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Scheme

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PCC	CI14	Data Science	3	-	-	3
2.	PCC	CI15	Cryptography and Network Security	3	-	-	3
3.	PEC	CI02	Professional Elective Course-II	2	1	-	3
4.	PEC	CI03	Professional Elective Course-III	2	1	-	3
5.	LC	CI14(P)	Data Science Lab	-	-	2	1
6.	IOC	-	Interdisciplinary Open Course-II	3	-	-	3
7.	PROJ	CI05	Major Project-I	-	-	8	4
8.	PROJ	CI06	Internship-II	-	-	6	3
						Total Credits	23

Note:

Professional Elective Course-II	Professional Elective Course-III	Interdisciplinary Open Course-II
CI02(A) Mobile Application Development	CI03(A) Information Theory and Coding	CS-01 Digital Marketing and SEO
CI02(B) Cloud Computing	CI03(B) Pattern Recognition	Robotics
CI02(C) Software Vulnerabilities and Security	CI03(C) Computational Intelligence	FT (A) Fundamental of Fire and Safety
CI02(D) Data Visualization	CI03(D) Deep and Reinforcement Learning	3D Printing and Application

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PCC-CI14	**Data Science**	**3L: 0T: 0P (3 hrs.)**	**3 credits**

Course Objective:

The objective of this course is to familiarize students with the roles of a data scientist and enable them to analyze data to derive meaningful information from it.

Course Contents: (40 hrs.)

Module 1: **(08 hrs.)**

Data Science and Big Data Overview: Types of data, Sources of data, Data collection, Data storage and management, Big Data Overview, Characterization of Big data, Drivers of Big Data, Challenges, Big Data Use Cases, Defining Big Data Analytics and examples of its use cases, Data Analytics Lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize.

Module 2: **(08 hrs.)**

Data Analytics: Exploratory Data Analytics Descriptive Statistics – Mean Standard Deviation, Skewness and Kurtosis, Box Plots, Pivot Table, Heat Map, Correlation Statistics, ANOVA. Exploratory Data Analysis - Basic tools (plots, graphs, and summary statistics) of EDA, Philosophy of EDA - The Data Science Process. Overview of Data Reduction Strategies, Wavelet Transforms, Principal Components Analysis, Attribute Subset Selection

Module 3: **(08 hrs.)**

Data Visualization: Basics, Simple and Multiple Regression, Model Evaluation using Visualization, Residual Plot, Distribution Plot, Polynomial Regression and Pipelines, Measures for In-sample Evaluation, Prediction and Decision Making.

Module 4: **(08 hrs.)**

Statistics: Descriptive Statistics including central tendency, variance, standard deviation, covariance, correlation, probability; Inferential Statistics including Central limit theorem, hypothesis testing, one-tailed and two-tailed test, and Chi-Square test.

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Module 5: **(08 hrs.)**

Introduction to Machine Learning: Regression, SVM, KNN & K-means; Rise of the deep learning: ANN-Artificial Neural Networks, CNN-Convolutional Neural Networks, RNN – Recurrent Neural Networks, Generative Models and GANs; Computer Vision

Course Outcome:

1. Understanding data and its types for analysis.
2. Describe the data using various statistical measures with understanding of data collection and pre-processing.
3. Use appropriate exploratory data analysis techniques for data science problems.
4. Perform data reduction to solve problems effectively.
5. Apply data science visualization techniques in real-world contexts to communicate these solutions effectively.

List of Text / Reference Books:

1. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015.
2. David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big data Analytics", EMC 2013.
3. Hadley Wickham and Garrett Grolemund, "R for Data Science", O'Reilly, 2017.
4. Machine Learning – Tom M. Mitchell, - MGH.
5. Crawley, M. J. (2006), "Statistics - An introduction using R", John Wiley, London 32.
6. K G Srinivas, G M Siddesh, "Statistical programming in R", Oxford Publications.

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PCC-CI15	**Cryptography and Network Security**	**3L: 0T: 0P (3 hrs.)**	**3 credits**

Course Objective:

1. Understand fundamental security principles and cryptographic techniques, including various types of attacks and encryption methods.
2. Master advanced cryptographic algorithms, network security protocols, and practical applications through real-world case studies.

Course Contents: (40 hrs.)

Module 1: (08hrs.)

Introduction to Security, The Need for Security, Security Approaches and Principles, Types of Security Attacks, Introduction to Cryptography, Plain Text and Cipher Text, Substitution and Transposition Techniques, Encryption and Decryption Processes, Symmetric and Asymmetric Key Cryptography.

Module 2: (08hrs.)

Symmetric Key Ciphers, Block Cipher Principles, Overview of DES, AES, Blowfish, RC5, IDEA Block Cipher Operations, Asymmetric Key Ciphers, Principles of Public Key Cryptosystems, RSA Algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange.

Module 3: (08hrs.)

Cryptographic Hash Functions, Message Authentication and Secure Hash Algorithm (SHA-512) Message Authentication Codes: HMAC, CMAC, Digital Signatures and Elgamal Digital Signature Scheme, Key Management and Distribution, Symmetric Key Distribution Using Symmetric and Asymmetric Encryption, Distribution of Public Keys, Kerberos, Public Key Infrastructure (PKI).

Module 4: (08hrs.)

Transport-Level Security, Web Security Considerations, Secure Socket Layer (SSL) and Transport Layer Security (TLS), HTTPS, Secure Shell (SSH), Wireless Network Security, Wireless Security Overview, Mobile Device Security, IEEE 802.11 Wireless LAN Security.

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Module 5: **(8hrs.)**

E-Mail Security, Pretty Good Privacy (PGP), S/MIME, IP Security, IP Security Overview and Architecture, Case Studies on Cryptography and Security: Secure Multiparty Computation, Virtual Elections, Single Sign-On (SSO).

Course Outcome:

1. Describe the importance of security and the principles of cryptography.
2. Apply symmetric and asymmetric key cipher techniques.
3. Explain cryptographic hash functions, authentication codes, and digital signatures.
4. Identify transport-level and wireless network security protocols.
5. Implement email and IP security measures and analyze cryptographic case studies for real-world applications.

List of Text / Reference Books:

1. Cryptography and Network Security: Principles and Practice by William Stallings.
2. Applied Cryptography: Protocols, Algorithms, and Source Code in C by Bruce Schneier.
3. Network Security Essentials: Applications and Standards by William Stallings.
4. E-Mail Security: How to Keep Your Electronic Messages Private by Bruce Schneier.
5. IPsec: The New Security Standard for the Internet, Intranets, and Virtual Private Networks by Naganand Doraswamy and Dan Harkins.
6. Cryptographic Hash Functions by B. Preneel.

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PEC- CI02(A)	**Mobile Application Development**	**2L: 1T: 0P (3 hrs.)**	**3 credits**

Course Objective:

1. To facilitate students to understand android SDK.
2. To help students to gain a basic understanding of Android application development.
3. To inculcate working knowledge of Android Studio development tool.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

Module 2: **(8hrs.)**

Android Application Design Essentials: Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

Module 3: **(6hrs.)**

Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation.

Module 4: **(8hrs.)**

Testing Android applications: Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.

Module 5: **(10hrs.)**

Using Common Android APIs: Using Android Data and Storage APIs, Managing data using Sqlite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

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Course Outcome:

1. Identify various concepts of mobile programming that make it unique from programming for other platforms.
2. Critique mobile applications on their design pros and cons.
3. Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces.
4. Program mobile applications for the Android operating system that use basic and advanced phone features.
5. Deploy applications to the Android marketplace for distribution.

List of Text / Reference Books:

1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)
2. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
3. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd3.R3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

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PEC-CI02(B)	Cloud Computing	2L: 1T: 0P (3 hrs.)	3 credits

Course Objectives:

1. To understand the concepts of Cloud Computing.
2. To learn Taxonomy of Virtualization Techniques.
3. To learn Cloud Computing Architecture.
4. To acquire knowledge on Aneka Cloud Application Platform.
5. To learn Industry Cloud Platforms.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Introduction of Grid and Cloud computing, characteristics, components, business and IT perspective, cloud services requirements, cloud models, Security in public model, public verses private clouds, Cloud computing platforms: Amazon EC2,Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.

Module 2: **(6hrs.)**

Cloud services- SAAS, PAAS, IAAS, cloud design and implementation using SOA, conceptual cloud model, cloud stack, computing on demand, Information life cycle management, cloud analytics, information security, virtual desktop infrastructure, storage cloud.

Module 3: **(6hrs.)**

Virtualization technology: Definition, benefits, sensor virtualization, HVM, study of hypervisor, logical partitioning- LPAR, Storage virtualization, SAN, NAS, cloud server virtualization, virtualized data center.

Module 4: **(12hrs.)**

Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control-Identity management, Access control, Autonomic Security, Cloud computing security challenges: Virtualization security management-virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud.

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Module 5: **(8hrs.)**

SOA and cloud, SOA and IAAS, cloud infrastructure benchmarks, OLAP, business intelligence, e-Business, ISV, Cloud performance monitoring commands, issues in cloud computing. QOS issues in cloud, mobile cloud computing, Inter cloud issues, Sky computing, Cloud Computing Platform, Xen Cloud Platform, Eucalyptus, OpenNebula, Nimbus, TPlatform, Apache Virtual Computing Lab (VCL), Anomaly Elastic Computing Platform.

Course Outcomes:

1. Understand the concept of virtualization and how this has enabled the development of Cloud Computing.
2. Know the fundamentals of cloud, cloud Architectures and types of services in cloud.
3. Understand scaling, cloud security and disaster management.
4. Design different Applications in cloud.
5. Explore some important cloud computing driven commercial systems.

List of Text / Reference Books:

1. Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi from TMH 2013.
2. George Reese Cloud Application Architectures, First Edition, O"Reilly Media 2009.
3. Cloud Computing and SOA Convergence in Your Enterprise A Step-by-Step Guide by David S. Linthicum from Pearson 2010.
4. Cloud Computing 2 nd Edition by Dr. Kumar Saurabh from Wiley India 2012.
5. Cloud Computing – web based Applications that change the way you work and collaborate Online – Micheal Miller.Pearson Education.

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PEC- CI02(C)	**Software Vulnerabilities and Security**	**2L: 1T: 0P (3 hrs.)**	**3 credits**

Course Objectives:

1. To understand common software vulnerabilities and their exploitation techniques.
2. To study secure coding practices and mitigation strategies.
3. To evaluate tools and techniques used for vulnerability detection.
4. To gain practical skills in analyzing and patching vulnerable software.
5. To comprehend security policies, models, and frameworks for secure software development.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Introduction to Software Security: Importance of software security, Common software vulnerabilities, Buffer overflows, format string attacks, integer overflows, etc.**,** Threat modeling and attack surface analysis**,** Case studies of real-world software exploits.

Module 2: **(8hrs.)**

Secure Coding Practices: Principles of secure software design, Defensive programming, Input validation and output encoding, Secure memory and string handling (C/C++ and Java), Avoiding race conditions and deadlocks.

Module 3: **(8hrs.)**

Vulnerability Assessment and Exploitation: Static and dynamic code analysis tools, Common Vulnerability Scoring System (CVSS), Penetration testing basics, Reverse engineering and binary analysis, Hands-on exploitation labs (with safe environments like DVWA, WebGoat, or SEED Labs).

Module 4: **(8hrs.)**

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Web Application and Database Security: OWASP Top 10 vulnerabilities, SQL Injection, Cross-site Scripting (XSS), Cross-site Request Forgery (CSRF), Session management and authentication flaw, Security misconfiguration and access control, Secure software lifecycle in web apps.

Module 5: **(8hrs.)**

Security Standards, Testing, and Policies: Security development lifecycle (SDL), Threat modeling methodologies (STRIDE, DREAD), Security testing strategies and fuzzing, Secure DevOps (DevSecOps), Compliance standards: ISO/IEC 27001, NIST, GDPR overview.

Course Outcome:

1. Identify and explain various software vulnerabilities and threats.
2. Demonstrate knowledge of secure coding and vulnerability mitigation techniques.
3. Analyze software systems for security flaws using appropriate tools.
4. Apply security best practices during software design and development.
5. Evaluate and apply security policies, models, and testing strategies in software projects.

List of Text / Reference Books:

1. The Web Application Hacker's Handbook by Dafydd Stuttard and Marcus Pinto.
2. Security Engineering by Ross Anderson.
3. Hacking: The Art of Exploitation" by Jon Erickson.
4. Secure Coding in C and C++ by Robert C. Seacord.
5. Software Security: Building Security In by Gary McGraw.

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PEC-CI02(D)	Data Visualization	2L: 1T: 0P (3 hrs.)	3 credits

Course Objective:

1. To understand the various types of data, apply and evaluate the principles of data visualization.
2. Acquire skills to apply visualization techniques to a problem and its associated dataset.
3. To apply structured approach to create effective visualizations thereby building visualization dashboard to support decision making

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Introduction to Data Visualization: Overview of data visualization, Data Abstraction, Analysis: Four Levels for Validation, Task Abstraction, Analysis: Four Levels for Validation.

Module 2: **(8hrs.)**

Visualization Techniques: Scalar and point techniques, Color maps, Contouring Height Plots, Vector visualization techniques, Vector properties, Vector Glyphs, Vector Color Coding Stream Objects.

Module 3: **(8hrs.)**

Visual Analytics: Visual Variables, Networks and Trees, Map Color and Other Channels, Manipulate View, Arrange Tables Geo Spatial data Reduce Items and Attributes.

Module 4: **(8hrs.)**

Visualization Tools and Techniques: Introduction to data visualization tools, Tableau Visualization using R.

Module 5: **(8hrs.)**

Diverse Types of Visual Analysis: Time- Series data visualization Text data visualization Multivariate data visualization and case studies. Dashboard creation using visualization tools for the use cases: Finance-marketing insurance healthcare etc.

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Course Outcome:

1. Identify the different data types, visualization types to bring out the insight. Relate the visualization towards the problem based on the dataset.
2. Identify the different attributes and showcasing them in plots. Identify and create various visualizations for geospatial and table data.
3. Ability to visualize categorical, quantitative and text data. Illustrate the integration of visualization tools with hadoop.
4. Ability to visualize categorical, quantitative and text data.
5. Develop dashboards and storytelling visualizations to derive insights and support decision-making in real-world applications.

List of Text / Reference Books:

1. Tamara Munzer, Visualization Analysis and Design -, CRC Press 2014
2. AlexandruTelea, Data Visualization Principles and Practice CRC Press 2014.
3. Paul J. Deitel, Harvey Deitel, Java SE8 for Programmers (Deitel Developer Series) 3 rd Edition, 2014.
4. Y. Daniel Liang, Introduction to Java programming-comprehensive version-Tenth Edition,Pearson ltd 2015.
5. Paul Deitel Harvey Deitel ,Java, How to Program, Prentice Hall; 9th edition , 2011.
6. Cay Horstmann BIG JAVA, 4th edition,John Wiley Sons,2009
7. Nicholas S. Williams, Professional Java for Web Applications, Wrox Press, 2014.

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PEC-CI03(A)	**Information Theory and Coding**	**2L: 1T: 0P (3 hrs.)**	**3 credits**

Course Objective:

The course aims to introduce information theory, fundamentals of error control coding techniques and their applications, importance of various communication channels, utilization of codes for error detection and correction as well as for practical applications.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Information Theory: Introduction to uncertainty, entropy and its properties, entropy of binary memoryless source and its extension to discrete memory-less source, Measure of information, Information content of message, Average Information content of symbols. Self information, Mutual information and its properties,

Module 2: **(6hrs.)**

Coding theorem: Source coding theorem, prefix coding, Shannon's Encoding Algorithm, Shannon Fanon Encoding Algorithm, Huffman coding, Extended Huffman coding, Arithmetic Coding, Lempel-Ziv Coding, Run Length Encoding.

Module 3: **(8hrs.)**

Information Channels: Communication Channels, Channel Models, Channel Matrix, Joint probability Matrix, Discrete memory less channels, Binary symmetric channel and its channel capacity, channel coding theorem, and its application to Binary Erasure Channel, Shannon's theorem on channel capacity, capacity of channel of infinite bandwidth, Continuous Channels.

Module 4: **(10hrs.)**

Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Probability of undetected error for linear block code in BSC, hamming Codes and their applications, Cyclic

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Codes: Cyclic codes and its basic properties, Encoding using an (n-k) Bit Shift register, Generator & parity check matrix of cyclic codes, encoding & decoding circuits, syndrome computation, error detection and correction.

Module 5: **(8hrs.)**

Introduction to BCH codes, its encoding & decoding, error location & correction. Convolution Codes: Introduction to convolution codes, its construction, Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram, Viterbi algorithm: Introduction of theorem for maximum likelihood decoding.

Course Outcome:

1. Acquire the knowledge in measurement of information and errors.
2. Know the application of coding theorem for efficient utilization of communication resources.
3. Understand the utilization of various communication channels for communication system.
4. Design the block and cyclic codes for error correction and detection in communication systems.
5. Know the significance of source and channel codes in various applications.

List of Text / Reference Books:

1. Digital Communication -by Haykins Simon Wiley Publ.
2. Error control Coding: Theory and Application, - by Shu Lin and Cosstlello, PHI.
3. Digital Communication - by Sklar, Pearson Education.
4. Error Correcting Codes - by Peterson W., MIT Press.
5. Digital Communication - by Proakis, TMH.
6. Information Theory, Coding and Cryptography – By Ranjan Bose, TMH.
7. Communication Systems – By Singh and Sapre, TMH.

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PEC-CI03(B)	Pattern Recognition	2L: 1T: 0P (3 hrs.)	3 credits

Course Objectives:

The objective of this course is to learn the fundamentals of pattern recognition and its relevance to classical and modern problems.

Course Contents: (40 hrs.)

Module 1: **(08 hrs.)**

Introduction – Definitions, data sets for Pattern, Application Areas and Examples of pattern recognition, Design principles of pattern recognition system, Classification and clustering, supervised Learning, unsupervised learning and adaptation, Pattern recognition approaches, Decision Boundaries, Decision region , Metric spaces, distances.

Module 2: **(10 hrs.)**

Classification: introduction, application of classification, types of classification, decision tree, naïve Bayes, logistic regression , support vector machine, random forest, K Nearest Neighbor Classifier and variants, Efficient algorithms for nearest neighbor classification, Different Approaches to Prototype Selection, Combination of Classifiers, Training set, test set, standardization and normalization.

Module 3: **(10 hrs.)**

Different Paradigms of Pattern Recognition, Representations of Patterns and Classes, Unsupervised Learning & Clustering: Criterion functions for clustering, Clustering Techniques: Iterative square -error partitional clustering – K means, hierarchical clustering, Cluster validation.

Module 4: **(06 hrs.)**

Introduction of feature extraction and feature selection, types of feature extraction , Problem statement and Uses, Algorithms - Branch and bound algorithm, sequential forward / backward selection algorithms, (l, r) algorithm.

Module 5: **(06 hrs.)**

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Recent advances in Pattern Recognition, Structural PR, SVMs, FCM, Soft computing and Neurofuzzy techniques, and real-life examples, Histograms rules, Density Estimation, Nearest Neighbor Rule, Fuzzy classification.

Course Outcome:

1. Understand the concept of a pattern and the basic approach to the development of pattern recognition.
2. Acquire the knowledge of classification, its types and normalization.
3. Understand unsupervised learning & clustering in pattern recognition.
4. Understand the basic methods of feature extraction, feature evaluation, and data mining.
5. Understand soft computing and fuzzy classification for recent advancements in pattern recognition.

List of Text / Reference Books:

1. Richard O. Duda, Peter E. Hart and David G. Stork, “Pattern Classification”, 2nd Edition, John Wiley, 2006.
2. C.M. Bishop, “PatternRecognitionandMachineLearning”, Springer, 2009.
3. S. Theodoridis and. Koutroumbas, “Pattern Recognition”, 4th Edition, academic Press, 2009.
4. Robert Schalk off, “pattern Recognition: statistical, structural and neural approaches”, JohnWiley&sons, Inc, 2007.

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PEC-CI03(C)	**Computational Intelligence**	**2L: 1T: 0P (3 hrs.)**	**3 credits**

Course Objective:

1. Understand the fundamentals of neural networks, fuzzy logic, and evolutionary algorithms.
2. Learn the theoretical foundations of intelligent learning and adaptation.
3. Explore soft computing models for handling uncertainty and approximation.
4. Analyze and compare various CI techniques.
5. Apply CI methods to solve complex real-world problems.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Introduction to Computational Intelligence: types of Computational Intelligence, components of Computational Intelligence. Concept of Learning/Training model. Parametric Models, Nonparametric Models. Multilayer Networks: Feed Forward network, Feedback network.

Module 2: **(8hrs.)**

Fuzzy Systems: Fuzzy set theory: Fuzzy sets and operations, Membership Functions, Concept of Fuzzy relations and their composition, Concept of Fuzzy Measures; Fuzzy Logic: Fuzzy Rules, Inferencing; Fuzzy Control - Selection of Membership Functions, Fuzzyfication, Rule Based Design & Inferencing, Defuzzyfication.

Module 3: **(8hrs.)**

Genetic Algorithms: Basic Genetics, Concepts, Working Principle, Creation of Offsprings, Encoding, Fitness Function, Selection Functions, Genetic Operators-Reproduction, Crossover, Mutation; Genetic Modeling, Benefits.

Module 4: **(8hrs.)**

Rough Set Theory - Introduction, Fundamental Concepts, Set approximation, Rough membership, Attributes, Optimization. Hidden Markov Models, Decision tree model.

Module 5: **(8hrs.)**

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Introduction to Swarm Intelligence, Swarm Intelligence Techniques: Ant Colony Optimization, Particle Swarm Optimization, Bee Colony Optimization etc. Applications of Computational Intelligence.

Course Outcome:

1. Understand the core concepts and theoretical foundations of computational intelligence techniques such as neural networks, fuzzy logic, and evolutionary computation.
2. Analyze the behavior and learning capabilities of various neural network architectures including perceptrons, multi-layer networks, and self-organizing maps.
3. Understand the principles of fuzzy set theory and fuzzy inference systems for reasoning under uncertainty and imprecision.
4. Evaluate the mechanisms and performance of nature-inspired optimization techniques such as Genetic Algorithms and Swarm Intelligence.
5. Compare and assess the suitability of different computational intelligence techniques for solving complex real-world problems across diverse domains.

List of Text / Reference Books:

1. Russell C. Eberhart and Yuhui Shi, Computational Intelligence: Concepts to Implementations, Morgan Kaufmann Publishers.
2. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Wiley Publishing.
3. Simon Haykin, Neural Networks: A Comprehensive Foundation, Prentice Hall.
4. David E. Goldberg, Genetic Algorithm in Search Optimization and Machine Learning, Pearson Education.
5. Jagdish Chand Bansal, Pramod Kumar Singh, Nikhil R. Pal, Evolutionary and Swarm Intelligence Algorithms, Springer Publishing, 2019.
6. S. Rajeskaran, G.A. VijaylakshmiPai, “Neural Networks, Fuzzy Logic, GeneticAlgorithms Synthesis and Applications”.
7. J.S. Roger Jang, C.T.Sun, E. Mizutani, “Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning & Machine Intelligence”, PHI, 2002

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PEC-CI03(D)	**Deep and Reinforcement Learning**	**2L: 1T: 0P (3 hrs.)**	**3 credits**

Course Objective:

1. To introduce the foundational concepts and mathematical principles behind deep learning models and architectures.
2. To equip students with practical skills to design, train, and evaluate neural networks using modern deep learning frameworks such as TensorFlow or PyTorch.
3. To explore advanced deep learning architectures including CNNs, RNNs, and transformers for solving complex tasks in computer vision and natural language processing.
4. To explain the core concepts of reinforcement learning, including agent-environment interaction, reward systems, and policy optimization.
5. To enable students to implement and apply deep reinforcement learning algorithms to real-world problems involving sequential decision-making and control.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Foundations of Deep Learning: Introduction to AI, ML, and DL, Perceptron and Multi-layer Perceptron, Activation Functions: ReLU, Sigmoid, Tanh, Loss Functions and Gradient Descent, Backpropagation (Conceptual Overview), Introduction to TensorFlow/PyTorch.

Module 2: **(8hrs.)**

Deep Neural Networks and CNNs: Deep Neural Network Architectures, Issues: Overfitting, Vanishing Gradient, Regularization: Dropout, Batch Normalization, Convolutional Neural Networks (CNNs): Convolution, Pooling, Flattening, CNN Applications: Image Classification, Transfer Learning Basics.

Module 3: **(8hrs.)**

Introduction to Reinforcement Learning: RL Basics: Agent, Environment, Reward, Policy, Value Function, Markov Decision Process (MDP), Exploration vs Exploitation, Q-Learning and Temporal Difference Learning, Basic Grid World Examples**.**

Module 4: **(8hrs.)**

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Deep Reinforcement Learning: Need for Deep RL, Deep Q-Networks (DQN): Experience Replay, Target Networks, Policy Gradient Methods (Intro), Applications: Game Playing (e.g., CartPole, Pong).

Module 5: (8hrs.)

Applications and Trends: Real-world Applications: Robotics, Games, NLP, Healthcare, Ethics and Limitations in DL and RL, Autoencoders and GANs (Introduction only), Recent Trends: AlphaGo, ChatGPT, OpenAI Gym.

Course Outcome:

1. Understand and explain the fundamental concepts of deep learning, including neural networks, activation functions, optimization techniques, and loss functions.
2. Design and implement deep learning models using frameworks like TensorFlow or PyTorch for tasks such as classification, object detection, and sequence modeling.
3. Analyze and optimize neural network architectures, including convolution neural networks (CNNs) and recurrent neural networks (RNNs), for real-world data.
4. Explain the principles of reinforcement learning, including Markov Decision Processes (MDPs), policy/value iteration, and Q-learning.
5. Develop and apply reinforcement learning algorithms (such as DQN and policy gradient methods) to solve control and decision-making problems.

List of Text / Reference Books:

1. Deep Learning, An MIT Press book, Ian Goodfellow and YoshuaBengio and Aaron Courville
2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.
3. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
4. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds.

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LC-CI14(P)	Data Science Lab	0L: 0T: 2P (2 hrs.)	1 credits

Course Objectives:

1. To provide hands-on experience in applying data science techniques using tools such as Python/R.
2. To enable students to preprocess data and perform exploratory data analysis.
3. To teach students how to implement data visualization techniques.
4. To help students understand and apply machine learning algorithms.
5. To develop problem-solving and analytical skills through real-world data sets

Module 1:

Introduction to Data Science – Overview of Data Science Life Cycle, Introduction to Python/R for Data Science, Data types, Libraries (NumPy, Pandas, Matplotlib).

Module 2:

Data Collection and Data Pre-Processing: Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization.

Module 3:

Exploratory Data Analytics: Descriptive Statistics – Mean, Standard Deviation, Skewness and Kurtosis – Box Plots – Pivot Table – Heat Map – Correlation Statistics – ANOVA.

Module 4:

Data Visualization techniques: Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots.

Module 5:

Model Development: Simple and Multiple Regression; Model Evaluation: Generalization Error – Out-of-Sample Evaluation Metrics – Cross Validation – Overfitting – Under Fitting and Model Selection – Prediction by using Ridge Regression – Testing Multiple Parameters by using Grid Search.

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Course Outcome:

1. Preprocess and analyze datasets using programming tools.
2. Apply statistical and visual techniques for data exploration.
3. Implement machine learning algorithms for classification and regression.
4. Interpret model results and evaluate performance metrics.
5. Work with real-time datasets and build mini-projects using end-to-end data science pipelines.

List of Experiments:

1. Introduction to R tool for data analytics science
2. Basic Statistics and Visualization in R
3. To clean a raw dataset by handling missing data, dealing with duplicates, and correcting errors in the dataset.
4. To integrate and transform multiple datasets to form a unified, consistent dataset ready for analysis or modeling.
5. Perform EDA on Credit Card Fraud Detection Dataset (open source dataset) for analyzing the data
6. Perform EDA on a sales dataset to identify trends, patterns, outliers, and relationships between variables like Customer Age, Annual Income, Purchase Amount, and Product Category
7. Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots.
8. Linear Regression
9. Logistic Regression
10. Plotting Accuracy and Error Metrics against number of iterations for evaluation of model performance.

List of Text / Reference Books:

1. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.
3. Anil Maheshwari, Data Science and Big Data Analytics, Wiley.
4. Wes McKinney, Python for Data Analysis, O'Reilly Media.
5. Rafael A. Irizarry, Introduction to Data Science, CRC Press.

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IOC-CS01	**Digital Marketing and SEO**	**3L: 0T: 0P (3hrs.)**	**3 credits**

Course Objective:

Developing an overall understanding of digital marketing / online marketing platforms, mainly web analytics, social media tools, marketing through search engines, search engine optimization, mobile marketing, email marketing, Pay per click, digital display marketing, content marketing and Strategizing marketing.

Course Contents: (40 hrs.)

Module 1: **(8hrs.)**

Digital Marketing: Introduction, Moving from Traditional to Digital Marketing, Integrating Traditional and Digital Marketing, Reasons for Growth. Need for a comprehensive Digital Marketing Strategy. Concepts: Search Engine Optimization (SEO); Concept of Pay Per Click

Module 2: **(8hrs.)**

Social Media Marketing: Introduction, Process - Goals, Channels, Implementation, Analyze Tools: Google and the Search Engine, Facebook, Twitter, YouTube and LinkedIn, Issues: Credibility, Fake News, Paid Influencers, Social Media and Hate/ Phobic campaigns, Analytics and linkage with Social Media, The Social Community.

Module 3: **(10hrs.)**

Email Marketing: Introduction, email marketing process, design and content, delivery, discovery. Mobile Marketing: Introduction and concept, Process of mobile marketing: goals, setup, monitor, analyze; Enhancing Digital Experiences with Mobile Apps. Pros and Cons; Targeted advertising. Issues: Data Collection, Privacy, Data Mining, Money and Apps, Security, Spam. Growth Areas.

Module 4: **(4hrs.)**

Managing Digital Marketing: Content Production; Video based marketing; Credibility and Digital Marketing; IoT; User Experience; Future of Digital Marketing.

Module 5: **(10hrs.)**

SEO Analytics, Monitoring & Reporting : Google Search Console (GSC),Key Sections & Features of GSC; How to monitor SEO progress with Key Features of GSC: Overview, Performance, URL Inspection, Coverage, Sitemaps, Speed, Mobile Usability, Backlinks, Referring Domains, Security & Manual Actions, How to do SEO Reporting

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Course Outcomes:

1. Understand the concept of digital marketing and its real-world iterations.
2. Articulate innovative insights of digital marketing enabling a competitive edge.
3. Understand how to create and run digital media based campaigns.
4. Identify and utilize various tools such as social media etc.
5. Understand how to do SEO Audit.

List of Text / Reference Books:

1. Dodson, Ian: The Art of Digital Marketing - The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Campaigns. Wiley.
2. Ryan, Damien: Understanding Digital Marketing - Marketing Strategies for Engaging the Digital Generation. Kogan Page Limited.
3. Gupta, Sunil: Driving Digital Strategy. Harvard Business Review Press.
4. Tuten, Tracy L. and Solomon, Michael R.: Social Media Marketing. Sage.
5. Bhatia, Puneet S.: Fundamentals of Digital Marketing. Pearson.
6. Kotler, Philip: Marketing 4.0: Moving from Traditional to Digital. Wiley.

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PROJ- CI05	Major Project-I	0L: 0T: 8P (8hrs.)	4 credits

Course Objectives:

To carry out a small scale project to develop hands-on experience of working in a project. During the course, the student will also develop knowledge of application development platforms and tools (Java /C# dotnet / Visual C++/PHP /Python or any platform of current trend). The students will learn working as a team and basic collaboration and project management skills. The student will also learn about formulating project documentations.

1. Project ideas and proposal guidance (4 hours)

2. Application development (10 hours)

1. Visual programming (object oriented)
    1. Language basics
    2. Frameworks and APIs
2. Programming basics and design patterns

3. Project management, team work and collaboration(6 hours)

1. Project management techniques
2. Collaborative development environment

4. Project guidance & Project work (20 hours)

5. Project documentation guidance (3 hours)

Course Outcome:

1. Understanding the problem identification process and design a proposal for particular problem handling.
2. Design a solution model using any programming language.
3. Learn about different types of project management techniques.
4. Develop a complete project with deployment.
5. Learn about team work and documentation process.

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PROJ- CI06	**Internship-II**	**0L: 0T: 6P (6hrs.)**	**3 credits**

Course Outcome:

1. To explore career alternatives prior to graduation.
2. To develop communication, interpersonal and other critical skills in the job interview process.
3. To assess interests and abilities in their field of study.
4. To identify, write down, and carry out performance objectives related to their job assignment.
5. To integrate theory and practice.