Centre for Distance and Online Education (CDOE)
Open and Distance Learning Programmes

Programme Structure

(2026-27)

Programme Name – M.Sc. Computer Science **Programme Code - ODLMSCS**

SEMESTER- I

S. No	Course Code	Course Title	Type of Course	Credits
1	6.0 ODLCSC01	Introduction to Artificial Intelligence	CC	4
2	6.0 ODLCSC02	Advanced Algorithms	CC	4
3	6.0 ODLCSC03	Advanced Python Programming	CC	4
4	6.0 ODLCSC12	Internet of Things(IoT)	DSE	3
5	6.0 ODLCSC15	Distributed Systems	DSE	3
6	6.0 ODLCSC04	Professional Communication	AECC	2
			Total Credits	**20**

SEMESTER- II

S. No	Course Code	Course Title	Type of Course	Credits
1	6.0 ODLCSC05	Natural Language Processing	CC	4
2	6.0 ODLCSC06	Machine Learning	CC	4
3	6.0 ODLCSC07	Big Data Analytics	CC	4
4	6.0 ODLCSC17	Cyber Security	DSE	4
5	6.0 ODLCSC19	Cloud Computing	DSE	4
			Total Credits	**20**

SEMESTER- III

S. No	Course Code	Course Title	Type of Course	Credits
1	6.5 ODLCSC01	Image Processing & Computer Vision	CC	4
2	6.5 ODLCSC02	Data Mining & Warehousing	CC	4
3	6.5 ODLCSC03	Neural Networks & Deep Learning	DSE	4
4	6.5 ODLCSC06	Compiler Design	DSE	3
5	6.5 ODLCSC15	Soft Computing	DSE	3
	6.5 ODLCSC16	Software Agent and Swarm Intelligence		
6	6.5 ODLCSC04	Internship	AECC	2
			Total Credits	**20**

SEMESTER- IV

S. No	Course Code	Course Title	Type of Course	Credits

1	6.5 ODLCSC05	Project Work in Industry or Institution	CC	20
			Total Credits	**20**

Abbreviation	
CC	Core Course
DSE	Departmental Specific Elective Courses offered by the Department
OE	Open Elective Courses offered by ODL Basket
AECC	Ability Enhancement Compulsory Course

Detailed Syllabus

Semester-I

Total Credits: 20

Course Title: Introduction to Artificial Intelligence (6.0 ODLCSC01) Credits :04	
UNIT I	**Introduction:** Introduction to AI, Historical Development, Turing Test. Problem Solving, Search Algorithms, State-space and Solution Space Search, State space as graph- state v/s node; Evaluating Search Strategies- Time, Space, Completeness, Optimality. **Uninformed search:** Breadth First Search, Depth First Search, Iterative Deepening Search, Bi-directional Search, Uniform Cost Search.
UNIT II	**Informed search:** Best First Search, Heuristic Search, A* Search, Admissible heuristic, Consistent heuristic, optimality and admissibility, IDA* search, Weighted A* search and inconsistency. Hill Climbing, Local Search, Simulated Annealing, local beam search and Genetic Algorithms. **Adversarial search:** Adversarial Search and Game Playing, Min-max Algorithm, Alpha-beta pruning, partially observable games, stochastic games.
UNIT III	**Constraint satisfaction problems:** Introduction to CSPs, Constraint Networks, Binary and non-binary constraints, qualitative and quantitative CSPs, Consistencies- Local and global consistencies; Constraint propagation and generalizations − Related Methods: backtracking search; dynamic programming; variable elimination; Handling Spatial and Temporal constraints. **AI planning:** Introduction, complexity, PDDL, Domain Independent Planning, Domain Description, PDDL (syntax), forward vs. backward search, planning graph, Graph Plan.
UNIT IV	**Probabilistic reasoning:** Uncertainties in AI; Markov random fields; Markov networks; Baye's Theorem; Bayesian networks – Concepts, Representation and Inference; Hidden Markov Model and Dynamic Bayesian Network. Dempster-Shaffer Framework of Evidential Reasoning.

Reference Books:

1. Artificial Intelligence: A Modern Approach (third Edition): S. Russel and P. Norvig.
2. Artificial Intelligence: Foundation of Computational Agents: D Poole and AMckworth.

Course Title: Advanced Algorithms (6.0 ODLCSC02) Credits :04	
UNIT I	Design Paradigms Overview: Overview of complexity notations, Divide and Conquer method, Greedy and Dynamic Programming.
UNIT II	Backtracking, Branch and Bound, Max Flow Problem, String Matching etc.
UNIT III	Brief overview of Notations and Recurrence analysis, Amortized analysis, B- Trees, AVL trees
UNIT IV	Dictionaries and tries, Binomial Heaps, Fibonacci Heaps, Disjoint Sets, Union by Rank and Path Compression
UNIT V	Randomized Algorithms and Parallel Algorithms: Randomized Algorithms: Las Vegas and Monte Carlo algorithms, Applications on graph problems, Finger Printing, Pattern Matching, Primality testing algorithm

UNIT VI	Introduction, Combinatorial optimization, approximation factor, PTAS, FPTAS, Approximation algorithms for vertex cover, set cover, TSP, subset-sum problem etc., Analysis of the expected time complexity of the algorithms

Reference Books:

1. Introduction to Algorithms: T.H. Cormen, C.E.Leiserson and R.L. Rivest
2. Fundamentals of Algorithmics : G.Brassard and P.Bratley
3. Approximation Algorithms: Vijay V.Vazirani
4. Randomized Algorithms: R. Motwani and P.Raghavan
5. Parallel Computing: Theory and Practice: M. J. Quinn
6. Introduction to Parallel Computing: T. G. Lewis and H. El-Rewini

Course Title: Advanced Python Programming (6.0 ODLCSC03) **Credits :04**	
UNIT I	Python Fundamentals and Data Handling: Introduction to Python, use of IDLE to develop programs, basic coding skills, working with data types and variables, handling numeric data, string processing, Python functions, Boolean expressions, selection structure, iteration structure, working with lists, working with lists of lists, working with tuples, handling dates and times, introduction to dictionaries.
UNIT II	Object-Oriented Programming in Python: Classes in Python, OOPS concepts, classes and objects, constructors, data hiding, creating classes, instance methods, special methods, class variables, inheritance, polymorphism.
UNIT III	File Handling and Exception Handling: Introduction to input and output operations, data streams, creating user-defined data streams, file access modes, writing data to files, reading data from files, additional file methods, handling I/O exceptions, errors and runtime errors, exception model, exception hierarchy, handling multiple exceptions, working with directories.
UNIT IV	Modules and Packages: Introduction to Python modules, creating and using modules, standard library modules, packages in Python, creating and using packages, namespace and scoping, importing modules and packages.
UNIT V	Database and GUI Programming: Introduction to relational databases, SQL statements for data manipulation, using SQLite Manager to work with a database, using Python to interact with databases, database connectivity concepts, creating GUI applications, event handling in GUI, working with GUI components.
UNIT VI	Data Analysis and Machine Learning: Implementation of machine learning algorithms, usage of NumPy for numerical data processing, usage of Pandas for data analysis, Matplotlib for data visualization, Seaborn for statistical plots, interactive and dynamic visualizations, introduction to Scikit-Learn for machine learning.

Reference Books:

1. Mark Lutz, Programming Python, O'Reilly Media, 4th Edition.
2. Michael Urban and Joel Murach, Python Programming, Shroff / Murach, 2016.
3. John V. Guttag, Introduction to Computation and Programming Using Python, MIT Press.

Course Title: Internet of Things(IoT) (6.0 ODLCSC12) Credits :03	
UNIT I	Introduction: Overview of Wireless Sensor Networks – Characteristics, Applications, Design objectives, challenges. Different types of sensors and applications of wireless sensor networks.
UNIT II	Medium Access Control protocols for Wireless sensor networks: Functions of MAC layer, Fundamental MAC protocols, Objectives of MAC protocols, Energy efficiency in MAC design, Fixed assignment protocols, demand assignment protocols.
UNIT III	Network and Transport Layer protocols for wireless sensor networks: Fundamentals and Challenges of Routing protocol, routing strategies in wireless sensor networks. Traditional transport protocols, Transport protocols for sensor networks.
UNIT IV	Basics on Internet of Things: Introduction, Components of IoT, IoT communication technologies and protocols, developing basic IoT applications.
UNIT V	Physical and Data link layer protocols for IoT like Zigbee and Z-Wave. Network layer protocols for IoT like RPL.
UNIT VI	Transport layer protocols for IoT. Application layer protocols for IoT like MQTT. Emerging technologies in IoT.

Reference Books:

1. Jun Zheng, Abbas, " Wireless sensor networks: A networking perspective", WILEY, 2009.
2. Kazem Sohraby, Daniel Minoli, & Taieb Znati, ―Wireless Sensor Networks-Technology, Protocols, And Applications‖, John Wiley, 2007
3. Thomas Haenselmann, ―Wireless Sensor Networks: Design Principles for Scattered Systems‖, Oldenbourg Verlag, 2011
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st 9 Edition, VPT, 2014.
5. E. H. Callaway, Jr. E. H. Callaway, Wireless Sensor Networks Architecture and Protocols: CRC Press.

Course Title: Distributed Systems (6.0 ODLCSC15) Credits :03	
UNIT I	**Introduction to Distributed System:** Concepts, Architectures, transparency Self-management in Distributed system ,Thread, Virtualization, Client, server, code migration Semantics, Remote Procedure Calls, Communication, Naming.
UNIT II	Monolithic kernel, layered systems, virtual machines. Process based models and client server model. The micro-kernel based client-server approach. Inter- process communication and Remote Procedure Call. Tasks and Threads. Examples from LINUX, Solaris 2 and Windows NT.
UNIT III	**File System:** Flat naming, Structure naming and Attribute based naming, Security, Concurrency control and recovery, local area network, distributed languages and communication primitives, case studies of distributed systems.

UNIT IV	**Distributed Synchronization:** Clocks and Election algorithm, Consistency Model, Consistency Protocol, Resilience, Reliable communication, Distributed Commit, recovery in Distributed systems. Security issues in distributed systems. Deadlock in distributed systems.
UNIT V	Distributed Operating Systems, Distributed File System, Sun NFS, and the Coda files system. NTFS, UNIX ext2 and ext3.
UNIT VI	**Case studies** of Distributed object based systems (CORBA), Distributed web based Systems.

Reference Books:

1. P. K. Sinha, "Distributed Operating Systems," PHI. Paradigms.
2. Bacon, J., "Concurrent Systems", 2nd Edition, (ISBN 0-201-177-676), Addison Wesley 1998.
3. Silberschatz, A., Galvin, P. and Gagne, G., "Applied Operating Systems Concepts", 1st Edition," (ISBN0-471-36508-4), Wiley 2000.
4. Coulouris, G. et al, "Distributed Systems: Concepts and Design, 3rd Edition," (ISBN 0-201-61918-0), Addison Wesley 2001.

Course Title: Professional Communication (6.0 ODLCSC04) **Credits :02**	
UNIT I	Grammar and Vocabulary: Tenses, subject–verb agreement. Sentence Analysis: Simple, Compound and Complex sentences. Phrases: Adjective, Adverb and Noun Phrase, Clauses: Adjective, Adverb and Noun Phrase. Voice, Narration, Gerund, Participle.
UNIT II	Oral Communication
UNIT III	Listening Skill – Active listening, Barriers to active listening**.** Speaking Skill-Stress patterns in English, Questioning skills, Barriers in Speaking**.**
UNIT IV	Reading Skill-Skimming, Scanning, Intensive reading, linking devices in a text, Different versions of a story/ incident**.**
UNIT V	Written communication: Writing process, paragraph organization, writing styles.Types of Writing - Technical vs.creative; Types of technical writing, Scientific Writing:Writing a Scientific Report Soft Skills:
UNIT VI	Body Language– Gesture, posture, facial expression. Group Discussion– Giving up of PREP, REP Technique. Presentation Skills: (i) How to make power point presentation (ii) Body language during presentation (iii) Resume writing:Cover letter, career objective, Resume writing (tailor made) Interview Skills: Stress Management, Answering skills.

Reference Books:

1. Advanced English Usage: Quirk & Greenbaum; Pearson Education.
2. Developing Communication Skills: Banerjee Meera & Mohan Krishna; Macmillan Publications, 1990.
3. Business Communication: Chaturvedi, P.D.; Pearson Publications.
4. Communication of Business; Taylor, Shirley; Pearson Publications.
5. Raymond Murphy: English Grammar in Use (4th edition)

Semester-II

Total Credits: 20

Course Title: Natural Language Processing (6.0 ODLCSC05) **Credits :04**	
UNIT I	Introduction to Natural Language Understanding: The study of Language, Evaluating Language Understanding Systems, Different levels of Language Analysis, Representations and Understanding, Organization of Natural language Understanding Systems.
UNIT II	Linguistic Background: An outline of English syntax.
UNIT III	Grammars and Parsing: Grammars and sentence Structure, Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top-Down Chart Parsing, Morphological Analysis and the Lexicon.
UNIT IV	Parsing with Features, Augmented Transition Networks, Various Lexicon Resource & Knowledge Source, Study of Word Net and Indo Net.
UNIT V	Grammars for Natural Language: Auxiliary Verbs and Verb Phrases, Movement Phenomenon in Language, Handling questions in Context-Free Grammars, Hold mechanisms in ATNs. Human preferences in Parsing, Encoding uncertainty, Deterministic Parser, Study of POS Tagger, Stemmer.
UNIT VI	Ambiguity Resolution: Statistical Methods, Estimating Probabilities, Part-of-Speech tagging, Obtaining Lexical Probabilities, Probabilistic Context-Free Grammars, Best First Parsing. Semantics and Logical Form: Word senses and Ambiguity, Encoding Ambiguity in Logical Form. Discourse Analysis and Pragmatic Analysis.

Reference Books:

1. JAMES ALLEN, Natural Language Understanding, 2/e, Pearson Education, 2003.
2. D. JURAFSKY, J. H. MARTIN, Speech and Language Processing, Pearson Education, 2002.
3. CHRISTOPHER D. MANNING, HINRICH SCHÜTZE, Foundations of Statistical Natural Language Processing, The MIT Press, Cambridge, Massachusetts.1999.
4. U. S. TIWARY, TANVEER SIDDIQUI, Natural Language Processing and Information Retrieval, Oxford University Press (2008).
5. AKSHAR BHARATI, VINEET CHAITANYA, RAJEEV SANGAL, Natural Language Processing: A Paninian Perspective.

Course Title: Machine Learning (6.0 ODLCSC06) **Credits :04**	
UNIT I	Basics: Introduction to Machine Learning - Different Forms of Learning, Basics of Probability Theory, Linear Algebra and Optimization. Regression Analysis: Linear Regression, Ridge Regression, Lasso, Bayesian Regression, Regression with Basis Functions.
UNIT II	Classification Methods: Instance-Based Classification, Linear Discriminant Analysis, Logistic Regression, Large Margin Classification, Kernel Methods, Support Vector Machines, Multi-class Classification, Classification and Regression Trees.
UNIT III	Neural Networks: Non-linear Hypotheses, Neurons and the Brain, Model Representation, Multi-layer Networks, Back-propagation, Multi-class Discrimination, Training Procedures, Localized Network Structure, Deep Learning.

UNIT IV	Graphical Models: Hidden Markov Models, Bayesian Networks, Markov Random Fields, Conditional Random Fields. Ensemble Methods: Boosting - Adaboost, Gradient Boosting, Bagging - Simple Methods, Random Forest.
UNIT V	Clustering: Partitional Clustering - K-Means, K-Medoids, Hierarchical Clustering - Agglomerative, Divisive, Distance Measures, Density Based Clustering – DBscan, Spectral Clustering.
UNIT VI	Dimensionality Reduction: Principal Component Analysis, Independent Component Analysis, Multidimensional Scaling, and Manifold Learning. Reinforcement Learning: Q-Learning, Temporal Difference Learning

Reference Books:

1. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.
2. Pattern Recognition and Machine Learning: Christopher Bishop
3. Pattern Classification: R.O. Duda, P.E. Hart and D.G. Stork
4. Data Mining: Tools and Techniques: Jiawei Han and Michelline Kamber

Course Title: Big Data Analytics (6.0 ODLCSC07) **Credits :04**	
UNIT I	Introduction to Big Data, Types of Digital Data, Characteristics of Data, Evolution of Big Data, Data Storage and Analysis, Characteristics of Big Data, Big Data Architecture, Requirement for new analytical architecture, Challenges in Big Data analytics, Need of big data frameworks.
UNIT II	Requirement of Hadoop Framework, Design principle of Hadoop, Comparison with other system, Hadoop Components, Hadoop versions, HDFS, Map Reduce Programming: I/O formats, Map side join, Reduce Side Join, secondary sorting, Pipelining MapReduce jobs.
UNIT III	Introduction to Hadoop ecosystem technologies: Serialization: AVRO, Co-ordination: Zookeeper, Databases: HBase, Hive, Scripting language: Pig, Streaming: Flink, Storm.
UNIT IV	MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.
UNIT V	Spark Framework, Writing Spark Application, Spark Programming in Scala, Python, R, Java, Application Execution.
UNIT VI	SQL Context, Importing and Saving data, Data frames using SQL, GraphX overview, Creating Graph, Graph Algorithms.

Reference Books:

1. Mike Framton, “Mastering Apache Spark”, Packt Publishing, 2015.
2. Tom White “Hadoop: The Definitive Guide",O'Reilly,4th Edition,2015.
3. Nick Pentreath Machine Learning with Spark,Packt Publishing,2015.
4. Mohammed Guller, Big Data Analytics with Spark, Apress,2015.
5. Donald Miner, Adam Shook, “Map Reduce Design Pattern”, O’Reilly, 2012.

Course Title: Cyber Security (6.0 ODLCSC17) Credits :04	
UNIT I	Introduction to security, attacks, computer criminals, security services. Cryptography: Substitution ciphers, transposition cipher, confusion, diffusion, symmetric and asymmetric encryption. DES, odes of DES. Hash function, key exchange, digital signatures and certificates.
UNIT II	Public Key Cryptosystems: Principles of Public Key Cryptosystems, Factorization, RSA Algorithm, security analysis of RSA, Exponentiation in Modular Arithmetic. Key Management in Public. Key Cryptosystems: Distribution of Public Keys, Distribution of Secret keys using Public Key Cryptosystems. Discrete Logarithms, Diffie-Hellman Key Exchange.
UNIT III	Message Authentication & Hashing: Birthday Paradox and General case of Duplications, Basic functions of Message Authentication and Hashing, Introduction to Hash & MAC algorithms. Digital Signatures: RSA Based, El Gamal Signatures, Undeniable Signatures. Authentication: Model of Authentication Systems, Impersonation, Substitution and spoofing games, Authentication schemes for mutual authentication based on shared secret, two-way public key, one-way public key, Mediated Authentication, One way Authentication.
UNIT IV	Security in networks: Threats in networks, network security controls, firewalls, intrusion detection system Administrating security: Security planning, risk analysis, physical security, Ethical issues in security.
UNIT V	Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace on-state attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., non-state actors,Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies.

Reference Books:

1. Stalling Williams: Cryptography and Network Security: Principles and Practices, 4th Edition, Pearson Education, 2006.
2. Kaufman Charlie et.al; Network Security: Private Communication in a Public World, 2nd Ed.,PHI/Pearson.
3. Pieprzyk Josef and et.al; Fundamentals of Computer Security, Springer-Verlag, 2008.
4. Trappe & Washington, Introduction to Cryptography, 2nd Ed. Pearson.

Course Title: Cloud Computing (6.0 ODLCSC19) Credits :04	
UNIT I	Introduction to Cloud Computing, Roots of Cloud Computing: Fundamental concepts of Distributed Systems, Cluster Computing, Grid Computing, and Mobile Computing.
UNIT II	Cloud Models Basics of Cloud Computing Concepts, Characteristics of Cloud Computing, Need for Cloud, Cloud Deployment models: private, public, hybrid and community cloud, Cloud Services: Resource-as-a-Service (RaaS), Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS), Examples of each service.
UNIT III	Cloud Services RaaS: Usage of Physical resources like servers, networks, data center etc, IaaS: Virtualization,. PaaS: Integrated lifecycle platform: Google App Engine, Microsoft Azure, Anchored life cycle platform: Salesforce platform, SaaS: Characterizing SaaS, Salesforce's software environment.

UNIT IV	Resource Scheduling for Cloud Computing: - Introduction, Virtual Machine provisioning and Migration Services, Scheduling techniques of Virtual machines for resource reservation, Cloud Service Scheduling hierarchy.
UNIT V	Economic models for Resource-allocation scheduling , Heuristic Models for task –execution scheduling : Static Strategies , Dynamic Strategies , Heuristic Schedulers.
UNIT VI	Cloud Applications Cloud Applications, Cloud challenges, Cloud Security and privacy issues, Mobile Cloud Computing, Integration of Cloud with Wireless Sensor Network and its application.

Reference Books:

1. Cloud Computing Bible by Barrie Sosinsky, Wiley Publication, 2011.
2. Cloud Computing: A Practical Approach by Anthony T. Velte Toby J. Velte, Robert Elsenpeter, The McGraw-Hill Publication, 2010.
3. Cloud Computing: Concepts, Technology and Architecture by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, 1st Edition, Prentice Hall.
4. Cloud Computing: Data-Intensive Computing and Scheduling by Frederic Magoules , Jie Pan, and Fei Teng. CRC Press. Taylors & Francis Group.

Semester-III

Total Credits: 20

Course Title: Image Processing & Computer Vision (6.5 ODLCSC01) **Credits :04**	
UNIT I	Overview of image processing systems, Image formation and perception, Continuous and digital image representation, Image quantization: uniform and non-uniform, visual quantization (dithering).
UNIT II	Image contrast enhancement: linear and non-linear stretching, histogram equalization, Continuous and discrete-time Fourier Transforms in 2D; and linear convolution in 2D.
UNIT III	Image smoothing and image sharpening by spatial domain linear filtering; Edge detection, Discrete Fourier transform in 1D and 2D, and image filtering in the DFT domain.
UNIT IV	Median filtering and Morphological filtering, Color representation and display; true and pseudo color image processing, Image sampling and sampling rate conversion (resize).
UNIT V	Image segmentation and Feature Extraction Various methods of image segmentation, edge detection, object proposals, SIFT features. Multi-view Geometry (2 weeks) Shape from stereo and motion, feature matching, surface fitting, Active ranging Object Recognition: Traditional Methods HoG/SIFT features, Bayes classifiers, SVM classifier.
UNIT VI	Object Recognition: Deep Learning Methods : Image classification, object detection and semantic segmentation, adversarial attacks. Various neural network architectures, visualization techniques. Motion analysis and Activity Recognition: Motion detection and tracking, Inference of human activity from image sequences.

Reference Books:

1. Forsyth and Ponce, "Computer Vision – A Modern Approach", Second Edition, Prentice Hall, 2011.
2. Emanuele Trucco and Alessandro Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998.
3. Olivier Faugeras, "Three Dimensional Computer Vision", MIT Press, 1993.
4. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011
5. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", Third Edition, CL Engineering, 2013.

Course Title: Data Mining and Warehousing (6.5 ODLCSC02) **Credits :04**	
UNIT I	Fundamentals of Data Mining: Data Mining, History of Data Mining, Data Mining Strategies, Data Mining Techniques, KDD process, Applications of Data Mining, Challenges and Future of data mining. Data Preprocessing and Data Warehousing: Data, information, knowledge, and intelligence, Types of data, Data warehouses, Data cleaning, Data de-normalization, Data transformation, Data quality measures, OLAP technology, OLAP vs OLTP. Data Sampling.
UNIT II	The Classification Task: Introduction to classification, Decision trees, Random forests, Naïve Bayes', K-NN, SVM, ANNs, applications of classification. Model evaluation techniques- ROC, Lift Charts, cost and utility, Parsimony, Bagging and Boosting, The model ranking approach.

UNIT III	The Clustering Task: Introduction to clustering, Distance measures, types of clustering-hierarchical: agglomerative and divisive, Non-hierarchical: Partition based, Density based, Probability based, K-means clustering, Self-organizing concept, self-organizing maps, SOM algorithm, cluster validation, strength and weaknesses of clustering algorithms, applications of clustering.
UNIT IV	Association Rule Mining: Concepts of association rules, relevance and functions of association rules, the problem of large data set, Apriori algorithm, scalable association rule mining-FP-Growth algorithm, Applications of ARM, strength and weaknesses of ARM.
UNIT V	Information Retrieval: Boolean Retrieval, The term vocabulary and postings lists: Document delineation and character sequence decoding, determining the vocabulary of terms. Dictionaries and tolerant retrieval: Search structures for dictionaries, spelling correction. Scoring, term weighting and vector space model, the vector space model for scoring, variant tf-idf functions.
UNIT VI	Computing scores in a complete search system: Efficient scoring and ranking, components of an information retrieval system. Evaluation in information retrieval. Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, global methods for query reformulation.

Reference Books:

1. Data Mining Concepts & techniques: Jai wei Han and Micheline Kamber, Morgan Kaufman.
2. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, Introduction to Information Retrieval, Cambridge University Press.
3. Data Mining Techniques : Arun K. Pujari, Universities Press, Fourth Edition, ck and ps2016.
4. Mastering Data Mining: M. Berry and G. Linoff, John Wiley & Sons., 2000.
5. Data Mining: Methods and Techniques: A B M Shawkat Ali, Saleh A. Wasimi, 2009, Cengage Learning.

Course Title: Neural Networks & Deep Learning (6.5 ODLCSC03) **Credits :04**	
UNIT I	Overview of biological neurons: Structure of biological neurons relevant to ANNs. Fundamental concepts of Artificial Neural Networks: Models of ANNs; Feed-forward & feedback networks; learning rules; Hebbian learning rule, perception learning rule, delta learning rule, Widrow-Hoff learning rule, correction learning rule, Winner –lake all learning rule, etc.
UNIT II	Single layer Perception Classifier: Classification model, Features & Decision regions; training & classification using discrete perceptron algorithm, single layer continuous perceptron networks for linearly separable classifications.
UNIT III	Multi-layer Feed forward Networks: linearly non-separable pattern classification, Delta learning rule for multi-perceptron layer, generalized delta learning rule, Error back-propagation training, learning factors, Examples. Single layer feedback Networks: Basic Concepts, Hopfield networks, Training & Examples
UNIT IV	Self-Organizing Networks: Introduction, Self-organizing concept, self-organizing maps, SOM algorithm, adaptive resonance theory (ART), ART algorithm, and variations of ART algorithm. Adaptive pattern classification.

UNIT V	Associative memories: Linear Association, Basic Concepts of recurrent. Auto associative memory: retrieval algorithm, storage algorithm; Bi-directional associative memory, Architecture, Association encoding & decoding, and Stability.
UNIT VI	Introduction to Deep Learning: Deep learning vs. machine learning, significance of deep learning, deep neural networks vs. traditional neural networks. Convolutional neural networks (CNNs): convolution, pooling, padding, and stride. Image classification using CNNs.

Reference Books:

1. Neural networks a comprehensive foundation, Simon Haykin, Pearson Education 2nd Edition 2004.
2. Artificial neural networks - B.Vegnanarayana Prentice Halll of India P Ltd 2005
3. Neural networks in Computer intelligence, Li Min Fu TMH 2003
4. "Neural Networks, Fuzzy Logic and Genetic Algorithms", S. Rajasekaran and G. A. V. Pai, PHI, 2003.
5. Introduction to artificial neural systems", Jacek M. Zurada, 1994, Jaico Publ. House.

Course Title: Compiler Design (6.5 ODLCSC06) **Credits :03**	
UNIT I	Overview of Compilation: Phases of Compilation – Lexical Analysis, Regular Grammar and regular expression for common programming language features, pass and Phases of translation, interpretation, bootstrapping, data structures in compilation – LEX lexical analyzer generator.
UNIT II	Top down Parsing: Context-free grammars, Top down parsing – Backtracking, LL (1), recursive descent parsing, Predictive parsing, Preprocessing steps required for predictive parsing.
UNIT III	Bottom up parsing: Shift Reduce parsing, LR and LALR parsing, Error recovery in parsing, handling ambiguous grammar, YACC – automatic parser generator.
UNIT IV	Semantic analysis: Intermediate forms of source Programs – abstract syntax tree, polish notation and three address codes. Attributed grammars, Syntax directed translation, Conversion of popular Programming languages language Constructs into Intermediate code forms, Type checker.
UNIT V	Symbol Tables: Symbol table format, organization for block structures languages, hashing, and tree structures representation of scope information. Block structures and non-block structure storage allocation: static, Runtime stack and heap storage allocation, storage allocation for arrays, strings and records.
UNIT VI	Code optimization: Consideration for Optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, DAG representation. Data flow analysis: Flow graph, data flow equation, global optimization, redundant sub expression elimination, Induction variable elements, Live variable analysis, Copy propagation. Object code generation: Object code forms, machine dependent code optimization, register allocation and assignment generic code generation algorithms, DAG for register allocation.

Reference Books:

1. Principles of compiler design -A.V. Aho . J.D.Ullman; Pearson Education.
2. Modern Compiler Implementation in C- Andrew N. Appel, Cambridge University Press
3. Modern Compiler Design- Dick Grune, Henry E. BAL, Cariel T. H. Jacobs, Wiley dreamtech.
4. Engineering a Compiler-Cooper & Linda, Elsevier.
5. Compiler Construction, Louden, Thomson

Course Title: Soft Computing (6.5 ODLCSC15) Credits :03	
UNIT I	Foundations: Stochastic processes; Principal Component Analysis; Learning theory; Generalization and Regularization; Simulated Annealing.
UNIT II	Fuzzy Sets, membership functions in one dimension, membership functions in two dimensions.
UNIT III	Fuzzy relations, fuzzy if-then rules: single rule with single antecedent, single rule with multiple antecedents, multiple rules with multiple antecedents. Fuzzy reasoning. Evolutionary algorithms and genetic programming.
UNIT IV	Fuzzy inference system.
UNIT V	Evolutionary computation, Genetic algorithms, encoding, selection, crossover and mutation.
UNIT VI	Particle swarm optimization, Artificial Bee colony search, Ant colony algorithm and similar algorithms.

Reference Books:

1. Neuro Fuzzy & Soft Computing - J.-S.R.Jang, C.-T.Sun, E.mizutani, Pearson Education
2. Digital Neural Network - S.Y.Kung, Prentice Hall International Inc.
3. Spiking Neural Networks - Wulfram Gerstner, Wenner Kristler, Cambridge University Press.
4. Neural Networks and Fuzzy Systems: Dynamical Systems Application to Machine Intelligence - Bart Kosko, Prentice Hall.

Course Title: Software Agent and Swarm Intelligence (6.5 ODLCSC16) Credits :03	
UNIT I	Introduction to Software Agents: Software agents in business and private area, Economic potential, Definition, Characteristics, Classification.
UNIT II	Areas of Influence of software agents, Architecture – BDI architecture, Deliberative agent architecture, Architecture of Reactive agent, A few existing architectures. Mobile architecture – Remote programming, Remote procedure call, Advantages and disadvantages, Technical implementations, Layers of base software, Migration, A few existing architectures –Rao-Georgeff BDI architecture, Brooks Subsumption architecture, Muller Interrap architecture.
UNIT III	Communication – Distributed problem solving, Communication methods: Blackboard, Messege passing, KQML. Cooperation Protocols - Contract net systems, Partial Global Planning, Negotiations, Matching and brokering. Learning and Planning, Security.
UNIT IV	Honey Bee Colony – Introduction, Decentralized decision making, Where to forage?, Exploration, Exploitation method, Waggle dance, Where to live?, House hunting, Ant Colony Optimization – Introduction, ACO modelling, Solving travelling salesman problem using ACO.
UNIT V	Particle Swarm Optimization – PSO modelling, Variants of PSO, Applications, Introduction to Swarm Robotics

Reference Books:

1. Intelligent software agents: foundations and applications by Walter Brenner, Rudiger Zarnekow, Hartmut Witting Springer, 1998.
2. Swarm intelligence: introduction and applications By Christian Blum, Daniel Merkle., Springer 2008.