Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

NEP Compliant Structure & Syllabus of

Department of Computer Science and Engineering – Data Science Pattern 'A-24'

T. Y. B. Tech.

Effective from Academic Year 2026-27

Prepared by: - Board of Studies in Computer Science and Engineering – Data Science

Approved by: - Academic Board, Vishwakarma Institute of Technology,

Dr. Deepa Abin
Chairman-Bos

Dr. Parikshit Mahalle
Dean-Academics

Dr. Rajesh Jalnekar
Chairman-Academic Board

Bansilal Ramnath Agarwal Charitable Trust's
VISHWAKARMA INSTITUTE OF TECHNOLOGY – PUNE
(Autonomous Institute affiliated to Savitribai Phule Pune University)

Vision & Mission Statement

Institute

Vision:

Excellence in Technical Education with Holistic Development

Mission:

- To make the industry ready graduating engineers with high human values
- To Impart technical, social, innovative, and entrepreneurial skills of the highest standards.
- To prepare passing graduates for higher studies and high quality research.

Department of CSE (Data Science)

Vision:

Excellence in Data Science to empower the future of technology with holistic development

Mission:

- To equip students for industry, academia, research, and entrepreneurship by offering excellent education in emerging data science techniques.
- To empower students with ethical values and ensure their positive impact on society and beyond.
- To envision students with interdisciplinary skill sets, fully equipped to address the evolving needs of society.

Program Outcomes

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, social and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Academic Information – Please visit www.vit.edu

PSOs- Program Specific Outcomes

PSO-1: Apply Data Science techniques to extract valuable insights from real-world data for informed decision-making.

PSO-2: Apply Machine Learning and AI concepts for predictive modelling and intelligent system development.

PEOs- Program Educational Objectives

PEO 1 : To excel in a professional career in artificial intelligence, data science engineering, and related interdisciplinary domains by applying advanced knowledge and practical skills.

PEO 2 : To demonstrate a strong foundational understanding that supports higher education, research endeavors, and innovation in emerging areas of technology.

PEO 3 : To embody professional ethics, a commitment to lifelong learning, leadership qualities, and a collaborative spirit aimed at contributing meaningfully to society and promoting environmental sustainability.

Nomenclature for Teaching and Examination Assessment Scheme AY 2026-27

Sr No.	Category	Head of Teaching/ Assessment	Abbreviation used
1	Teaching	Theory	Th
2	Teaching	Laboratory	Lab
3	Teaching	Tutorial	Tut
4	Teaching	Open Elective	OE
5	Teaching	Multi-Disciplinary	MD
6	Teaching	Computer Science	CS
7	Assessment	Laboratory Continuous Assessment	CA
8	Assessment	Mid Semester Assessment	MSA
9	Assessment	End Semester Assessment	ESE
10	Assessment	Home Assignment	HA
11	Assessment	Course Project	CP
12	Assessment	Group Discussion	GD
13	Assessment	PowerPoint Presentation	PPT
14	Assessment	Class Test –1	CT1
15	Assessment	Class Test –2	CT2
16	Assessment	Mid Semester Examination	MSE
17	Assessment	End Semester Examination	ESE
18	Assessment	Written Examination	WRT
19	Assessment	Multiple Choice Questions	MCQ
20	Assessment	Laboratory	LABs

Contents

FF No.: 653

Structure of Third Year CSE-DS for Academic Year 2026-27

Course Code	Course Name	Type	Teaching Learning Scheme				
			Th	Tut	Lab	Hrs. / Week	Credits
Module 5 - Semester V							
DS3201	DEEP LEARNING	PCC	3		2	5	4
DS3202	PROMPT ENGINEERING	PCC	2		2	4	3
DS3203A DS3203B DS3203C	PROGRAM ELECTIVE-1	PEC	3		2	5	4
	PROGRAM ELECTIVE-2	PEC					3
	OPEN ELECTIVE	OE					4
MM0402A	MULTIDISCIPLINARY MINOR	MDM	2	1		3	3
DS3205	DESIGN THINKING-3/ INTERNATIONAL DESIGN THING MODULE	VSEC					1
DS3204	ENGINEERING RESEARCH AND INNOVATION-1/ INTERNATIONAL ENGINEERING DESIGN PROGRAM	PEC					2

Assessment Scheme

Course Code	Course Name	Type	ESE TH (W)	CV V	CP	GD/ PPT	Lab	MS E (R)	ES E (R)	H A	ESE Direct Evalu ation	PR AC T+ CV V	Total
DS3201	DEEP LEARNING	PCC	40									60	100
DS3202	PROMPT ENGINEERING	PCC	40	20	30		10						100
DS3203A DS3203B DS3203C	PROGRAM ELECTIVE-1	PEC		20	40	20				20			100
	PROGRAM ELECTIVE-2 (Coursera)	PEC									100		100
	OPEN ELECTIVE-1 (Coursera)	OE									100		100
MM0402A	MULTIDISCIPLINARY MINOR	MDM	40		30	20				10			100
DS3205	DESIGN THINKING-3/ INTERNATIONAL DESIGN THING MODULE	VSEC									100		100
DS3204	ENGINEERING RESEARCH AND INNOVATION-1/ INTERNATIONAL ENGINEERING DESGN PROGRAM	PEC						30	70				100

S3	PROGRAM ELECTIVE-1
1	CLOUD COMPUTING
2	SOFT COMPUTING
3	NATURAL LANGUAGE PROCESSING
4	GAME DEVELOPMENT (INDUSTRY)
5	MAINFRAME TECHNOLOGIES (INDUSTRY)

S4	PROGRAM ELECTIVE-2
1	META BACK-END DEVELOPER
2	IBM DEVOPS AND SOFTWARE ENGINEERING
3	IBM FULL STACK SOFTWARE DEVELOPER
4	AWS SKILL BUILDER-1 (INDUSTRY)

S5	OPEN ELECTIVE-1
1	BUCKET-1: FINTECH
2	BUCKET-2: DIGITAL MARKETING
3	BUCKET-3: ENTREPRENEURSHIP
4	BUCKET-4: MANAGEMENT

S6	MDM
1	IOT AND SUSTAINABILITY
2	PRODUCT LIFE CYCLE MANAGEMENT (INDUSTRY)

Chairman-Bos
Dr. Deepa Abin

Dean-Academics
Dr. Parikshit Mahalle

Chairman-Academic Board
Dr. Rajesh Jalnekar

Vishwakarma Institute of Technology

FF No. 653_A

Title : Course Structure

Branch : CSE-DS **Year:** TY **Academic Year :** 2026-27 **Semester:** I **Module:** 5 **Pattern:** A-24

Level 5.5

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks													Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/TUT	GD/PPT	HA	MSE(W)	MSE(R)	MSE(O)	ESE(R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
Semester V																						
DS3201	PCC	DEEP LEARNING	3		2										40		60		3		1	4
DS3202	PCC	PROMPT ENGINEERING	2		2	20	30	10							40				2		1	3
DS3203A DS3203B DS3203C ID3001 ID3002	PEC	CLOUD COMPUTING SOFT COMPUTING NATURAL LANGUAGE PROCESSING GAME DEVELOPMENT (INDUSTRY) MAINFRAME TECHNOLOGIES (INDUSTRY)	3		2	20	40		20	20									3		1	4
DS04COURSERA ID3004	PEC	PROGRAM ELECTIVE-2 (COURSERA) MODERN INFRASTRUCTURE TECHNOLOGIES																100				3
DS05COURSERA	OE	OPEN ELECTIVE-1 (COURSERA)																100				4
MM0402A MM1501D	MDM	IOT AND SUSTAINABILITY PRODUCT LIFE CYCLE MANAGEMENT (INDUSTRY)	2	1			30		20	10					40				2	1		3
DS3205	VSEC	DESIGN THINKING-3																100				1
DS3204	PEC	ENGINEERING RESEARCH AND INNOVATION-1										30		70								2
Total			**10**	**1**	**6**	**40**	**100**	**10**	**40**	**30**	**0**	**30**	**0**	**70**	**120**	**0**	**60**	**300**	**10**	**1**	**3**	**24**

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
R /W/O	Review /Written/Online

BOS Chairman

Dean Academics

FF No.: 654

DS3201: DEEP LEARNING

Course Prerequisites: Linear Algebra, Probability and Statistics, Fundamentals of Machine Learning, and Programming using Python

Course Objectives:

1. To understand the basics and evolution of deep learning.
2. To learn neural network architecture and training mechanisms.
3. To apply activation functions, loss functions, and optimization techniques.
4. To design CNN models for image-based applications.
5. To implement RNN models for sequential data.
6. To explore deep generative models and modern DL frameworks.

Credits: 4 **Teaching Scheme Theory: 3** Hours/Week

Lab: 2 Hours/Week

Course Relevance: This course is highly relevant in the current era of artificial intelligence as it equips students with fundamental and advanced concepts of deep learning, enabling them to design, implement, and optimize intelligent systems for real-world applications such as image processing, natural language processing, healthcare analytics, and predictive modeling, thereby preparing them for careers in AI, machine learning, and data-driven industries.

SECTION-1
Unit I: Foundations of Deep Learning Evolution from Machine Learning to Deep Learning, Need for Deep Learning in Modern Applications, Deep Learning vs. Traditional Machine Learning. Artificial Neural Networks (ANN): Biological Inspiration and Key Concepts. Perceptron Model: Introduction, Single Layer Perceptron (SLP), Multi-Layer Perceptron (MLP). Feedforward Neural Networks (FNN): Architecture and Working, Deep Feedforward Networks, Hidden Units, EX-OR Problem. Introduction to Neural Network Training: Forward Propagation, Cost Functions, Error Computation. **7Hrs** **Unit II: Training Mechanisms and Activation Functions** Backpropagation Algorithm: Derivation, Error Backpropagation, Weight Update Mechanism. Loss Functions: Notation and Importance, Loss Functions for Regression, Classification, and Reconstruction. Activation Functions: Need and Properties, Linear and Non-Linear Functions – Step, Sigmoid, Tanh, ReLU, SoftMax. Challenges in Training Deep Networks: Vanishing and Exploding Gradient Problems. **7Hrs**

Unit III : Optimization and Regularization Techniques

Gradient Descent Optimization: Batch Gradient Descent, Stochastic Gradient Descent (SGD). Advanced Optimization Algorithms: Momentum, RMSprop, Adam. Hyperparameter Tuning: Learning Rate, Batch Size, Number of Epochs. Regularization Techniques: L1 and L2 Regularization (Weight Decay), Dropout, Batch Normalization. Overview of Training Stability and Generalization **7Hrs**

SECTION-2

Unit IV: Convolutional Neural Network(CNN)

Motivation for CNNs in Image Processing, CNN Architecture: Convolution & Pooling layers, Fully Connected Layers , Feature Extraction and Feature Maps, Types of Pooling: Max Pooling, Average Pooling, CNN Architectures: AlexNet, VGG, ResNet Transfer Learning and Fine-Tuning ,Object Detection: YOLO, R-CNN, SSD ,Applications of CNNs in Image Classification, Medical Imaging, etc. **7 Hrs**

Unit V: Recurrent Network

Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and RNNs, Optimization for LongTerm Dependencies. **7 Hrs**

Unit VI: Deep Generative Models

Introduction to deep generative model: Autoencoders and Variational Autoencoders (VAE), Generative Adversarial Networks (GANs) – Architecture and Training, Boltzmann Machine, Deep Belief Networks, Transformers and Self Attention Mechanism, Introduction to BERT. Overview of Deep Learning Frameworks: TensorFlow, PyTorch, and Keras **7 Hrs**

List of Practical:

1. Implement and compare different activation functions (Sigmoid, Tanh, ReLU) in a Multi-Layer Perceptron (MLP) to classify loan applications as approved or rejected based on applicant data. Take "Loan Prediction Dataset" from Kaggle (https://www.kaggle.com/datasets/itsmesunil/bank-loanmodelling)
2. Implement and compare different loss functions, gradient descent optimizers, and regularization techniques in a deep learning model for medical image classification (e.g., detecting pneumonia from chest X-ray images).
3. Develop and train a Convolutional Neural Network (CNN) to classify different types of skin diseases using medical images and evaluate the effectiveness of feature extraction, pooling, and fine-tuning in deep learning.

4. Implement real-time object detection using the YOLO (You Only Look Once) model to identify vehicles, pedestrians, and traffic signs, enhancing autonomous vehicle systems.
5. Build and train a Recurrent Neural Network (RNN) for sentiment analysis on a real-world text dataset, applying different RNN architectures (Bidirectional RNN, LSTM, GRU) and evaluating their effectiveness in handling long-term dependencies.
6. Train a Generative Adversarial Network (GAN) to generate realistic images, exploring the impact of GAN architecture and training challenges.
7. Apply SHAP (Shapley Additive Explanations) and LIME (Local Interpretable Model-Agnostic Explanations) to explain decisions made by a deep learning model.
8. Implement a Tic-Tac-Toe RL Agent (train a bot to play against a human or another AI).

Suggest an assessment Scheme:

ESE(w)	***PR+CVV***
40	60

PR- Practical
CVV –Comprehensive Viva Voce
ESE(W) - End Semester Examination written

Text Books:

1) Ian Goodfellow, Yoshua Bengio, and Aaron Courville authored *Deep Learning* (1st edition, MIT Press, 2016, ISBN: 978-0262035613).
2) S. Sridhar and D. Narasimhan authored *Deep Learning* (1st edition, Pearson India, 2025, ISBN: 978-9367138663).
3) Charu C. Aggarwal authored *Neural Networks and Deep Learning* (2nd edition, Springer, 2023, ISBN: 978-3-031-29644-4).

Reference Books:

1. Richard S. Sutton and Andrew G. Barto authored *Reinforcement Learning: An Introduction* (2nd edition, MIT Press, 2018, ISBN: 978-0262039246).
2. Seth Weidman authored *Deep Learning from Scratch: Building with Python from First Principles* (1st edition, O'Reilly Media, 2019, ISBN: 978-1492041412).
3. Francois Duval authored *Deep Learning for Beginners: Practical Guide with Python and TensorFlow* (1st edition, 2019, ISBN: 978-1099903205).

MOOCs Links and additional reading material

1 **Deep Learning Specialization (Coursera)** – Series of DL courses by DeepLearning.AI (Andrew Ng). https://www.coursera.org/specializations/deep-learning

2 **Deep Learning Courses & Tutorials List** – Comprehensive list of paid + free courses. https://onlinecourseing.com/deep-learning-courses-and-tutorials

Course Outcomes:

Students should be able to

1 Explain the evolution of deep learning, differentiate it from traditional machine learning, and implement basic neural network models such as perceptron, MLP, and feedforward networks.

2. Apply forward and backpropagation algorithms, select appropriate activation and loss functions, and analyze training challenges such as vanishing and exploding gradients.

3. Implement gradient-based optimization algorithms, perform hyperparameter tuning, and apply regularization techniques to improve model generalization.

4. Design, train, and evaluate convolutional neural network architectures for image classification, feature extraction, transfer learning, and object detection tasks.

5. Develop and evaluate recurrent neural network models, including RNN, LSTM, and Bidirectional RNN for sequence and time-dependent data applications.

6. Implement deep generative models such as autoencoders, GANs, and transformer-based models using modern deep learning frameworks

CO PO Map

co/po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso1	pso2
CO:1	3	2	-	-	-	-	-	-	-	1	2	2	2	2
CO:2	3	3	2	2	2	1	1	-	-	2	3	2	3	2
CO:3	3	3	2	2	2	1	-	-	1	2	3	2	3	2
CO:4	3	3	3	2	2	1	1	-	1	2	3	2	3	2
CO: 5	3	3	3	2	2	2	1	1	2	2	2	3	3	3
CO:6	3	3	3	3	2	2	1	1	2	2	3	3	3	3

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	
CO .5	
CO .6	

Future Courses Mapping:

Advanced Optimization Techniques, Evolutionary Computing, Robotics and Intelligent Systems, Control Systems and Automation, and Computational Intelligence.

Job Mapping:

Data Scientist, Machine Learning Engineer, AI Engineer, Optimization Engineer, Research Scientist (AI/ML), Robotics Engineer, Control Systems Engineer, Decision Support Systems Analyst, and Business Intelligence Analyst.

FF No.: 654

DS3202: PROMPT ENGINEERING

Course Prerequisites: Basic programming (Python preferred), Fundamentals of AI/ML, Basic NLP concepts, Familiarity with APIs/tools.

Course Objectives:

1. To understand the fundamentals of Generative AI and Large Language Models.
2. To develop skills in designing effective prompts for various AI tasks.
3. To apply prompt engineering techniques in solving real-world problems.
4. To analyze and evaluate AI-generated outputs considering ethics and limitations.

Credits: 3 **Teaching Scheme Theory: 2** Hours/Week

Lab: 2 Hours/Week

Course Relevance: This subject equips students with the ability to effectively interact with AI systems by designing structured prompts, enabling them to build intelligent applications, automate tasks and contribute to modern AI-driven solutions.

SECTION-1
Unit I: Foundations of Prompt Engineering Introduction to Artificial Intelligence, Generative AI, and Large Language Models; evolution of NLP and language models; concept and importance of prompt engineering; types of prompts including instruction-based, role-based, and contextual prompts; structure of effective prompts with context, constraints, and output format; prompt lifecycle including design, testing, and refinement; limitations of LLMs such as hallucination, bias, and lack of reasoning. **7 Hrs** **Unit II: Prompt Design Techniques** Zero-shot, one-shot, and few-shot prompting techniques; Chain-of-Thought (CoT) prompting for reasoning; role-based and persona-driven prompting; prompt templates and reusable patterns; context management and token optimization; handling ambiguity and improving clarity; prompt debugging, evaluation, and refinement strategies. **7 Hrs**
SECTION-2
Unit III: Tools, APIs, and Applications Working with LLM tools and platforms; introduction to APIs such as OpenAI and Hugging Face; prompt engineering for code generation, debugging, and automation; prompt-based data analysis and summarization; introduction to Retrieval-Augmented Generation (RAG); prompt chaining and workflow design; integration of prompts into real-world applications like chatbots and intelligent assistants. **7 Hrs**

Unit IV : Advanced Topics, Ethics, and Case Studies **7 Hrs**

Advanced prompting techniques including self-consistency and reflection; multi-step reasoning and problem decomposition; evaluation metrics such as accuracy, relevance, coherence, and cost; bias, fairness, and responsible AI practices; security concerns including prompt injection attacks; case studies across domains; future trends and career opportunities in prompt engineering.

List of Practical:

1. Explore an LLM tool and summarize its capabilities, including input/output behavior, supported tasks, and limitations; perform basic prompt creation and analyze generated outputs for correctness and relevance.
2. An educational institute wants to automate content generation for students. Design prompts to:
   - Generate short notes and explanations
   - Create examples for given topics
   - Compare outputs for simple vs structured prompts
3. A content writing company needs automated blog generation. Design a prompt workflow to:
   - Generate blog outlines
   - Create detailed content
   - Refine prompts to improve coherence and readability
4. A customer service system needs automated responses. Develop prompts to:
   - Handle customer complaints
   - Generate polite and professional responses
   - Compare tone variations (formal vs empathetic)
5. A coding platform wants AI assistance for students. Design prompts to:
   - Generate code for a given problem
   - Debug errors in code
   - Provide step-by-step explanations
6. A company wants to automate report generation from text data. Develop prompts to:
   - Summarize large text documents
   - Extract key points and insights
   - Improve output structure using prompt refinement
7. A dataset is provided with description and sample values. Design prompts to:
   - Analyze and summarize dataset characteristics
   - Identify trends and patterns
   - Generate insights in structured format
8. A chatbot system needs context-aware responses. Develop prompts to:
   - Maintain conversation context
   - Improve response accuracy
   - Handle ambiguous user queries

9. A software company wants to integrate AI using APIs. Perform the following:
   - Use an API (OpenAI/HuggingFace) for prompt execution
   - Send prompts programmatically
   - Analyze and compare API outputs with manual prompts
10. A knowledge-based system requires accurate answers from documents. Design prompts to:
   - Extract information from given text
   - Answer user queries based on context
   - Improve accuracy using structured prompts

List of Course Project:

1. AI-Based Academic Content Generator: A university wants to automate generation of study material for students across subjects. Students need to perform:
   - Design prompts for notes, explanations, and examples
   - Compare outputs for different prompt styles
   - Optimize prompts for clarity and depth
   - Document best prompt templates
2. Resume Analysis and Recommendation System: A recruitment firm wants to evaluate resumes automatically. Students need to perform:
   - Design prompts for resume evaluation and scoring
   - Extract skills and match with job descriptions
   - Generate improvement suggestions
   - Refine prompts for structured outputs
3. Intelligent Customer Support System: An e-commerce company wants automated customer support. Students need to perform:
   - Design prompts for handling queries and complaints
   - Apply role-based prompting
   - Ensure tone consistency and correctness
   - Optimize prompts for real-world scenarios
4. AI-Based Code Assistant: A learning platform wants an AI assistant for coding help. Students need to perform:
   - Design prompts for code generation and debugging
   - Apply reasoning-based prompting
   - Evaluate correctness and efficiency
   - Refine prompts for better explanations

5. Data Insight and Report Generator: A company wants to generate insights from business data automatically. Students need to perform:
   • Design prompts for data summarization and analysis
   • Generate insights and recommendations
   • Optimize prompts for structured reporting
   • Evaluate accuracy and usefulness of outputs

Suggest an assessment Scheme:

ESE(W)	*CP*	*Lab*	*CVV*
40	***30***	***10***	***20***

CP - Course Project
LAB - Continuous Assessment
ESE(W)-End semester examination(written)
CVV – Comprehensive Viva

Text Books:

1) Daniel Koch, Andreas Kohne, and Nils Brechbühler, “Prompt Engineering in the Enterprise: An Introduction” (1st edition, Springer, 2024, ISBN: 978-3658492182).
2) Vladimir Geroimenko, “The Essential Guide to Prompt Engineering” (1st edition, Springer, 2024, ISBN: 978-3031862069).
3) Eslam Wahba, “Prompt Engineering Handbook: A Complete Guide and Examples” (1st edition, Independently Published, 2024, ISBN: 979-8329692297).

Reference Books:

1. Lee Boonstra, “Prompt Engineering Guide (Google AI Whitepaper)”, (latest edition, Google, 2024).
2. OpenAI, “GPT-4 Prompt Engineering Guide”, (latest edition, OpenAI Documentation, 2025).
3. Xavier Amatriain, “Prompt Design and Engineering: Introduction and Advanced Methods” (latest edition, arXiv, 2024).
4. Chip Huyen, “AI Engineering: Building Applications with Foundation Models”, (1st edition, O’Reilly Media, 2025, ISBN: 978-1098157009).

Moocs Links and additional reading material

1. Prompt Engineering for ChatGPT (Coursera) – Course by Vanderbilt University covering

2. prompt patterns, techniques, and applications. https://www.coursera.org/learn/prompt-engineering
3. Prompt Engineering Specialization (Coursera) – Multi-course specialization covering advanced prompt design and real-world use cases. https://www.coursera.org/specializations/prompt-engineering
4. Prompt Engineering 101 (Udemy) – Beginner-friendly course focusing on prompt basics and real-world examples. https://www.udemy.com/course/prompt-engineering-101/
5. Prompt Engineering for Testers (NPTEL) – Indian context course focusing on prompt usage in software testing and automation. https://elearn.nptel.ac.in/shop/completed-courses/partnering-closed/prompt-engineering-for-testers-harnessing-ai-for-smarter-qa/

Course Outcomes:

1: Explain the fundamental concepts of Generative AI and Large Language Models, including their working principles and limitations.

2: Design and construct effective prompts using various prompt engineering techniques for different AI tasks.

3: Apply prompt engineering methods to develop solutions for real-world problems using AI tools and APIs.

4: Analyze and evaluate AI-generated outputs in terms of accuracy, relevance, bias, and ethical considerations.

CO PO Map

co/po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso1	pso2
CO:1	2	1	-	-	1	-	-	-	-	-	-	2	1	2
CO:2	-	2	3	1	3	-	-	-	1	1	-	2	2	3
CO:3	2	2	3	2	3	1	-	-	2	1	1	2	3	3
CO:4	1	3	2	2	2	2	1	3	1	1	-	2	2	3

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:

Agentic AI, Generative AI, Natural Language Processing, Machine Learning, and AI System Design.

Job Mapping:

Prompt Engineer, AI Engineer, NLP Engineer, Chatbot Developer, AI Product Engineer.

FF No.: 654

DS3203C: NATURAL LANGUAGE PROCESSING

Course Prerequisites: Machine Learning

Course Objectives:

1. To study some of the problems and solutions of NLP and their relation to linguistics and statistics.
2. To understand and carry out proper experimental methodology for training and evaluating empirical NLP systems
3. To estimate parameters using supervised and unsupervised training methods.
4. To design, implement, and analyze NLP algorithms. Able to design different language modeling Techniques

Credits: 4 **Teaching Scheme Theory: 3** Hours/Week

Lab: 2 Hour/Week

Course Relevance: This course introduces the relevance of Natural Language Processing (NLP) in enabling computers to understand, interpret, and generate human language. NLP is widely used in applications such as chatbots, sentiment analysis, machine translation, voice assistants, and information retrieval systems. Learning NLP equips students with skills to work with text and speech data, supporting careers in AI, data science, and software development while solving real-world language-based problems

SECTION-1

Unit I: Natural Language processing (NLP)

Introduction, Applications or Use cases of NLP, Components of NLP, Steps in NLP, Finding the Structure of Words: Words and Their Components, Lexemes, Morphemes, Morphology, Problems in morphological processing, Typology, Morphological Typology, Natural Language Processing with python NLTK package: Word Tokenization, Sentence Tokenization, Filtering Stop words, Stemming, Tagging Parts of Speech, Lemmatization, Chunking, Chinking, Named Entity Recognition

Case Study: Social Media Text Cleaning for Disaster Response **7 Hrs.**

Unit II: Syntax Analysis and Parsing

Syntax Analysis: Parsing Natural Language, Tree banks: A Data-Driven Approach to Syntax, Syntax Analysis using Dependency Graph, Syntax Analysis using Phrase Structure Trees, Parsing Algorithms: Shift Reduce Parsing, Hyper Graphs and Chart Parsing (CYK Parsing), Models for ambiguity Resolution in Parsing: Probabilistic Context Free Grammar, Generative Models, Discriminative models for Parsing.

Case Study: Grammar Checking Tool (like Grammarly) **7 Hrs.**

Unit III: Language Modeling

Language Modeling: Introduction, N-Gram Models, Language Model Evaluation, Parameter Estimation, Language Model Adaptation, Bag-of-Words model, Word Embeddings (Word2Vec, GloVe) Types of Language Models, Language-Specific Modeling Problems.

Case Study: Improving Next-Word Prediction using N-Gram and Word Embeddings **7 Hrs.**

SECTION-2

Unit IV: Semantic Analysis

Semantic Analysis: Introduction, Semantic Interpretation, System Paradigms, Word Sense Systems, Software, Predicate-Argument Structure, Meaning Representation Systems, Software. Discourse Processing: Cohesion, Reference Resolution, Discourse Cohesion and Structure.

Case Study: Chatbot Understanding User Intent using Semantic and Discourse Analysis **7 Hrs.**

Unit V: Sentiment Analysis and Text Classification

Understanding sentiment analysis tasks: Sentiment lexicons and rule-based approaches, Machine learning approaches for sentiment analysis, Text Classification: Supervised learning for text classification, Feature extraction techniques, Classification algorithms Support Vector Machines

Case Study: Sentiment Analysis of Product Reviews for E-Commerce **7 Hrs.**

Unit VI: Topic Modeling and Applications

Topic Modeling: LSA (Latent Semantic Analysis), Latent Dirichlet Allocation (LDA), Non-negative Matrix Factorization (NMF), Applications of topic modeling, Applications in machine translation, summarization, and question answering, Overview of real-world NLP applications, Ethical Considerations in NLP, Future trends and directions in NLP research and development

Case Study: Topic Modeling for News Article Categorization **7 Hrs.**

List of Practical:

Implement any 7 of them.

1. During natural disasters, authorities need to quickly analyze social media posts to identify emergency needs (food, shelter, rescue).
   Scenario:
   Tweets like: “Flood in my area 😨 need help urgently!!! #PuneFlood”
   Approach:
   Tokenization → extract words
   Stop-word removal → remove irrelevant terms
   Lemmatization → normalize words
   NER → identify locations (e.g., Pune)
   Keyword extraction → “flood”, “help”
2. A company receives thousands of resumes and wants to automate candidate filtering.
   Scenario:
   Resume text:
   “Experienced Python developer with 3 years in machine learning”
   Approach:
   Tokenization & POS tagging
   Named Entity Recognition → skills, experience
   Chunking → extract phrases like “Python developer”
   Morphological analysis → normalize variations (developing → develop)
3. A voice assistant must correctly interpret user commands for actions.
   Scenario:
   “Play songs by Arijit Singh on Spotify”
   Approach:
   Dependency Parsing:
   “Play” → action
   “songs” → object

"Arijit Singh" → artist
Phrase Structure Tree:
NP → "songs by Arijit Singh"
Use of parsing models to resolve ambiguity

4. News headlines often have ambiguous structures that can mislead readers or NLP systems.
   Scenario:
   "Visiting relatives can be annoying"
   Ambiguity:
   Relatives who visit are annoying
   Visiting relatives is annoying
   Approach:
   Generate multiple parse trees using CYK parsing
   Apply Probabilistic Context-Free Grammar
   Select most probable interpretation
5. A mobile keyboard application aims to improve its **next-word prediction** feature to enhance typing speed and user experience. The existing system uses a simple unigram model, which often gives irrelevant suggestions.
   Approach:
   Baseline Model (Unigram Model):
   Predicts the most frequent word in the corpus. Limitation: Ignores context.
   Improved Model (N-Gram Model):
   Implemented **bigram and trigram models**.
   Example:
   Input: *"I am going to"*
   Prediction: "school", "market" based on probability
   Used smoothing techniques (Laplace smoothing) to handle unseen words.
   Evaluation:
   Metrics used: Perplexity and Accuracy of next-word prediction
   Result: Trigram model significantly reduced perplexity compared to unigram.
6. A company wants to classify customer feedback into categories (e.g., complaint, suggestion, appreciation). Raw text must first be converted into a machine-understandable format.

- Apply **TF-IDF Vectorization**:
- Use TfidfVectorizer from scikit-learn
- Convert text into feature vectors
- Display:
- Vocabulary
- TF-IDF matrix

7. A recommendation system needs to understand semantic similarity between words (e.g., "king" ≈ "queen", "car" ≈ "vehicle") for better search and suggestions.

- Train **Word2Vec model** using Gensim:
- CBOW or Skip-gram approach
- Generate word vectors
- Perform similarity tasks:
- Find similar words (e.g., "good" → "great", "excellent")

8. A customer support chatbot for an e-commerce platform struggles to correctly interpret user queries, especially when users ask follow-up questions or use ambiguous words.
   Approach:

Semantic Analysis Implementation:
Used **predicate-argument structure** to identify:
Applied **word sense disambiguation** to interpret ambiguous terms:
Meaning Representation:
Converted user input into structured form (e.g., semantic frames):
Discourse Processing:
Applied **reference resolution**:
Maintained **context across conversation turns**
Cohesion Handling:
Linked multiple sentences logically:

9. An e-commerce company wants to automatically classify customer reviews into **positive, negative, or neutral sentiments** to improve product recommendations and customer satisfaction.
Dataset:
Customer reviews from online platforms
Example:
"The product quality is excellent!" → Positive
"Very खराब experience, not recommended." → Negative
"It's okay, average performance." → Neutral
10. A digital news platform wants to automatically organize thousands of daily articles into meaningful topics (e.g., politics, sports, technology) without manual labeling.
Dataset:

- Collection of news articles from multiple domains
- Unlabeled text data

List of Projects:

1. **Chatbot for College Enquiry System**
Develop an intelligent chatbot that answers student queries related to admissions, courses, fees, and schedules. The system uses NLP techniques like intent detection and entity extraction to provide automated responses.

2. **Sentiment Analysis of Product Reviews**
Build a model to classify customer reviews as positive, negative, or neutral. This project involves text preprocessing, feature extraction, and supervised learning for opinion mining.
3. **Spam Email Detection using NLP**
Design a classification system to distinguish between spam and legitimate emails. It uses techniques like TF-IDF and machine learning algorithms to filter unwanted messages.
4. **Text Summarization of News Articles**
Create a system that generates concise summaries of long news articles. It may use extractive or abstractive summarization techniques to retain key information.
5. **Movie Review Classification (Positive/Negative)**
Implement a binary classification model to determine sentiment in movie reviews. The project focuses on feature engineering and classification algorithms.

6. **Language Translation System (English to Hindi/Marathi)**
   Develop a basic machine translation system using rule-based or neural approaches. It aims to convert English sentences into regional languages while preserving meaning.
7. **Resume Parser and Job Skill Extractor**
   Build a system to extract key information like skills, education, and experience from resumes. It uses Named Entity Recognition and pattern matching techniques.
8. **Fake News Detection using Text Analysis**
   Create a model to classify news articles as real or fake based on linguistic patterns and content features. This involves classification and possibly deep learning methods.
9. **Question Answering System for FAQs**
   Develop a system that retrieves or generates answers to frequently asked questions. It uses techniques like information retrieval and semantic matching.
10. **Twitter Sentiment Analysis on Trending Topics**
    Analyze tweets related to trending topics and classify public sentiment. The project includes handling noisy and short text data.
11. **Speech-to-Text Based Note Generator**
    Convert spoken input into written text and generate structured notes. This combines speech recognition with NLP for formatting and summarization.
12. **Plagiarism Detection using Text Similarity**
    Design a system to compare documents and detect similarity or copied content. It uses cosine similarity, n-grams, or embedding-based approaches.
13. **Grammar Correction Tool**
    Develop a tool to detect and correct grammatical errors in text. It may use rule-based methods or machine learning models for error correction.
14. **Smart Email Reply Generator using NLP**
    Build a system that suggests automatic replies based on email content. It uses intent recognition and text generation techniques.

Suggest an assessment Scheme:

GD/PPT	***CP***	***CVV***	***HA***
20	***40***	***20***	***20***

CVV- course viva

HA- home assignments

GD/PPT - Group Discussion/Presentation

CP - Course Project

Textbooks:

1. Multilingual Natural Language Processing Applications: From Theory to Practice–Daniel M. Bikel and Imed Zitouni, IBM Press Publication First Edition. ISBN-10: 9788131791370
2. Speech and Language Processing-Daniel Jurafsky & James H Martin, Pearson Publications. 2nd Edition. ISBN-10: 9789332518414

Reference Books:

1. Introduction to Large Language Models Generative AI by Tanmoy Chakraborty Wiley Publication, ISBN-10: 936386474X
2. Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning by Delip Rao, Brian McMahan, O'Reilly Publication. Greyscale Indian Edition ISBN 10: 935213768X

Moocs Links and additional reading material:

1. https://onlinecourses.nptel.ac.in/noc25_cs51/preview
2. https://www.coursera.org/specializations/natural-language-processing
3. https://www.coursera.org/learn/packt-applied-generative-ai-and-natural-language-processing-with-python-unemz/home/welcome

Course Outcomes:

Student should be able to

1. Identify and explain key problems in Natural Language Processing (NLP) and evaluate various linguistic and statistical approaches used to solve them.
2. Implement parameter estimation techniques using both supervised and unsupervised learning methods in NLP tasks.
3. Design and develop NLP algorithms for core language tasks such as tokenization, parsing, named entity recognition, and sentiment analysis.
4. Develop and evaluate different language modeling techniques (e.g., n-gram, neural models) to perform tasks such as text generation or speech recognition.

CO PO Map

co/po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso1	pso2
CO:1	3	3	1	1	1	-	-	-	-	1	-	1	1	-
CO:2	3	3	1	3	3	-	-	-	-	1	-	1	1	3
CO:3	3	3	3	1	3	-	-	-	1	1	-	1	1	3

CO:4	3	3	3	3	3	-	-	-	-	1	-	3	1	3

CO attainment levels

CO	**Attainment level**
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:

Generative AI, Conversational AI, Prompt Engineering and Data Science

Job Mapping:

Data Scientist, AI Engineer, Text Analytics Specialist, and Conversational AI Developer etc.

FF No.: 654

DS3203B: SOFT COMPUTING

Course Prerequisites: Linear Algebra, Probability and Statistics, Fundamentals of Machine Learning, and Programming using Python

Course Objectives:

1. To introduce the fundamental concepts and principles of soft computing and its distinction from hard computing techniques.
2. To develop an understanding of fuzzy logic and its application in handling uncertainty and approximate reasoning.
3. To provide knowledge of evolutionary algorithms, particularly genetic algorithms, for solving optimization problems.
4. To explore swarm intelligence techniques such as PSO and ACO for solving complex engineering problems.
5. To enable the design of hybrid soft computing systems for intelligent decision-making applications.
6. To apply soft computing techniques to real-world problems across various domains.

Credits: 4 **Teaching Scheme Theory: 3** Hours/Week

Lab: 2 Hours/Week

Course Relevance: This course provides foundational knowledge of soft computing techniques such as fuzzy logic, evolutionary algorithms, and swarm intelligence for solving complex, nonlinear, and uncertain problems. It equips students with skills to design intelligent and adaptive systems applicable in domains like healthcare, finance, agriculture, and engineering optimization. The course complements machine learning and artificial intelligence by offering alternative approaches for optimization, decision-making, and control systems, thereby enhancing problem-solving capabilities and industry readiness.

SECTION-1
Unit I: Introduction to Soft Computing & Intelligent Systems: Concept and evolution of Soft Computing, Hard Computing vs Soft Computing, Characteristics of Soft Computing (imprecision, uncertainty, approximation), Components of Soft Computing (Fuzzy Logic, Evolutionary Algorithms, Swarm Intelligence), Intelligent Systems and their characteristics, Hybrid Intelligent Systems, Applications in healthcare, finance, control systems 7**Hrs**

Unit II: Fuzzy Logic and Approximate Reasoning

Crisp Sets vs Fuzzy Sets, Membership Functions (triangular, trapezoidal, Gaussian), Fuzzy Set Operations and Properties, Fuzzy Relations and Composition, Linguistic Variables, Fuzzy Rules, Approximate Reasoning, Fuzzy Inference Systems (Mamdani, Sugeno), Defuzzification Methods (centroid, bisector, mean of maxima), Design of Fuzzy Controllers **7 Hrs**

Unit III: Evolutionary Computing – Genetic Algorithms

Introduction to Evolutionary Computing, Biological inspiration (natural selection, genetics), Genetic Algorithm framework and workflow, Encoding Techniques (binary, real-valued), Fitness Function Design, Selection Methods (roulette wheel, tournament selection), Crossover (single-point, multi-point), Mutation, Constraint Handling, Multi-objective Optimization (introduction), Applications of Genetic Algorithms 7 **Hrs**

SECTION-2

Unit IV: Swarm Intelligence and Bio-Inspired Optimization

Introduction to Swarm Intelligence, Collective Behavior and Self-organization, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Grey Wolf Optimization (GWO), Whale Optimization Algorithm (WOA), Exploration vs Exploitation, Comparative Analysis of Swarm Algorithms, Applications in routing, clustering, engineering optimization 7 **Hrs**

Unit V: Hybrid Soft Computing Techniques

Introduction to Hybrid Systems, Neuro-Fuzzy Systems (conceptual overview), Fuzzy–Genetic Algorithm Integration, GA–PSO Hybrid Optimization, Adaptive and Self-learning Systems, Design Considerations of Hybrid Models, Case Studies (medical diagnosis, financial prediction, control systems) **7Hrs**

Unit VI: Applications and Emerging Trends in Soft Computing (6 Hrs.)

Applications in Healthcare, Agriculture, Finance, Soft Computing in Machine Learning (feature selection, optimization), Explainable AI using Fuzzy Systems, Soft Computing for real-time and embedded systems, Edge AI with Soft Computing, Comparison of Soft Computing with Machine Learning and Deep Learning, Case Studies and Problem-based Applications **7 Hrs**

List of Practical:

1. Implementation and Analysis of Fuzzy Set Operations and Membership Function Models
2. Design and Development of Mamdani-Based Fuzzy Inference System for Decision-Making Applications
3. Modeling and Implementation of Sugeno-Type Fuzzy Inference System for Comparative Analysis
4. Comparative Study and Implementation of Various Defuzzification Techniques in Fuzzy Systems
5. Design and Simulation of Fuzzy Logic Controller for Real-Time Control Applications
6. Development of Genetic Algorithm for Solving Single-Objective Optimization Problems
7. Application of Genetic Algorithm for Optimal Feature Selection in Data-Driven Problems
8. Implementation and Performance Analysis of Particle Swarm Optimization for Continuous Optimization Problems
9. Simulation and Implementation of Ant Colony Optimization for Shortest Path and Routing Problems
10. Design and Development of Mini Project Using Soft Computing Techniques for Real-World Applications

List of Projects:(Suggested)

1. Fuzzy Logic-Based Smart Temperature Control System
2. Medical Diagnosis System Using Fuzzy Inference Techniques
3. Crop Recommendation System Using Fuzzy Logic
4. Stock Price Optimization Using Genetic Algorithm
5. Feature Selection and Optimization Using Genetic Algorithm for Classification Problems
6. Hybrid Fuzzy–Genetic Algorithm-Based Decision Support System
7. Resource Allocation Optimization Using Swarm Intelligence Techniques
8. Real-Time Prediction System Using Hybrid Soft Computing Techniques

List of Course Seminar Topics:

1. Role of Soft Computing in Modern Artificial Intelligence Systems
2. Fuzzy Logic Applications in Real-Time Control Systems
3. Genetic Algorithms for Optimization in Engineering Problems
4. Swarm Intelligence and Its Applications in Routing and Scheduling
5. Comparison of Soft Computing Techniques with Machine Learning and Deep Learning
6. Hybrid Soft Computing Models for Decision Support Systems
7. Applications of Particle Swarm Optimization in Data Science
8. Ant Colony Optimization in Network Routing and Logistics
9. Explainable AI Using Fuzzy Logic Systems
10. Emerging Trends in Bio-Inspired Optimization Techniques

Suggest an assessment Scheme:

GD/PPT	***CP***	***CVV***	***HA***
20	***40***	***20***	***20***

CVV- course viva
HA- home assignments
GD/PPT - Group Discussion/Presentation
CP - Course Project

Text Books:

1) S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, 2nd Edition, Wiley India Pvt. Ltd., 2018, ISBN: 978-8126571130
2) Timothy J. Ross, Fuzzy Logic with Engineering Applications, 4th Edition, Wiley, 2016, ISBN: 978-1119235866
3) J. S. R. Jang, C. T. Sun and E. Mizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, 1st Edition, Prentice Hall India, 2012 (Reprint), ISBN: 978-8120322431
4) S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications, 1st Edition, PHI Learning Pvt. Ltd., 2003 (Reprint editions available), ISBN: 978-8120321861

Reference Books:

1. H. J. Zimmermann, Fuzzy Set Theory and Its Applications, 4th Edition, Springer, 2001, ISBN: 978-0792374350
2. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, 1st Edition, Pearson Education, 1989 (Reprint editions available), ISBN: 978-0201157673
3. Melanie Mitchell, An Introduction to Genetic Algorithms, 1st Edition, MIT Press, 1998, ISBN: 978-0262631853
4. Kennedy, J. and Eberhart, R., Swarm Intelligence, 1st Edition, Morgan Kaufmann, 2001, ISBN: 978-1558605954
5. Fakhreddine O. Karray and Clarence W. De Silva, Soft Computing and Intelligent Systems Design: Theory, Tools and Applications, 1st Edition, Pearson, 2004, ISBN: 978-0321116178
6. N. K. Kasabov, Foundations of Neural Networks, Fuzzy Systems and Knowledge Engineering, 1st Edition, MIT Press, 1996, ISBN: 978-0262112123

Moocs Links and additional reading material

1. **Bio-Inspired Optimization Algorithms (PSO, ACO, Swarm Intelligence)**

Platform: NPTEL (IIT Kharagpur)
Link: https://nptel.ac.in/courses/106/105/10610517

2. **Evolutionary Computing (Genetic Algorithms and Optimization)**

Platform: Coursera
Link: https://www.coursera.org/learn/evolutionary-computing

3. **Fuzzy Logic and Control Systems**

Platform: NPTEL (IIT Kharagpur)
Link: https://onlinecourses.nptel.ac.in/noc22_ee82/prev

Course Outcomes:

Students should be able to

1. Explain the fundamental concepts of soft computing and differentiate between hard computing and soft computing approaches.
2. Apply fuzzy logic principles and design fuzzy inference systems for solving real-world problems involving uncertainty.
3. Analyze and implement genetic algorithms for solving optimization problems using appropriate encoding and operators.
4. Apply swarm intelligence techniques such as Particle Swarm Optimization and Ant Colony Optimization for solving engineering problems.
5. Design hybrid soft computing systems by integrating fuzzy logic and evolutionary algorithms for decision-making applications.
6. Evaluate and apply soft computing techniques to real-world problems and compare them with machine learning and deep learning approaches.

CO PO Map

co/po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso1	pso2
CO:1	3	2	-	-	-	-	-	-				1	2	2
CO:2	3	3	2	2	2	1	-	1				2	3	2
CO:3	3	3	2	2	2	1	-	-	1			2	3	2
CO:4	3	3	2	2	2	1	1	-	1			2	3	2
CO: 5	3	3	3	2	2	2	1	1	2	1	1	2	3	3
CO:6	3	3	3	3	2	2	1	1	2	2	1	3	3	3

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	
CO .5	
CO .6	

Future Courses Mapping:

Advanced Optimization Techniques, Evolutionary Computing, Robotics and Intelligent Systems, Control Systems and Automation, Computational Intelligence

Job Mapping:

Data Scientist, Machine Learning Engineer, AI Engineer, Optimization Engineer, Research Scientist (AI/ML), Robotics Engineer, Control Systems Engineer, Decision Support Systems Analyst, Business Intelligence Analyst

DS3203A: CLOUD COMPUTING

Course Prerequisites: Programming Paradigm Methodology

Course Objectives:

1. Understand the fundamental concepts of cloud computing, networking, storage, and Linux essentials to build a strong foundation for cloud-based solutions.
2. Apply AWS core services, security mechanisms, Infrastructure as Code (IaC), and serverless computing to design and deploy scalable cloud applications
3. Understand and utilize core services of Amazon Web Services to build, deploy, and manage scalable, reliable, and secure cloud-based applications.
4. Understand security and compliance practices in cloud environments using services of Amazon Web Services to protect data, manage access, and ensure regulatory compliance
5. Understand how relational databases are designed, managed, and deployed
6. Build scalable cloud-native applications and understand emerging cloud technologies and trends.

Credits: 4

Teaching Scheme Theory: 3 Hours/Week
Tutorial: NA
Lab: 2 Hours/Week

Course Relevance:. This course is highly relevant as it equips professionals with in-demand skills for designing, deploying, and managing scalable, secure, and cost-efficient cloud solutions. It also boosts career opportunities through globally recognized AWS certifications and industry adoption.

SECTION-1

Unit 1:Introduction to Cloud: Network Fundamentals: The OSI Model, TCP vs UDP, IP addressing & Subnetting, Routing & Firewall. Storage Fundamentals: Block Storage, Object Storage, File storage, SAN, NAS Linux Introduction and Essential Commands: Introduction, History, Usage, Flavours. Linux Commands Shell Scripting: Basics, Arithmetic & Logical Operations, Cron, Loops. Cloud Fundamentals: Introduction to Cloud Computing, Properties of Cloud, Benefits of Using Cloud, Cloud Service Models (IaaS, PaaS, SaaS), Cloud Deployment Models (Public, Private, Hybrid, Multi-Cloud). **7Hrs.**

Case Study: Configure IP addressing, subnetting, and firewalls in a Linux environment.

Unit 2:AWS Fundamentals: AWS Accounts and Security: Overview of AWS Accounts, Creating an AWS Account, Securing an AWS Account, Setting Up a Budget in AWS, Introduction to Identity and Access Management (IAM), Creating Access Keys and Configuring AWS CLI v2 Tools. **7Hrs**

Case Study: Configure Account with IAM policies.

Unit 3: AWS Core Services: Introduction to Simple Storage Service (S3), Basics of Virtual Private Cloud (VPC), Introduction to Elastic Compute Cloud (EC2), Load Balancing Concepts, Overview of AWS Systems Manager. Infrastructure as Code & Serverless Computing: Introduction to Infrastructure as Code with AWS CloudFormation, Basics of AWS Lambda for Serverless Computing. **7Hrs**

Case Study: Develop a serverless function using AWS Lambda and trigger it using an S3 event.

SECTION-2

Unit 4:Cloud Security & Compliance: Security in Cloud: Shared Responsibility Model, Cloud Security Best Practices; Identity and Access Control: IAM Policies, MFA, Roles, Federated Access; Data Protection: Encryption at Rest/In Transit, Key Management (AWS KMS); Compliance & Auditing: AWS Artifact, Cloud Trail, GDPR, HIPAA, PCI-DSS; Threat Detection: Guard Duty, AWS Inspector, Security Hub. **7Hrs**

Case Study: Implement role-based access control in AWS with IAM & configure Cloud Trail for activity logging.

Unit 5:Relational Database service: Introduction to RDS, Different database services: Amazon RDS, Dynamo DB, Redshift, Configuring the database and backups, strong and eventual consistency. **7Hrs**

Case Study: configure DB instance with security

Unit 6:Cloud-Native Applications & Emerging Trends: Cloud-Native Architecture: Microservices, 12-Factor App Principles; Serverless & Event-Driven Architecture: AWS Lambda, SNS, SQS; Containers & Microservices: Service Mesh (Istio), Container Orchestration Trends; Edge & Hybrid Cloud: AWS Outposts, Azure Stack, Edge Use. **7Hrs**

Case Study: Deploy ,build scalable, resilient, and agile applications

List of practical :

1. Execute basic Linux commands (file operations, process management, user management).
2. Write and execute Shell scripts (arithmetic operations, loops, conditional statements)
3. Deploy a Static Website on AWS – Host a website using Amazon S3 and configure public access to banking users.
4. Launch and configure an EC2 instance with a web server to perform operations on an application
5. Build connectivity in VPC to VPC for peering.
6. Implement S3 cross region data replication of users
7. Automating Infrastructure Deployment – A bank needs to deploy multiple virtual machines and networking components on AWS. Use Terraform or Cloud Formation to automate the deployment and explain the advantages of Infrastructure as Code (IaC).
8. Building a Secure Web Application of Bank – Develop and deploy a secure web application to give access to all users of Bank using AWS EC2, S3, and a load balancer. Implement IAM roles and policies for access control.
9. Launch DB instance from Linux to store data of Customers
10. Perform operations on DynamoDB like create table,item,scan
11. Deploy SQS using lambda function
12. Deploy SNS to send mail/sms to all customers
13. Implement a monitoring solution using AWS Cloud Watch for a cloud-based application. Analyze logs and set up alerts to organization.
14. Optimizing Cloud Costs for an Enterprise – A company experiences high cloud costs. Analyze their AWS billing and suggest optimizations using auto-scaling, reserved instances, and cost monitoring tools

Suggest an assessment Scheme:

GD/PPT	*CP*	*CVV*	*HA*
20	*40*	*20*	*20*

CVV- course viva

HA- home assignments

GD/PPT - Group Discussion/Presentation

CP - Course Project

Text Books:

1. Karl Matthias, Sean P. Kane – Docker: Up & Running: Shipping Reliable Containers in Production, O'Reilly Media, Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0- 07008770-5, 2017, TMH.
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi – Mastering Cloud Computing, McGraw Hill, ISBN-13: 978-1-25-902995-0, 2013

Reference Books:

1. David Clinton, Bernard Golden – AWS Certified Solutions Architect Study Guide, Sybex, 2022
2. Michael Hausenblas, Stefan Schimanski – Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, O'Reilly Media, 2019

Moocs Links and additional reading material:

https://online-pmo.com/wp-content/Education/Learning%20DevOps.pdf

https://git-scm.com/book/en/v2, https://www.techmagic.co/blog/best-application-deployment-strategies

Course Outcomes:

Student should be able to

1. Explain cloud computing, networking, storage, and Linux essentials.
2. Utilize AWS services, security mechanisms, and Infrastructure as Code (IaC) for cloud application deployment.
3. Apply cloud security best practices, access control mechanisms, data protection techniques, and compliance tools to ensure secure cloud operations
4. Design and deploy cloud-native applications leveraging micro services, serverless architectures, and explore emerging cloud technologies such as AI/ML and edge computing.
5. Design and implement distributed, decoupled applications using SNS and SQS.
6. Design, develop, and deploy cloud-native applications using containers, micro services, and serverless technologies

CO PO Map

co/po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	Pso1	Pso2
CO:1	3	2	-	-	1	-	-	-	-	-	-	1	1	1
CO:2	2	2	3	1	3	-	-	-	-	1	2	1	2	2
CO:3	2	3	2	2	2	3	2	3	-	1	-	1	1	1
CO:4	2	2	3	2	3	-	1	-	1	1	1	2	2	2
CO:5	2	2	2	3	3	1	2	-	-	1	1	3	2	3
CO:6	2	3	3	2	3	-	-	-	2	2	2	2	2	2

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	
CO .5	
CO .6	

Future Courses Mapping:

AWS Cloud Practitioner

AWS Solutions Architect – Associate

Job Mapping:

Cloud Architect, Solutions Architect, Cloud-Native Application Developer, DevOps Engineer

FF No. : 654

MM0402A: IOT AND SUSTAINABILITY

Course Prerequisites: Basics of Computer Networks, Computer Organization.

Course Objectives:

1. To understand the fundamentals of IoT.
2. To choose appropriate IoT things for sustainable application development
3. To analyze basic IoT components for sustainable applications.
4. To design basic IoT applications based on requirements.

Credits: 3 **Teaching Scheme Theory:** 2 Hour/Week

Tutorial: 1 Hour/Week

Course Relevance: The course is highly relevant as it integrates modern IoT technologies with solutions to global environmental and resource challenges. It enables students to design smart systems for efficient energy use, environmental monitoring, and sustainable urban and agricultural development. The course also builds awareness of data-driven decision-making and responsible technology use. Overall, it prepares learners to contribute to sustainable and smart future ecosystems.

SECTION-1

Unit-1: Introduction to IOT

Definition and characteristics of IoT, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks, IoT communication models, IoT Communication APIs, IoT enabling technologies, IoT levels, IoT Issues and Challenges, Applications. **7 Hrs**

Unit-2: IOT Things

Introduction to IoT platforms, Sensors, Actuators, and Smart Objects, Classification of things, Sensor Networks, Connecting Smart Objects: Communications Criteria, IoT Access Technologies: IEEE 802.15.4 **7 Hrs**

SECTION-2

Unit-3: IOT Core components for Sustainability

Core components required for developing Sustainable applications (Microcontrollers): Arduino, Raspberry Pi, ESP8266, ESP32 and interfaces. IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT for sustainable systems like Weather Monitoring, Home Intrusion Detection, Smart cities etc. **7 Hrs**

Unit-4: IoT Protocols and Case Studies for Sustainability

IoT Protocols overview: CoAP, MQTT, IPv6, ZigBee, Bluetooth, Wi-fi, Comparison of Traditional Networking Protocols and IoT Protocols, Issues with IoT Standardization.

Discuss protocols suitable for sustainable applications like Smart Irrigation, Air and water quality monitoring, Waste management systems etc. Mounting of electronic components on PCB **7 Hrs**

List of Tutorials: (Any 5)

1. Draw and explain IoT architecture for a smart system (e.g., smart home)
2. Choose appropriate IOT Things for a given application (Ex air/water monitoring).
3. Compare MQTT, HTTP, and CoAP, Analyze use cases and efficiency
4. Compare different Microcontrollers in IOT
5. C**ase** Study Analysis
    i. Study an IOT-based sustainability project
    ii. Identify benefits, limitations, and improvements
6. **Mi**ni Design Project
    i. Propose a complete IoT solution for a sustainability issue
    ii. Include: Problem statement, Architecture, Expected outcomes
7. Simulate the IOT solution for proposed Mini project

    Recommended Tools (Conceptual Use- not limited to tools below)
    - ThingSpeak (data visualization)
    - Blynk (IoT dashboards)
    - Basic exposure to Python / Embedded C

Suggest an assessment Scheme:

ESE(w)	CP	GD/PPT
40	30	30

ESE(W) - end semester examination written

CP – course project

GD/PPT – group discussion/presentation

Text Books:

1. Internet of Things: A Hands-On Approach Arshdeep Bahga, Vijay Madisetti VPT – Paperback 2015 978- 0996025515 628/-
2. IOT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things David Hanes, Gonzalo Salgueiro, Patrick Grossetete Cisco Press – Paperback – 16 Aug 2017 978-1- 58714-456- 1 599.

Reference Books:

1. Smart Internet of things projects Agus Kurniawan Packt - Sep 2016 978- 1- 78646- 651-8 2 The Internet of Things Key Olivier Willy Publication 2nd Edition 978
2. Applications and protocols Hersent s 119- 99435-0, 3 The Internet of Things Connecting Objects to the Web Hakima Chaouchi, Willy Publications 978-1- 84821- 140-7.

Moocs Links and additional reading material:

1. https://www.netacad.com/courses/industrial-iot-and-control-systems-in-energy?courseLang=en-US
2. https://www.netacad.com/courses/introduction-iot?courseLang=en-US
3. https://www.netacad.com/courses/introduction-iot?courseLang=en-US

Course Outcomes:

Student should be able to

1. Understand the fundamentals of IOT.
2. Identify IoT things for sustainable application development.
3. Analyze basic IoT components for sustainable applications..
4. Design conceptual IoT systems for real-world problems.

CO PO Map

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO1
CO:1	2												
CO:2	2												
CO:3	2												
CO:4	2	2	2		2		2						

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:
Advance Internet Of Things, Industrial IOT

Job Mapping:
Embedded Systems Engineer, IoT Engineer / IoT Developer, Energy Management Engineer, Embedded Systems Engineer, Sustainability Analyst.

DS3205: Design Thinking 3

Teaching Scheme	Examination Scheme
Credits : 1	ESE Direct Evaluation: 100 marks
Tutorial : 1 Hrs/week	

Prerequisites:	
●	Course Prerequisites: Problem Based Learning, Project Centric Learning Course Relevance:
Course Objectives:	
●	To provide ecosystem for students and faculty for paper publication and patent filing
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand the importance of doing Research
2.	Interpret and distinguish different fundamental terms related to Research
3.	Apply the methodology of doing research and mode of its publication
4.	Write a Research Paper based on project work
5.	Understand Intellectual property rights
6.	Use the concepts of Ethics in Research , Understand Entrepreneurship and Business Planning

Section1:	Topics/Contents
What is research? Importance of Paper Publication and Patents Importance of Paper Publication and Patents Structure of Paper Journal Publication Publication in conference Literature Review Research Paper Writing Journal Ratings and Evaluation How to rate a Journal?	

Intellectual property (IP) Research Ethics Entrepreneurship	
Section2:	**Topics/Contents**
Structure of The paper Journal List (Top 50 Journals) Selection of the journal Use of various online journal selection tools Plagiarism checking Improving contents of the paper Patent drafting Patent search Filing of patent Writing answers to reviewer questions Modification in manuscript Checking of publication draft	

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)												PSO		
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1							1	1	2	2
CO2	1	1	1	1	1							1	1	2	2
CO3	2	2	3	3	2	2	1	2	2	3		1	1	3	3
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	3	3
CO5	1	1	1	1	1							1	1	2	2
CO6	2	2	2	2	2	2	1	3	2	3		1	1	3	3
Avg	1.7	1.7	1.8	1.8	1.7	2.0	1.0	2.3	2.0	3.0	1.0	1.0	1.0	2.5	2.5

FF No.: 654

DS3204: Engineering Research & Innovation

Teaching Scheme	**Examination Scheme**
Credits: 2	MSE (R):30 Marks
Practical: 2 Hrs./week	ESE (R):70 Marks

Prerequisites:	
●	Course Prerequisites: Research Based Learning Course Relevance: Research Centric Learning (RCL) is a powerful tool for students to work in areas of their choice and strengths. Along with course-based research projects, curriculum can be enriched with semester long Engineering Research and Innovation courses, in which students can investigate socially relevant problems using various technologies and research methods from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. To gain the necessary skills to tackle such research problems, students can select relevant online courses and acquire skills from numerous sources under guidance of faculty and enrich their knowledge in the research domain, thereby achieving research centric learning. Modern world sustained and advanced through the successful completion of research and innovation. In short, if students are prepared for success in life, we need to prepare them for a research-based world. It is a style of active learning and inquiry-based learning. Research centric learning will also redefine the role of teacher as mentor in the learning process. The RCL model focuses the student on a big open-ended question, challenge, or problem to research and respond to and/or solve. It brings students not only to know, understand and remember rather it takes them to analyze, design and apply categories of Bloom's Taxonomy.
Course Objectives:	
●	To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.

●	To Evaluate alternative approaches, and justify the use of selected tools and methods,
●	To emphasize learning activities those are long-term, inter-disciplinary and student-centric.
●	To engage students in rich and authentic learning experiences.
●	To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.
●	To develop an ecosystem to promote entrepreneurship and research culture among the students
Course Outcomes:	
	After completion of the course, student will be able to
1.	Identify a real-life research problem or gap from societal and technological need point of view
2.	Choose and compare alternative research methodologies to select the most feasible one
3.	Analyze and synthesize the identified research problem from a technological and scientific perspective.
4.	Design a reliable and scalable research methodology/experimental approach to meet the challenges.
5.	Evaluate the research outcomes based on the criteria specified
6.	Inculcate a long-life learning and research attitude towards the societal problems

Section1:	**Topics/Contents**
Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ERI, laboratory course contents of “Engineering Research” are designed as a ladder to extend connectivity of research methodologies and emerging technologies to solve real world problems using an interdisciplinary approach. The ladder in the form of gradual steps can be seen as below:	

Industry Communication Standards, Research Databases and Literature Repositories (IEEE Xplore, Scopus, Google Scholar), Patent Search and IPR Tools, Statistical and Data Analysis Tools, Computational Biology (Biomedical and Bioinformatics), Robotics and Automation, Industry 4.0 (Artificial Intelligence, Machine Learning, 5G and IoT, Cloud Computing, Big Data and Cyber Security etc).

Group Structure:

There should be a team/group of 4-5 students. A supervisor/mentor teacher assigned to individual groups. It is useful to group students of different abilities and nationalities together.

Selection of Research Problem/Topic:

● Students must focus on initiating the task/idea. The idea of inception and consideration shall be from following areas as a real-world problem:

-Health Care, Agriculture, Defense, Education, Smart City, Smart Energy, Swaccha Bharat Abhiyan, Environment, Women Safety.

● This is the sample list to start with. Faculty and students are free to include other ar

eas which meet society's requirements at large.

● The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyze the problem/project within an articulated disciplinary subject frame/domain.

● A problem can be theoretical, practical, social, technical, symbolic, cultural, and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases.

● By exemplarity, a problem needs to refer to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry.

Teacher's Role in RCL:

● Teacher is not the source of solutions rather he will act as the facilitator and mentor.

● To utilize the principles of problem solving, critical thinking and metacognitive skills of the students.

● To make the group aware about time management.

● Commitment to devote the time to solving student's technical problems and interested in helping students to empower them better.

Student's Role in RCL:

● Students must have ability to initiate the task/idea, they should not be mere imitators.

● They must learn to think.

● Students working in RCL must be responsible for their own learning.

● Students must quickly learn how to manage their own learning, instead of passively receiving instruction.

● Students in RCL are actively constructing their knowledge and understanding of the situation in groups.

● Students in RCL are expected to work in groups.

● They have to develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Developing Inquiry Skills:

● Students in PCL are expected to develop critical thinking abilities by constantly relating: What they read to do? What do they want to do with that information?

● They need to analyze information presented within the context of finding answers.

● Modeling is required so that the students can observe and build a conceptual model of the required processes.

● Use the following mechanism to maintain the track of moving towards the solution.

How effective is …….?

How strong is the evidence for ……?

How clear is ……?

- What are the justifications for thinking? Why is the method chosen?
- What is the evidence given to justify the solution?

Literature Survey – To avoid reinvention of wheel:

- It is an integral part of self- directed learning
- Identify the information needed to solve a given problem or issue
- Be able to locate the needed information
- Use the information to solve the given problem effectively.
- Skills required by students in information literacy include:
- · How to prepare for the search? How to carry out research
- Sorting and assessing of information in general

Use of Research Methodology: - investigation, collaboration, comprehension, application, analysis, synthesize and evaluation

Focus on the following skills while working in a team to reach to solution:

- Collaborative learning
- Interpersonal Skills
- Resources Evaluation
- Metacognitive Skills
- Reflection Skills

Section2:	**Topics/Contents**

ERI Sample Research Case Studies: -

With the adaptation of industry communication standards and modern research tools and platforms, the following research problems can be taken up:

1) Research on soil moisture prediction and detection using sensor data and machine learning

2) Research on temperature monitoring and prediction using IoT sensors and analytics

3) Research on pressure sensing and anomaly detection techniques for industrial applications

4) Research on early smoke and fire detection using sensor fusion and AI 5) Research on human motion detection and activity recognition using sensors 6) Research on collision detection and avoidance systems using sensor fusion 7) Research on acoustic and sound-based anomaly detection using machine learning	
Text Books:	
1	*Research Methodology: Methods and Techniques. By C.R. Kothari. New Age International Publishers. ISBN:978-8122415223; 2004*
2	*Research Methodology: A Step-by-Step Guide for Beginners. By Ranjit Kumar, SAGE Publications. 2019.*
3	*Practical Research: Planning and Design. By Paul D. Leedy, Jeanne Ellis Ormrod, Pearson. 2019*
4	*The Craft of Research. By Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams. University of Chicago Press. 2016*
Reference Books:	
1	Creswell J.W.: Research Design: Qualitative, Quantitative and Mixed Methods Approaches. Sage Publications. 2014.
2	Research project management core textbook, second edition, Indian Edition, by Gopalan.
3	The Craft of Research. By Wayne C. Booth, Gregory G. Colomb & Joseph M. Williams

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CO3	2	2	3	2	3		2		3	1	2	2	3	3	2
CO4	2	2	3	2	3	3		2	3		2	2	3	3	2
CO5	2	2	3	2	3	2			3		2	2	3	3	2
CO6	2	2	3	3	2				3		3	2	3	3	2
Avg	2.0	2.0	2.83	2.83	2.6	2.5	2.0	2.0	3.0	1.0	2.16	2.0	3.0	3.0	2.0