Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	**CS425**	**Title of the Course**	Introduction to Machine Learning	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	**VI**	**3**	**1**	**0**	**4**
Pre-Requisite	**Python**	**Co-requisite**	**None**				
Course Objectives	• To understand the basic theory underlying machine learning. • To be able to formulate machine learning problems corresponding to different applications. • To understand a range of machine learning algorithms along with their strengths and weaknesses. • Analyze Deep learning Mathematical Models. • To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.						

Course Outcomes	
CO1	To Understand the fundamentals of Learning Algorithms
CO2	To design appropriate machine learning algorithms and apply the algorithms to a real-world problem
CO3	To analyze Deep Learning Mathematical Models.
CO4	To apply Regression model on various data sets.
CO5	To apply Reinforcement learning for better predictions

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Fundamental of Learning Methods**	Learning, Types of Learning, well defined learning problems, Designing a Learning System, History of ML, Introduction of Machine Learning Approaches (Supervised, Unsupervised, Reinforcement), Issues in Machine Learning, Data Science Vs Machine Learning.	8	1
2	**Machine Learning Methods**	**Decision Tree Learning** - Decision tree learning algorithm, Inductive bias, Inductive inference with decision trees, Issues in Decision tree learning. **Artificial Neural Network:** Perceptron's, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of backpropagation Algorithm, Generalization.	8	2
3	**Deep Learning Methods**	Deep Learning - Introduction, concept of convolutional neural network, Types of layers (Convolutional Layers, Activation function, pooling, fully connected), Concept of Convolution (1D and 2D) layers, Training of network, Case study of CNN for eg on Diabetic Retinopathy, Building a smart speaker, Self-deriving car etc.	8	3
4	**Regression**	**Regression:** Linear Regression and Logistic Regression**,** Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, Support Vector Machine (SVM).	8	4
5	**Reinforcement Learning**	**Reinforcement Learning** Introduction to Reinforcement Learning, Learning Task, Example of Reinforcement Learning in Practice, Learning Models for Reinforcement (Q Learning), Application of Reinforcement Learning-means, Principal Component Analysis, Singular Value Decomposition, Introduction to Genetic Algorithms.	8	5

Reference Books:

Machine Learning Algorithms: Handbook by Aman Kharwal (2023)

Machine Learning for Imbalanced Data: Tackle Imbalanced Datasets Using Machine Learning and Deep Learning Techniques by Mounir Abdelaziz (2023)

Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron (2nd Edition, 2019)

Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

Ethem Alpaydin, ―Introduction to Machine Learning (Adaptive Computation and Machine Learning), MIT Press 2004.

Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition,1997.

Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.

Russell. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice-Hall Series in Artificial Intelligence, 2003.

Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press.1995

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	1	3		3	1	1			1	1	3	
CO2	2	3	3	3	1	1	2	2	1			2	2	2	1
CO3	1	2	1	2	3	1		2	2			1		3	1
CO4	2	2	1	2	2	1	2	1	3		1		2	1	1
CO5	1	2	1	3	1		1		2	3	1	1	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**CS410**	**Title of the Course**	**Distributed Systems**	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	**VII**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	1. The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis. 2. This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms. 3. Aim is to develop a workable knowledge of the mathematics used in cryptology in this course. 4. Reveal different types of cipher generation method to solve engineering and other problems. 5. Understand the theory and applications of cryptography and network security.						

Course Outcomes	
CO1	Understand the software and hardware concepts of distributed systems
CO2	Evaluate and analyze the issues and implementations of deadlock detection and the agreement problems.
CO3	Analyze the RMI, RPC and security issues, replication and fault tolerance in the distributed systems.
CO4	Compare and analyze the flat and nested transactions, applications and analysis of locks in view of distributed systems, File systems and recent advances.
CO5	Implement and analyze distributed multimedia, CORBA RMI, Java RMI, CORBA services.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**CHARACTERIZATION OF DISTRIBUTED SYSTEMS:**	Introduction: Examples of Distributed Systems, Resource Sharing and the Web Challenges. System Models Architectural Models, Fundamental Models, Theoretical Foundation for Distributed System: Limitation of Distributed System, Absence of Global Clock, Shared Memory, Logical Clocks, Lamports & Vectors Logical Clocks, Causal Ordering of Messages, Global State, Termination Detection. Distributed Mutual Exclusion: Classification of Distributed Mutual Exclusion, Requirement of Mutual Exclusion Theorem, Token Based and Non-Token Based Algorithms, Performance Metric for Distributed Mutual Exclusion Algorithms.	8	1
2	**DISTRIBUTED DEADLOCK DETECTION:**	System Model, Resource vs Communication Deadlocks, Deadlock Prevention, Avoidance, Detection & Resolution, Centralized Dead Lock Detection, Distributed Dead Lock Detection, Path Pushing Algorithms, Edge Chasing Algorithms. Agreement Protocols: Introduction, System Models, Classification of Agreement Problem, Byzantine Agreement Problem, Consensus Problem, Interactive Consistency Problem, Solution to Byzantine Agreement Problem, Application of Agreement Problem, Atomic Commit in Distributed Database System.	8	2
3	**DISTRIBUTED OBJECTS AND REMOTE INVOCATION:**	Communication Between Distributed Objects, Remote Procedure Call, Events and Notifications, Security: - Overview of Security Techniques, Cryptographic Algorithms, Cryptography Pragmatics, Needham Schroeder, Kerberos, SSL & Millicent, Replication: System Model and Group Communication, Fault – Tolerant Services, Highly Available Services, Transactions with Replicated Data.	8	3
4	**TRANSACTIONS AND CONCURRENCY CONTROL:**	Transactions, Nested Transactions, Locks, Optimistic Concurrency Control, Timestamp Ordering, Comparison of Methods for Concurrency Control. Distributed Transactions: Flat and Nested Distributed Transactions, Atomic Commit Protocols, Concurrency Control in Distributed Transactions, Distributed Deadlocks, Transaction Recovery, Distributed File Systems: File Service Architecture, Sun Network File System, The Andrew File System, Recent Advances.	8	4
5	**DISTRIBUTED SHARED MEMORY(DSM):**	Architecture, Algorithms for implementing DSM, Client- Server Algorithm, Migration Algorithm, Read Replication Algorithm, Full Replication Algorithm. Distributed Multimedia Systems: Introduction, Characteristics of Multimedia data, Quality of service management, Resource management, Stream Adaption. Case Study: CORBA RMI, CORBA Services, Java RMI.	8	5

Reference Books:

1. Couloris, Dollimore, Kindberg," Distributed systems: Concepts and Design". PearsonEducation Asia, 3ed.

2. Sighal and Shivratri," Advanced Concepts in Operating Systems", Mc Graw Hill.

e-Learning Source:

https://nptel.ac.in/courses/106106168

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**2**	**1**		**1**		**1**			**1**		**1**	**1**	**2**	
CO2	**2**	**3**	**2**	**1**		**1**		**1**	**1**	**1**	**3**	**1**	**1**	**1**	**2**	1
CO3	**3**	**2**	**3**	**2**				**1**	**1**	**1**	**2**	**1**	**1**	**2**	**3**	1
CO4	**3**	**2**	**2**	**2**	**1**	**1**		**1**		**1**	**2**	**2**	**2**	**1**	**3**	1
CO5	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS412**	**Title of the Course**	**Cryptography and Network Security**	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	**VII**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	Understand the theory and applications of cryptography and network security. The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis. This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms. Aim is to develop a workable knowledge of the mathematics used in cryptology in this course. Reveal different types of cipher generation method to solve engineering and other problems.						

Course Outcomes	
CO1	To understand both classical and modern encryption techniques, as well as the ability to analyze cryptographic systems and evaluate their effectiveness in securing data.
CO2	Apply your knowledge of block cipher modes to achieve secure communication and analyze the role of random numbers in cryptographic algorithms.
CO3	Apply, analyze and compare various public key cryptography techniques
CO4	To design, implement, and analyze secure authentication and digital signature systems in real-world scenarios.
CO5	Able to analyze appropriate secure communication protocols based on security requirements and implement basic network security measures using firewalls.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to OSI Security Architecture:**	Security Attacks, Services and Mechanisms, Introduction to Cryptology. Conventional Encryption: Conventional Encryption Model, Classical Encryption Techniques – Substitution Ciphers: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One-Time Pad; Transpositions Ciphers: Rail Fence Technique; Rotor Machines, Cryptanalysis, Steganography. Modern Block Ciphers- Block Ciphers Principles: Stream & Block Ciphers, Fiestal Cipher, Shannon's Theory of Confusion and Diffusion, S-DES, Data Encryption Standards (DES): DES Encryption and Decryption, Strength of DES.	8	1
2	**Block Cipher Modes of Operation:**	ECB, CBC, CFB, OFB, CTR, Triple DES: Double DES, TDES with Two Keys, TDES with Three Keys. Symmetric Key Distribution using KDC, Random Number Generation: Use of Random Numbers, Pseudo Random Number Generators, Cryptographically Generated Random Numbers, Blum BlumShub Generator. Introduction to Graph, Ring and Field, Prime and Relative Prime Numbers, Modular Arithmetic, Fermat's & Euler's Theorem, Primality Testing, Euclid's Algorithm.	8	2
3	**Principles of Public Key Cryptosystems:**	Introduction, Application & Requirement; RSA Algorithm: Computational Aspects, Security of RSA; Diffie-Heilman Key Exchange Algorithm, Introductory Idea of Elliptic Curve Cryptography. Message Authentication & Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes (MAC), Hash Functions: Requirement for a Hash Function, Simple Hash Functions, Security of Hash Function & MAC, MD5 Message Digest Algorithm, Secure Hash Algorithm (SHA-1).	8	3
4	**Digital Signatures:**	Requirements, Direct & Arbitrated Digital Signature, Protocols: Mutual & One way Authentication; Digital Signature Standard (DSS): DSS Approach, Digital Signature Algorithm. Authentication Applications: Kerberos Version 4 & Difference between Kerberos v4 & v5, Kerberos Realms; X.509 Authentication Service: Authentication Procedures, Directory Authentication Service; Electronic Mail Security – Pretty Good Privacy (PGP): Operational Description, Cryptographic Keys, Key Rings, Public Key Management.	8	4
5	**IP Security:**	Architecture, Authentication Header, Encapsulating Security Payloads, Combining Security Associations, Key Management; Web Security: Secure Socket Layer & Transport Layer Security, Secure Electronic Transaction (SET). System Security: Intruders, Viruses and Related Threats: Malicious Programs, The Nature of Viruses, Types of Viruses, Macro Viruses, Email Viruses; Firewall: Firewall Design Principles, Trusted Systems.	8	5

Reference Books:

1. William Stallings, "Cryptography and Network Security: Principles and Practice" Prentice Hall, New Jersey.

2. Johannes. A. Buchmann, "Introduction to cryptography", Springer Verlag. Bruce Schiener, "Applied Cryptography".

e-Learning Source:

https://nptel.ac.in/courses/106105031

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**2**	**1**		**2**						**2**	**3**	**3**	**2**	
CO2	**3**	**3**	**3**	**3**								**3**	**3**	**2**	**1**	**2**
CO3	**3**	**3**	**1**	**2**							**2**	**2**	**3**	**2**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**1**	**3**		**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**		**3**			**1**		**3**	**3**	**3**	**3**	**2**	**1**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS415**	**Title of the Course**	**Fuzzy Logic & Neural Networks**	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	**VII**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	1. Learn about neural network history, neuron structure, different architectures, and their supervised learning applications and training algorithms 2. Learn about network pruning algorithms and prediction networks, and their role in optimizing neural network architectures for improved performance. 3. Learn about Unsupervised Learning methods and other methods for tasks like pattern recognition. 4. Explore the fundamentals of fuzzy logic, variable inference techniques, and their application in system design, alongside an introduction to optimization methods and hybrid systems integration. 5. Discover associative memory networks and optimization, as well as an introduction to hybrid systems and deep learning.						

Course Outcomes	
CO1	Understand and analyze the concept of soft computing techniques and their applications
CO2	Analyze and Illustrate various neural network architectures.
CO3	Gain knowledege about the state-of-the-art of different Unsupervised Learning Algorithms.
CO4	Know basic concepts of fuzzy systems and their methods.
CO5	Ability to employ a variety of optimization methods and Evolutionary Computation, to solve complex problems across different domains effectively.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	History of Neural Networks, Structure and Function of a Single Neuron, Architectures and Their Applications, Supervised Learning: Single Layer Networks: Perceptron's, Linear Separability, Perceptron Training Algorithms and Their Modifications: Pocket Algorithm and Adaline. Supervised Learning: Multiplayer Networks: Multilevel Discrimination, Preliminaries, and Backpropagation Algorithm, Setting the Parameters Values, Accelerating the Learning Process.	8	1
2	**Adaptive Multilayers Networks:**	Network Pruning Algorithms, Marchand Algorithm, Upstart Algorithm, Cascade Correlation. Prediction Networks: Feed Forward Networks for Forecasting, Recurrent Networks (Partially, Fully), Radial Basis Functions and Probabilistic Neural Networks.	8	2
3	**Unsupervised Learning:**	Winner-Take-All Networks: Hamming Networks, Maxnet. Learning Vector Quantization, Counter Propagation Networks (Forward Only Counter Propagation networks), Adaptive Resonance Theory (ART1), K-Means Clustering Algorithms, Kohonens Self Organization Maps, Principal Component Analysis.	8	3
4	**Fuzzy Logic:**	Fuzzy Sets, Properties, Operation on Fuzzy Sets, Fuzzy Relations, Operation on Fuzzy Relations, Fuzzy IF-THEN Rules, Variable Inference Techniques, Fuzzification and Defuzzification Methods, Fuzzy System Design.	8	4
5	**Associative Models:**	Auto-Association, Hetro-Association, Hopefield Networks, Brain State-In-ABox Networks, and Boltzman Machines. Optimization Methods: Optimization Using Hopefield Networks, Introduction to Simulated Annealing and Ant Colony Optimization and Evolutionary Computation, Introduction to Hybrid Systems, Introduction to Deep Learning.	8	5

Reference Books:

1. Kishan Mehrotra, Chilukuri K. Mohan, Sanjay Ranka, Elements of Artificial Neural Networks, MIT Press/Penram International.
2. Simon Haykin, Neural Network a comprehensive Foundation, Macmillan College, proc, Con, Inc.
3. Ross T.J., Fuzzy Logic with Engineering Applications, McGraw-Hill.
4. Zurada J.M., Introduction to Artificial Neural Systems, Jaico Publishers.
5. Riza C. Berkiu and Trubatch, Fuzzy system Design Principles, Building Fuzzy IF-THEN Rule Bases, IEEE Press.
6. Goldberg D.E., Genetic Algorithms in Search Optimization and Machine Learning, Addison Wesley.
7. Intelligent Hybrid Systems, SuranGoonatilake and Sukhdev Khebbal (Eds.), Intelligent Hybrid Systems, John Wiley.
8. Dorigo and Thomas Stützle, Ant Colony Optimization, MIT Press.

e-Learning Source:

1. https://onlinecourses.nptel.ac.in/noc22_ge04/preview
2. https://www.udemy.com/course/fuzzy-logic/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3		1		2			1			**2**	3		2	1
CO2	3	3	2	2	1	3	2		2		1	2	3	2	2	2
CO3	3	3	2	2	1	3	2		2		1	2	3	3	2	2
CO4	3	3		2		1			2			2	3			3
CO5	3	3	3	3	2	3			2		3	**2**	3			2

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlatio**

Integral University, Lucknow

Effective from Session: 2016-17								
Course Code	**CS417**	**Title of the Course**	**Mobile Computing**					
Year	IV	**Semester**	VII	**L**	**T**	**P**		
Pre-Requisite	**None**	**Co-requisite**	**None**	3	1	0	4	

Course Objectives

1. To understand and compare the various wireless communication technologies and signal characteristics
2. Explore the fundamentals and advanced concepts of Channel Allocation techniques to understand their applications,
3. Understand telecommunications systems with a focus on GSM and satellite technology.
4. Explore the the important aspects of Wireless LAN and it's various technologies
5. Learn about Mobile IP, including its protocol and requirements

Course Outcomes	
CO1	To understand and compare the various wireless communication technologies and signal characteristics
CO2	Explore the fundamentals and advanced concepts of Channel Allocation techniques to understand their applications,
CO3	Understand telecommunications systems with a focus on GSM and satellite technology.
CO4	Explore the the important aspects of Wireless LAN and it's various technologies
CO5	Learn about Mobile IP, including its protocol and requirements

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Wireless Communication:**	Application, Frequencies for radio transmission, Signals, Antennas, Signal propagation, Multiplexing: Space division multiplexing, Frequency division multiplexing, Time division multiplexing, Code division multiplexing, Modulation: Amplitude shift keying, Frequency shift keying, Phase shift keying, Advanced frequency shift keying, Advanced phase shift keying, spread spectrum: Direct sequence spread spectrum, Frequency hopping spread spectrum, Cellular systems.	8	1
2	**Channel Allocation:**	Motivation for a specialized MAC, Hidden and exposed terminals, Near and far terminals, SDMA, FDMA, TDMA, Fixed TDM, Classical Aloha, Slotted Aloha, Carrier sense multiple access, Carrier sense multiple access with collision detection, Multiple access with collision avoidance.	8	2
3	**Telecommunications Systems:**	GSM: Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security; Satellite systems: History, Applications, Basics of GEO, LEO and MEO, Routing, Localization, Handover, Examples; GPRS.	8	3
4	Wireless LAN:	Infra-red vs radio transmission, Infrastructure and ad-hoc network, IEEE 802.11: System architecture, Protocol architecture, Physical layer, medium access control layer, MAC management, 802.11b, 802.11a, Bluetooth: User scenarios, Architecture, Radio layer, Baseband layer. Introduction to WAP architecture and Protocol stack.	8	4
5	**Mobile network layer:**	Mobile IP: Goals, assumptions and requirements, Entities and terminology, *IP* packet delivery, Agent discovery, Registration, Tunneling and encapsulation, Optimizations, Reverse tunneling, IPv6, Dynamic host configuration protocol.	8	5

Reference Books:

1. Jochen Schiller, "Mobile Communications, Pearson Education, 2nd Edition, 2003.
2. Dharma Prakash Agrawal & Qing-A Zeng "Introduction to Wireless & Mobile Systems", Thomson Brooks/Cole, 2nd Edition 2003.
3. Krzysztof Wesolowski, "Mobile Communication Systems ", John Wiley & Sons, Ltd.
4. Ron Olexa, "Implementing 802.11, 802.16 and 802.20 Wireless Networks, Elsevier

e-Learning Source:

https://nptel.ac.in/couivses/106106147\

CO-PO Mapping																
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO 1	3	2	2	3	2	3						1	3			2
CO 2	3	3	2	1	2	1						3	2			2
C03	3	2	2	2	3	2	3					3	3	2	1	2
C04	3	3	3	3	3	2	2	3				2	2	3	3	3
C05	3	3	3	2	3	2	3	3				1	3	2	3	3

1- **1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS418**	**Title of the Course**	**Data Warehouse and Data Mining**	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	**VII**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	Understand the concepts of Data Warehouse and its building blocks. Study the architecture of Data Warehouse and the essential processes in building a data warehouse. Study of data mining functionalities, related technologies and its techniques. Study of various classification and prediction algorithms. Study of major clustering techniques and current trends in data mining.						

Course Outcomes	
CO1	Develop a strong foundation of knowledge about data warehouse and related techniques.
CO2	Design and build a data warehouse from the available historical data and perform OLAP operations to discover knowledge.
CO3	Pre-process the data using cleaning, integration, transformation and reduction and find associations and correlations among that data.
CO4	Classify the given dataset by using statistical and probabilistic models to predict the class labels of new data.
CO5	Perform cluster analysis by using some major clustering methods and work on the recent advancements on text and web mining.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Overview & Concepts**	The Compelling Need for Data Warehousing: Introduction to Data Warehousing, Failures of Past Decision Support System, Data Warehouse Building Blocks: -Nature of data in Datawarehouse, OLAP in the Data Warehouse: Major Features and Functions, OLAP Models, Comparison between operational Data Base Systems & Data warehouse.	8	1
2	**Data Warehouses and Data Marts**	Overview of Components, Meta data & its types, Multidimensional Data Model: - Data cubes, Schemas for multidimensional databases, concept hierarchies, OLAP operations in multidimensional data models, Data Warehouse Architecture: - 3-tier architecture, Data Extraction, Transformation, and Loading, Data Quality: Why is data Quality Critical? Data Quality Challenges.	8	2
3	**Data Mining**	Introduction, Data Mining Functionalities, Classification of Data Mining System; Major Issues in Data Mining, Data Preprocessing: Preprocess, Descriptive Data Summarization, Data Cleaning, Data Integration & Transformation, Data Reduction, Mining Frequent Patterns, Association, and Correlations, Basic Concept, Efficient & Scalable Frequent Item set Mining Methods, Mining Various Kinds of Association Rules.	8	3
4	**Classification & Prediction**	Issues, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back Propagation, Associative Classification, nearest neighbor classification, Prediction.	8	4
5	**Cluster Analysis**	What is Cluster Analysis, Types, Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical Methods- cure and chameleon, Density-Based Methods: DBSCAN &OPTICS, Wave Cluster, CLIQUE. Current trends: Text mining, web mining.	8	5

Reference Books:

1. "Data Warehousing Fundamental" by PaulrajPonniah, John Wiley & Sons INC.
2. Data Mining Concepts & Techniques by Jiawei Han &MichlineKamber.
3. Mallach," Data Warehousing System", McGraw Hill
4. M.H. Dunham, "Data Mining: Introductory and Advanced Topics" Pearson Education

e-Learning Source:

https://nptel.ac.in/courses/106106168

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1								2	3	1	3	
CO2	3	3	3	2							2	1	2	3	3	1
CO3	2	3	1	1		2			2		2	2	1	2	3	2
CO4	3	3	3	2							2	2	2	2	3	3
CO5	3	3	3	2		2		2	2	1	2	3	3	2	2	3

3- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**CS419**	**Title of the Course**	**Pattern Recognition**	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	**VII**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	This course introduces fundamental statistical methods for pattern recognition and covers basic algorithms and techniques for analyzing multidimensional data, including algorithms for classification, feature selection, and dimensionality reduction of the data. The course will also introduce students to active research topics.						

Course Outcomes	
CO1	Understand basic concepts in pattern recognition along with its mathematical foundation.
CO2	Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
CO3	Gain knowledge about state-of-the-art algorithms used in pattern recognition research.
CO4	Know basic concepts in other major approaches including syntactic methods.
CO5	Apply pattern recognition techniques in practical problems.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test	8	1
2	**Statistical Pattern Recognition**	Statistical Pattern Recognition: Bayesian Decision Theory, Classifiers, Normal density and discriminant functions.	8	2
3	**Parameter Estimation Methods**	Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models.	8	3
4	**Non Parametric Techniques**	Nonparametric Techniques: Density Estimation, Parzen Windows, K-Nearest Neighbour Estimation, Nearest Neighbour Rule, Fuzzy classification.	8	4
5	**Unsupervised Learning and Clustering**	Unsupervised Learning & Clustering: Criterion functions for clustering, Clustering Techniques: Iterative square - error partition clustering – K-means, agglomerative hierarchical clustering, Cluster validation.	8	5

E resources

https://www.coursera.org/learn/machine-learning (Machine Learning by Andrew Ng on Coursera)

https://scikit-learn.org/stable/documentation.html

https://www.tensorflow.org/guide/keras/sequential_model

https://skim.math.msstate.edu/LectureNotes/Machine_Learning_Lecture.pdf

Reference Books:

Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", 2nd Edition, John Wiley, 2006.

C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2009.

S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Edition, Academic Press, 2009.

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	1	2			2						1	3		3	1
CO 2	3	3	2	3	3	1				1		2	3	3	2	1
CO 3	3		3	2	3					2		2	3	3	1	2
CO 4	3	3		2	2	3			2		3	3	3		2	3
CO 5		3	3	3	2	3			3	2	2	2	3	3	3	2

Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17								
Course Code	**CS421**	**Title of the Course Minor Project**						
Year	IV	**Semester**	VII		**L**	**T**	**P**	**C**
Pre-Requisite	**None**	**Co-requisite**	**None**		0	0	1	1
Course Objectives	Learn project management, technical skills, and teamwork. Apply advanced computer science knowledge for innovative solutions. Gain practical experience in software development. Improve communication and documentation skills.							

Minor Project, students will work on exploring, experimenting, or analyzing technical problems in different areas of Computer Science and Engineering. This includes tasks like software development, algorithm design, system design, software testing, data analysis, cybersecurity, artificial intelligence, network systems, or computer applications. The assessment for the project will be done both within the department and externally, following the established procedures. Students will also need to submit a detailed project report by the end of the seventh semester

Course Outcomes	
CO 1	Proficient in project, technical skill and team management for the final year major project in computer science and engineering.
CO 2	Apply advanced computer science knowledge to innovate solutions in the final year major project.
CO 3	Gain practical experience in the software development life cycle throughout the final year minor project. Demonstrate effective communication and documentation skills through reports and presentations for the final year minor project.

S.No	Skill Set	Content	Mapped CO
1	**Technical Problem Solving in Computer Science and Engineering**	Students will develop skills in exploring, experimenting, and analyzing technical problems across various areas of Computer Science and Engineering, including software development, algorithm design, system design, software testing, data analysis, cyber security, artificial intelligence, network systems, or computer applications. The assessment for the project will be conducted both within the department and externally, by established procedures. Additionally, students will be required to submit a project report by the end of the seventh semester.	CO-1, CO-2,CO-3

CO-PO Mapping																
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	3	3	3	2	2	1	2	1	3	2	3	3	3	3	3
CO2	3	2	2	3	0	2	2	2	2	2	3	2	3	2	2	1
C03	2	3	2	2	2	3	1	2	1	3	3	3	3	3	3	2

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CS424	**Title of the Course**	SciLab	**L**	**T**	**P**	**C**
Year	IV	**Semester**	VII	0	0	2	1
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The aim of this unit is to obtain the necessary knowledge to solve numerical problems through SciLab capacities.						

Course Outcomes	
CO1	Given a problem, would be able to analyze the problem and design an efficient algorithm to solve it by using & modifying classical design techniques or creating a new solution technique
CO2	For an algorithm given all the required parameters, would be able to analyze the algorithm and evaluate its utility in the given situation
CO3	Given more than one solution for the problem, would be able to evaluate and compare them using standard mathematical techniques and select the best solution
CO4	For a design problem given, would be able to compare and evaluate different Data Structures available and modify or create new them for the same

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	Introduction to Scilab, installing scilab, getting help in SciLab, Variables, Basic Commands: Finding the roots and cube of roots of the polynomial equations. Basic functions, help, clc	4	1
2	**Vector Operations**, define vector, Calculate length of a vector. Perform mathematical operations on Vectors such as addition, subtraction and multiplication. Define a matrix, calculate size of a matrix, Perform mathematical operations on Matrices such as addition, subtraction and multiplication. Finding products of two matrices	4	2
3	**Matrix Operations,** Access the elements of Matrix, Determine the determinant, inverse and eigen values of a matrix, define special matrices, perform elementary row operations, Solve the system of linear equations.	3	3
4	**Conditional Branching,** 'if' and 'then' with the example, use of the 'else' keyword use of the 'else if' keyword, example for select.	3	2
5	**Iteration,** explain syntax of 'for' statement- tell that the variable iterates over a list/vector/matrix.	3	3
6	**Scripts and Functions,** Introduction to the file formats in Scilab.	3	2
7	**Plotting 2D graphs,** About linspace: linspace is a linspace. Plot a simple graph: x=linspace (12,34,10), y=linspace (-.1,2,10), plot (x, y) plot2d, Use of "clf ()". Configure the title for the plot Configure a legend, Plotting the points in graph and two graphs showing in the same window using subplot command. Plotting a histogram, Plotting function in one variable. Plotting polygon.	4	4
8	**SIVP Basic Commands:** Reading and showing image, Load an image in Scilab in gray shades. Change the number of gray levels to 64, 16, 8 to display the same image. **Image Transforms**: Load an image and find its Discrete Cosine Transform. Find digital negative and perform thresholding of the image. Take an image and carry out edge detection. Pass the image through a low pass and high pass filter. Comment your observation. Take a low contrast image and improve the quality using histogram modification.	4	2
Reference Books:			

PO- PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	1	3		3	1	1			1	1	3	
CO2	2	3	3	3	1	1	2	2	1			2	2	2	1
CO3	1	2	1	2	3	1		2	2			1		3	1
CO4	2	2	1	2	2	1	2	1	3		1		2	1	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CS426	**Title of the Course**	Competitive Coding	**L**	**T**	**P**	**C**
Year	IV	**Semester**	VII	0	0	2	1
Pre-Requisite	CS204 CS208	**Co-requisite**	None				
Course Objectives	• Learn to manage time effectively during coding competitions, which is crucial for solving problems within time limits. • Hone critical thinking skills to analyze problems and devise innovative solutions. • To develop a competitive mindset, fostering a spirit of healthy competition and continuous improvement. • To enhance problem-solving and coding skills, • To providing insights into practical problem-solving scenarios.						

Course Outcomes	
CO1	Able to understand the issue and devising improved strategies to solve specific problems.
CO2	Able to Develop a logical framework to identify solutions for the problem and successfully meet all test case requirements.
CO3	Able to sharpens the ability to approach and solve complex problems efficiently.
CO4	Develop a solid understanding of various algorithms and data structures essential for efficient coding.
CO5	Improve your coding skills by writing concise, optimized, and error-free code under time constraints.

Competitive Coding on www.hackerrank.com and www.codingninjas.com (Not limited)
Any wo problems from each experiment

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	**Array** • https://www.codingninjas.com/studio/problems/binary-search_972?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav&count=25&page=1&search=&sort_entity=order&sort_order=ASC • https://www.hackerrank.com/domains/data-structures	2	1-5
2	**Stacks & Queues** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav&count=25&page=1&search=&sort_entity=order&sort_order=ASC • https://www.hackerrank.com/domains/data-structures	2	1-5
3	**Linked List** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav • https://www.hackerrank.com/domains/data-structures	2	1-5
4	**Searching and Sorting** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav • https://www.hackerrank.com/domains/data-structures	2	1-5
5	**Graph** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav • https://www.hackerrank.com/domains/data-structures	2	1-5
6	**Trees** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav • https://www.hackerrank.com/domains/data-structures	2	1-5
7	**String** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav • https://www.hackerrank.com/domains/data-structures	2	1-5
8	**Dynamic Programming** • https://www.hackerrank.com/domains/data-structures	2	1-5

	• https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav		
9	**Backtracking** • https://www.codingninjas.com/studio/problems/sum-of-infinite-array_873335?challengeSlug=7-day-streak-challenge-linked-list&interviewProblemRedirection=true&leftPanelTabValue=PROBLEM&customSource=studio_nav • https://www.hackerrank.com/domains/data-structures	2	1-5

		Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		3	2	3			1	1							
CO2	3			3	2	3								3		
CO3	3	2		3	2							3	3		3	
CO4	3	3			3	2			2			3				
CO5	3							1	2	3	2	3				2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17								
Course Code	**CS400**	**Title of the Course Industrial Training/ internship/Apprentices-III**						
Year	III	**Semester**	VII	**L**	**T**	**P**	**C**	
Pre-Requisite	**None**	**Co-requisite**	**None**	0	0	1	1	
Course Objectives	Learn project management, technical skills, and teamwork. Apply advanced computer science knowledge for innovative solutions. Gain practical experience in software development. Improve communication and documentation skills.							

Minor Project, students will work on exploring, experimenting, or analyzing technical problems in different areas of Computer Science and Engineering. This includes tasks like software development, algorithm design, system design, software testing, data analysis, cybersecurity, artificial intelligence, network systems, or computer applications. The assessment for the project will be done both within the department and externally, following the established procedures. Students will also need to submit a detailed project report by the end of the seventh semester

Course Outcomes	
CO 1	Develop practical skills relevant to the industry through hands-on training and exposure to real-world tasks and challenges.
CO 2	Enhance professional competencies such as communication, teamwork, problem-solving, and adaptability within an industrial setting.
CO 3	Apply theoretical concepts learned in academic studies to solve practical problems and contribute effectively to projects within the industry, bridging the gap between academic learning and real-world applications.
CO 4	Demonstrate Proficient Communication and documentation Skills in Reports and Presentations Throughout and Following Industrial Training / Internship.

S.No	Skill Set	Content	Mapped CO
1	**Practical Skill Development**	Develop practical skills relevant to the industry through hands-on training and exposure to real-world tasks and challenges.	CO-1
2	**Professional Growth**	Enhance professional competencies such as communication, teamwork, problem-solving, and adaptability within an industrial setting.	CO-2
3	**Application of Theoretical Knowledge**	Apply theoretical concepts learned in academic studies to solve practical problems and contribute effectively to projects within the industry, bridging the gap between academic learning and real-world applications.	CO-3
4	**Documentation Communication Proficiency**	Demonstrate Proficient Communication and documentation Skills in Reports and Presentations Throughout and Following Industrial Training / Internship.	CO-4

CO-PO Mapping																
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO 1	2	3	1	3	1	0	1	2	3	0	1	3	3	3	2	2
CO 2	3	2	2	1	1	0	1	2	3	2	3	3	2	3	3	3
C03	2	2	1	2	2	1	1	2	2	3	2	3	3	3	3	3
C04	1	2	2	2	0	0	1	0	2	3	2	2	2	2	0	3

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS499**	**Title of the Course Major Project**					
Year	IV	**Semester**	VIII	**L**	**T**	**P**	**C**
Prerequisite	**None**	**Co-requisite**	**None**	0	0	1	1
Course Objectives	1. Proficient in project, technical skill and team management for the final year major project in computer science and engineering. 2. Apply advanced computer science knowledge to innovate solutions in the final year major project. 3. Gain hands-on experience in the software development life cycle during the final year major project. 4. Demonstrate proficiency in using cutting-edge tools for scalable solutions in the final year major project. 5. Showcase effective communication and documentation skills in reports and presentations for the final year major project.						

Major Project : The project work can involve investigative, experimental, or analytical analysis of a technical problem in various fields of Computer Science and Engineering, such as software development, algorithm design, system design, software testing, data analysis, cyber security, artificial intelligence, network systems, or computer applications. The assessment for the project will be conducted both internally and externally, following the department's established procedures. Students are also required to submit a detailed project report at the end of the eighth semester.

Course Outcomes	
CO1	Proficient in project, technical skill and team management for the final year major project in computer science and engineering.
CO2	Apply advanced computer science knowledge to innovate solutions in the final year major project.
CO3	Gain hands-on experience in the software development life cycle during the final year major project.
CO4	Demonstrate proficiency in using cutting-edge tools for scalable solutions in the final year major project.
CO5	Showcase effective communication and documentation skills in reports and presentations for the final year major project.

S. No	Skill Set	Content	Mapped CO
1	Integrated Technical Analysis and Development (ITAD)	The project work can involve investigative, experimental, or analytical analysis of a technical problem in various fields of Computer Science and Engineering, such as software development, algorithm design, system design, software testing, data analysis, cyber security, artificial intelligence, network systems, or computer applications.	CO-1
2	Advanced Technical Problem Solving (ATPS)	The project will require students to apply advanced knowledge in areas such as software development, algorithm design, system design, data analysis, and other specialized fields to address and solve technical problems.	CO-2
3	Practical Project Lifecycle Engagement (PPLE)	Students will engage in practical tasks such as system design, software testing, and development, gaining comprehensive hands-on experience throughout the project lifecycle.	CO-3
4	Modern Technology Integration for Scalable Solutions (MTISS)	The project encourages the use of modern tools and technologies to develop scalable solutions, emphasizing fields like Software Engineering, cyber security, artificial intelligence, and network systems.	CO-4
5	Comprehensive Project Assessment and Documentation (CPAD)	The assessment for the project will be conducted both internally and externally, following the department's established procedures. Students are also required to submit a detailed project report at the end of the eighth semester, ensuring effective communication and documentation of their work.	CO-5

CO-PO Mapping																
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	2	2	2	3	3	2	3	3	3	3	3
CO2	3	2	2	3	0	2	2	3	2	2	3	3	3	3	2	2
C03	3	2	2	2	3	1	3	2	3	3	3	3	3	3	3	2
C04	3	3	2	2	0	2	3	3	3	3	3	2	2	2	2	3
C05	3	1	3	3	3	2	2	3	2	2	2	2	2	3	2	3

Integral University, Lucknow

Effective from Session:2015-16							
Course Code	CS451	**Title of the Course**	Seminar	**L**	**T**	**P**	**C**
Year	IV	**Semester**	VIII	-	-	-	3
Pre-Requisite	Nil	**Co-requisite**	Nil				
Course Objectives	● To understand organization of topic for presentation and research. ● To learn the skill set required to perform research.						

Course Outcomes	
CO1	Identify recent technical topics from interested domains
CO2	Analyze the applicability of modern software tools and technology.
CO3	Develop Presentation and Communication skills.
CO4	Develop Technical report preparation skills.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	-	Moderately mapped as students able to describe the rationale for requirement for continuing professional development Identify. deficiencies or gaps in knowledge and demonstrate an ability to source. information to close this gap analyze sourced technical and popular. information for feasibility, viability, sustainability, etc.		CO1 and CO2
2	-	Select any topic related to Computer science engineering, investigate the topic and accumulate the knowledge. Organize the information collected and deliver the presentation along with report.		CO3 and CO4
Reference Books:				
-				
e-Learning Source:				
-				

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	2	2	0	1	1	2	1	2	0	2	2	2	2	3	0
CO2	2	2	2	1	0	0	2	2	2	1	2	2	3	2	1	0
CO3	1	2	2	1	0	1	1	2	1	1	2	1	3	0	0	0
CO4	1	1	2	1	0	0	2	1	2	0	2	0	1	1	2	0

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation