SURANA COLLEGE AUTONOMOUS

Affiliated with Bangalore University

REGULATIONS, SCHEME, AND SYLLABUS

For the course

MASTER OF COMPUTER APPLICATIONS (MCA)

(Choice-Based Credit System)

2024-2026 Batch

Effective from Academic Year 2025-26 and onwards

MCA PROGRAMME

SURANA COLLEGE (Autonomous)

Regulations of Master of Computer Applications (MCA) Course

1. **TITLE OF THE COURSE:** The course shall be called MCA – Master of Computer Applications.

2. **DURATION OF THE COURSE**: The course of study shall be two years.

3. **ELIGIBILITY FOR ADMISSION**: A candidate with any degree of a minimum of 3 years duration (10+2+3) of Bangalore University or of any other University equivalent there in towith a minimum of 50% of marks in the aggregate of all subjects including languages, if any, provided further, that the candidate has studied Mathematics / Computer science /Business Mathematics / Statistics / Computer Applications / Electronics as a subject at PUC level or equivalent HSC (XII Standard) or at Degree level is eligible for admission to MCA Course. Relaxation to SC/ST, Group I be extended as per university norms.

4. **ATTENDANCE**: In each Semester a candidate should be considered to have successfully undergone the prescribed Course of study if the candidate has attended at least 75% of the classes in each subject (Theory, Lab & Practical).

5. **SCHEME OF EXAMINATION**:

   A. The Internal Assessment marks should be decided for each of the theory subjects by conducting 2 tests, each of 90 minutes duration, spread over the span of a Semester. A seminar should also be given by the student in the second year and the same to be assessed and evaluated for internal assessment along with two tests.

   B. The Internal Assessment marks in Practical course is based on the performance in the Laboratory. The Internal Assessment marks for Project work of a candidate is based on the dissertation and seminar.

6. **ELIGIBILITY TO GO TO THE HIGHER SEMESTER**:

   A. A Candidate is allowed to carry over all the previously uncleared (failed) theory papers and Practical to subsequent semesters from the first to fourth semester.

   B. The maximum period for the completion of the course shall be four years from the date ofadmission.

7. **MINIMUM FOR PASS AND DECLARATION OF RESULTS**

   A. For a pass in a semester, a candidate shall secure a minimum of 40% of the marks prescribed for a subject in the University Examination (Theory, Practical, Project work) and 50% of the marks in the aggregate inclusive of the Internal Assessment marks obtained in all subjects put together.

   B. The candidates who do not satisfy 7(A) shall be deemed to have failed and must take exams in the subjects in which he has secured less than 40% at the University examination.

   C. Provision is made for rejection of results of all the subjects of a Semester only once if the candidate decides to reappear for all the subjects of that semester. Such rejection should be made within 30 days of the

announcement of the result, by making a written application, through the Head of the Institution. If such rejection is in respect of the results of all the subjects of one semester and earns fresh Internal marks as well.

D. The results of any semester will be declared as pass or fail as the case may be in accordance with regulation 7(A).

E. To be eligible for the award of the MCA degree, a candidate shall have completed the scheme of training and passed all subjects prescribed for the Course.

8. A candidate shall complete examinations of all Semesters of the MCA Course within – FOUR years from the date of admission.

Department Vision

To be a leading destination for students and learners in advancing knowledge, learning experiences in technology and multidisciplinary fields, driven by research and innovation, contributing to the holistic development of human resources for the betterment of society.

Department Mission

- ✓ To develop state-of-the-art laboratories, modern infrastructure, and a competent faculty to provide quality education, hands-on skills, and to foster research, innovation, and entrepreneurship.
- ✓ To foster values, ethics and academic integrity to develop students and learners into responsible citizens.
- ✓ To collaborate with institutes of national and international repute as well as industry to develop synergy and advance new knowledge and skills.
- ✓ To contribute to the global cause and environment.

Program Educational Objectives (PEOs)

Students in the first 3 to 5 years of their professional life should be able to:

- ✓ **PEO-1**: Demonstrate innovative mind, analytical thinking and problem-solving competence as a “lead” in infotech projects at workplace.
- ✓ **PEO 2**: Demonstrate consciousness in values, ethics and concern for the society while working on advances in science, technologies and research.
- ✓ **PEO-3**: Work in teams, collaborate, develop synergy, build knowledge and skills to enhance professional attainments.
- ✓ **PEO-4**: Contribute to community, nation and to the global cause of climate, environment protection and sustainability.
- ✓ **PEO-5**: Demonstrate a mindset for the life-long learning.

Program Outcomes

PO1-Foundation Knowledge: Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.

PO2-Problem Analysis: Identify, review, formulate and analyse problems for primarily focussing on customer requirements using critical thinking frameworks.

PO3-Development of Solutions: Design, develop and investigate problems with as an innovative approach for solutions incorporating ESG/SDG goals.

PO4-Modern Tool Usage: Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.

PO5-Individual and Teamwork: Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.

PO6-Conduct Research and Undertake Project: Use research-based knowledge and undertake projects to solve real-world engineering problems.

PO7-Ethics: Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware.

PO8-Life-long learning: Change management skills and the ability to learn, keep up with contemporary technologies and ways of working.

First Year MCA Course Matrix 2024-25

Sem	Course Code	Title of the course	Hours/ week	Marks			Credits	
				IA	Exam	Total	Course	Sem
I	24PS1.1	Object Oriented Programming concepts using Java	4	30	70	100	4	28
	24PS1.2	Art of Programming	4	30	70	100	4	
	24PS1.3	Statistical Analysis	4	30	70	100	4	
	24PS1.4	Theory of Computation	4	30	70	100	4	
	24PS1.5	Database Management Systems	4	30	70	100	4	
	24PS1.6	Data Communication Networks	4	30	70	100	4	
	24PS1.7	Java Programming Lab	4	30	70	100	2	
	24PS1.8	Art of Programming Lab	4	30	70	100	2	
II	24PS2.1	Data Structures and Algorithms	4	30	70	100	4	26
	24PS2.2	Research Methodology	4	30	70	100	4	
	24PS2.3	Agile Development and DevOps	4	30	70	100	4	
	24PS2.4	Web Technologies	4	30	70	100	4	
	24PS2.5	Mobile Application Development	4	30	70	100	4	
	24PS2.6	Data Structures and Algorithms Lab	4	30	70	100	2	
	24PS2.7	DBMS Lab	4	30	70	100	2	
	24PS2.8	Web Technologies and Mobile Application Development Lab	4	30	70	100	2	

Second Year MCA Course Matrix 2025-26

Sem	Course Code	Title of the course	Hours/ week	Marks			Credits	
				IA	Exam	Total	Course	Sem
III	24PS3.1	Artificial Intelligence & Machine Learning	4	30	70	100	4	26
	24PS3.2	Cloud Computing	4	30	70	100	4	
	24PS3.3	Spec-1	4	30	70	100	3	
	24PS3.4	Spec-2	4	30	70	100	3	
	24PS3.5	Spec-3	4	30	70	100	3	
	24PS3.6	Machine Learning Lab	4	30	70	100	2	
	24PS3.7	Specialization Lab	4	30	70	100	3	
	24PSOECCS	Open Elective	4	30	70	100	4	
IV	24PS4.1	Data Science	4	30	70	100	4	28
	24PS4.2	Spec-4	4	30	70	100	3	
	24PS4.3	Spec-5	4	30	70	100	3	
	24PS4.4	Research Paper Presentation	4	30	70	100	2	
	24PS4.5	Main Project	16	150	250	400	16	

Specialization Pool

AI & ML	Cloud Computing
Natural Language Processing	Parallel And Distributed Computing
Big Data Analytics	Cloud Networking, Software and Economics
Deep Learning	Cloud Computing Platforms
Computer Vision and Explainable AI	DevOps for Cloud Computing
Generative AI	Emerging Trends in Cloud Computing

Third Semester

24PS3.1 – ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Total hours: 52

Course Outcomes (COs):

- **CO1**: Define foundational AI concepts, search strategies, and knowledge representation techniques, and identify suitable methods for intelligent problem-solving.
- **CO2**: Explain AI subdomains such as NLP, robotics, and expert systems, and analyze machine learning perspectives, system design principles, and performance metrics.
- **CO3:** Apply supervised learning techniques including Decision Trees, K-NN, Naive Bayes, SVM, and regression models to solve classification and prediction problems.
- **CO4**: Analyze and evaluate unsupervised learning algorithms such as clustering (K-means, DBSCAN, etc.) and dimensionality reduction (PCA, SVD) for complex datasets.
- **CO5**: Design and construct intelligent systems by integrating AI planning, supervised and unsupervised learning methods to address real-world problem scenarios.

Unit-I: Introduction to AI History of AI, agents, and environments, the structure of agents, problem-solving agents, uninformed search strategies, informed search strategies, heuristic search techniques, gameplaying, best first search, A* and AO* Algorithm, Knowledge representations and reasoning: types and examples.	**10 hours**
Unit -II : Planning and Learning Planning: block world, strips, Implementation using goal stack, Perception: Action. Introduction to Sub Domains of AI: Robotics, Expert Systems, NLP, Machine Learning. Introduction to Machine Learning (ML), Perspectives & Issues in ML, designing learning systems, Concepts of hypotheses, Version space, Performance metrics accuracy, precision, recall, sensitivity, specificity, AUC, RoC.	**14 hours**
Unit-III: Supervised Learning Decision Trees Learning: Basic algorithm (ID3), Issues in Decision Tree Learning – Overfitting, Solutions to overfitting, Random Forest Model, Classification using K-Nearest Neighbour algorithm, Understanding Naive Bayes - Conditional probability and Bayes theorem, Naive Bayes algorithm for classification. Support vector machines, Linear Regression, Logistic Regression	**14 hours**
Unit-IV: Unsupervised Learning Clustering: Hierarchical vs non-hierarchical clustering, Agglomerative and divisive clustering, K means clustering, Bisecting k-means, K-medoid	**14 hours**

clustering, DBSCAN. Dimensionality reduction techniques – PCA, SVD.EM Algorithm, GMM, Associative Rule Mining: Apriori algorithm.	

References:

1. Stuart Russel, Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, May 2022.
2. Tom Mitchell, "Machine Learning", Indian Edition, McGraw- Hill, 2017.
3. Ethem Alpaydin, "Introduction to Machine Learning", Second Edition, 2009.
4. Kevin P Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

24PS3.2 – CLOUD COMPUTING

Total hours: 52

Course Outcomes (COs):

- **CO1**: Understand the fundamental principles, architecture of cloud computing and its applications across industries like education and healthcare.
- **CO2**: Compare and contrast different cloud service models (SaaS, IaaS, and PaaS) and analyse their benefits, limitations, and use-case applicability
- **CO3**: Demonstrate the role of virtualization in cloud environments and analyze various hypervisors and virtual machine migration techniques using real-time case studies
- **CO4**: Analyse cloud platforms and tools such as Hadoop, AWS, Azure, and OpenStack to build and simulate cloud environments for computational tasks.
- **CO5**: Evaluate security and privacy concerns in cloud computing and propose secure architectures, ensuring safe and effective cloud deployment.

Unit-I: Foundations of Cloud Computing Computer system fundamentals: CPU, memory, storage and I/O. Memory hierarchy: cache, RAM, virtual memory. Processor architecture basics, system performance metrics: throughput, latency, benchmarking. Principles of Parallel and Distributed Computing, Introduction to cloud computing, Goals and challenges, cloud computing architecture, cloud concepts, and technologies, cloud services and platforms, types of cloud, the total cost of ownership, cloud computing in industry, education, and healthcare.	**16 hours**
Unit-II: Cloud Service Models Cloud Service Models: Software as a Service (SaaS): how it works? challenges, SaaS integration services, advantages, and disadvantages. Infrastructure as a Service (IaaS): how it works? challenges, the evolution of infrastructure migration approaches, cloud infrastructure services, advantages, and disadvantages. Platform as a service (PaaS): how it works? challenges, cloud platform services, advantages, and disadvantages.	**10 hours**

Unit-III: Virtualization in Cloud Environments Virtualization: Introduction, Characteristics, taxonomy, virtualization and cloud computing, pros and cons of virtualization, technology examples: Xen, VMware, Microsoft Hyper-V. Virtual Machine Migration in cloud computing, a case study of COMET Cloud.	**10 hours**
Unit-IV: Tools, Applications, and Security in the Cloud Cloud Computing Tools and Applications: Twister and Iterative MapReduce, Hadoop Library from Apache, Google App Engine, Amazon AWS, Microsoft Azure, Cloud Software Environments: Eucalyptus, Aneka, CloudSim. Cloud Security Tools and Technologies: Infrastructure Security, Network level security, Host level security, Application-level security. Data privacy and security Issues, Access Control and Authentication in cloud computing, data security in Private and Public Cloud Architecture, Service Level Agreements (SLAs), microservices, Legal issues, and Aspects, Multi-tenancy issues, CAP theorem, transaction management.	**16 hours**

References:

1. David A. Patterson, John L. Hennessy, “Computer Organization and Design RISC-V Edition: The Hardware Software Interface”, Morgan Kaufmann, 2017.
2. Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi, “Mastering Cloud Computing: Foundations and Applications”, Morgan Kaufmann, 2013.
3. Arshdeep Bahga, Vijay Madisetti, 'Cloud Computing', University Press, 2014.
4. Dr Kumar Saurab, “Cloud Computing: Architecting Next-Gen Transformation Paradigms”, Wiley India, 2017.
5. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud”, O'Reilly Gautam Shroff, Enterprise Cloud Computing, Cambridge University Press, 2011.
6. Judith Hurwitz, R Bloor, M.Kanfman, F.Halper, 'Cloud Computing for Dummies', Wiley India Edition, First Edition.
7. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, “Cloud Computing: Principles and Paradigms”, Wiley Publication, 2013.

24PS3.3NLP – NATURAL LANGUAGE PROCESSING (SPEC – AI&ML)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Understand and explain fundamental concepts of natural language processing, language analysis, morphological models, including the use of tools like NLTK and Python for basic text classification tasks.
- **CO2**: Apply word-level analysis techniques such as part-of-speech tagging, morphological parsing, syntactic parsing using rule-based and probabilistic methods to analyse sentence structures.
- **CO3**: Analyse semantic relationships, perform word sense disambiguation, implement tokenization, stemming, and lemmatization to resolve ambiguities in natural language.
- **CO4**: Evaluate sentiment analysis techniques, lexical resources for opinion mining and aspect-based sentiment classification, assessing the effectiveness of different affective lexicons and models.
- **CO5**: Design information retrieval and text generation systems in NLP, and measure system performance using evaluation metrics and research corpora for real-world applications.

Unit-I: Foundations of Language Analysis and NLP Applications The study of Language, Applications of NLP, Evaluating Language Understanding Systems, Different levels of Language Analysis. Finding the Structure of Words: Words and Their Components, Issues and Challenges, Morphological Models. Finding the Structure of Documents: Introduction, Methods, Complexity of the Approaches, Performances of the Approaches. Introduction to Various Grammar- based Language Models-Statistical Language Model. NLTK, Python 3 and the Jupyter Notebook, Introduction to HPC. Text Classification (linear classifier; BoW; TFIDF).	**12 hours**
Unit-II: Word-Level Analysis and Parsing Techniques Word Level Analysis: Regular Expressions-Finite State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes, Part-of-Speech Tagging, Word Representations (matrix factorization; word2vec), Syntactic Analysis: Context-free Grammar Constituency- Parsing-Probabilistic Parsing. Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top- Down Chart Parsing. Feature Systems and Augmented Grammars: Part-Of-Speech tagging (POS)- Tag set for English (Penn Treebank), Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Parsing with Features, Augmented Transition Networks.	**14 hours**
Unit-III: Semantic Analysis and Word Sense Disambiguation Attachment for fragment of English sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses – Homonymy,	**14 hours**

Polysemy, Synonymy, Hyponymy, Robust Word Sense Disambiguation (WSD), Dictionary based approach. Tokenization, N-grams and Scriptio, Stemming and Lemmatization, Synsets and Hypernyms Tokenizing your Corpus. WordNet.	
Unit-IV: Sentiment Analysis and Information Retrieval Systems Opinion Mining Sentiment Analysis introduction, Sentiment Analysis - Affective lexicons, learning affective lexicons, Computing with affective lexicons, Aspect based sentiment analysis. Data-to-text generation, Text-to-text generation, Dialogue. Information Retrieval: Design features of Information Retrieval Systems-Classical, non-classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame NetStemmers - POS Tagger- Research Corpora. Evaluating Self-Explanations in iSTART: Word Matching, Latent Semantic Analysis, and Topic Models: Introduction, iSTART: Feedback Systems.	**12 hours**

References:

1. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2021.
2. Anne Kao and Stephen R. Poteet (Eds.), “Natural Language Processing and Text Mining”, Springer-Verlag, 2007.
3. Daniel Jurafsky and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing”, Computational Linguistics and Speech Recognition, 3rd edition, 2025.
4. James Allen, “Natural Language Understanding”, 2nd edition, 1995.
5. Gerald J. Kowalski and Mark T. Maybury, “Information Storage and Retrieval Systems: Theory and Implementation”, 2nd edition, 2000.
6. Akmajian et al., “Linguistics: An Introduction to Language and Communication”, 7th edition, 2017.
7. Sanjeev Arora and Boaz Barak, “Computational Complexity: A Modern Approach”, 2006.

24PS3.4DL – DEEP LEARNING (SPEC – AI&ML)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Explain the fundamental principles of deep learning and applications.
- **CO2**: Apply feedforward neural networks and optimization techniques to solve real-world problems, including the use of regularization methods.
- **CO3**: Analyze CNN architectures and evaluate applications in computer vision.
- **CO4**: Evaluate RNN, LSTM, GRU architectures for sequential data and NLP tasks.
- **CO5**: Design and develop deep learning models using transfer learning techniques.

Unit-I: Introduction to Deep Learning Definition and importance of Deep Learning, Historical overview and milestones in Deep Learning, Comparison with traditional machine learning approaches, Basic concepts: neural networks, activation functions, layers, etc., Applications of Deep Learning in various domains.	**12 hours**
Unit-II: Feedforward Neural Networks Perceptron and the McCulloch-Pitts model, Feedforward neural networks: architecture, forward propagation, backpropagation, Activation functions: sigmoid, tanh, ReLU, etc., Loss functions and optimization techniques: gradient descent, stochastic gradient descent, etc., Regularization techniques: dropout, L2 regularization, etc.	**14 hours**
Unit-III: Convolutional Neural Networks Introduction to CNNs and their applications in computer vision, Convolutional layers: filters, feature maps, receptive fields, Pooling layers: max pooling, average pooling, CNN architectures: LeNet, AlexNet, VGG, ResNet, etc., Transfer learning and fine-tuning pretrained CNNs.	**12 hours**
Unit-IV: Recurrent Neural Networks Introduction to RNNs and their applications in sequential data analysis, Basic RNN architecture: recurrent connections, hidden states, time-series data, Long Short-Term Memory (LSTM) networks and Gated Recurrent Units (GRUs), Applications of RNNs: natural language processing, time series prediction, etc., Challenges and limitations of RNNs. Transfer Learning techniques.	**14 hours**

References:

1. "Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani, 2018.
2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal, 2018.
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2015.

24PS3.5BD – BIG DATA ANALYTICS (SPEC – AI&ML)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Understand data pre-processing techniques and application of association rule mining algorithms.
- **CO2:** Apply and list various Big Data concepts, tools and applications.
- **CO3:** Analyze the concept of data warehouse, Business Intelligence and OLAP.
- **CO4:** Develop and design the various Business Intelligence Applications using R Programming.
- **CO5:** Create and make use of Hadoop Cluster to deploy Map Reduce jobs, PIG, HIVE and Spark programs.

Unit-I: Foundations of Big Data Introduction to Big Data, Big data definition, enterprise / structured data, social/unstructured data, unstructured data needs for analytics, what is Big Data, Big Deal about Big Data, Big Data Sources, Industries using Big Data, Big Data challenges, Data Pre-processing, why to pre-process data? Data cleaning: Missing Values, Noisy Data, Data Integration and transformation, Data Reduction: Data cube aggregation, Dimensionality Reduction, Data Compression, Numerosity Reduction.	**12 hours**
Unit-II: Big Data Programming with Hadoop and HDFS Introduction of Big data programming-Hadoop, History of Hadoop, The ecosystem and stack, Components of Hadoop, Hadoop Distributed File System (HDFS), Design of HDFS, Java interfaces to HDFS, architecture overview, Development Environment, Hadoop distribution and-basic commands, Eclipse development.	**14 hours**
Unit-III: Big Data Tools: Pig, Hive, HBase, and R Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, querying Data and User-Defined Functions. Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL Data Analytics with R: Introduction.	**14 hours**
Unit-IV: NoSQL Databases and MongoDB Why NoSQL? The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, A (Mostly) Standard Model, Impedance Mismatch, Application and Integration, Databases, Attack of the Clusters, The Emergence of NoSQL, Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases. Introduction to MongoDB.	**12 hours**

References:

1. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
2. Tom White “Hadoop: The Definitive Guide” Third Edit on, O’Reilly Media, 2012.
3. Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph. By David Loshin, Elsevier, August 23, 2013.
4. White, T. (2012). Hadoop: The definitive guide. " O'Reilly Media, Inc."Smolan, R. (2013). The human face of big data.
5. Mayer-Schönberger, V., & Cukier, K. (2013). Big data: A revolution that will transform how we live, work, and think. Houghton Mifflin Harcourt. Holmes, A. (2012). Hadoop in practice. Manning Publications Co.
6. Robert D. Schneider, Hadoop for Dummies, Wiley India, 2014.

24PS3.3PDC – PARALLEL AND DISTRIBUTED COMPUTING (SPEC – CC)

Total hours: 52

Course Outcomes (COs):

- **CO1:** Understand the fundamental concepts of latency, scalability, and architecture types in cloud-based parallel systems.
- **CO2**: Explore the principles and implementation of distributed computing using modern tools like MPI, Kafka, and cloud-native services.
- **CO3:** Examine parallel computing paradigms using shared memory and task/data parallelism in distributed environments.
- **CO4**: Apply synchronization techniques and manage concurrent programming using modern APIs and orchestration tools.
- **CO5:** Develop GPU-based parallel solutions for high-performance computing on cloud platforms using CUDA and libraries like CuBLAS and CuFFT.

Unit-I: Introduction Latency vs. Bandwidth, Applications and Challenges in cloud environments, Types of architecture: cloud, on-premises, hybrid architectures, Cores, nodes, threads, processes in cloud computing infrastructure, Speedup, efficiency, overhead in cloud-based parallel systems, Strong and weak scaling (Amdahl's law, Gustafson's law) in cloud contexts, Programming Models for cloud computing.	**12 hours**
Unit-II: Distributed Computing and Cloud Platforms Distributed Memory and Message Passing Interface (MPI) in cloud applications, Cloud Native messaging using Apache Kafka, Asynchronous/Synchronous computation/communication in cloud services, Concurrency control in distributed cloud services, Fault tolerance and reliability in cloud applications, Distributed Programming with OpenMPI and modern cloud tools (AWS Lambda, Google Pub/Sub).	**14 hours**
Unit-III: Parallel Computing in Cloud Environments Shared memory in cloud and distributed systems, Data and task parallelism in cloud environments, Synchronization and managing concurrent data structures in distributed cloud systems, Shared Memory Programming with cloud-based APIs (PThreads, OpenMP, TBB) and container orchestration tools (Kubernetes).	**14 hours**
Unit-IV: GPU Programming for Cloud and HPC GPU Architecture in the context of cloud-based parallel processing, Programming Models (CUDA/OpenCL) in cloud computing, Basic GPU Concepts in cloud (Threads, Blocks, Grids), Using cloud GPU resources and programming with CUDA in cloud environments, Libraries such as CuBLAS, CuFFT for cloud applications.	**12 hours**

References:

1. "The Art of Multiprocessor Programming" by Maurice Herlihy and NirShavit, Morgan Kaufmann Publishers, 2020.
2. "Principles of Parallel Programming" by Calvin Lin, Larry Snyder, Addison-Wesley, 2008.
3. "Introduction to Parallel Computing" by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Second Edition.
4. Wen-Mei W Hwu, David B Kirk, "Programming Massively Parallel Processors: A Hands-on Approach", Morgann Kaufmann, Third Edition, 2010.

24PS3.4NSE – CLOUD NETWORKING, SOFTWARE AND ECONOMICS (SPEC – CC)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Describe fundamental concepts of cloud networking, including virtual networks, protocols, and key components such as VPNs, VLANs, SDN, and NFV.
- **CO2**: Illustrate cloud software architectures by differentiating between monolithic and microservices models and apply containerization, serverless computing concepts in cloud environments.
- **CO3**: Analyse advanced cloud networking issues such as latency, multi-cloud strategies, load balancing, and security mechanisms including firewalls, encryption, and identity management.
- **CO4**: Evaluate cloud economics by comparing pricing models, cost management tools, and assessing the financial impact of cloud adoption versus traditional data centres.
- **CO5**: Design cost-effective cloud networking solutions by integrating software architecture principles, security considerations, and economic strategies for optimizing cloud resource usage.

Unit-I: Introduction to Cloud Networking Definition, components, and importance, Virtual Private Networks (VPNs), Virtual Local Area Networks (VLANs), and Virtual Machines (VMs). Networking components: firewalls, load balancers, gateways. Protocols: TCP/IP, HTTP/S, DNS in cloud settings. Software-Defined Networking (SDN) for cloud. Network Function Virtualization (NFV). Role of data centres in cloud networking. Network virtualization and its importance in cloud infrastructures. Virtual Network Interfaces (VNIs).	**12 hours**
Unit-II: Cloud Software Architectures and Design Characteristics of cloud-native applications, Microservices architecture: benefits and challenges. Monolithic vs. Microservices-based deployments. Containers (Docker, Kubernetes) for cloud-native applications. REST, SOAP, GraphQL in cloud systems. API gateways and management. Serverless	**14 hours**

computing: Function as a Service (FaaS) – AWS Lambda, Google Cloud Functions. Benefits and limitations of serverless models.	
Unit-III: Cloud Networking - Advanced Network latency, jitter, and bandwidth in cloud systems. Inter-cloud connectivity and multi-cloud networking strategies. Types of load balancers: Layer 4 (transport-level) and Layer 7 (application-level). Traffic management across multi-region cloud services. Network security in the cloud: firewalls, encryption (SSL/TLS), and identity management, Security Groups and Network ACLs (Access Control Lists), Distributed Denial of Service (DDoS) protection in cloud systems. Data privacy laws (GDPR, HIPAA) and cloud service compliance. Role of cloud monitoring tools (AWS CloudWatch, Azure Monitor) in governance.	**14 hours**
Unit-IV: Cloud Economics Pay-as-you-go vs. Reserved Instance pricing models. On-demand, spot, and reserved pricing for cloud resources. Rightsizing instances, scaling, and automating resource allocation. Reserved instances vs. dynamic scaling in AWS, Google Cloud, Azure. Cloud monitoring and cost management tools (AWS Cost Explorer, Azure Cost Management). Comparing traditional data centers with cloud computing in terms of CapEx and OpEx. Hidden costs of cloud computing. Role of cloud service providers (CSPs) like AWS, Google Cloud, and Microsoft Azure in cost competitiveness. Pricing strategies for SaaS applications in the cloud.	**12 hours**

References:

1. Ricardo Puttini, Thomas Erl, Zaigham Mahmood, “Cloud Computing: Concepts, Technology & Architecture”, 2nd edition, Pearson, 2023.
2. Michael J. Kavis, “Architecting the Cloud: Design Decisions for Cloud Computing Service Models (IaaS, PaaS, SaaS)”, 1st edition, 2014.
3. Andreas Wittig & Michael Wittig, “Amazon Web Services in Action”, 3rd edition, 2023.
4. Bill Williams, “The Economics of Cloud Computing: An Overview for Decision Makers”, Cisco, 2012.

24PS3.5CP – CLOUD COMPUTING PLATFORMS (SPEC – CC)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Describe the fundamental components, service models, and offerings of major cloud platforms such as AWS, Azure, and GCP.
- **CO2**: Differentiate between various compute and storage services across AWS, Azure, and GCP in terms of features, pricing models, and use cases.

- **CO3**: Analyze the cloud networking structures and identity management solutions provided by AWS, Azure, and GCP, and assess their effectiveness in securing cloud applications.
- **CO4**: Evaluate advanced services like machine learning, big data, and container orchestration offered by cloud platforms, and justify the selection of cost optimization tools for specific application needs.
- **CO5**: Design a scalable and cost-effective multi-cloud architecture by integrating compute, storage, security, and advanced services considering workload and budget constraints.

Unit-I: Introduction to Cloud Platforms Introduction to AWS, Azure, and GCP. Market position and service offerings comparison. Popular services and their operations from AWS: EC2, S3, RDS, Lambda, Azure: Virtual Machines, Blob Storage, Azure SQL Database, Functions, and GCP: Compute Engine, Cloud Storage, BigQuery, Cloud Functions.	**12 hours**
Unit-II: Compute and Storage Services Deep dive into EC2 (AWS), Virtual Machines (Azure), and Compute Engine (GCP). Instance types, pricing models, and use cases. Serverless computing with AWS Lambda, Azure Functions, and Cloud Functions. AWS S3 vs. Azure Blob Storage vs. Google Cloud Storage: features, pricing, and best practices. Databases: AWS RDS, Azure SQL Database, and Google Cloud SQL. Object vs. block vs. file storage.	**14 hours**
Unit-III: Networking and Security Virtual Private Clouds (VPCs) in AWS, Virtual Networks in Azure, and VPCs in GCP. Load balancing, auto-scaling, and content delivery networks (CDNs). Identity and Access Management (IAM) in AWS, Azure AD, and GCP IAM. Security best practices for cloud applications. Understanding encryption, key management, and compliance tools available in each platform.	**14 hours**
Unit-IV: Advanced Services and Cost Management Introduction to machine learning and AI services: AWS SageMaker, Azure Machine Learning, Google AI Platform. Serverless architectures and container orchestration: AWS ECS/EKS, Azure AKS, GCP GKE. Overview of big data services: AWS EMR, Azure HDInsight, Google BigQuery. Data warehousing solutions and data lakes. Understanding pricing models across AWS, Azure, and GCP. Cost management tools: AWS Cost Explorer, Azure Cost Management, GCP Billing Reports. Best practices for cost optimization.	**12 hours**

References:

1. Ricardo Puttini, Thomas Erl, Zaigham Mahmood, “Cloud Computing: Concepts, Technology & Architecture”, 2nd edition, Pearson, 2023.
2. Joe Baron, Hisham Baz, Tim Bixler et al., “AWS Certified Solutions Architect Official Study Guide: Associate Exam”, 2nd edition, 2016.

3. Michael J. Kavis, “Microsoft Azure Fundamentals Certification and Study Guide”, 2023 (online study guide).
4. JJ Geewax, “Google Cloud Platform in Action”, 2018.

24PS3.6 – MACHINE LEARNING LAB

Total hours: 52

Course Outcomes (COs):

- **CO1:** Demonstrate basic statistical computations such as mean, median, mode, variance, and standard deviation, and utilize core Python libraries like math, statistics, numpy, and scipy for data processing.
- **CO2:** Illustrate the use of data manipulation and visualization libraries such as pandas and matplotlib to explore and interpret datasets for machine learning applications.
  CO3: Implement and compare fundamental machine learning algorithms such as FIND-S, Candidate-Elimination, ID3, Linear and Logistic Regression, KNN, ANN using Python and analyze their outputs on real datasets.
- **CO4:** Apply probabilistic reasoning techniques like Bayes Theorem and Naïve Bayes, and evaluate classification performance using metrics such as accuracy, precision, and recall.
- **CO5:** Design, implement, and assess unsupervised learning algorithms such as K-Means and EM clustering, and critically evaluate the clustering results to draw meaningful insights.

List of Lab Programs:

1. Write a Python program to compute
   a. Central Tendency Measures: Mean, Median, Mode
   b. Measure of Dispersion: Variance, Standard Deviation
2. Study of Python Basic Libraries such as Statistics, Math, Numpy and Scipy
3. Study of Python Libraries for ML applications such as Pandas and Matplotlib
4. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
5. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
6. Write a program to demonstrate the working of the decision tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
7. Implement linear regression using Python.
8. Implementation of Multiple Linear Regression for House Price Prediction using sklearn.
9. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
10. Implementation of KNN using sklearn.

11. Implementation of Logistic Regression using sklearn.
12. The probability that it is Friday and that a student is absent is 3%. Since there are 5 school days in a week, the probability that it is Friday is 20%. What is the probability that a student is absent given that today is Friday? Apply Baye's rule in Python to get the result. (Ans: 15%)
13. Implement the Naïve Bayes theorem to classify the dataset. Calculate the accuracy, precision, and recall for your data set.
14. Apply the EM algorithm to cluster a set of data stored in a .CSV file.
15. Implementation of K-Means Clustering using the same dataset. Compare the results of these two algorithms and comment on the quality of clustering.

24PS3.7MLL – ADVANCED AI & MACHINE LEARNING LAB (SPEC – AI&ML)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Apply data analysis and visualization techniques using R programming on structured datasets.
- **CO2**: Implement classic AI algorithms such as 8-puzzle and NLP pre-processing using NLTK.
- **CO3**: Construct deep learning models for image classification using MNIST and pre-trained CNN models like VGG.
- **CO4**: Develop and train RNN models for sequential data like handwriting digit recognition.
- **CO5**: Design and evaluate a complete machine learning pipeline including dataset selection, model training, testing, and performance analysis.

List of Lab Programs:

PART-A

1. Write a program to read a csv file and analyze the data in the file in R.
2. Create a data set and do statistical analysis and visualize on the data using R.
3. Write a program to implement solutions for 8 puzzle problem.
4. Design & implement a simple deep learning network for classification of images using MNIST dataset.
5. Implement any one of the algorithms VGG to classify objects in objects.
6. Implement RNN for handwriting digit recognition.
7. a. Write a python program to perform tokenization by word and sentence using nltk.
   b. Write a python program to eliminate stop words using nltk.

PART B

8. Develop a small machine learning application using the algorithms learnt in Machine Learning course. The application could include:
   - Selecting a dataset
   - Setting the goals for prediction or classification

- Features selection
- Training and testing
- Visualizing various measures and scores along with patterns (if any).

24PS3.7CCL – CLOUD COMPUTING LAB (SPEC – CC)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Design and simulate cloud infrastructure components using CloudSim and CloudAnalyst tools to evaluate the behavior of virtual machines, data centers, and task execution under varying configurations.
- **CO2**: Analyze and compare the impact of different resource allocation, scheduling, and load balancing policies on performance metrics such as response time, energy efficiency, and cost.
- **CO3**: Evaluate the effectiveness of energy-aware strategies, VM migration, and load balancing techniques for optimizing resource utilization and minimizing power consumption in cloud environments.
- **CO4**: Develop simulation scenarios involving multi-region cloud setups, user bases, and pricing models to derive insights for cost-effective and performance-optimized deployments.
- **CO5**: Demonstrate effective teamwork, documentation, and technical communication while collaboratively conducting simulations and presenting data-driven conclusions.

List of Lab Programs:

1. Install and set up CloudSim on your system, simulate the creation of a simple datacenter with multiple hosts and virtual machines (VMs).
2. Simulate different resource allocation policies (for example, space-shared vs. time-shared) in CloudSim and analyze the performance.
3. Simulate a datacenter with network topology and observe how the network affects VM allocation and task execution.
4. Simulate the execution of cloudlets (tasks) with different scheduling algorithms like First Come First Serve (FCFS) and Round Robin using CloudSim.
5. Implement energy-aware cloud resource scheduling in CloudSim to monitor power consumption during VM migrations and allocations.
6. Simulate cloud resources and calculate the cost of running tasks on different cloud configurations with variable pricing models.
7. Implement and simulate dynamic VM migration based on load balancing and energy efficiency using CloudSim.
8. Simulate task scheduling with deadline constraints in CloudSim to observe task completion based on priority.

Simulate the following list of experiments in CloudAnalyst:

9. Set up multiple data centers across various regions. Configure virtual machines with different capacities (CPU, memory, storage). Perform cost analysis for different infrastructure designs.
10. Simulate cloud scenarios using different load balancing policies (Round Robin, Throttled, and Active Monitoring Load Balancer). Measure response time, data processing time, and user request allocation.
11. Simulate different user bases in various regions (example, Europe, Asia, North America). Evaluate the effect of network latency on response time. Experiment with different numbers of users in each region and observe how latency affects performance.
12. Configure cloud data centers with different energy-efficient components. Simulate varying workloads and observe how energy consumption changes with workload intensity. Compare energy consumption with different types of virtual machines.

24PSOECCS - OPEN ELECTIVE: COMPUTER INTELLIGENCE AND WEB ANALYTICS

Total Hours: 52

Course Outcomes:

- **CO1**: Describe key concepts of artificial intelligence, machine learning, data science, and their subfields, comparing human and machine intelligence.
- **CO2**: Classify various types of data, data ecosystem roles, and popular tools for data analytics to illustrate their impact on business processes.
- **CO3**: Analyse the structure and design of web pages using HTML and examine the role of Key Performance Indicators and SEO for effective web analytics.
- **CO4**: Evaluate Google Analytics features, dashboards, and reporting functionalities to interpret data-driven insights for decision-making.
- **CO5**: Design and implement advanced web analytics solutions by integrating APIs, Python, and visualization tools to solve real-world case study problems such as CRM dashboards or social media analytics.

Unit-I: Introduction to the buzzwords

Artificial Intelligence, Machine Learning, Data Science, Data Analytics, Business Intelligence, and User Experience (UX). Classical AI, Subfields of artificial intelligence, limitations of computers' intelligence, and applications, human brain vs. computers.

Unit-II: Introduction to Data Analytics

Understanding data, types of data - structured and unstructured. Introduction to the data ecosystem, Introduction to data analytics, Job roles: Data Scientists vs. Data

Engineers vs. Business Analysts vs. Business Managers, popular tools, and platforms for data analytics.

Unit-III: HTML and Key Performance Indicators

Understanding the web, the internet, and the social media. Introduction to HTML, website structure, dos and don'ts in website design, introduction to digital marketing, Key Performance Indicators (KPIs), tools and technologies used, Introduction to search engines, Search Engine Integration and Optimization (SEI and SEO).

Unit-IV: Introduction to Google Analytics

Introduction to Google Analytics (GA), how it works, setting up GA, navigating the interface, turning data into insights, Python for data analytics, Application Programming Interfaces (APIs), and Case studies.

Sample case studies: Twitter (or X) data access and analysis, building Customer Relationship Management (CRM) Dashboard, YouTube data access and analysis, Tableau for visualization, etc.

References:

1. Warwick, Kevin. "Artificial intelligence: the basics", Routledge, 2013.
2. Moravec, Hans. "When will computer hardware match the human brain." Journal of evolution and technology, 1998.
3. Kampakis, Stylianos, "The Decision Maker's Handbook to Data Science", second edition, Apress, 2020.
4. Russ Henneberry, Ryan Deiss, "Digital Marketing For Dummies", John Wiley and Sons, 2020.
5. Google Analytics 4 official documentation: https://developers.google.com/analytics.

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SURANA COLLEGE AUTONOMOUS

Affiliated with Bangalore University

REGULATIONS, SCHEME, AND SYLLABUS

For the course

MASTER OF COMPUTER APPLICATIONS (MCA)

(Choice-Based Credit System)

2024-2026 Batch

Effective from Academic Year 2025-26 and onwards

MCA PROGRAMME

SURANA COLLEGE (Autonomous)

Regulations of Master of Computer Applications (MCA) Course

1. **TITLE OF THE COURSE:** The course shall be called MCA – Master of Computer Applications.

2. **DURATION OF THE COURSE**: The course of study shall be two years.

3. **ELIGIBILITY FOR ADMISSION**: A candidate with any degree of a minimum of 3 years duration (10+2+3) of Bangalore University or of any other University equivalent there in towith a minimum of 50% of marks in the aggregate of all subjects including languages, if any, provided further, that the candidate has studied Mathematics / Computer science /Business Mathematics / Statistics / Computer Applications / Electronics as a subject at PUC level or equivalent HSC (XII Standard) or at Degree level is eligible for admission to MCA Course. Relaxation to SC/ST, Group I be extended as per university norms.

4. **ATTENDANCE**: In each Semester a candidate should be considered to have successfully undergone the prescribed Course of study if the candidate has attended at least 75% of the classes in each subject (Theory, Lab & Practical).

5. **SCHEME OF EXAMINATION**:

   A. The Internal Assessment marks should be decided for each of the theory subjects by conducting 2 tests, each of 90 minutes duration, spread over the span of a Semester. A seminar should also be given by the student in the second year and the same to be assessed and evaluated for internal assessment along with two tests.

   B. The Internal Assessment marks in Practical course is based on the performance in the Laboratory. The Internal Assessment marks for Project work of a candidate is based on the dissertation and seminar.

6. **ELIGIBILITY TO GO TO THE HIGHER SEMESTER**:

   A. A Candidate is allowed to carry over all the previously uncleared (failed) theory papers and Practical to subsequent semesters from the first to fourth semester.

   B. The maximum period for the completion of the course shall be four years from the date ofadmission.

7. **MINIMUM FOR PASS AND DECLARATION OF RESULTS**

   A. For a pass in a semester, a candidate shall secure a minimum of 40% of the marks prescribed for a subject in the University Examination (Theory, Practical, Project work) and 50% of the marks in the aggregate inclusive of the Internal Assessment marks obtained in all subjects put together.

   B. The candidates who do not satisfy 7(A) shall be deemed to have failed and must take exams in the subjects in which he has secured less than 40% at the University examination.

   C. Provision is made for rejection of results of all the subjects of a Semester only once if the candidate decides to reappear for all the subjects of that semester. Such rejection should be made within 30 days of the

announcement of the result, by making a written application, through the Head of the Institution. If such rejection is in respect of the results of all the subjects of one semester and earns fresh Internal marks as well.

D. The results of any semester will be declared as pass or fail as the case may be in accordance with regulation 7(A).

E. To be eligible for the award of the MCA degree, a candidate shall have completed the scheme of training and passed all subjects prescribed for the Course.

8. A candidate shall complete examinations of all Semesters of the MCA Course within – FOUR years from the date of admission.

Department Vision

To be a leading destination for students and learners in advancing knowledge, learning experiences in technology and multidisciplinary fields, driven by research and innovation, contributing to the holistic development of human resources for the betterment of society.

Department Mission

- ✓ To develop state-of-the-art laboratories, modern infrastructure, and a competent faculty to provide quality education, hands-on skills, and to foster research, innovation, and entrepreneurship.
- ✓ To foster values, ethics and academic integrity to develop students and learners into responsible citizens.
- ✓ To collaborate with institutes of national and international repute as well as industry to develop synergy and advance new knowledge and skills.
- ✓ To contribute to the global cause and environment.

Program Educational Objectives (PEOs)

Students in the first 3 to 5 years of their professional life should be able to:

- ✓ **PEO-1**: Demonstrate innovative mind, analytical thinking and problem-solving competence as a “lead” in infotech projects at workplace.
- ✓ **PEO 2**: Demonstrate consciousness in values, ethics and concern for the society while working on advances in science, technologies and research.
- ✓ **PEO-3**: Work in teams, collaborate, develop synergy, build knowledge and skills to enhance professional attainments.
- ✓ **PEO-4**: Contribute to community, nation and to the global cause of climate, environment protection and sustainability.
- ✓ **PEO-5**: Demonstrate a mindset for the life-long learning.

Program Outcomes

PO1-Foundation Knowledge: Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.

PO2-Problem Analysis: Identify, review, formulate and analyse problems for primarily focussing on customer requirements using critical thinking frameworks.

PO3-Development of Solutions: Design, develop and investigate problems with as an innovative approach for solutions incorporating ESG/SDG goals.

PO4-Modern Tool Usage: Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.

PO5-Individual and Teamwork: Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.

PO6-Conduct Research and Undertake Project: Use research-based knowledge and undertake projects to solve real-world engineering problems.

PO7-Ethics: Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware.

PO8-Life-long learning: Change management skills and the ability to learn, keep up with contemporary technologies and ways of working.

First Year MCA Course Matrix 2024-25

Sem	Course Code	Title of the course	Hours/ week	Marks			Credits	
				IA	Exam	Total	Course	Sem
I	24PS1.1	Object Oriented Programming concepts using Java	4	30	70	100	4	28
	24PS1.2	Art of Programming	4	30	70	100	4	
	24PS1.3	Statistical Analysis	4	30	70	100	4	
	24PS1.4	Theory of Computation	4	30	70	100	4	
	24PS1.5	Database Management Systems	4	30	70	100	4	
	24PS1.6	Data Communication Networks	4	30	70	100	4	
	24PS1.7	Java Programming Lab	4	30	70	100	2	
	24PS1.8	Art of Programming Lab	4	30	70	100	2	
II	24PS2.1	Data Structures and Algorithms	4	30	70	100	4	26
	24PS2.2	Research Methodology	4	30	70	100	4	
	24PS2.3	Agile Development and DevOps	4	30	70	100	4	
	24PS2.4	Web Technologies	4	30	70	100	4	
	24PS2.5	Mobile Application Development	4	30	70	100	4	
	24PS2.6	Data Structures and Algorithms Lab	4	30	70	100	2	
	24PS2.7	DBMS Lab	4	30	70	100	2	
	24PS2.8	Web Technologies and Mobile Application Development Lab	4	30	70	100	2	

Second Year MCA Course Matrix 2025-26

Sem	Course Code	Title of the course	Hours/ week	Marks			Credits	
				IA	Exam	Total	Course	Sem
III	24PS3.1	Artificial Intelligence & Machine Learning	4	30	70	100	4	26
	24PS3.2	Cloud Computing	4	30	70	100	4	
	24PS3.3	Spec-1	4	30	70	100	3	
	24PS3.4	Spec-2	4	30	70	100	3	
	24PS3.5	Spec-3	4	30	70	100	3	
	24PS3.6	Machine Learning Lab	4	30	70	100	2	
	24PS3.7	Specialization Lab	4	30	70	100	3	
	24PSOECCS	Open Elective	4	30	70	100	4	
IV	24PS4.1	Data Science	4	30	70	100	4	28
	24PS4.2	Spec-4	4	30	70	100	3	
	24PS4.3	Spec-5	4	30	70	100	3	
	24PS4.4	Research Paper Presentation	4	30	70	100	2	
	24PS4.5	Main Project	16	150	250	400	16	

Specialization Pool

AI & ML	Cloud Computing
Natural Language Processing	Parallel And Distributed Computing
Big Data Analytics	Cloud Networking, Software and Economics
Deep Learning	Cloud Computing Platforms
Computer Vision and Explainable AI	DevOps for Cloud Computing
Generative AI	Emerging Trends in Cloud Computing

Fourth Semester

24PS4.1 – DATA SCIENCE

Total hours: 52

Course Outcomes (COs):

- **CO1**: Identify and explain fundamental concepts of data science, including types of data, preprocessing techniques, and data science tools and libraries in Python.
- **CO2**: Apply data manipulation and statistical techniques using R programming to perform descriptive and inferential analysis on various datasets.
- **CO3**: Analyze data using advanced visualization tools such as Power BI, Plotly, and GeoPandas to derive meaningful insights and support decision-making.
- **CO4**: Evaluate cloud-based data science platforms and recent advancements like AutoML and Predictive Analytics and discuss ethical considerations in real-world applications.
- **CO5**: Design and construct end-to-end data science workflows for practical case studies in domains such as healthcare, finance, and retail using appropriate tools and methods.

Unit-I: Introduction to Data Science Definition and Importance, Data Science vs. Data Analytics vs. Data Engineering, Applications in Industry, Types of Data (Structured, Semi-structured, Unstructured), Data Collection Techniques, Data Privacy and Ethics, Data Cleaning and Preprocessing, Handling Missing Data, Data Transformation and Normalization, Feature Engineering, Introduction to Python for Data Science, Overview of Data Science Libraries (Pandas, NumPy, Matplotlib, etc.).	**12 hours**
Unit-II: R programming for Data Science Overview of R as a Data Science Tool, Data Types and Structures (Vectors, Lists, Matrices, Data Frames, Factors), Basic Operations and Functions, Control Structures (if, for, while, repeat), R Packages (tidyverse, data.table, readr, readxl, tidyr, dplyr), Aggregation Techniques (Group By Operations, Summary Statistics), Descriptive Statistics and Inferential Statistics, Hypothesis Testing (t-tests, ANOVA, Chi-Square Tests), Correlation and Regression Analysis.	**14 hours**
Unit-III: Data Visualization Introduction to Data Visualization, Principles of Data Visualization, Tools for Visualization (Plotly, Bokeh), PowerBI: Creating Effective Charts and Graphs, Interactive Dashboards, Storytelling with Data, Visualizing Big Data. Introduction to geospatial data visualization with GeoPandas and Folium.	**14 hours**
Unit-IV: Real-World Applications and Recent Trends Introduction to cloud-based data analytics platforms from AWS, Google Cloud, Microsoft Azure, Augmented Analytics, AutoML, Predictive Analysis,	**12 hours**

Time Series Analysis and Forecasting, Ethical considerations and challenges in Data Science, Case Studies in Healthcare, Finance, Retail, etc.	

References:

1. "Python Data Science Handbook" by Jake VanderPlas, second edition, 2023.
2. "Data Science for Business" by Foster Provost and Tom Fawcett, 2013.
3. "The Book of R: A First Course in Programming and Statistics" by Tilman M. Davies, 2016.
4. "Introduction to Statistical Learning" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, second edition, 2023.

24PS4.2CV – COMPUTER VISION AND EXPLAINABLE AI (SPEC – AI&ML)

Total hours: 52

Course Outcomes (COs):

- **CO 1:** Understand the foundational principles, history, and necessity of Computer Vision and Explainable AI.
- **CO 2:** Explore image representation and preprocessing techniques for effective visual computing.
- **CO3:** Learn and implement traditional and machine learning-based methods for image classification and segmentation.
- **CO 4:** Gain hands-on experience with image-based feature extraction and classification using tools like Orange and deep learning APIs.
- **CO 5:** Implement and evaluate various Explainable AI (XAI) techniques and critically assess trade-offs in real-world applications.

Unit-I: Introduction to Computer Vision and Explainable AI Definition and applications of computer vision. Historical background and development. Importance and relevance in modern technology. The Black Box Problem in AI. Need for Explainability: Trust, Transparency, Accountability. Definitions and Goals of Explainable AI. Challenges and Limitations of XAI.	**12 hours**
Unit-II: Image Basics and Image processing Techniques Understanding digital images: pixels, resolution, colour spaces (RGB, grayscale). Image representation in computers: matrices and arrays, Image formats: JPEG, PNG, etc. Image enhancement: histogram equalization, contrast stretching. Image operations (blurring, sharpening, edge detection). Filtering techniques (convolution, Gaussian filter). Filtering: smoothing, sharpening, edge detection using techniques like Sobel, Prewitt, and Canny. Morphological operations: erosion, dilation, opening, and closing.	**14 hours**
Unit-III: Image Classification and Segmentation Feature Extraction: Introduction to feature extraction techniques such as Harris corner detection, SIFT, SURF, and ORB. Feature descriptors: Histogram	**14 hours**

of Oriented Gradients (HOG), Scale Invariant Feature. Image Classification: SVM, Decision Trees, Gradient Boosting Machines, Naïve Bayes Image Segmentation: Thresholding, Region-based segmentation, Edge based segmentation, Semantic segmentation, Instance segmentation. Working with Orange, Data Mining & Visualization tool for Classification tasks. Hands-on coding exercises using high-level APIs (Keras) and deep learning frameworks (TensorFlow, PyTorch).	
Unit-IV: Implementation and Evaluation of XAI Techniques Hands-on implementation of XAI libraries (example: LIME, SHAP). Explainability metrics and evaluation methods. Trade-offs between model performance and explainability. Case studies of XAI applications in real-world scenarios.	**12 hours**

References:

1. Wojciech Samek et al., "Explainable AI: Interpreting, Explaining and Visualizing Deep Learning", Springer, 2019.
2. Christoph Molnar, "Interpretable Machine Learning: A Guide for Making Black Box Models Explainable", independently published, 3rd Edition, 2025.
3. Sebastian Raschka & Vahid Mirjalili, "Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2", Packt Publishing, 3rd Edition, 2019.
4. Solon Barocas, Moritz Hardt & Arvind Narayanan, "Fairness and Machine Learning: Limitations and Opportunities", MIT Press, 2023.
5. Hugo Jair Escalante et al. (Eds.), "Explainable and Interpretable Models in Computer Vision and Machine Learning", Springer Cham, 1st Edition, 2019.

24PS4.3GA – GENERATIVE AI (SPEC – AI&ML)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Understand the foundational concepts of Generative AI including key models, neural networks, and common tools and frameworks.
- **CO2:** Analyse and Utilize Large Language Models including architecture and training mechanisms of Large Language Models (LLMs) such as GPT, BERT, and discuss their applications with ethical considerations.
- **CO3**: Apply and Evaluate Variational Autoencoder (VAE) for image generation and analyse its performance
- **CO4**: Develop a Generative Adversarial Network (GAN) to generate synthetic images or text and evaluate challenges in training such models.
- **CO5**: Design and create advanced generative models using frameworks such as StyleGAN or cGAN and critically assess their effectiveness in various applications.

Unit-I: Introduction to Generative AI Definition and Scope of Generative AI, Applications and Impact on Industry (Art, Music, Text, Design), Key Concepts: Generative Models vs. Discriminative Models, Neural Networks Basics (Feedforward, Convolutional, Recurrent), Understanding Model Training and Evaluation, Use Cases and Examples, Essential Libraries and Frameworks for Generative AI.	**12 hours**
Unit-II: Large Language Model Overview of Natural Language Processing (NLP) and its evolution, Introduction to Transformers and Self-Attention Mechanisms, Key LLMs: GPT, BERT, T5, Detailed Architecture: Encoder, Decoder, Attention Mechanisms, Training Techniques: Supervised, Unsupervised, Self-Supervised Learning, Data Collection and Preprocessing, Overview of Tools and Frameworks: Hugging Face Transformers, TensorFlow, PyTorch, Ethical Issues: Bias, Fairness, Privacy, and Responsible AI.	**14 hours**
Unit-III: Variational AutoEncoder Concept and Architecture of VAEs, Encoder-Decoder Framework, Latent Space Representation, Loss Functions: Reconstruction Loss and KL Divergence, Optimization Techniques, Hyperparameter Tuning, Image Generation and Reconstruction, Anomaly Detection, Data Augmentation, Implementing VAEs, Building and Training a VAE Model, Evaluating Model Performance.	**14 hours**
Unit-IV: Generative Adversarial Network Architecture: Generator vs. Discriminator, Training Process and Objective Function, Challenges in Training GANs (Mode Collapse, Stability), Deep Convolutional GANs (DCGANs), Conditional GANs (cGANs), Progressive Growing GANs (PGGANs), StyleGAN and StyleGAN2, Image Synthesis and Enhancement, Text-to-Image Generation, Video Generation and Super-Resolution, Implementing Basic GANs, Exploring advanced GAN Variants, Generating Synthetic Data.	**12 hours**

References:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. David Foster, “Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play”, O’Reilly Media, 2nd Edition, 2023.
3. Rafael Valle, “Hands-On Generative Adversarial Networks with Keras: Your Guide to Implementing Next-Generation Generative Adversarial Networks”, Packt Publishing Ltd, 1st Edition, 2019.

24PS4.2DV – DEVOPS FOR CLOUD COMPUTING (SPEC – CC)

Total hours: 52

Course Outcomes (COs):

- **CO1:** Understand the basic concepts of DevOps.
- **CO2:** Apply fundamental principles to DevOps environment and applications to be developed and deployed.
- **CO3**: Analyse the DevOps tools for scaling the team and organizational structure
- **CO4:** Develop various control techniques and OCR in RPA.
- **CO5:** Create the different types of variables, control flow and data manipulation techniques.

Unit-I: Introduction to DevOps in Cloud Introduction to DevOps, history, goals, and benefits, Continuous Integration (CI), Continuous Deployment (CD), Infrastructure as Code (IaC), popular tools for DevOps: Git, Jenkins, Docker, Kubernetes, and Ansible. DevOps and Cloud Computing, cloud-based DevOps services.	**12 hours**
Unit-II: Automation and IaC Infrastructure as Code (IaC) in details, concept, benefits, and best practices. Automations tools in cloud: Terraform, AWS CloudFormation, Azure Resource Manager (ARM) templates. Configuration management using Chef and Puppet. Automating deployments using Jenkins, GitLab CI/CD, and cloud-native solutions such as AWS CodePipeline and Azure Pipelines.	**14 hours**
Unit-III: Monitoring and Logging Importance, tools for monitoring: Prometheus, Grafana, ELK Stack. Cloud-native solutions with AWS CloudWatch, Azure Monitor, Google Stackdriver. Ensuring application performance and fault tolerance. Security considerations in DevOps, best practices, tools such as SonarQube, Checkmarx, and AWS GuardDuty. Securing DevOps pipelines,	**14 hours**
Unit-IV: Containerization and Orchestration Creating and managing containers, Kubernetes fundamentals, architecture, and managing containerized applications on the cloud, Continuous delivery in a serverless environment, challenges and solutions.	**12 hours**

References:

1. Gene Kim, Patrick Debois, John Willis, Jez Humble, “The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations”, IT Revolution Press, 2021.
2. Kief Morris, “Infrastructure as Code: Managing Servers in the Cloud”, O’Reilly Media, 2025.
3. Kelsey Hightower, Brendan Burns, Joe Beda, “Kubernetes Up & Running: Dive into the Future of Infrastructure”, O’Reilly Media, 2022.

4. Jez Humble, David Farley, “Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation”, Addison-Wesley, 2010.
5. Gene Kim, Kevin Behr, George Spafford, “The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win”, IT Revolution Press, 2018.

24PS4.3ET – EMERGING TRENDS IN CLOUD COMPUTING (SPEC – CC)

Total hours: 52

Course Outcomes (COs):

- **CO1**: Describe the evolution of cloud computing technologies, including key milestones, edge computing, serverless computing, and containerization concepts.
- **CO2**: Explain fundamental cloud security concepts, compliance frameworks, and tools, including zero trust architecture and identity management in multi-cloud environments.
- **CO3**: Analyse the impact of emerging technologies like 5G/6G, DevOps advancements, and hyper-automation on cloud services and resource optimization.
- **CO4**: Evaluate the benefits and challenges of cloud-native architectures, quantum computing applications, and sustainable practices in cloud environments, including strategies for mitigating vendor lock-in.
- **CO5**: Design innovative cloud solutions integrating emerging trends such as AI, edge computing, and quantum concepts while considering sustainability and multi-cloud complexity.

Unit-I: Introduction Evolution of cloud computing technologies, Key milestones in cloud development, Edge Computing, Multi-Cloud Strategies, Serverless Computing Containerization and Kubernetes, Artificial Intelligence in Cloud, Business implications of cloud adoption, Case studies of emerging trends.	**12 hours**
Unit-II: Cloud Security and Compliance Cloud security fundamentals, Key security challenges in cloud computing, Compliance best practices for cloud environments, Zero Trust Architecture, Identity and Access Management (IAM), Encryption and Data Protection, AI and machine learning for security, Security in hybrid and multi-cloud environments, automating compliance and regulations, tools used.	**14 hours**
Unit-III: Future trends in Cloud Computing - I The impact of 5G and 6G technologies on cloud services and real-time data processing, digital twin, simulate and optimize cloud resources, DevOps advancements in cloud computing, CI/CD integration for cloud development, hyper-automation, interoperability between different CSPs, role of Augmented and Virtual Reality in cloud computing.	**14 hours**

Unit-IV: Future trends in Cloud Computing - II Principles of cloud-native architecture, Benefits of cloud-native applications, Overview of quantum computing concepts, Potential applications in cloud computing, Eco-friendly practices in cloud services, Role of cloud computing in sustainable development, Definition and benefits of edge computing, Use cases and impact on cloud architecture, Managing complexity in multi-cloud environments, Vendor lock-in and strategies to mitigate it, Predictions for the future of cloud computing, potential future risks in cloud computing.	**12 hours**

References:

1. Thomas Erl, "Cloud Computing: Concepts, Technology & Architecture", Pearson, 2023.
2. Michael J. Kavis, "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)", John Wiley & Sons, 2014.
3. David Dempsey, Felicity Kelliher, "Industry Trends in Cloud Computing: Alternative Business-to-Business Revenue Models", Palgrave Macmillan, 2018.

24PS4.4 – RESEARCH PAPER PRESENTATION

Total hours: 52

Course Outcomes (COs):

- **CO1**: Formulate a research problem by analyzing relevant literature and defining clear research objectives.
- **CO2**: Select and justify suitable research methods, tools, and techniques to address the proposed problem.
- **CO3**: Design and propose feasible solutions or models with consideration for societal, environmental, and ethical factors.
- **CO4**: Compose a well-structured research paper adhering to academic standards and ethical publishing practices.
- **CO5**: Present research findings through appropriate platforms and reflect on the process for continuous professional improvement.

Students must propose a research problem to which they must identify a methodology to solve. A feasible implementation of the solution must be proposed. The entire process must be converted into a research paper and to be published in one of the following avenues:

- A national/international conference organized by an AICTE/UGC recognized institutions.
- A Scopus/Web of Science (ESCI) indexed journal.
- A peer-reviewed journal with more than 5 years of publication history.

- Any book chapters by a renowned publishing house with more than 10 years of publication history.

The certificate of publication/presentation or letter of acceptance of the paper must be produced for the evaluation. In addition to this, students must take the consent of the research supervisor assigned to them by the department before submitting a paper to any journal.

Note: Publication in cloned/blacklisted journals are strictly not considered for the evaluation of the course.

24PS4.5 – MAIN PROJECT

Hours per week: 16

Course Outcomes (COs):

- **CO1**: Design and implement a comprehensive software solution based on real-world requirements using appropriate tools and technologies.
- **CO2**: Analyze industry problems and apply research-based methods, including data collection and synthesis, to derive valid conclusions in the internship domain.
- **CO3**: Demonstrate awareness of professional responsibilities, ethical practices, and societal impacts in the context of real-world project development.
- **CO4**: Collaborate effectively within a team or organizational setting, assuming leadership roles where necessary to accomplish project goals.
- **CO5**: Present project outcomes and internship experiences clearly through technical reports and oral presentations, demonstrating commitment to lifelong learning and self-improvement.

Internship of a minimum of four weeks followed by a report. Students must undergo an internship in any organization of national repute or any reputed/well-known industry. Students are expected to update the progress of learning timely and submit a progress report and give a presentation. Multiple internships are accepted under the condition that the internship timelines are not overlapping.

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