

Deccan Education Society's

Kirti M. Doongursee College of Arts, Science and Commerce (AUTONOMOUS)



Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Masters of Science
Course: M.Sc Part-II
Subject: Computer Science

Choice Based Credit System (CBCS)
with effect from
Academic Year 2025-2026

PROGRAM OUTCOMES

PO	Description
	A student completing Master's Degree in Science Program will be able to
PO1	Demonstrate an in-depth understanding of the relevant science discipline. Recall, explain, extrapolate, and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance
PO2	Critically evaluate, analyze, and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
PO3	Access, evaluate, understand, and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
PO4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language
PO5	Demonstrate initiative, competence, and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups
PO6	Use an objective, unbiased and non-manipulative approach in the collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance
PO7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills, and lead a team in the planning and execution of a task
PO8	Understand the cross-disciplinary relevance of scientific developments and relearn and reskill to adapt to technological advancements.

Deccan Education Society's
Kirti M. Doongursee College (Autonomous)
Proposed Curriculum as per NEP-2020
Year of implementation- 2025-2026
Name of the Department-Computer Science

Semester	Course Code	Course Title	Vertical	Credit
III	25CSMJ911	Web3 Technologies	Major	4
	25PSMJ91	Web3 Technologies — Practical	Major practical	2
	25CSMJ912	Fundamentals of Data Science	Major	4
	25CSMJ92	Fundamentals of Data Science-Practical	Major Practical	2
	25CSMJ913	Ethical and Responsible AI	Major	2
	25CSEL921 25CSEL922 25CSEL923	a. Social Network Analysis OR b. Advance Robotics (OR) c. Fuzzy Systems	Elective	2
	25CSELP92 25CSELP93 25CSELP94	a. Social Network Analysis (P) OR b. Advance Robotics (P) (OR) c. Fuzzy Systems (P)	Elective Practical	2
	25CSR4	Research Project(proposal)	RP	4
		25CSMJT11 25CSMJPT1	Deep Learning Deep Learning --- Practical	Major Major
	25CSMJT12 25CSMJPT2	Visualization Tools and Techniques Visualization Tools and Techniques --- Practical	Major Major	4 2

IV	25CSELT21	a.Trends in cloud computing (OR)	Elective	2
	25CSELT22	b.Remote Sensing (OR)		
	25CSELT23	c.Server Virtualization		
	25CSELPT2	Trends in cloud computing -(P) (OR)	Elective Practical	2
25CSELPT3	Remote Sensing- (P) (OR)			
	25CSELPT4	Server Virtualization-(P)		
	25CSOJTT3	Research Project	RP	6

SEMESTER-III

Course Code	MAJOR SEM – III	Credits	Lectures/Week
25CSMJ911	Advanced Computing (Web3 Technologies)	4	4
<p>Course Outcomes: After successful completion of this course, students would be able to</p> <p>CO1: Recall key concepts of Web3, including blockchain, decentralized applications (dApps), smart contracts, and tokenization.the blockchain technology.</p> <p>CO2: Explain the principles of decentralization, consensus mechanisms, and cryptographic security in Web3 technologies..</p> <p>CO3: Build and deploy blockchain applications for on-premise and cloud-based architecture, Implement smart contracts using Solidity and interact with blockchain networks through decentralized applications.</p> <p>CO4: Evaluate the impact of Web3 technologies on industries such as finance, healthcare, and supply chain management.</p>			
Unit	Topics	No of Lectures	
I	<p>Introduction to Web3 Technologies</p> <p>Blockchain: Growth of blockchain technology, Distributed systems, the history of blockchain and Bitcoin, Blockchain, Consensus, CAP theorem and blockchain, Decentralization using blockchain,Methods of decentralization,Routes to decentralization, Blockchain and full ecosystem decentralization, The consensus problem, Analysis and design, Classification, Algorithms,</p> <p>Bitcoin: Overview, Cryptographic keys, Transactions, Blockchain Mining, Bitcoin network, Wallets, Bitcoin payments, Innovation in Bitcoin, Advanced protocols, Bitcoin investment, and buying and selling Bitcoin</p>	15	
II	<p>Smart Contracts & Ethereum</p> <p>Smart Contracts: History, Definition Ricardian contracts, Smart contract templates, Oracles, Deploying smart contracts, The DAO</p> <p>Ethereum: Overview, Ethereum network, Components of the Ethereum ecosystem, The Ethereum Virtual Machine (EVM), Smart contracts, Blocks and Blockchain, Wallets and client software, Nodes and miners, APIs, tools, and DApps, Supporting protocols, Programming languages.</p> <p>Ethereum Development Environment: Overview, Test networks, Components of a private network, starting up the private network,</p>	15	

	mining on the private network, Remix IDE, MetaMask, Using MetaMask and Remix IDE to deploy a smart contract	
III	<p>Serenity, Ethereum, Hyperledger & Tokenization Web3: Exploring Web3 with Geth, Contract deployment, interacting with contracts via frontends Development frameworks: Serenity, Ethereum 2.0—an overview, Development, phases, Architecture Serenity: Ethereum 2.0—an overview, Development phases, Architecture Hyperledger: Projects under Hyperledger, Hyperledger reference architecture, Hyperledger Fabric, Hyperledger Sawtooth, Setting up a sawtooth development environment.</p> <p>Tokenization: Tokenization on a blockchain, Types of tokens, Process of tokenization, Token offerings, Token standards, Trading and finance, DeFi, Building an ERC-20 token, emerging concepts</p>	15
IV	<p>Solidity Programming</p> <p>Introduction to Solidity Programming: Layout of a Solidity Source File, Structure of a Contract, Types, Units, and Globally Available Variables, Input Parameters and Output Parameters, Control Structures, Function Calls, Creating Contracts via new, Order of Evaluation of Expressions, Assignment, Scoping and Declarations,</p> <p>Error handling: Assert, Require, Revert and Exceptions Smart Contracts: Solidity Programming –Contracts, Creating Contracts, Visibility and Getters, Function Modifiers, Constant State Variables, Functions, Inheritance, Abstract Contracts, Interfaces, Libraries.</p>	15
<p>REFERENCE BOOKS:</p> <ul style="list-style-type: none"> • Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition 2020 • Andreas M. Antonopoulos, Dr.Gavin wood “Mastering Ethereum” O” Reilly Media Inc, 2019 • Ritesh Modi, “Solidity Programming Essentials: A Beginner” s Guide to Build Smart Contracts for Ethereum and BlockChain”, Packt Publishing. • Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition 2020 • Josh Thompson, „Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming” , Create Space Independent Publishing Platform, First Edition - 2017. 		

Course Code	Course Title	Credits	Lectures/Week
25CSMJ91	Practical : Advanced Computing (Web3 Technologies)	02	4
<p>Note: The following practical can be performed using Solidity, NodeJS. Ethereum and any other suitable platform</p> <p>Prerequisite: Knowledge of Solidity, NodeJS</p> <p>Course Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <p>CO1: Recall the concept of the docker with respect to BlockChain Applications. CO2: Describe smart contracts and Ethereum development environment. CO3: Implement the concept of Ethereum framework, serenity and Tokenization,Apply Solidity programming for Smart contracts and tokenization. CO4: Evaluate the impact of Web3 technologies on industries such as finance, healthcare, and supply chain management.</p>			
1	Install and understand Docker container, Node.js, Java and Hyperledger Fabric, Ethereum and perform necessary software installation on local machine/create instance on Cloud to run.		
2	Create and deploy a block chain network using Hyperledger Fabric SDK for Java		
3	Interact with a block chain network. Execute transactions and requests against a block chain network by creating an app to test the network and its rules		
4	Deploy an asset-transfer app using block chain. Learn app development within a Hyperledger Fabric network.		
5	Use block chain to track fitness club rewards..		
6	Build a web app that uses Hyperledger Fabric to track and trace member rewards		
7	Car auction network: A Hello World example with Hyperledger Fabric Node SDK and IBM Block chain Starter Plan. Use Hyperledger Fabric to invoke chaincode while storing results and data in the starter plan		
8	Develop an IoT asset tracking app using Block chain. Use an IoT asset tracking device to improve a supply chain by using Block chain, IoT devices, and Node-RED.		
9	Create a global finance block chain application with IBM Block chain Platform Extension for VS Code. Develop a Node.js smart contract and web app for a Global Finance with block chain use case		
10	Develop a voting application using Hyperledger and Ethereum.		

Course Code	MAJOR SEM – III	Credits	Lectures/Week
25CSMJ911	Fundamentals of Data Science	4	4
<p>Course Outcomes: After successful completion of this course, students would be able to</p> <p>CO1: Recall fundamental concepts, history, and importance of data science CO2: Describe the key theories, methods, and algorithms used in data science.. CO3: Implement theoretical principles to interpret and analyze data-related problems. CO4: Analyze the ethical, societal, and methodological impact of data science.</p>			
Unit	Topics	No of Lectures	
I	<p>Foundations of Data Science</p> <ul style="list-style-type: none"> • Definition and scope of Data Science • History and evolution of Data Science • Applications in various domains (Healthcare, Finance, Business, etc.) <p>Data and Its Characteristics</p> <ul style="list-style-type: none"> • Types of Data: Structured, Semi-structured, Unstructured • Sources of Data and Challenges in Data Collection • Data Quality, Cleaning, and Storage Approaches 	15	
II	<p>Statistical and Mathematical Foundations</p> <ul style="list-style-type: none"> • Probability Theory and Distributions • Descriptive and Inferential Statistics • Regression Analysis and Hypothesis Testing. 	15	
III	<p>Theoretical Machine Learning Principles</p> <ul style="list-style-type: none"> • Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning • Introduction to key algorithms: Decision Trees, Naïve Bayes, K-Means Clustering • Model Evaluation Metrics (Accuracy, Precision, Recall, F1-score) 	15	

IV	Ethical, Privacy, and Societal Aspects <ul style="list-style-type: none"> ● Bias and Fairness in Data Science ● Ethical Concerns and Responsible AI Development ● Legal Frameworks (GDPR, CCPA) and Data Protection Policies 	15
-----------	--	-----------

REFERENCE BOOKS:

- Data Science for Business – Foster Provost & Tom Fawcett 1st Edition, 2013
- The Elements of Statistical Learning – Hastie, Tibshirani, & Friedman 2nd Edition, 2009
- Practical Statistics for Data Scientists – Peter Bruce & Andrew Bruce 2nd Edition, 2020
- An Introduction to Statistical Learning – Gareth James et al. 2nd Edition, 2021
- Pattern Recognition and Machine Learning – Christopher Bishop 1st Edition, 2006
- Machine Learning – Tom M. Mitchell, 1st Edition, 1997
- Weapons of Math Destruction – Cathy O’Neil 1st Edition, 2016
- Data Science Ethics: Concepts, Techniques, and Cautionary Tales – David Martens (2022)

Course Code	Course Title	Credits	Lectures /Week
25CSMJ92	Practical : Fundamentals of Data Science	02	4

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Recall core data science concepts, terminology, and foundational theories.

CO2: Summarize key principles of data collection, analysis, visualization, and statistical methods.

CO3: Use theoretical knowledge to interpret datasets, evaluate models, and discuss algorithmic outcomes.

CO4: Analyze ethical considerations, real-world case studies, and societal implications of data science.

1	Understanding Data Science and Its Evolution <ul style="list-style-type: none"> ● Objective: <i>Remember & Understand</i> ● Activity: Research the history and evolution of Data Science from statistics to modern AI. ● Task: Write a timeline-based report explaining key milestones in Data Science. ● Expected Output: 2-page essay outlining the progression and impact of Data Science.
2	Classifying Different Types of Data <ul style="list-style-type: none"> ● Objective: <i>Remember & Apply</i> ● Activity: Categorize real-world examples of structured, semi-structured, and unstructured data. ● Task: Identify at least five datasets (e.g., medical records, tweets) and classify them.

	<ul style="list-style-type: none"> ● Expected Output: A classification report with explanations of each type.
3	<p>Case Study on Data Quality and Cleaning</p> <ul style="list-style-type: none"> ● Objective: <i>Understand & Analyze</i> ● Activity: Study a case where poor data quality led to incorrect decisions in business or healthcare. ● Task: Identify data issues like missing values, biases, or inconsistencies and suggest solutions. ● Expected Output: A critical review highlighting errors and theoretical strategies for data cleaning.
4	<p>Probability Theory in Data Science</p> <ul style="list-style-type: none"> ● Objective: <i>Apply & Analyze</i> ● Activity: Research the role of probability distributions and Bayes' Theorem in data science applications. ● Task: Explain how probability helps in predictive models (e.g., spam detection, fraud detection). ● Expected Output: A written report with formulas and examples.
5	<p>Theoretical Analysis of Statistical Measures</p> <ul style="list-style-type: none"> ● Objective: <i>Understand & Apply</i> ● Activity: Study mean, median, mode, standard deviation, and correlation in dataset analysis. ● Task: Research how statistical measures help in understanding data trends. ● Expected Output: A research paper with real-world examples.
6	<p>Comparing Machine Learning Algorithms Theoretically</p> <ul style="list-style-type: none"> ● Objective: <i>Apply & Analyze</i> ● Activity: Compare any two machine learning models based on theory (not coding). ● Task: Discuss how Decision Trees vs. Naïve Bayes work and their pros/cons. ● Expected Output: A comparative analysis report.
7	<p>Ethics & Bias in Data Science</p> <ul style="list-style-type: none"> ● Objective: <i>Analyze</i> ● Activity: Study an example of biased AI decision-making (e.g., biased hiring algorithms). ● Task: Identify how training data bias affects fairness and suggest improvements. ● Expected Output: A case study report discussing ethical concerns.
8	<p>Understanding Model Evaluation Metrics</p> <ul style="list-style-type: none"> ● Objective: <i>Understand & Apply</i> ● Activity: Research how Accuracy, Precision, Recall, and F1-score measure AI performance. ● Task: Explain how these metrics determine a model's effectiveness in real-world scenarios.

	<ul style="list-style-type: none"> ● Expected Output: A written report with metric calculations and applications.
9	<p>Legal Frameworks & Privacy Regulations</p> <ul style="list-style-type: none"> ● Objective: <i>Analyze</i> ● Activity: Study legal data science frameworks like GDPR and CCPA. ● Task: Identify how companies comply with privacy laws when handling customer data. ● Expected Output: A case study review on compliance challenges
10	<p>Societal Impact of Data Science</p> <ul style="list-style-type: none"> ● Objective: <i>Analyze</i> ● Activity: Research how Data Science affects government policies, healthcare, and business decisions. ● Task: Write a theoretical analysis of benefits, risks, and challenges in data-driven society. ● Expected Output: A written reflection analyzing real-world impacts.

Course Code	MAJOR SEM – III	Credits	Lectures/Week
25CSMJ913	Ethical & Responsible AI	2	4

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Learn the fundamental ethical issues that arise in the field of data science.

CO2: Summarize the ethical implications of data collection, and decision-making processes., explain concerns related to data collection, storage, and sharing and along with the principles to make decisions in data science projects.

CO3: Use privacy concerns to data collection, storage, and sharing, Implement Responsible AI Ethics and Accountability Auditing

CO4: Analyze the emerging ethical issues and future directions in data science

Unit	Topics	No of Lectures
I	Introduction to Responsible AI Artificial Intelligence Fundamentals, Introduction to responsible AI. Need for ethics in AI. AI for Society and Humanity Fairness and Bias Sources of Biases Exploratory data analysis, limitation of a dataset Preprocessing, in processing and post processing to remove bias Group fairness and Individual fairness, Counterfactual fairness Interpretability and explainability Interpretability through simplification and visualization Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality Model agnostic Interpretation	15

II	<p>Implementation of Responsible AI Ethics and Accountability Auditing:</p> <p>AI models, fairness assessment Principles for ethical practices Privacy preservation Attack models Privacy Preserving Learning, Differential privacy Federated learning Case study Recommendation systems medical diagnosis Hiring/ Education Computer Vision Natural Language Processing, Data Compliance Data Protection Policies and rights of the data subjects. Roles of the Controller, Processor and Data Protection Officer (DPO) Planning for compliance - privacy compliance frameworks and gap analysis. Data Protection Impact Assessment (DPIA) Data breaches, notification and incident response.</p>	15
-----------	---	-----------

REFERENCE BOOKS:

- Virginia Dignum, “Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way” Springer Nature, 04-Nov-2019;ISBN-10 : 3030303705, ISBN-13 : 978-3030303709
- Christoph Molnar “Interpretable Machine Learning”.Lulu, 1st edition, March 25, 2019; eBook. ISBN-10 : 0254768528, ISBN-13 : 978-0254768522

Course Code	ELECTIVE SEM – III	Credits	Lectures/Week
25CSEL921	Elective-1: Social Network Analysis	2	4

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Gain a comprehensive understanding of social network concepts, including nodes, edges, centrality, clustering, and network dynamics.

CO2: Develop skills in visualizing social network data using appropriate tools and techniques, including node-link diagrams, matrix plots, and network layouts.

CO3: Use various methods/ techniques for performing Social Network Analysis.

CO4: Analyze and compare methods for measuring equivalence of distances, such as Maxsim, and regular equivalence, in various network contexts and analyze the results in the context of network analysis, such as identifying the significance of the singular values and their implications for the network’s properties.

Unit	Topics	No of Lectures
I	<p>Introduction to Social Network Analysis (SNA)</p> <p>Understanding networks- density, reachability, connectivity, reciprocity, group-external and group-internal ties in networks, ego networks, extracting and visualizing ego networks, structural holes, Centrality-</p>	15

	degree of centrality, closeness and betweenness centrality, local and global centrality, centralization and graph centers, notion of importance within network, Google pagerank algorithm, Analyzing network structure bottom up approaches using cliques, N-cliques, N-clans, K-plexes, K-cores, F-groups and top-down approaches using components, blocks and cut points, lambda sets and bridges, and factions.	
II	Measures of similarity and structural equivalence in SNA:- Measures of similarity and structural equivalence in SNA Approaches to network positions and social roles- defining equivalence or similarity, structural equivalence, automorphic equivalence, finding equivalence sets, brute force and Tabu search, regular equivalence, equivalence of distances: Maxsim, regular equivalence, Measuring similarity/dissimilarity- valued relations, Pearson correlations covariance and cross-products, Understanding clustering- agglomerative and divisive clusters, Euclidean, Manhattan, and squared distances, binary relations, matches: exact, Jaccard, Hamming Two-mode networks for SNA Understanding mode networks- Bi-partite data structures, visualizing two-mode data, quantitative analysis using two-mode Singular value decomposition (SVD) analysis.	15

REFERENCE BOOKS:

- Introduction to Social Network Methods: Robert A. Hanneman, Mark Riddle, University of California, 2005 [Published in digital form and available at <http://faculty.ucr.edu/~hanneman/nettext/index.html>].
- Social Network Analysis for Startups- Finding connections on the social web: Maksim Tsvetovat, Alexander Kouznetsov, O'Reilly Media, 2011.
- Social Network Analysis- 3rd edition, John Scott, SAGE Publications, 2012.
- Exploratory Social Network Analysis with Pajek, Second edition: Wouter de Nooy, Andrej Mrvar, Vladimir Batagelj, Cambridge University Press, 2011.
- Analyzing Social Networks, Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications, 2013.
- Statistical Analysis of Network Data with R: Eric D. Kolaczyk, Gábor Csárdi, Springer, 2014.
- Network Analysis: Methodological Foundations, (Editors) Ulrik Brandes, Thomas Erlebach. Springer, 2005.
- Models and Methods in Social Network Analysis: (Editors) Peter J. Carrington, John Scott, Stanley Wasserman, Cambridge University Press, 2005.

Course Code	Course Title	Credits	Lectures /Week
25CSELP92	Practical Course on Elective-1: Social Network Analysis	02	4

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Gain a comprehensive understanding of social network concepts, including nodes, edges, centrality, clustering, and network dynamics.

CO2: Develop skills in visualizing social network data using appropriate tools and techniques, including node-link diagrams, matrix plots, and network layouts.

CO3: Implement various methods/ techniques for performing Social Network Analysis.

CO4: Analyze the results in the context of network analysis, such as identifying the significance of the singular values and their implications for the network's properties.

Note: The Practical to be performed preferably in R Studio or Python

1	Write a program to compute the following for a given a network: (i) number of edges, (ii) number of nodes; (iii) degree of node; (iv) node with lowest degree; (v)the adjacency list; (vi) matrix of the graph.
2	Perform following tasks: (i) View data collection forms and/or import onemode /two-mode datasets; (ii) Basic Networks matrices transformations
3	Compute the following node level measures: (i) Density; (ii) Degree; (iii) Reciprocity; (iv) Transitivity; (v) Centralization; (vi) Clustering.
4	For a given network find the following: (i) Length of the shortest path from a given node to another node; (ii) the density of the graph; (iii) Draw egocentric network of node G with chosen configuration parameters.
5	Write a program to distinguish between a network as a matrix, a network as an edge list, and a network as a sociogram (or “network graph”) using 3 distinct networks representatives of each.
6	Write a program to exhibit structural equivalence, automatic equivalence, and regular equivalence from a network.
7	Create Sociograms for the persons-by-persons network and the committee-bycommittee network for a given relevant problem.
8	Create one-mode network and two-node network for the same.
9	Perform SVD analysis of a network.
10	Identify ties within the network using two-mode core periphery analysis.

Course Code	ELECTIVE SEM – III	Credits	Lectures/Week
25CSEL922	Advance Robotics	2	2

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Define the basics of control schemes used in manipulators and PID control.

CO2: Summarize the concepts of linear and angular velocity in rigid body motion and their applications in robot motion analysis.

CO3: Use transformations to vectors in different coordinate frames and compute the effects of rotation and translation.

CO4: Analyse the relationship between linear and angular motion in rigid bodies, and combined motion for robotic systems.

Unit	Topics	No of Lectures
I	Introduction to Robotics, Industrial robot, Types of drive systems, Classification by co-ordinate system and control system, Precision of movement (or) parameters of robot, Components of industrial robotics, Manipulator kinematics, The Challenge: Complexity and Uniformity, D-H Convention, Manipulator Dynamics, Jacobian Matrix, R-R Manipulator, Trajectory Planning.	15
II	Robotics-Actuators and Sensors, Electric Actuators, Hydraulic Actuators, Pneumatic Actuators, Sensor Type, Force Sensing, Touch Sensor Tactile Sensing, Robot-Vision, Touch, Hearing. Robot Applications, Assembly, Inspection, Service Robotics, Key Challenges.	15

REFERENCE BOOKS:

- Mittal RK & Nagrath, “*Robotics and Control*”, 2nd Edition, TMH, 2008.
- Lung-Wen Tsai, “*Robot Analysis: The Mechanics of Serial and Parallel Manipulators*”, John Wiley and sons. Inc. 1999
- Mark W. Spong and M. Vidyasagar, “*Robot Dynamics and Control*”, Johan Wiley & Sons (ASIA) Pvt. Ltd.

Course Code	ELECTIVE SEM - III	Credits	Lectures/Week
25CSELP93	Advance Robotics Practical	2	4
<p>Course Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <p>CO1: Identify the protocol used for secure file transfer (SFTP) to the Raspberry Pi. CO2: Describe the steps involved in transferring files to a Raspberry Pi from a PC using SFTP. CO3: Develop a Python script to program a robot to autonomously follow a predefined path. CO4: Evaluate the robustness of the implemented line-following behavior under varying lighting conditions or line characteristics.</p>			
1	Making a Raspberry Pi headless, and reaching it from the network using WiFi and SSH		
2	Using sftp upload files from PC.		
3	Write Python code to test motors.		
4	Write a script to follow a predetermined path.		
5	Develop Python code for testing the sensors		
6	Add the sensors to the Robot object and develop the line-following behaviour code.		
7	Using the light strip develop and debug the line follower robot.		
8	Add pan and tilt service to the robot object and test it.		
9	Create an obstacle avoidance behaviour for the robot and test it.		
10	Detect faces with Haar cascades.		

Course Code	ELECTIVE SEM – III	Credits	Lectures/Week
25CSEL923	Fuzzy Systems	2	4

Prerequisite: Basic understanding of Probability and Fuzzy Concepts

Course Outcome:

After successful completion of this course, students would be able to

- CO1:** Recall the fundamental concepts of fuzzy systems, including their historical background, and describe the key differences between classical and fuzzy logic.
- CO2:** Explain the effectiveness of different types of fuzzy relations (e.g., fuzzy equivalence and compatibility relations) in solving complex problems, and propose improvements where necessary.
- CO3:** Demonstrate the process of fuzzy clustering using Fuzzy C-Means and analyze the results in the context of data mining and image processing.
- CO4:** Recognize the role of fuzzy logic in artificial intelligence and machine learning systems.

Unit	Topics	No of Lectures
I	<p>Introduction to Fuzzy System: Historical Background, Comparison between Classical and Fuzzy Logic, Applications of Fuzzy Logic</p> <p>Fuzzy Sets: Definition and Examples of Fuzzy Sets, Membership Functions, Types of Membership Functions (Triangular, Trapezoidal, Gaussian, etc.), Operations on Fuzzy Sets (Union, Intersection, Complement)</p> <p>Fuzzy Relations: Definition and Types of Fuzzy Relations, Composition of Fuzzy Relations, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations</p> <p>Fuzzy Rule-Based Systems: Fuzzy If-Then Rules, Fuzzy Inference Systems, Mamdani vs. Sugeno Fuzzy Models, Applications in Control Systems</p> <p>Fuzzy Arithmetic: Fuzzy Numbers, Arithmetic Operations on Fuzzy Numbers, Extension Principle, Applications of Fuzzy Arithmetic</p> <p>Fuzzy Logic Control: Basic Concepts of Fuzzy Control, Design of Fuzzy Controllers, Stability Analysis of Fuzzy Control Systems, Real-World Applications</p>	15
II	<p>Fuzzy Decision Making: Fuzzy Decision-Making Process, Multi-Criteria Decision Making, Fuzzy Optimization Techniques, Case Studies</p> <p>Fuzzy Clustering: Introduction to Clustering, Fuzzy C-Means Clustering, Evaluation of Clustering Results, Applications in Image Processing and Data Mining</p> <p>Fuzzy Pattern Recognition: Fuzzy Pattern Recognition Systems, Fuzzy Neural Networks Hybrid Systems (Fuzzy Logic and Neural Networks), Practical Examples and Applications</p> <p>Fuzzy Logic in Artificial Intelligence: Integration of Fuzzy Logic in AI, Fuzzy Expert Systems, Fuzzy Logic in Machine Learning, Case Studies.</p>	15

REFERENCE BOOKS:

- Timothy Ross, "Fuzzy Logic with Engineering Applications", John Wiley and Sons, Second Edition.
- An Introduction to Fuzzy Logic Applications in Intelligent Systems by Ronald R. Yager and Lotfi A. Zadeh
- Fuzzy Sets and Fuzzy Logic: Theory and Applications by George J. Klir and Bo Yuan

Course Code	Course Title	Credits	Lectures/Week
25CSELP94	Fuzzy System Practical	02	4

Prerequisite: Knowledge of Python and matlab

Course Outcome:

After successful completion of this course, students would be able to

CO1: Recall the fundamental concepts of fuzzy sets, fuzzy logic, and membership functions.

CO2: Understand the significance of support, height, and crossover in fuzzy logic systems and how they affect the output.

CO3: Use fuzzy logic principles to create a fuzzy sets model for house pricing, incorporating real-world variables.

CO4: Analyze the impact of different membership functions (triangular, trapezoidal, and Gaussian) on fuzzy logic outcomes.

1	Develop a Fuzzy Sets model for House Pricing example.
2	Calculate support in fuzzy logic.
3	Calculate height and cross over in Fuzzy.
4	Create a triangular function in Matlab using trimf.
5	Implement fuzzy_trapezoidal_membership-function
6	Implement fuzzy_gaussian_membership_function
7	Implement Fuzzy Sets Union Intersection
8	Implement fuzzy logic medical exam regarding the blood pressure and age
9	Implement Tipping Problem without Fuzzy Logic

10	Implement Water Level Control in a Tank using Fuzzy Logic
----	---

Course Code	SEM - III	Credits	Lectures/Week
25CSRP93	Research Proposal	4	4

Introduction

The NEP 2020 has emphasized on the inclusion of research and development in Higher Education Institutions. As colleges are an integral part of the knowledge impartment and creation NEP 2020 has introduced the research component to quite a substantial degree at postgraduate level. The multidisciplinary, transdisciplinary and translational research culture is expected to be introduced at postgraduate level. Such research projects undertaken will obviously enhance the research productivity, collaboration at national and international level in various industries, government as well as community based organizations and agencies.

Course Outcomes:

CO1: Define well formulated specific objectives that help to develop the overall research methodology

CO2: Identifying the research methods and literature review

CO3: Apply pre-learnt concepts to design research problem with the help of literature survey and develop a thorough research proposal.

CO4: Analyze the research gap by comparative study.

Guidelines for Research Project

A student is expected to devote at least 2 to 3 months of effort to the Research Project Proposal.

A student should submit a Research Project Proposal report with the following details:

- Title: Title of the Research Project.
- Objective: A detailed objective of the proposal is needed.
- Introduction/Background
- Related works/Literature Survey: A detailed survey of the relevant works done by others in the domain. The student is expected to refer to at least 30 recent (last five years) research papers in addition to textbooks and web links in the relevant topic.
- Proposed Methodology: - Describe the overall research design, including whether it will be quantitative, qualitative, or mixed-methods. Explain the rationale behind the chosen design and how it aligns with the research objectives. Explain the characteristics of the participants, including demographics, sample size, selection criteria, and recruitment methods. Outline the methods used for data collection, such as surveys, interviews, observations, or document analysis.
- Significance / Scope of the work
- Conclusion
- References

Certified Spiral Bound Copy duly signed by Internal Guide and Head of the Department is required to submit at the time of External Viva Examination

Course Code	SEM III	Credits	Lectures/Week
25CSR4	Research PROJECT	4	120

Introduction

The NEP 2020 has emphasized on the inclusion of research and development in Higher Education Institutions. As colleges are an integral part of knowledge impartment and creation, NEP 2020 has introduced the research component to quite a substantial degree at postgraduate level. The multidisciplinary, transdisciplinary and translational research culture is expected to be introduced at postgraduate level. Such research projects undertaken will obviously enhance the research productivity, collaboration at national and international level in various industries, government as well as community based organizations and agencies.

Course Outcomes:

- CO1: Define well formulated specific objectives that help to develop the overall research methodology
- CO2: Identifying the research methods and literature review
- CO3: Apply pre-learnt concepts to design research problem with the help of literature survey and develop a thorough research proposal.
- CO4: Analyze the research gap by comparative study.

Guidelines for Research Project

A student is expected to devote at least 2 to 3 months of effort to the Research Project Proposal.

A student should submit a Research Project Proposal report with the following details:

- Title: Title of the Research Project.
- Objective: A detailed objective of the proposal is needed.
- Introduction/Background
- Related works/Literature Survey: A detailed survey of the relevant works done by others in the domain. The student is expected to refer to at least 30 recent (last five years) research papers in addition to textbooks and web links in the relevant topic.
- Proposed Methodology: - Describe the overall research design, including whether it will be quantitative, qualitative, or mixed-methods. Explain the rationale behind the chosen design and how it aligns with the research objectives. Explain the characteristics of the participants, including demographics, sample size, selection criteria, and recruitment methods. Outline the methods used for data collection, such as surveys, interviews, observations, or document analysis.
- Significance / Scope of the work
- Conclusion
- References

Certified Spiral Bound Copy duly signed by Internal Guide and Head of the Department is required to submit at the time of External Viva Examination

Scheme of Examination for Research Project

Internal Examination A) Continuous Internal Evaluation:

Method			Marks	
Internal Viva 1			25	
Topic Weightage	Introduction	Objectives	Literature Survey	Total
05	05	05	10	25
Internal Viva2				
Proposed Methodology	Significance / Scope and Conclusion	Documentation	Total	
10	05	10	25	

External Examination A) External Evaluation:

Method				Marks			
External Viva				50			
Topic Weightage	Introduction	Objectives	Literature Review	Proposed Methodology	Documentation	Presentation/ Viva	Total
05	05	05	10	05	10	05	50

SEMESTER IV

Course Code	MAJOR SEM – IV	Credits	Lectures/Week
25CSMJT11	Deep Learning	4	4
<p>Prerequisite: Fundamental concepts of Machine Learning and Neural Network</p> <p>Course Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <p>CO1: Recall fundamental concepts of neural networks, deep learning, and machine learning models.</p> <p>CO2: Describe the key concepts of convolutional neural networks, such as kernels, filters, and the building blocks of CNNs.</p> <p>CO3: Apply feed-forward networks to solve multiclass classification problems and evaluate the model's performance.</p> <p>CO4: Analyze the impact of overfitting in deep learning models and apply strategies like regularization and early stopping to mitigate it.</p>			
Unit	Topics	No of Lectures	
I	<p>Neural Network for Deep Learning</p> <p>Optimization and Neural Network: Review of Neural Network fundamentals, the problem of Learning, Implementing single Neuron-Linear and Logistic Regression,</p> <p>Deep Learning: Fundamentals, Deep Learning Applications, Popular open-source libraries for deep learning</p> <p>Feed-Forward Networks: Networks architecture and Matrix notation, Overfitting, Multiclass Classification with Feed-Forward Neural Networks, Estimating Memory requirement of Models</p>	15	
II	<p>Convolutional and Recurrent Networks for Deep Learning</p> <p>Regularization: Complex Network and Overfitting, Regularization and related concepts, Hyperparameter tuning</p> <p>Convolutional Neural Networks: Kernels and Filters, Building Blocks of CNN, Inception Network, Transfer Learning</p> <p>Recurrent Neural Network: Notation and Idea of recurrent neural networks, RNN Topologies, backpropagation through time, vanishing and exploding gradients</p>	15	

III	<p>Advanced Concepts for Deep Learning Autoencoders: Introduction, Network Design, Regularization in Autoencoders, Denoising autoencoders, Feed-Forward Autoencoders, sparse and Contractive autoencoders Unsupervised Feature Learning: Hopfield networks and Boltzmann machines, restricted Boltzmann machine, Deep belief networks</p> <p>Generative Adversarial Networks (GANs): Introduction, training algorithms, Conditional GANs, applications, Deep convolutional generative adversarial networks</p>	15
IV	<p>Deep Learning Application</p> <p>Deep Learning for AI Games: AI Game Playing, Reinforcement learning, Maximizing future rewards, Q-learning, The deep Q-network as a Q- function, Balancing exploration with exploitation, Experience replay, or the value of experience</p> <p>Deep Learning for Object Localization and classification: Intersect Over Union (IoU), Sliding Window Approach, Region-Based CNN (R-CNN) Deep Learning for Language Modelling and Speech Recognition, Generative AI- Arts Generation, Content Generation</p>	15
<p>REFERENCES BOOKS:</p> <ul style="list-style-type: none"> ● Python Deep Learning, Valentino Zocca, Packt Publication, 2017 ● Applied Deep Learning, with TensorFlow 2, Umberto Michelucci, Apress, 2022 ● Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017 ● Advanced Deep Learning with Keras, Rowel Atienza, Packt Publication, 2018 ● Python Deep Learning Cookbook, Indra den Bakker, Packt Publication, 2017 ● Deep Learning with Keras, Antonio Gulli, Packt Publication, 2017 		

Course Code	Course Title	Credits	Lectures/ Week
25CSMJPT1	Deep Learning Practical	02	4

Prerequisite: Basic understanding of machine learning concepts, familiarity with Python programming language, knowledge of common datasets (e.g., Iris, MNIST), proficiency in using machine learning libraries (e.g., scikit-learn, TensorFlow).

Course Outcomes:

After successful completion of this course, students would be able to

- CO1:** Recall fundamental concepts of neural networks, deep learning, and machine learning models.
- CO2:** Describe the key concepts of convolutional neural networks, such as kernels, filters, and the building blocks of CNNs.
- CO3:** Apply DL techniques to different datasets.
- CO4:** Analyze the impact of overfitting in deep learning models and apply strategies like regularization and early stopping to mitigate it.

Note: All the Practical's should be implemented using Python and TensorFlow. Link:Python :<https://www.python.org/downloads/> TensorFlow :<https://www.tensorflow.org/install>

1	Implement Feed-forward Neural Network and train the network with different optimizers and compare the results.
2	Write a Program to implement regularization to prevent the model from overfitting.
3	Implement deep learning for recognizing classes for datasets like CIFAR-10 images for previously unseen images and assign them to one of the 10 classes.
4	Implement deep learning for the Prediction of the autoencoder from the test data (e.g. MNIST data set).
5	Implement Convolutional Neural Network for Digit Recognition on the MNIST Dataset.
6	Write a program to implement Transfer Learning on the suitable dataset (e.g. classify the cats versus dogs dataset from Kaggle).
7	Write a program for the Implementation of a Generative Adversarial Network for generating synthetic shapes (like digits)
8	Write a program to implement a simple form of a recurrent neural network. E.g. (4-to-1 RNN) to show that the quantity of rain on a certain day also depends on the values of the previous day
9	Implement LSTM for sentiment analysis on datasets like UMICH SI650 for similar.
10	Write a program for object detection from the image/video.

Course Code	MAJOR SEM – IV	Credits	Lectures/Week
25CSMJT12	Data Visualization Tools and Techniques	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- CO1:** Learn fundamental concepts of data visualization.
- CO2:** Describe different concepts of data storing, cleaning, wrangling and different operations that

can be performed on data.

CO3: Use various techniques of data visualization to solve real-world data analysis problems with thorough, detailed examples and create a story using the dashboard.

CO4: Use the data from various sources and perform analysis using Tableau

Unit	Topics	No of Lectures
I	<p>Preparing and Storing Data</p> <p>Series: Creating a Series with index, creating a Series from a Dictionary, Creating a Series from a Scalar Value, Vectorized Operations and Label Alignment with Series, Name Attribute. Accessing Data from a Series with a Position, Exploring and Analysing a Series, Operations on a Series.</p> <p>Data Frames: Creating a Data Frame from a Dict of Series or Dicts, Creating Data Frames from a Dict of Ndarrays, Creating Data Frames from a Structured or Record Array, Creating Data Frames from a List of Dicts, Creating Data Frames from a Dict of Tuples, Selecting, Adding, and Deleting Data Frame Columns, Assigning New Columns in Method Chains, Row Selection, Row Addition, Row Deletion, Exploring and Analysing a Data Frame, Indexing and Selecting Data Frames, Transposing a Data Frame, Data Frame Interoperability with Numpy Functions.</p> <p>Visualizing Data: Data visualization in Business Intelligence, Data visualization techniques. Data visualization libraries in Python</p>	15
II	<p>Data Cleaning and Data Wrangling</p> <p>Data Gathering and Cleaning: Cleaning Data, Checking for Missing Values, Handling the Missing Values, Reading and Cleaning CSV Data, Merging and Integrating Data, Reading Data from the JSON Format, HTML Format, XML Format.</p> <p>Data Transformation Removing Duplicates: Replacing Values, Renaming Axis Indexes</p> <p>Hierarchical Indexing: Reordering and Sorting Levels Summary/ Statistics by Level Indexing with a DataFrame's columns. Combining and Merging Datasets Database-Style, DataFrame Joins Merging on Index Concatenating Along with an Axis Combining Data with Overlap</p> <p>Reshaping and Pivoting: Reshaping with Hierarchical Indexing Pivoting "Long" to "Wide" Format Pivoting "Wide" to "Long" Format</p>	15

	<p>Statistical Analysis, Data Aggregation: Data Grouping, Iterating Through Groups, Aggregations, Transformations, Filtration.</p>	
III	<p>Basics of Tableau</p> <p>Tableau: Introduction, connecting to data, Visualizing Data using Tableau, Graphs, charts, and reports</p> <p>Connecting to Data: Connecting various data sources, Managing data source metadata, Extract Data, Filtering data. Moving beyond basic visualization.</p> <p>Calculations: Introduction to Calculation, Row-level Calculations, Aggregate calculations, parameters, Leveraging level of Detail Calculations.</p> <p>Telling Data Story with Dashboards: Designing Dashboards in tableau, Designing for different displays and devices.</p>	15
IV	<p>Data Visualization (Skill Enhancement)</p> <p>Trend Visualization: Trend Models, Analysing Trend Models. Clustering, Distributions, and Forecasting, Different Charts and Visualization.</p> <p>Dynamic Dashboards: Sheet Swapping, Automatically Showing and hiding controls.</p> <p>Exploring Mapping and Advanced Geospatial Features: Rendering maps with Tableau. Using Geospatial Data Creating custom territories.</p> <p>Structuring Messy Data to Work Well in Tableau: Structuring data for Tableau.</p> <p>Taming data with Tableau Prep: Cleaning, Transforming, Filtering, and Calculating data. Sharing Data story.</p>	15
<p>REFERENCE BOOKS:</p> <ul style="list-style-type: none"> • Dr. Ossama Embarak, Data Analysis and Visualization Using Python, Apress, 2018 • Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O’Reilly, 2nd Edition, 2018. • Learning Tableau 2020, Create effective data visualizations, build interactive visual analytics, and transform your organization. Joshua Milligan, Fourth Edition, Packt, 2020. • Jake VanderPlas, “Python Data Science Handbook: Essential Tools for Working with Data”, O’Reilly, 2017 • Visual Data Storytelling with Tableau, Linda Ryan, Pearson Addison Wesley Data & Analytics Series, 2018 • Visual Analytics with Tableau, Alexander Loth, Wiley, 2019 		

Course Code	Course Title	Credits	Lectures /Week
25CSMJPT2	Data Visualization Tools and Techniques Practical	02	4
<p>Course Outcomes: After successful completion of this course, students would be able to</p> <p>CO1: Learn fundamental concepts of data visualization. CO2: Describe different concepts of data storing, cleaning, wrangling and different operations that can be performed on data. CO3: Use various techniques of data visualization to solve real-world data analysis problems with thorough, detailed examples and create a story using the dashboard. CO4: Use the data from various sources and perform analysis using Tableau.</p>			
1	Create one-dimensional data using series and perform various operations on it.		
2	Create Two-dimensional data with the help of data frames and perform different operations on it.		
3	Write a code to read data from the different file formats like JSON, HTML, XML, and CSV files and check for missing data and outlier values and handle them.		
4	Perform Reshaping of the hierarchical data and pivoting data frame data.		
5	Connecting and extracting with various data resources in tableau.		
6	Performing calculations and creating parameters in Tableau		
7	Designing Tableau Dashboards for different displays and devices.		
8	Create a Trend model using data, Analyse-it and use it for forecasting.		
9	Create a Trend model using data, Analyse-it and use it for forecasting.		
10	Create Dashboard and Storytelling using tableau.		

Course Code	ELECTIVE SEM – IV	Credits	Lectures/Week
25CSELT21	Trends in Cloud Computing	2	2
<p>Course Outcomes: After successful completion of this course, students would be able to</p> <p>CO1:Recall the core concepts of the cloud computing paradigm, DevOps & Container in Clouds and techniques for Cloud Application Development</p> <p>CO2:Summarize the basic concepts and need of Cloud Computing along with various techniques</p> <p>CO3:Implement the fundamental concepts and techniques in datacenters to understand the tradeoffs in power, efficiency and cost.</p> <p>CO4: Analyze various cloud programming models and apply them to solve problems on the cloud.</p>			
Unit	Topics	No of Lectures	
I	<p>Basic Concepts & Techniques for Cloud Application Development Fundamentals of Cloud Application Development:Business case for implementing cloud application, Requirements collection for cloud application development, Cloud service models and deployment models, Open challenges in Cloud Computing: Cloud interoperability and standards, scalability and fault tolerance, security, trust, and privacy Application Development framework</p> <p>Accessing the clouds: Web application vs Cloud Application, Frameworks: Model View Controller (MVC). Cloud platforms in Industry – Google AppEngine, Microsoft Azure, Openshift, CloudFoundry</p> <p>Sessions and API: Storing objects in the Cloud, Session management, Working with third party APIs: Overview of interconnectivity in Cloud ecosystems. Facebook API, Twitter API, Google API.</p> <p>Architecting for the Cloud: Best practices in architecture cloud applications in AWS cloud, Amazon Simple Queue Service (SQS), RabbitMQ</p> <p>Managing the data in the Cloud: Securing data in the cloud, ACL, OAuth, OpenID,XACML, securing data for transport in the cloud, scalability of applications and cloud services</p>	15	
II	<p>DevOps and Containers in Cloud</p> <p>Basics of DevOps: Introduction to DevOps, Continuous Deployment: Containerization with Docker, Orchestration (Kubernetes and Terraform), Automating Infrastructure on Cloud, Application Deployment and Orchestration using ECS, ECR & EKS, Application Deployment using Beanstalk, Configuration Management using OpsWorks</p> <p>Application: Designing a RESTful Web API, PubNub API for IoT to cloud, mobile device as IoT, Mobile cloud access</p>	15	

	<p>Azure essentials: Azure Compute and Storage, Azure Database and Networking, Monitoring and Managing Azure Solutions, GCP Compute and Storage, GCP Networking and Security, Google App Engine (PaaS)</p> <p>Cloud applications: Amazon Simple Notification Service (Amazon SNS), multi- player online game hosting on cloud resources, building content delivery networks using cloud</p>	
--	---	--

REFERENCE BOOKS:

- Kevin L. Jackson, Scott Goessling, Architecting Cloud Computing Solutions, Packt Publishing 2018
- Shailendra Singh, Cloud Computing: Focuses on the Latest Developments in Cloud Computing, Oxford University Press; First edition, June 2018
- JJ GEEWAX, Google Cloud Platform in Action, Manning Publications Co, 2018
- Haishi Bai, Dan Stolts, Santiago Fernández Muñoz, Exam Ref 70-535 Architecting Microsoft Azure Solutions, Pearson Education, 2018
- Dr. Kumar Saurabh, Cloud Computing, 4ed: Architecting Next-Gen Transformation Paradigms, Wiley, 2017

Course Code	Course Title	Credits	Lectures /Week
25CSELPT2	Trends in Cloud Computing Practical	02	4

Course Outcomes:

After successful completion of this course, students would be able to

- CO1:** Recall the basic concepts of web application development, including the MVC framework, servlets, and Java web technologies.
- CO2:** Explain the features and capabilities of Google App Engine (GAE) as a Platform as a Service (PaaS) model, and the role of cloud platforms in modern application development.
- CO3:** Develop and deploy a web application on Google App Engine, implementing features such as a guestbook or a model-view-controller (MVC) application.
- CO4:** Analyze the performance of web applications deployed on various cloud platforms (Google App Engine, Azure, IBM Bluemix) and compare their features and limitations.

1	Using the software like / API / Tools JDK 1.7/1.8, Eclipse IDE, Dropbox API, Apache tomcat server 7.0/8.0, Google AppEngine API, Servlets, Struts, Spring framework design and develop Web applications using MVC Framework
2	Installing and configuring the required platform for Google App Engine
3	Studying the features of the GAE PaaS model.

4	Creating and running Web applications (Guest book, MVC) on localhost and deploying the same in Google App Engine
5	Developing an ASP.NET based web application on the Azure platform
6	Creating an application in Dropbox to store data securely. Develop a source code using Dropbox API for updating and retrieving files.
7	Installing Cloud Foundry in localhost and exploring CF commands
8	Cloud application development using IBM Bluemix Cloud
9	Installing and Configuring Dockers in localhost and running multiple images on a Docker Platform
10	Configuring and deploying VMs/Dockers using Chef/Puppet Automation tool

Course Code	ELECTIVE SEM – IV	Credits	Lectures/Week
25CSELT22	Remote Sensing & GIS	2	2

Prerequisite: Fundamental concepts of Machine Learning and Neural Network

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Recall the components and functions of a Geographic Information System (GIS) and understand the difference between GIS and general information systems.

CO2: Summarize the principles of remote sensing sensors, their imaging modes, and characteristics such as resolution and detector specifications.

CO3: Use the principles of electromagnetic radiation and remote sensing to analyze the spectral signatures of different land cover features.

CO4: Analyze GIS data types, including vector and raster structures, and how they are used for geographic representation and spatial operations.

Unit	Topics	No of Lectures
I	Basics of Remote Sensing Overview of Remote sensing: Definition of Remote sensing Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms and definitions, Radiation Laws, EM spectrum, Sources of EM, Interaction	15

	<p>of EM Radiation with atmosphere, and target, Atmospheric Windows, imaging spectrometry, Spectral signature of various land cover features</p> <p>Platform and Sensors :-Platforms: Types of platforms, ground, airborne, and space born platforms, Orbit of satellites, Kepler's Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana)</p> <p>Sensors: Types and classification of sensors, imaging modes, Characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, Characteristics of detectors, GPS-Coordinate and time systems, Satellite orbital motions, GPS observables, Estimation procedures</p>	
II	<p>GIS</p> <p>Introduction to GIS, Understand the difference between GIS and information system in general, GIS components and function of GIS: hardware software requirement of GIS, data types and spatial data models, idea of conceptual, logical and physical models, RDBMS, database normalization Representation of real world via vector and raster representation model. Applications in land use and land cover analyses, Raster data structure, Vector data structures for geographical entities. GIS Operation Layers and Operations.</p>	15
<p>REFERENCE BOOKS:</p> <ul style="list-style-type: none"> ● Applied Remote Sensing, C.P. Lo, Longman, Scientific and Technical Publishers ● Remote Sensing in hydrology, Engman, E.T. Gurney, R.J. ● Remote Sensing in water management in command areas, Govardhan, V. ● Satellite oceanography, An introduction for oceanographers and Remote Sensing Scientists, I.R. Robinson, Ellis Horwood series marine sciences. 		

Course Code	Course Title	Credits	Lectures /Week
25CSELPT3	Remote Sensing and GIS Practical	02	4
<p>Note: - The following set of practicals should be implemented in CodeVisionAVR, Proteus8, Cisco Packet Tracer, Keli V5, Python</p> <ul style="list-style-type: none"> ● Link:-Python:https://www.python.org/downloads/ ● CodeVisionAVR:https://www.codevision.be/ ● Proteus8:https://www.labcenter.com/downloads/ ● Cisco Packet Tracer:https://www.netacad.com/courses/packet-tracer ● Keli V5: https://www.keil.com/download/ <p>Course Outcomes:</p>			

After successful completion of this course, students would be able to

CO1: Recall the basic concepts of vector and raster data, and their roles in geographic information systems (GIS).

CO2: Describe the process of working with terrain data, including hillshade analysis, and how to generate topographic maps.

CO3: Implement hillshade analysis techniques to terrain data for visualizing the 3D structure of landforms.

CO4: Analyze vector data to extract statistical information and calculate line lengths, and assess the accuracy of spatial data used in GIS applications.

1	Creating and Managing Vector Data a) Adding vector layer b) Setting properties Vector Layer Formatting
2	Write a program to Calculate line lengths and statistics
3	Write a program to Add raster layers, Raster Styling and Raster Mosaicking and Clipping.
4	Develop a map and download openstreetmap data.
5	Work with Terrain Data and Perform Hill shade analysis
6	Work with Projections and WMS Data
7	Generate Topo Sheets and Scanned Maps.
8	Perform spatial queries
9	Work with Interpolating Point Data.
10	Develop Automating Complex Workflows using Processing Modeler
11	Develop Automating Map Creation with Print Composer Atlas
12	Validate Map Data and note down observations

Course Code	ELECTIVE SEM – IV	Credits	Lectures/Week
25CSELT23	Server Virtualization	2	2

Prerequisite: Basic concepts of Virtualization

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Recall the basic concepts of virtualized IT infrastructure, including physical vs. virtual infrastructure, types of virtualization, and key components like virtual machines (VM), hypervisors, and virtual networks.

CO2: Explain the significance of network and storage virtualization, and how they contribute to the overall efficiency and scalability of modern IT infrastructure.

CO3: Implement VM migration techniques, such as MVM migration, and assess the impact of different migration types (e.g., live migration) on virtualized environments.

CO4: Analyze the benefits and challenges of different virtualization types, such as desktop, storage, and memory virtualization, in various business contexts.

Unit	Topics	No of Lectures
I	<p>Virtualized IT Infrastructure: Concepts & Trends Virtualized IT Infrastructure: Concepts & Trends Physical Vs Virtual IT Infrastructure, machines, Data Centres, Types of Virtualizations, Desktop, Application, Server, Hardware, Storage, Memory and I/O virtualization, Need of Network and Storage Virtualization, Recent Trends & technologies in virtualized environments</p> <p>Virtual Machine Management Introduction to Hypervisors, Role of VMM. VM lifecycle, VM configurations, MVM migrations, Migration types and process, VM provisioning, Scaling, VM scheduling, Load balancing: Significance, Types and Algorithms, Comparing workstation products, QoS parameters – Performance, Functionality, Windows Vs Linux Hosting, Software Migration, Migrating workloads from Physical to Virtual Machines</p>	15
II	<p>Network Virtualization Network Virtualization How to build guest OS, planning for automatic installations, Virtual Interfaces, VNIC profiles, Virtual Switches and Routers, TUN/TAP drivers and data flow between VMs, NAT, host-only</p>	15

	<p>approaches, Designing virtual networks, Bridged, NAT and host-only networking.</p> <p>Virtual Data Centers introduction, Data Center Virtualization with ESXi, Networking with Switches and port groups, Optimizing resource utilization Server Virtualization Server Partitioning, choosing virtual server hosts, Security implications, Server VMs, Interactive mode, deploying virtual servers, managing virtual servers remotely, Server health monitoring using vSphere Monitoring and Performance services, VM Cluster, Distributing workloads via Network Load Balancing (NLB)</p>	
--	--	--

REFERENCE BOOKS:

- Mickey Iqbal 2010, IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach, MC Press [ISBN: 978-1583473542]
- Mike Laverick, VMware vSphere 4 Implementation [ISBN: 978-0071664523]
- Jason W. McCarty, Scott Lowe, Matthew K. Johnson, VMware vSphere 4 Administration Instant Reference [ISBN: 978-0470520727]
- Brian Perry, Chris Huss, Jeantet Fields, VCP VMware Certified Professional on vSphere 4 Study Guide [ISBN: 978-0470569610]
- Brian Perry, Chris Huss, Jeantet Fields, VCP VMware Certified Professional on vSphere 4 Study Guide [ISBN: 978-0470569610]
- Jason Kappel, Anthony Velte, Toby Velte, Microsoft Virtualization with Hyper- V: Manage Your Datacenter with Hyper-V, Virtual PC, Virtual Server, and Application Virtualization [ISBN: 978-0071614030]

Course Code	Course Title	Credits	Lectures/ Week
25CSELPT4	Server Virtualization Practical	02	4

Note: - The following set of practical's should be implemented in Scrape, python: Link:-Python :
<https://www.python.org/downloads/>

Course Outcomes:

After successful completion of this course, students would be able to

CO1: Recall the basic concepts and definitions related to vCenter Server Appliance, virtual machine provisioning, and resource pool management in VMware environments.

CO2: Explain the principles behind using vSphere vMotion and Storage vMotion for virtual machine migration across hosts and storage devices.

CO3: Implement Use vSphere vMotion and Storage vMotion to migrate virtual machines seamlessly between hosts and storage devices without downtime.

CO4: Analyze and evaluate the efficiency of resource pool configurations in vCenter Server, and determine how resource allocation impacts virtual machine performance.

1	Configure and use vCenter Server Appliance. Assign roles and permissions to Active Directory users to perform functions in vCenter Server Appliance
2	Create a standard switch and a port group. Configure access to an iSCSI datastore.
3	Create and manage VMFS datastores. Configure access to an NFS datastore. Deploy a new virtual machine from a template and clone a virtual machine.
4	Create a content library to clone and deploy virtual machines. Modify a virtual machine's hardware and add a raw LUN to a virtual machine
5	Use vSphere vMotion and vSphere Storage vMotion to migrate virtual machines.
6	In vCenter Server, create and use resource pools on an ESXi host. Use the system monitoring tools to reflect the CPU workload.
7	In vCenter Server, create and use resource pools on an ESXi host. Use the system monitoring tools to reflect the CPU workload.
8	Use the vCenter Server Appliance alarm feature.
9	Use vSphere HA functionality.
10	Implement a vSphere DRS cluster. b. Install, configure, and use vSphere Update Manager.

Course Code	Course title	Credits	Lectures/Week
25CSOJTT3	RESEARCH PROJECT	6	4

Introduction

The research project proposal needs to be implemented by following the given timeline Under the NEP, students are expected to get industry ready by the time they pass out of their Masters' degree course. There is also an emphasis on research so that every student is expected to carry out independent research project as a part of their Post Graduate program. The emphasis is on research that is socially applicable, and carried out with scientific rigor. One benchmark of good quality research is publication of the project either in International or National level scientific journals or the presentation of students' research work at International, National or State level conferences. With this broad objective, the following has been proposed for student research projects at Masters level.

Course Outcomes:

- CO1: Facilitate substantial data collection for the proposed research work
- CO2: Carry out research following ethical aspects of research activities.
- CO3: Develop the proposed system
- CO4: Analyze the research findings/conclusions / results obtained

Note: A student is expected to devote at least 3 to 4 months of effort to the Research Project Implementation on the proposal submitted in Semester III. Students should submit a detailed research project implementation report at the time of viva. Students are not permitted to change the project they submitted as a proposal in Semester III.

Guidelines for Documentation of Research Project Implementation in Semester –IV

A student should submit a Research Project Implementation report with the following details:

- Title: Title of the Research Project.
- Objective: A detailed objective of the proposal is needed.
- Introduction/Background:
- Related works/Literature Survey: A detailed survey of the relevant works done by others in the domain. The student is expected to refer to at least 30 recent (last five years) research papers in addition to textbooks and web links in the relevant topic.
- Methodology: A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software, and data to be used.
- Implementation details: A description of how the project has been implemented.
- Experimental setup and results: A detailed explanation of how experiments were conducted, what software was used, and the results obtained. Details like screenshots, tables, and graphs can come here.
- Analysis of the results: A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this.
- Conclusion: A conclusion of the project performed in terms of its outcome
- Future enhancement: A small description of what enhancement can be done when more time and resources are available
- Program code: The program code may be given as an appendix.

Certified Spiral Bound Copy duly signed by Internal Guide and Head of the Department is required to submit at the time of External Viva Examination

Scheme of Examination for Research Project

Internal Examination A) Continuous Internal Evaluation:

Method		Marks		
Internal Viva 1		40		
Methodology	Implementation	Total		
20	20	40		
Internal Viva 2				
Experimental setup and results	Analysis of the results	Code	Document	Total
05	10	15	05	35

External Examination A) External Evaluation:

Method				Marks			
External Viva				75			
Introduction	Objectives	Methodology	Code/Mode	Results	Document	Viva	Total
05	05	10	20	20	05	10	75

Evaluation Scheme for Second Year (PG) under NEP (4 credits)

I. Internal Evaluation for Theory Courses – 40 Marks

1) Continuous Internal Assessment(CIA) Assignment - Tutorial/ Case Study/ Project / Presentations/ Group Discussion / Ind. Visit. – 20 marks

2) Continuous Internal Assessment(CIA) ONLINE Unit Test – 20 marks

II. External Examination for Theory Courses – 60 Marks

Duration: 2 Hours

Theory question paper pattern:

Question	Based on	Marks
Q.1	Unit I	15
Q.2	Unit II	15
Q.3	Unit III	15
Q.4	Unit IV	15

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be subdivided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.
- **Paper Pattern of Theory Paper:(for 4 credits)**

DES's Kirti M. Doongursee College (AUTONOMOUS), Dadar (W), Mumbai-28		
Regular / Additional / ATKT Examination		
Duration: 2 Hour		Max Marks: 60
Date:	Time:	Code:
<i>(For office use)</i>		
N. B.	i)	<i>All Questions are compulsory.</i>
	ii)	<i>Mixing of sub-questions is not allowed</i>
	iii)	<i>Draw neat labeled diagrams wherever necessary.</i>
Q. No.		Marks
Q.1 A		07
OR		
Q.1 B		07
Q.1 C		08
OR		
Q.1 D		08
Q.1 E		07
OR		

Q.1 F		07
Q.2 G		08
OR		
Q.2 H		08
Q.3 I		07
OR		
Q.3 J		07
Q.3 K		08
OR		
Q. 3 L		08
Q.4 M		07
OR		
Q.4 N		07
Q.4 O		08
OR		
Q.4 P		08

Evaluation Scheme for Second Year (PG) under NEP (2 credits)

I. Internal Evaluation for Theory Courses – 20 Marks

- 1) Continuous Internal Assessment(CIA) Assignment - Tutorial/ Case Study/ Project / Presentations/ Group Discussion / Ind. Visit. – 10 marks
- 2) Continuous Internal Assessment(CIA) ONLINE Unit Test – 10 marks

II. External Examination for Theory Courses – 30 Marks

Duration: 1 Hours

Theory question paper pattern:

Question	Based on	Marks
Q.1	Unit I	15
Q.2	Unit II	15

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be subdivided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.
- **Paper Pattern of Theory Paper:(for 2 credits)**

DES's Kirti M. Doongursee College (AUTONOMOUS), Dadar (W), Mumbai-28		
Regular / Additional / ATKT Examination		
Duration: 1 Hour		Max Marks: 30
Date:	Time:	Code:
<i>(For office use)</i>		
N. B.	i)	<i>All Questions are compulsory.</i>
	ii)	<i>Mixing of sub-questions is not allowed</i>
	iii)	<i>Draw neat labeled diagrams wherever necessary.</i>
Q. No.		Marks
Q.1 A		07
OR		
Q.1 B		07
Q.1 C		08
OR		
Q.1 D		08
Q.1 E		07
OR		
Q.1 F		07
Q.2 G		08
OR		
Q.2 H		08

III. Practical Examination

- Each core subject carries 50 Marks
- Duration: 2 Hours for each practical course.
- Minimum 80% practical from each core subjects are required to be completed.
- Certified Journal is compulsory for appearing at the time of Practical Exam

NOTE: To pass the examination, attendance is compulsory in both Internal & External (Theory + Practical) Examinations.