloud Integration and Data Logging using Firebase
11	Implement Smart Agriculture Monitoring using LoRa Communication
12	Deploy a simple machine learning model (e.g., vibration anomaly detection) on an ESP32 or Arduino Nano etc.
13	Digital Twin Simulation for a Smart Factory
14	Temperature and Humidity Monitoring with Edge Data Filtering
15	Mini-project: Design a prototype IoT/IIoT solution integrating sensors, cloud, and analytics.

Batch wise laboratory work of minimum ten experiments from the above suggested list or any other experiment based on syllabus will be include, which would help the learner to apply the concept learnt.

Program: Artificial Intelligence & Machine Learning	TY.B.Tech.	Semester:VI
Course: Cyber Security and Ethical Hacking (DJS23ACPE613)		
Course: Cyber Security and Ethical Hacking Laboratory (DJS23ALPE613)		

Prerequisite: Computer Network.

Course Objectives:

1. To prepare students with the technical knowledge and skills needed to protect and defend cyber-attacks and understand ethical hacking methodology
2. To analyse and understand security attacks, web server vulnerabilities and prevention techniques to avoid exploitation.

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

1. To understand the breaching process of cyber threats.
2. To apply the knowledge of different cryptographic algorithm
3. To identify different Cyber-attacks and apply Cyber Security mechanisms.
4. Analyze and evaluate the cyber security needs of an organization.
5. Conduct a web security attack and demonstration of attack detection techniques.
6. Measure the performance and troubleshoot cyber security systems.

Cyber Security and Ethical Hacking (DJS23ACPE613)		
Unit	**Description**	**Duration**
1	**Introduction to Cyber Security:** Overview of Cyber Security, Internet, Governance – Challenges and Constraints, Cyber Threats, Vulnerabilities and its types Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, Need for an International convention on Cyberspace. **Cyber Security Safeguards**: Cyber security safeguards- overview, access control, audit, authentication, biometrics, cryptography, deception, denial of service filters, ethical hacking, firewalls, intrusion detection systems, response,scanning, security policy, threat management.	07
2	**Cryptography:** Introduction to Cryptography, stream and block cipher, Symmetric key (DES and AES) and Asymmetric key Cryptography (RSA), Key exchange protocol (DH), Hash algorithm(MD5 and SHA1, SHA256), Message Authentication code(MAC), Public key Infrastructure(PKI), Digital Signatures	08
3	Introduction to AI Security,Overview of AI Security: Need, challenges, and importance,Threat landscape in AI systems Multi-Agent Systems (MAS) and Security: Overview of Multi-Agent Systems (MAS): Agents, environment, communication Security challenges in MAS: Trust, deception, coordination, and privacy	07

4	**Overview of Ethical hacking Methodology:** Ethical hacking process, Hacker's behaviour & mindset, Maintaining Anonymity, Hacking Methodology, Information Gathering, Active and Passive Sniffing, Physical security vulnerabilities and countermeasures. Internal and External testing.	07
5	**Attacks and countermeasures:** Social Engineering attacks and countermeasures. Password attacks, Privilege Escalation and Executing Applications, Network Infrastructure Vulnerabilities, IP spoofing, DNS spoofing, Wireless Hacking: Wireless footprint, Wireless scanning and enumeration, Gaining access (hacking 802.11), WEP, WPA, WPA2.	06
6	**Web server vulnerabilities and exploitation:** DoS attacks, Web server and application vulnerabilities, SQL injection attacks, Vulnerability Analysis and Reverse Engineering, Buffer overflow attacks. Client-side browser exploits, Exploiting Windows Access Control Model for Local Elevation Privilege. Exploiting vulnerabilities in Mobile Application.	07
	TOTAL	**42**

Books Recommended:

Textbooks:

1. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill..
2. Baloch, R., Ethical Hacking and Penetration Testing Guide, CRC Press, 2015.

Reference Books:

1. Sunit Belapure Nina Godbole, Cyber Security, Wiley India Pvt. Harish Chander, Cyber Laws
2. Davidoff, S. and Ham, J., Network Forensics Tracking Hackers through Cyberspace, Prentice Hall, 2012

Web Links:

1. Web resources:

Cybrary: Cybersecurity Fundamentals : https://www.cybrary.it/course/intro-to-it-and-cybersecurity/

Ethics & Law: https://www.eccouncil.org/ethics/

2. Online Courses: NPTEL / Swayam:

1. An advanced course focusing on cybersecurity concepts, technologies, and practices with a managerial perspective.: https://onlinecourses.nptel.ac.in/noc23_cs127/preview?utm_source=chatgpt.com
2. Ethical Hacking: https://onlinecourses.nptel.ac.in/noc23_cs44/preview?utm_source=chatgpt.com
3. Practical Cyber Security for Cyber Security Practitioners: https://onlinecourses.nptel.ac.in/noc25_cs120/preview?utm_source=chatgpt.com

Suggested List of Experiments:

Cyber Security and Ethical Hacking Laboratory (DJS23ALPE613)	
Sr. No.	**Title of the Experiment**
1	Hands-on Cyber Lab Environment Setup with Cyber Ethics & Legal Response Analysis
3	Packet capture and protocol analysis: Analyzing Network Traffic through Packet Capture Techniques
4	Nmap scanning: Network Scanning and Enumeration Using Nmap
5	Passive reconnaissance & OSINT: Open-Source Intelligence (OSINT) Based Passive Information Gathering
6	Password cracking basics: Exploring Basic Password Cracking Methods and Tools
7	Web app mapping & Burp Suite basics: Web Application Structure Mapping Using Burp Suite Tools
8	SQL Injection – discovery and exploitation: Discovering and Exploiting SQL Injection in a Secure Practice Setup
9	Malware analysis (static): Static Malware Inspection and Feature Extraction
10	Wireless security (WEP/WPA2 testing): esting and Analyzing Wireless Security Protocols (WEP/WPA2)
11	Log analysis & SIEM basics: Log Management and SIEM Analysis Techniques
12	Password Strength Assessment. Implement AI tools to evaluate and improve password policies
13	Automated Web Application Security Testing. Scan for vulnerabilities like SQL injection or XSS using AI-enhanced scanners
14	Generative Adversarial Networks (GANs) for Security. Use GANs both to create synthetic threats for testing defense systems and to detect fake content perpetrated by attackers.
15	Threat Modeling: Analysis and Evaluation of System Security through Threat Modeling

Batch wise laboratory work of minimum ten 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.

Program: Artificial Intelligence & Machine Learning	TY.B.Tech.	Semester :VI
Course: Agentic and Explainable AI (DJS23ACPE614)		
Course: Agentic and Explainable AI Laboratory (DJS23ALPE614)		

Prerequisite:

1. Basic **Python programming** and familiarity with libraries like numpy, pandas, and matplotlib.
2. Understanding of **Machine Learning** and **Deep Learning** fundamentals (e.g., model training, evaluation, and architecture concepts).
3. Introductory knowledge of **AI concepts** such as reasoning, environment, and search algorithms.
4. Familiarity with **API integration** and simple web frameworks (Flask or Streamlit) is recommended but not mandatory.

Course Objectives (At the end of course, student will be able to):

1. Introduce the evolution of AI from traditional systems to *agentic* architectures with autonomy, reasoning, and goal-oriented behavior.
2. Explore Explainable AI (XAI) principles, techniques, and frameworks for building transparent and ethical AI systems.
3. Provide hands-on experience with OpenAI tools and APIs for developing intelligent, multimodal, and explainable agents.
4. Integrate concepts of agentic design and explainability to create trustworthy, real-world AI applications.

Course Outcomes:

1. Explain the principles and architecture of agentic AI systems, including perception, reasoning, memory, and goal-setting.
2. Apply Explainable AI (XAI) techniques such as LIME, SHAP, and Grad-CAM to interpret and evaluate AI model decisions.
3. Design and implement agentic systems and chat-based applications using OpenAI APIs and frameworks such as LangChain or AutoGen.
4. Integrate explainability into agentic decision-making to develop transparent, ethical, and accountable AI solutions.

Agentic and Explainable AI (DJS23ACPE614)		
Unit	**Description**	**Duration**
1.	**Foundations of Agentic AI** Evolution of AI: From Rule-based → Machine Learning → Generative → Agentic AI, What makes an AI *agentic*: autonomy, perception, reasoning, memory, goal-setting, planning, and reflection, Components of agent architecture (environment, sensors, actuators, policies), Categories: Reactive agents, Deliberative agents, Hybrid models, Frameworks and tools: LangChain, AutoGen, CrewAI, HuggingFace Agents, LlamaIndex Case examples: personal	7

	assistants, autonomous research bots, recommender agents.	
2.	**Multi-Agent Systems and Coordination** Introduction to multi-agent environments, Communication and coordination: messaging, negotiation, task allocation, Emergent behavior, cooperation vs competition, Role-based and hierarchical agent design (planner, executor, verifier), Applications in distributed AI, simulations, and research agents, Frameworks: AutoGen multi-agent, LangGraph, CrewAI orchestrations	7
3.	**Explainable AI (XAI) Foundations** Motivation and need for explainability in AI, Key concepts: interpretability, transparency, accountability, Ethics and fairness in AI, Techniques: LIME, SHAP, Grad-CAM, Counterfactual explanations, Interpreting ML/DL models (decision trees, CNNs, transformers), XAI for Large Language Models (LLMs), Evaluation of explainability metrics	7
4.	**OpenAI Ecosystem and API Integration** Overview of OpenAI's tools and APIs: GPT (text), DALL·E (image), Whisper (audio), Embeddings, Codex, OpenAI API structure and authentication, Using API for NLP, vision, and multimodal tasks, Building chatbots, tutors, and assistants using GPT models, Prompt design and engineering, Fine-tuning overview and parameter-efficient methods, Integration with Python, Flask, or Streamlit	7
5.	**Integrating XAI with Agentic AI** Explainable decision-making within agents, Designing agents that justify their actions, Generating and surfacing "reasoning traces" safely, Case study: AI Tutor that explains learning path, AI Recommender that clarifies suggestions, Combining XAI frameworks (SHAP, LIME) with agent reasoning, Frameworks and patterns for XAI + Agentic design	7
	Applications and Future Directions Design and implementation of Explainable AI Agents using OpenAI tools, Example projects: AI Healthcare Assistant with Explainability, Financial Advisory Bot with Transparent Recommendations, Autonomous Research Assistant using OpenAI + XAI, Local Data Chatbot with Explainable Responses, Handling local/private data securely, Trends: self-reflective agents, goal memory, retrieval-augmented reasoning, ethical AI, Open-source & enterprise deployment (LangServe, FastAPI)	7
	TOTAL	42

Books Recommended:

Textbooks:

1. Anjanava Biswas, Wrick Talukdar, "Building Agentic AI Systems", O'Reilly 2025.
2. Mayuri Mehta, Vasile Palade, Indranath Chatterjee, "Explainable AI (XAI): Foundations, Methodologies and Applications", Springer 2023.
3. Michael Munn, David Pitman, "Explainable AI for Practitioners", O'Reilly 2022.

Reference Books:

1. Michael Lanham, "AI Agents in Action", Manning 2025.
2. Nicole Koenigstein, "AI Agents: The Definitive Guide", O'Reilly 2025.

NPTEL Courses:

1. An Introduction to Artificial Intelligence https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. Artificial Intelligence: Concepts and Techniques https://onlinecourses.nptel.ac.in/noc25_cs159/preview
3. Fundamentals of Artificial Intelligence https://onlinecourses.nptel.ac.in/noc22_ge47/preview
4. Programming with Generative AI https://onlinecourses.nptel.ac.in/noc25_cs137/preview
5. Responsible & Safe AI Systems https://onlinecourses.nptel.ac.in/noc24_cs132/preview

Suggested Experiments:

Agentic and Explainable AI Laboratory (DJS23ALPE614)	
Sr. No.	**Title of Experiment**
1	Implement a simple reactive AI agent (rule-based)
2	Create a goal-based agent with memory and reasoning
3	Build a multi-agent chat (planner & executor) using LangChain
4	Implement communication between agents (task delegation)
5	Train and interpret a decision tree using LIME
6	Use SHAP to interpret a neural network
7	Visualize CNN activations using Grad-CAM
8	Query OpenAI GPT API for text summarization and explain results
9	Build a custom chatbot with memory using OpenAI + LangChain
10	Add explainability layer to chatbot (show reasoning path)
11	Create an explainable recommendation system (e.g., course or movie)
12	Design a local data QA chatbot with vector embeddings
13	Implement a healthcare advisor agent with explainable suggestions
14	Integrate Whisper (speech-to-text) + GPT (response) for an explainable voice agent
15	Mini project: Multi-agent explainable system (research assistant or advisor)

Batch wise laboratory work of minimum ten experiments from the above suggested list or any other experiment based on syllabus will be include, which would help the learner to apply the concept learnt.

Program: Artificial Intelligence & Machine Learning	TY.BTech	Semester: VI
Course: Time Series and Financial Analysis (DJS23ACPE615)		
Course: Time Series and Financial Analysis Laboratory (DJS23ALPE615)		

Prerequisite: - Basic Statistics and Probability, Knowledge of Regression Analysis, Fundamentals of Financial Concepts — returns, volatility, and risk measures.

Course Objectives:

1. To introduce fundamental concepts of time series data, its structure, components, and patterns with emphasis on financial and economic datasets.
2. To develop an understanding of methods for identifying trends, seasonality, and randomness in time series and their statistical properties.
3. To apply smoothing and regression-based techniques for forecasting and model building
4. To Explore models incorporating trend and volatility such as ARCH and GARCH, and understand their applications in financial data modelling.
5. To Integrate modern computational tools for data acquisition, pre-processing, and forecasting of financial time series, emphasizing real-world case studies.

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

1. Describe the fundamental components, types, and properties of time series data and explain concepts of stationarity and stochastic processes.
2. Apply descriptive and smoothing techniques (moving averages, exponential smoothing, regression) for trend and seasonal analysis
3. Construct and estimate parameters of AR, MA, ARMA, and ARIMA models using statistical tools.
4. Evaluate models with trend and intervention effects; perform VAR and Monte Carlo simulation for multivariate time series.
5. Implement and interpret nonlinear time series models such as ARCH and GARCH for financial volatility modelling.
6. Acquire, pre-process, and forecast financial data using time series and machine learning-based approaches.

Time Series and Financial Analysis (DJS23ACPE615)		
Unit	**Description**	**Duration**
1.	**Introduction to Time Series**: Definition of a time series, Interpolation vs Extrapolation, Components of time series, Types of Time Series, Types of time series patterns, different types of data, simple descriptive techniques, Trends in time series (Parametric trends, differencing, non-parametric methods, noise), measurement of trends, seasonality, seasonal indices, stochastic processes. Stationary Time Series: the sample mean and its standard error, Stationary processes (weak and strict), statistical inference of time series.	08

2.	**Smoothening Methods:** Regression analysis and forecasting- Least square estimation, Regression models for General Time Series Data, Autocorrelation detection using Durbin Watson Test, Estimating Parameters in Time Series. Exponential Smoothening Methods- 1st Order exponential smoothening, 2nd Order exponential smoothening, higher order exponential smoothening, Forecasting, exponential smoothening for seasonal data.	08
3.	**Autoregressive Integrated Moving Average:** Autocorrelation function (ACF) and Partial Autocorrelation function (PACF) plot, Linear time series and MA models, theoretical properties of time series with a MA (1) and MA (2) model, The AR model, simulating from an autoregressive process, The ARMA model, The ARIMA model Forecasting ARIMA processes, SARIMA model.	08
4.	**Models with Trend:** Removing trend, Unit Root (Augmented Dickey Fuller Test) and Regression Residuals, The Monte Carlo Method, Multi-equation Time Series Models: Intervention Analysis, Estimating the Intervention Effect, ADLs and Transfer Functions, Introduction to VAR Analysis.	06
5.	**Non Linear Time series**: The ARCH model: Feature of an ARCH, interpretation of ARCH model, The GARCH model: Existence of stationary solution of a GARCH(1,1) and Bilinear models.	06
6.	**Financial Data Analysis using Time Series:** Obtaining and exploring Financial Data, pre-processing financial data for deep learning, adding quantities of Interest, scaling, building and training forecasting models. Case studies on Financial forecasting using: Smoothening, Autoregressive models and Nonlinear time series.	06
	TOTAL	**42**

Books Recommended:

Textbooks:

1. Introduction to Time Series Analysis and Forecasting, Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, 2nd Edition, Wiley

2. Practical Time Series Analysis Prediction with Statistics & Machine Learning, Aileen Nielsen, O'reilly

Reference Books:

1. Time Series Analysis with Python Cookbook: Practical recipes for exploratory data analysis, data preparation, forecasting, and model evaluation, Tarek A. Atwan, Packt Publishing Limited, 2022
2. Hands-on Time Series Analysis with Python, B. V. Vishwas and Ashish Patel, APress 2020
3. Time Series Analysis and Its Applications : With R Examples, Robert H. Shumway and David S. Stoffer, 4th Edition, Springer

4. Time Series Databases: New Ways to Store and Access Data, Ted Dunning and Ellen Friedman, First Edition, O'Reilly, 2019

Web Links:

1. MIT Open courseware: https://ocw.mit.edu/courses/14-384-time-series-analysis-fall-2013/pages/lecture-notes/
2. Penn state Eberly College of Science: https://online.stat.psu.edu/stat510/
3. Forecasting: Principles and Practice (3rd ed): https://otexts.com/fpp3/
4. NIST Engineering Statistic Handbook : https://www.itl.nist.gov/div898/handbook/pmc/section4/pmc4.htm

Suggested List of Experiments

Time Series and Financial Analysis (DJS23ALPE615)	
Sr. No.	**Title of Experiment**
1	Detecting Trend in Time Series Data
2	Detecting Seasonality in Time Series Data
3	Time Series Decomposition
4	Exploratory Data Analysis of Time Series Data
5	Data Wrangling and Pre-processing for Time Series
6	Stationarity Testing and Making data stationary
7	Smoothening methods in Time Series
8	2nd order and Higher Order Exponential Smoothening
9	Autoregressive Moving Average Models
10	ARIMA and SARIMA Models
11	VAR Models
12	ARCH and GARCH Models
13	Review of Research articles
14	Mini Project

Minimum ten 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

Program: Artificial Intelligence & Machine Learning	TY.B. Tech.	Semester: VI
Course: Probabilistic Graph Models (DJS23ACPE616)		
Course: Probabilistic Graph Models Laboratory (DJS23ALPE616)		

Pre-requisite: Machine learning, Probability

Course Objectives:

The objectives of this course are

1.To model problems using graphical models
2. To design inference algorithms
3. To learn the structure of the graphical model from data.

Course Outcomes: Students will be able to

1. Explain the basic fundamentals of probabilistic graph theory.
2. Illustrate various principles of graph theory and algorithms.
3. Integrate core theoretical knowledge of graph theory to solve problems.

Probabilistic Graph Models (DJS23ACPE616)		
Unit	**Description**	**Duration**
1	**Fundamentals:** Overview and Motivation of Probabilistic Graphical Models, Structured Probabilistic Models, Marginal and Joint Distributions, Independence and Conditional Independence, Factors. **Representation of Bayesian networks:** Semantics and Factorization, Reasoning Patterns, Flow of Probabilistic Influence, Conditional Independence, Independence in Bayesian Networks, Naïve Bayes, Applications.	6
2	**Temporal Models of Bayesian Network:** Overview of Temporal Models, Dynamic Bayesian Networks (DBN), Hidden Markov Model (HMM), Plate Models. Representation of Structured CPDs: Overview of Structured CPDs, Tree-Structured CPDs, Independence of Casual Influence, Continuous Variable, Applications.	7
3	**Representation of Markov networks:** Pairwise Markov Networks, General Gibbs Distribution, Conditional Random Fields, Independencies in Markov Networks, Imaps and perfect maps	6
4	**Exact inference:** Conditional Probability Queries, MAP Inference, Analysis of Complexity, Sum- and Max-product algorithms, Variable elimination, Belief propagation (message passing) on trees, Clique tree.	7
5	**Inference and sampling methods:** Simple Sampling, MCMC method, Gibbs sampling Algorithm, Importance sampling, Particle filtering.	7

6	**Learning Parameter Estimation:** Learning Overview, Maximum Likelihood Estimation for Bayesian Networks, Bayesian Estimation, Bayesian Prediction, Bayesian Estimation for Bayesian Networks. Maximum Likelihood for Log-Linear Models, Maximum Likelihood for MRFs and CRFs. Structure Learning: Overview, Likelihood Scores, BIC and Asymptotic Consistency, Bayesian Scores, Learning Tree Structured Networks, Learning General Graphs: Heuristic Search	9
	TOTAL	**42**

Books Recommended:

Text Books:

1. Koller, D. and Friedman, N. "Probabilistic Graphical Models: Principles and Techniques," MIT Press, 2009.

Reference Books:

1. Jensen, F. V. and Nielsen, T. D. "Bayesian Networks and Decision Graphs. Information Science and Statistics," 2nd edition, Springer, 2002.
2. Luis Enrique Sucar, "Probabilistic Graphical Models Principles and Application", Advances in Computer Vision and Pattern Recognition, Second Edition, Springer, 2021
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective," 4th Printing. MIT Press, 2013.
4. Barber, D. "Bayesian Reasoning and Machine Learning," 1st edition, Cambridge University Press, 2011.
5. Bishop, C. M. "Pattern Recognition and Machine Learning (Information Science and Statistics)". 2nd printing, Springer, 2011.
6. Wainwright, M. and Jordan, M. "Graphical Models, Exponential Families, and Variational Inference," Foundations and Trends in Machine Learning, 2008.
7. Ankur Ankan, Abinash Panda Mastering Probabilistic Graphical Models with Python Packt Publishing

Web Resources Blogs and Websites:

1. https://www.coursera.org/specializations/probabilistic-graphical-models?msockid=0fba0991cc8d64af281a1ae9cd3f657a
2. https://createmomo.github.io/2019/01/07/Probabilistic-Graphical-Models-Revision-Notes/
3. https://github.com/mcharrak/probabilistic-graphical-models-PGM-representation-coursera-daphne-koller

Online Resources

1. Probabilistic Graphical Models : https://girishvarma.in/teaching/prob-graph-models/
2. COL 776: Learning Probabilistic Graphical Models: https://www.cse.iitd.ac.in/~parags/teaching/2015/au15/col776/

Suggested List of Experiments:

Probabilistic Graph Models Laboratory (DJS23ALPE616)	
Sr. No.	**Title of the Experiment**
1	Implement Discrete Bayesian Networks
2	Implementation of Alarm Bayesian Network
3	Implementation of Linear Gaussian Bayesian Networks (GBNs).
4	Implementation of Monty Hall Problem using Bayesian Network
5	Implementation of Exact inference in Bayesian Networks.
6	Implementation of Inference in Discrete Bayesian Network
7	Implementation of Causal Inference
8	Implement Approximate Inference using MCMC.
9	Implementation of Parameter Learning in Discrete Bayesian Networks.
10	Implementation of Dynamic Bayesian Networks (DBNs) for Temporal Modeling
11	Implementation of Nonlinear Conditional Dependencies in Continuous Bayesian Networks
12	Comparative Analysis of Exact and Approximate Inference Techniques
13	Mini project

Minimum ten 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.

Program: Artificial Intelligence & Machine Learning	TY. B.Tech.	Semester:VI
Course: DevOps and MLOps (DJS23ACMD601)		
Course: DevOps and MLOps Laboratory (DJS23ALMD601)		

Prerequisite: Machine Learning.

Course Objectives:

1. To understand the need for DevOps as a software engineering practice.
2. To know and understand the concept of Continuous Integration Continuous Delivery (CICD).
3. To learn the concept of continuous deployment and monitoring strategies.
4. To learn various tools used in DevOps
5. To comprehend the concepts and deployment strategies in MLOps

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

1. Understand the fundamental concepts of DevOps
2. Comprehend the concept of continuous integration and continuous delivery
3. Compare various stages of continuous deployment and monitoring strategies
4. Explore various tools to implement concepts in DevOps
5. Describe the concepts used in the automation of Machine Learning life cycle phases
6. Elaborate deployment strategies in MLOps

DevOps and MLOps (DJS23ACMD601)		
Unit	**Description**	**Duration**
1	**Introduction:** Software Engineering- process framework, Software Development Life Cycle (SDLC) Process Models: Incremental and Evolutionary models. **Fundamentals of Agile Process**: Need of Agile software development, Overview of Agile Development Models: Scrum, Extreme Programming, Feature Driven Development. **Devops**: Introduction to Devops, History of Devops, Devops definition, DevOps Main Objectives, Continuous Integration & Deployment, Containers and Virtual Development, Configuration Management Tools.	06
2	**Source Code Management:** Version Control: GIT Features, 3-Tree Architecture, GIT – Clone /Commit / Push, GIT Hub Projects, GIT Hub Management, GIT Rebase & Merge, GIT Stash, Reset, Checkout, GIT Clone, Fetch, Pull, Membership GITHUB **Continuous Integration and Continuous Delivery:** Jenkins Architecture, Integrating Source code management, Continuous delivery to a staging environment or the pre-production, environment, Self-healing systems.	06

3	**Continuous Deployment and Continuous Monitoring**: **Implementing a testing Strategy:** Types of Tests, **Continuous Deployment:** Trade-offs in the deployment pipeline, Basic Deployment pipeline, Deployment pipeline practices & Commit stage, Automated Acceptance Test Gate, **Factors involved in monitoring systems:** white-box and black-box monitoring, building a monitoring system, Site reliability engineering, SRE and DevOps, roles, and responsibilities of SRE, common tools used by SREs.	06
4	**Configuration Management:** The Process of Configuration in Devops. Docker introduction, Docker Image, working with Docker Containers, Devops Monitoring Tool: Introduction to Nagios, Architecture. Virtualization and Containerization Difference between orchestration: Introduction to Kubernetes and automation.	06
5	**Introduction to MLOps and ML Model Deployment :** MLOps Motivation, MLOps (ML Engineering + Operations), Machine Learning Life Cycle, MLOps Vs DevOps, **Data Management, Model Development and Training for MLOps** Model Development and Training for MLOps, Data versioning and reproducibility, Data preprocessing and feature engineering pipelines, Data validation and monitoring, Data quality assurance and governance, Model versioning and tracking. Creating and deploying ML/AI models, MLOps: Testing, Monitoring and Maintenance	04
	TOTAL	**28**

Books Recommended:

Textbooks:

1. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication, 2nd edition, 2018.
2. PierluigiRiti, “Pro DevOps with Google Cloud Platform”, Apress, ISBN: 978-1-4842-3896-7.
3. Gene Kim, Kevin Behr, George Spafford “The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business” It Revolution Press publication, 2018.
4. Gene Kim, Patrick Debois, John Willis, Jez Humble “The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations” IT Revolution Press, 2021.
5. Noah Gift , "Practical MLOps: A Guide to Building Real-World Machine Learning Systems", O'Reilly, First Edition, September 2021.

Reference Books:

1. Viktor Farcic, “The DevOps 2.0 Toolkit: Automating the Continuous Deployment Pipeline with Containerized Microservices”
2. Jennifer Davis and Katherine Daniels, “Effective DevOps: Building a Culture of Collaboration, Anity, and Tooling at Scale”, O’Reilly Media, Inc., ISBN: 978-1-491-92630-7
3. Sanjeev Sharma and Bernie Coyne, “DevOps for Dummies”, John Wiley & Sons, Inc., 2nd

IBM Limited Edition, ISBN: 978-1-119-04705-6

4. Sridhar Alla, Suman Kalyan Adari, Beginning MLOps with MLFlow: Deploy Models in AWS SageMaker, Google Cloud, and Microsoft Azure
5. Mark Treveil, Nicolas Omont, "Introducing MLOps: How to Scale Machine Learning in the Enterprise", O'Reilly Media, First Edition, January 5, 2021
6. Chris Fregly, Antje Barth, "Data Science on AWS: Implementing End-to-End Continuous Machine Learning Pipelines", O'Reilly, First Edition, 9 May 2021.

Web Links:

1. https://www.redhat.com/en/resources/cloud-native-container-design-whitepaper
2. https://www.redhat.com/en/topics/cloud-native-apps/what-is-serverless
3. https://www.redhat.com/en/topics/automation/what-is-orchestration
4. https://www.atlassian.com/continuous-delivery/continuous-integration
5. https://www.flagship.io/glossary/site-reliability-engineer/
6. https://docs.microsoft.com/en-us/learn/paths/intro-to-vc-git/
7. https://www.javatpoint.com/kubernetes
8. https://www.javatpoint.com/docker-tutorial
9. https://www.javatpoint.com/jenkins
10. https://www.javatpoint.com/jenkinss
11. https://www.javatpoint.com/ansible
12. https://www.javatpoint.com/selenium-tutorial
13. https://prometheus.io/docs/introduction/overview/
14. https://www.javatpoint.com/jira-tutorial
15. https://www.geeksforgeeks.org/what-is-elastic-stack-and-elasticsearch/
16. Coursera: Machine Learning Engineering for Production (MLOps) Specialization by Andrew Ng
17. Coursera: "Machine Learning Engineering for Production (MLOps)" by deeplearning.ai. This course provides a comprehensive introduction to MLOps, covering topics like data and model versioning, deployment, monitoring, and more.
18. Udacity: "Machine Learning Deployment" by Google Cloud. This course focuses on deploying and scaling machine learning models using Google Cloud technologies and covers MLOps principles.

Suggested List of Experiments:

DevOps and MLOps Laboratory (DJS23ALMD601)	
Sr. No.	**Title of the Experiment**
1	Develop a web application and Deploy on the github. To Study DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities
2	To configure Scrum and Kanban boards in JIRA, create sprints, and visualize issue progress.
3	To carry out Version Control System / Source Code Management on the web application, install git and create a GitHub account.
4	To Perform various GIT operations on local and Remote repositories using GIT Cheat-

	Sheet
5	Continuous Integration, install and configure Jenkins with Maven/Ant/Gradle to setup a build Job on the above web application.
6	To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an above application over the tomcat server.
7	To Setup and Run Selenium Tests in Jenkins Using Maven on on the above web application.
8	To study Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers.
9	To study Dockerfile instructions, build an image for a sample web application using Dockerfile.
10	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet.
11	To perform Software Configuration Management and provisioning using Puppet Blocks (Manifest, Modules, Classes, Function).
12	Setting up a Version Control System (VCS) for ML Projects: a) Experiment with popular VCS tools like Git and create a repository for ML projects. b) Learn to track code changes, collaborate with team members, and manage different branches.
13	Creating a Continuous Integration (CI) Pipeline: a) Build a CI pipeline using tools like Jenkins, Travis CI, or GitLab CI. b) Automate the process of building, testing, and validating ML models with each code commit
14	Containerization with Docker: a) Containerize ML models and their dependencies using Docker. b) Experiment with Docker images, containers, and Dockerfile configurations
15	Orchestrating ML Workflows with Kubernetes: a) Deploy ML models as scalable and resilient services using Kubernetes. b) Experiment with deploying, managing, and scaling ML workloads in Kubernetes clusters.use tool like Microsoft Azur/AWS
16	Experiment Tracking and Management: a) Use tools like MLflow or Neptune.ai to track experiments, log metrics, and manage model versions. b) Explore features like hyperparameter tuning, model registry, and experiment reproducibility
17	Mini Project: Example like AI Model Monitoring and Explainability Post-Deployment Security and Maintenance. Model Metrics Logging with MLflow Detecting Data Drift Using EvidentlyAI Building a Grafana Dashboard for AI Model Monitoring Local Kubernetes deployment Deploying to AKS and CI/CD Etc..

Batch wise laboratory work of minimum ten 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.

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Innovative Product Development IV(DJS23IPSCX04)		

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-book 10
  - 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 committee10

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

- In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.
- First shall be for finalisation of the product selected.
- Second shall be on finalisation of the proposed design of the product.
  - In the semester VI, the expected work shall be procurement of components/systems, building of the working prototype, testing and validation of the results based on work completed in semester III.
- First review is based on readiness of building the working prototype.
- Second review shall be based on a presentation as well as the demonstration of the working model, during the last month of semester IV. This review will also look at the readiness of the proposed technical paper presentation of the team.

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

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

- 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 IV.Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

Program: Artificial Intelligence & Machine Learning	TY. B.Tech.	Sem: VI
Course: Constitution of India (DJS23ICHSX09)		

Prerequisite: NA.

Course Objectives:

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

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

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Engineering ethics and responsibilities of Engineers.
6. Understand Engineering Integrity & Reliability.

Detailed Syllabus:

Constitution of India (DJS23ICHSX09)		
Unit	**Description**	**Duration**
1	**Introduction to the Constitution of India** The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution. Fundamental Rights & its limitations.	02
2	**Directive Principles of State Policy:** Relevance of Directive Principles, State Policy, Fundamental Duties. Union Executives – President, Prime Minister, Parliament, Supreme Court of India.	02
3	**State Executives:** Governor, Chief Minister, State Legislature, High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.	03
4	**Special Provisions:** For SC & ST, Special Provision for Women, Children & Backward Classes, Emergency Provisions.	02
5	**Human Rights:** Meaning and Definitions, Legislation Specific Themes in Human Rights, Working of National Human Rights Commission in India, Powers and functions of Municipalities, Panchayats and Co- Operative Societies.	03

6	**Scope & Aims of Engineering Ethics:** Responsibility of Engineers and Impediments to Responsibility. Risks, Safety and liability of Engineers. Honesty, Integrity & Reliability in Engineering.	02
	Total	14

Books

Text books:

1. Durga Das Basu, "Introduction to the Constitution on India", (Students Edition) Prentice Hall EEE, 19th / 20th Edition, 2001.
2. Charles E. Haries, Michael S. Pritchard and Michael J. Robins, "Engineering Ethics", Thompson Asia, 2003.

References:

1. M. V. Pylee, "An Introduction to Constitution of India", Vikas Publishing, 3rd Edition, 2003.
2. M. Govindarajan, S. Natarajan, V. S. Senthilkumar, "Engineering Ethics", Prentice Hall of India Pvt. Ltd. New Delhi, 2013.
3. Brij Kishore Sharma, "Introduction to the Constitution of India", PHI Learning Pvt. Ltd., New Delhi, 7th Edition 2015.
4. Latest Publications of Indian Institute of Human Rights, New Delhi

Online Resources:

1. www.nptel.ac.in
2. www.hnlu.ac.in
3. www.nspe.org
4. www.preservearticles.com