Detailed SYLLABUS
(3rd Year)
Fifth Semester

for

BACHELOR OF TECHNOLOGY

for

Artificial Intelligence and Data Science
Artificial Intelligence and Machine Learning

Applicable from Batch Admitted in Academic Session 2021-2022 Onwards

Semester: 5th			
Paper code: AIDS301/AIML301	**L**	**T/P**	**Credits**
Subject: Operating Systems	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts and functions of operating systems.
2.	To use different process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
3.	To understand Processes, Threads and Deadlocks and Memory Management algorithms of operating systems.
4.	To analyze the several operating systems and their utilities such Linux, Unix, Window to develop operating system functions in programming.

Course Outcomes:

CO1	Understand fundamental operating system abstractions such as processes, threads, files, semaphores, IPC abstractions, shared memory regions, etc.
CO2	Apply process scheduling and memory management concepts.
CO3	Analyze the operating system's resource management techniques, deadlock management techniques, memory management techniques.
CO4	Design device drivers and multi-threading libraries for a tiny OS and develop application programs using UNIX system calls.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	1	1	1	-
CO2	3	1	-	-	-	-	-	-	1	1	1	-
CO3	2	2	-	1	1	-	-	-	2	1	1	1
CO4	2	1	2	1	1	-	1	-	2	1	2	1

Course Overview:
This course covers the fundamentals of operating systems, mechanisms, and their implementations. The core of the course contains concurrent programming (threads and synchronization), inter process communication, process scheduling, memory management, input output devices and organization.

Unit I **[10]**

Introduction: Operating system and function, Evolution of operating system, Batch, Interactive, Time Sharing and Real Time System, System protection. Operating System Structure: System Components, System structure, Operating System Services.

CPU Scheduling: Scheduling Concept, process scheduling strategies- First-Come, First-Served (FCFS) Scheduling, Shortest-Job-Next (SJN) Scheduling, Priority Scheduling, Shortest Remaining Time, Round Robin (RR) Scheduling, Multiple-Level Queues Scheduling, Performance Criteria of Scheduling Algorithm, Evolution, Multiprocessor Scheduling.

Unit II **[10]**

Concurrent Processes: Process concept, Principle of Concurrency, Producer Consumer Problem, Critical Section problem, Semaphores, Binary and counting semaphores, P() and V() operations, Classical problems in Concurrency, Inter Process Communication, Process Generation, Process Scheduling.

Deadlocks: examples of deadlock, resource concepts, necessary conditions for deadlock, deadlock solution, deadlock prevention, deadlock avoidance with Bankers algorithms, deadlock detection, deadlock recovery.

Unit III **[10]**

Memory Organization & Management: Memory Organization, Memory Hierarchy, Memory Management Strategies, Contiguous versus non- Contiguous memory allocation, Partition Management Techniques, Logical versus Physical Address space, swapping, Paging, Segmentation, Segmentation with Paging Virtual Memory: Demand Paging, Page Replacement, Page-replacement Algorithms, Performance of Demand Paging, Thrashing, Demand Segmentation, and Overlay Concepts.

Unit IV **[10]**

I/O Device and the organization: I/O Device and the organization of the I/O function, I/O Buffering, Disk I/O, Disk Scheduling Algorithms, File system: File Concepts, attributes, operations, File organization and Access mechanism, disk space allocation methods, Directory structure, free disk space management, File sharing, Implementation issues. Case studies: Unix system, Windows XP.

Textbooks:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, “Operating System Concepts”, Wiley, 9th Edition
2. Tannenbaum, “Morden Operating Systems”, Pearson, 4th Edition, 2014

Reference Books:

1. William Stallings, “Operating Systems –Internals and Design Principles”, 8/E, Pearson Publications, 2014.
2. Dietel, “An introduction to operating system”, Addison Wesley, 1983

Semester: 5th			
Paper code: AIDS303/AIML303	**L**	**T/P**	**Credits**
Subject: Design and Analysis of Algorithms	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand and apply the algorithm analysis techniques to generate solution space.
2.	To critically analyze the efficiency of alternative algorithmic solutions for the same problem.
3.	To analyze different algorithm design techniques.
4.	To classify a problem as computationally tractable or intractable, and discuss strategies to address intractability

Course Outcomes:

CO1	Understand the asymptotic performance of algorithms to analyze formal correctness proof for algorithms
CO2	Apply major algorithms' knowledge and data-structures corresponding to each algorithm design paradigm
CO3	Design efficient algorithms for common computer engineering design problems
CO4	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	1	-	-	1	1	1	1	2
CO2	2	2	1	1	1	-	-	1	1	1	1	2
CO3	2	2	2	1	1	-	-	-	-	-	1	3
CO4	2	2	2	2	1	1	-	-	-	-	1	2

Course Overview:
This course is designed to enable the student to design and analyze algorithms for the problems. This course covers basic strategies of algorithm design: top-down design, divide and conquer, asymptotic costs, applications to sorting and searching, matrix algorithms, shortest-path and spanning tree problems, dynamic programming, greedy algorithms and graph algorithms.

UNIT I **[10]**

Introduction to Algorithms: Time Complexity and Space Complexity, Asymptotic analysis, Growth rates, some common bounds (constant, logarithmic, linear, polynomial, exponential), Complexity Analysis techniques: Master theorem, Substitution Method, Iteration Method, Time complexity of Recursive algorithms. art of problem-solving and decision making, role of data structure in algorithm design, Basic algorithmic structures of problem-solving and optimization algorithms, constraints, solution space, and feasible reasons, and representation of solution space. Sorting and searching algorithms: Selection sort, bubble sort, insertion sort, Sorting in linear time, count sort, Linear search.

UNIT II **[10]**

Divide and Conquer Algorithms: Overview of Divide and Conquer algorithms, Quick sort, Merge sort, Heap sort, Binary search, Matrix Multiplication, Convex hull and Searching, Closest Pair of Points.
Greedy Algorithms: Greedy methods with examples, Huffman Coding, Knapsack, Minimum cost Spanning trees – Prim's and Kruskal's algorithms, Single source shortest paths – Dijkstra's and Bellman Ford algorithms.

UNIT III **[10]**

Dynamic programming: Dynamic programming with examples such as Knapsack, shortest path in graph All pair shortest paths –Warshal's and Floyd's algorithms, Resource allocation problem. Backtracking, Branch and Bound with examples such as Traveling Salesman Problem, longest common sequence, n-Queen Problem.

UNIT IV: **[10]**

Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Bipartite graphs. Graph Coloring, Hamiltonian Cycles and Sum of subsets.
Computational complexity: Problem classes: P, NP, NP-complete, NP-hard. Reduction. The satisfiability problem, vertex cover, independent set and clique problems Cook's theorem. Examples of NP-complete problems.

Textbooks:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI ,4th Edition
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2006

Reference Books:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Second Edition, Universities Press, 2011.
2. Anany Levitin. “Introduction to the Design and Analysis of Algorithms”, Pearson.

Semester: 5th			
Paper code: AIDS305	**L**	**T/P**	**Credits**
Subject: Data Mining	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To identify the different types of data and using data pre-processing techniques applicable on the dataset.
2.	To evaluate various classification and clustering techniques on real world datasets.
3.	To apply data mining techniques on complex data types.
4.	To analyze different association rule mining and sequence mining techniques.

Course Outcomes:

CO1	Interpret the basic concepts of data mining techniques to identify interesting and relevant patterns.
CO2	Apply and perform pre-processing steps to prepare the data and get insights into the dataset.
CO3	Analyze different association rules identified using association rule mining or sequence mining on real life datasets.
CO4	Design and Develop models using classification and clustering techniques on complex data types.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	3	-	-	1	-	-	-	-
CO2	2	2	2	3	-	-	-	-	1	-	-	-
CO3	2	-		2	3	-	1	-	-	1	-	-
CO4	2	2		3	3	-	-	-	-		1	2

Course Overview:

The subject gives a detailed overview on data mining as a process starting from pre-processing the dataset to classification/clustering techniques on the data. The students are introduced to

different techniques that can be applied to various types of complex data. Concepts like association rule mining and ensemble methods are also discussed in this subject.

UNIT I **[8]**

Data Mining Basics- What is Data Mining, Kinds of Patterns to be Mined, Tasks of Data Mining, Data Mining Applications- The Business Context of Data Mining, Data Mining as a Research Tool, Data Mining for Marketing, Benefits of Data Mining, Date Warehousing vs Data Mining.

UNIT II **[12]**

Data Pre-processing- Review of Data Pre-processing: Types of Data, Data Quality, Measurement and Data Collection Issues, Feature Subset Selection, Feature Creation, Data Discretization and Binning, Knowledge Discovery in Databases.

UNIT III **[10]**

Machine Learning in Data Mining - Types of classifiers, Rule based classifiers, Model Selection, Model Evaluation, Ensemble Methods, Bias-Variance trade-off, Handling Class Imbalance Problem, Association Rule Mining **-** Mining Frequent Patterns, Market Basket Analysis, Apriori algorithm, Data Mining using decision trees and KNN algorithm.

UNIT IV **[10]**

Cluster Analysis- Different Types of Clusters, Hierarchical Methods of Clustering, Density based Clustering: DBSCAN algorithm, Cluster Evaluation. Outlier Analysis, Outlier Detection Methods, Mining Complex Data Types, avoiding False Discoveries.

Textbooks:

1. Tan Pang- Ning, Steinbach M., Viach, Kumar V., “Introduction to Data Mining”, Second Edition, Pearson, 2013.
2. Han J., Kamber M. and Pei J., “Data Mining Concepts and Techniques”, Second Edition, Hart Court India P. Ltd., Elsevier Publications, 2001.

Reference Books:

1. Zaki M.J., Meira W., "Data Mining and Machine Learning: Fundamental Concepts and Algorithms", Second Edition, Cambridge University Press, 2020
2. Witten, E. Frank, M. Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann Publishers, 2011.

Semester: 5th			
Paper code: AIML305	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn basic computational units inspired from biological systems (brain).
2.	To study various algorithms in deep learning for various domains.
3.	To understand fundamental machine learning concepts w.r.t. neural networks.
4.	To apply deep learning models to solve sequence and vision problems.

Course Outcomes:

CO1	Interpret the basic computational units inspired from biological systems (brain).
CO2	Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
CO3	Define the fundamental machine learning concepts w.r.t. neural networks.
CO4	Apply basic deep learning models to solve sequence-based problems and vision problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	2	1	2	1
CO2	3	1	1	1	2	1	1	1	2	1	2	2
CO3	3	1	1	1	2	1	1	1	2	1	2	2
CO4	3	1	1	1	2	1	1	1	2	1	2	2

Course Overview:

The main objective of this course is to develop the understanding of key mathematical principles which are used behind the working of neural networks. Convolution Neural Networks and Recurrent Neural Networks have also been covered in this course. This course also provides the details for usage of Deep Learning for Natural Language Processing.

Unit I: **[10]**

Introduction to Deep Learning: Introduction to Deep Learning, Bayesian Learning, Overview of Shallow Machine Learning, Difference between Deep Learning and Shallow Learning, Linear Classifiers ,Loss Function and Optimization Techniques -Gradient Descent and batch optimization.

Unit II: **[10]**

Introduction to Neural Network: Introduction to Neural Network, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation through time. Architectural Design Issues.

Unit III: **[10]**

Training deep neural networks: Difficulty of training deep neural networks, Activation Function, Evaluating, Improving and Tuning the ANN. Hyper parameters Vs Parameters, Greedy layer wise training, Recurrent Neural Networks, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

Unit IV: **[10]**

Convolutional Neural Networks: Convolutional Neural Networks, Building blocks of CNN, Transfer Learning , Pooling Layers , Convolutional Neural Network Architectures.Well known case studies: LeNet, AlexNet, VGG-16, ResNet, Inception Net.Applications in Vision, Speech, and Audio-Video.

Text Books

1. Richard O. Duda," Pattern classification, Wiley, 2022
2. Adam Gibson and Josh Patterson, "Deep Learning: A Practical approach", 2017
3. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Reference Books

1. Charu C. Aggarwal, "Neural Networks and Deep Learning", 2018
2. Duda, R.O. and Hart, P.E., Pattern classification. John Wiley & Sons, 2006.

Semester: 5th			
Paper code: AIDS307/AIML307	**L**	**T/P**	**Credits**
Subject: Computer Organization & Architecture	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts of computer operation.
2.	To analyze different memory hierarchies along with their mapping.
3.	To apply and analyze different pipelining and parallelism.
4.	To implement various signed and unsigned arithmetic operations with digital hardware.

Course Outcomes:

CO1	Interpreting the basic concepts of register transfer language and computer operations.
CO2	Apply and analyze various instruction formats for CPU/GPU together with a variety of addressing modes.
CO3	Analyze different types of Parallel Computer Models.
CO4	Implementing arithmetic operations with digital hardware.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1		1						2
CO2	2	1	1	1							1	3
CO3	3	2	3	2	1	1	1				1	3
CO4	1	1	1	1								2

Course Overview:

This course enables the students to understand the principles of computer organization and the basic architectural concepts. It begins with basic organization, design, and programming of a simple digital computer and introduces simple register transfer language to specify various computer operations. Topics include computer arithmetic, instruction set design,

microprogrammed control unit, pipelining and vector processing, memory organization and I/O systems, and multiprocessors.

Unit I **[8]**

Register Transfer Language: Register transfer language, bus and memory transfer, bus architecture using multiplexer and tri-state buffer, micro-operation: arithmetic, logical, shift micro-operation with hardware implementation, arithmetic logic shift unit.

Computer Organization and Design: Instruction codes, general computer registers with common bus system, computer instructions: memory reference, register reference, input-output instructions, timing and control, instruction cycle, input-output configuration, and interrupt cycle. Levels of programming languages: Machine language, Assembly language, High level language.

Unit II **[8]**

Central processing Unit: Introduction, general register organization, stack organization, instruction format, addressing modes. Overview of GPU, CPU vs GPU computing difference.

Memory Hierarchy: Introduction, basics of cache, measuring and improving of cache performance, cache memory: associative mapping, direct mapping, set-associative mapping, cache writing and initialization, virtual memory, common framework for memory hierarchies. Case study of PIV and AMD opteron memory hierarchies.

Unit III **[8]**

Parallel Computer Models: The state of computing, classification of parallel computers, multiprocessors and multicomputers, multivector and SIMD computers. Program and Network Properties: conditions of parallelism, data and resource dependences, hardware and software parallelism, program partitioning and scheduling, grain size and latency, program flow mechanisms, control flow versus data flow, data flow Architecture, demand driven mechanisms, comparisons of flow mechanisms.

Unit IV **[8]**

Pipelining: Introduction to Flynn‘s classification, arithmetic pipeline, instruction pipeline, pipeline conflict and hazards, RISC pipeline, vector processing.

Arithmetic for Computers: Unsigned, signed 1‘s, 2‘s compliment notations, addition, subtraction, multiplication and division (hardware implementation), CPU performance and its factors, evaluating performance of CPU.

Textbooks:

1. M. Morris, Mano, “Computer System Architecture”, PHI 3rd Edition 2007.
2. Kai Hwang, “Advanced computer architecture”; TMH. 2000
3. D. A. Patterson and J. L. Hennessey, “Computer organization and design”, Morgan Kaufmann, 2nd Ed. 2002

Reference Books:

1. W. Stallings, “Computer organization and Architecture”, PHI, 7th ed, 2005.

2. Harvey G.Cragon,"Memory System and Pipelined processors"; Narosa Publication. 1998
3. V.Rajaranam & C.S.R.Murthy, "Parallel computer"; PHI. 2002
4. R.K.Ghose, Rajan Moona & Phalguni Gupta, "Foundation of Parallel Processing", Narosa Publications, 2003.

Semester: 5th			
Paper code: AIDS309/AIML309	**L**	**T/P**	**Credits**
Subject: Introduction to Internet of Things	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:	
1.	To learn fundamentals of IoT and how to build IoT based systems
2.	To emphasize on development of Industrial IoT applications
3.	To recognize the factors that contributed to the emergence of IoT
4.	To utilize and implement solid theoretical foundation of the IoT Platform and System Design.
Course Outcomes:	
CO1	Ability to understand design flow of IoT based systems
CO2	Analyse and understand different communication protocols for connecting IoT nodes to server
CO3	Apply coding concepts to design real-time IoT solutions
CO4	Develop the state-of-the-art IoT based systems, suitable for real life and Industry applications

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:

The course enables student to understand the basics of Internet of things and protocols. It introduces some of the application areas where Internet of Things can be applied. Students will learn about the middleware for Internet of Things. The course addresses various components of Internet of things such as Sensors, internetworking, protocols. In the end students will also be able to design and implement IoT circuits and solutions.

UNIT I **[8]**

The Internet of Things: An Overview of what is IoT? Why IoT? Explain the definition and usage of the term "Internet of Things (IOT)" in different contexts. Design Principles for Connected Devices, internet principles: internet communications-An overview, Physical Design of IoT, Logical Design of IoT, IoT standards, IoT generic architecture and IoT protocols. IoT future trends, Understand IoT Applications and Examples. Understand various IoT architectures based on applications. Understand different classes of sensors and actuators. Sensors: sensor terminology, sensor dynamics and specifications. Understand the basics of hardware design needed to build useful circuits using basic sensors and actuators.

UNIT II **[8]**

Communication protocols and Arduino Programming: Understand various network protocols used in IoT, Understand various communication protocols (SPI, I2C, UART). Design and develop Arduino code needed to communicate the microcontroller with sensors and actuators, build circuits using IoT supported Hardware platforms such as Arduino, ESP8266 etc., Use of software libraries with an Arduino sketch that allows a programmer to use complicated hardware without dealing with complexity, Learning IoT application programming and build solutions for real life problems and test them in Arduino and Node MCU environments. Understand various wireless Technologies for IoT and its range, frequency and applications.

UNIT III **[8]**

Fundamentals of IEEE 802.15.4, Zigbee and 6LOWPAN: Importance of IEEE 802.15.4 MAC and IEEE 802.15.4 PHY layer in constrained networks and their header format, Importance of Zigbee technology and its applications, use of IPv6 in IoT Environments, Understanding importance of IPv6 and how constrained nodes deal with bigger headers (IPv6). Understand IPv6 over Low-Power WPAN (6LoWPAN) and role of 6LoWPAN in wireless sensor network. Various routing techniques in constrained network. Understanding IoT Application Layer Protocols: HTTP, CoAP Message Queuing Telemetry Transport (MeTT).

UNIT IV **[8]**

Application areas and Real-time Case Studies: Role of big data, cloud computing and data analytics in a typical IoT system. Analyze various case studies implementing IoT in real world environment and find out the solutions of various deployment issues. Smart parking system, Smart irrigation system-block diagram, sensors, modules on Arduino and Node MCU.

Text Books:

5. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of things" by David Hanes, Cisco Press.
6. Internet of things with ESP 8266, Macro Schwartz, Pact publication.
7. Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach. Vpt.
8. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

Reference Books:

5. Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications.
6. Mastering internet of things by Peter Waher, Pact publication.
7. The Internet of Things: connecting objects to the web, Hakima chaouchi, Wiley Publications.
8. Course Era: "Interfacing with the Arduino" by Ian Harris, University of Irvine, California.

Semester: 5th			
Paper code: AIDS 311/AIML 311	**L**	**T/P**	**Credits**
Subject: Principles of Entrepreneurship Mindset	**2**	**0**	**2**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Identify and apply the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial & innovation mindset and engaging in successful appropriate entrepreneurial and innovative behaviour.
2.	Understand the basic concepts of finance and marketing for first time entrepreneurs.
3.	Study Business Model Canvas and apply it for product and services area.
4.	Create and write a business plan.

Course Outcomes:

CO1	Apply the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial & innovation mindset and engaging in successful appropriate entrepreneurial and innovative behaviour.
CO2	Conceptualize the basic concepts of finance and marketing.
CO3	Evaluate the business model canvas and apply the same for product and services area.
CO4	Create and write a business plan.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:
This course gives exposure to the students for the core entrepreneurship concepts. Three real time case studies have been covered to give the students real time understanding of setting up a startup. Business canvas model has been covered under the syllabus followed by the finance and marketing skills for budding entrepreneurs. Students will be able to create and write a business plan after the completion of the course.

Unit I **[6]**

Introduction to Entrepreneurship and Innovation: Entrepreneurship: Concepts, entrepreneurship mindset, challenges; Innovation: What is innovation, role of technology, creating new ventures through innovative initiatives; Business opportunities: concepts & techniques for identifying opportunities, writing a problem statement, tools and techniques for idea generation; Introduction to social entrepreneurship. Study and Analyze at least three case studies of startups in computing (mixture of both successful and failed startups, an Indian startup, startup by a student)

Unit II **[6]**

Understanding Business Model Canvas: Introduction to Business Model Canvas; customer segments; value proposition, distribution channels; Customer Relationship, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure, Preparing a business model canvas of a problem statement

Unit III **[6]**

Finance and Marketing for early entrepreneurs: Basic understanding of P&L, Balance sheet and cash flow; Understanding of terms like CAGR, NPV, Angle funding, Venture capital, Debt funding, Equity, private equity, valuation, Break-even analysis, Return on Investment, Working Capital, Cost of Good Sold, Customer Acquisition cost, Customer life time value, profit margins.
Marketing for budding entrepreneurs: Understanding customer requirements, Customer Profiling and segmentation, Marketing strategy, 4Ps of Marketing, Network effect.

Unit IV **[6]**

Creating and writing a Business Plan: Introduction to different Business Models. Process of Business Planning - Purpose, structure and content, business plan outline, how to write Business plan, Preparing a business plan of a problem statement. Application of Business Model Canvas in creating the business plan. Understand customer needs, design and conduct a survey. Presentation of Business Plan. Process of incorporating a new company in India.

Textbooks:

1. “Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers” by Alexander Osterwalder, Yves Pigneur
2. “Making Breakthrough Innovation Happen” by Porus Munshi
3. Ries Eric (2011), “The lean Start-up: How constant innovation creates radically successful businesses”, Penguin Books Limited.

Reference Books:

1. Blank, Steve (2013), "The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company", K&S Ranch.
2. S. Carter and D. Jones-Evans, "Enterprise and small business- Principal Practice and Policy", Pearson Education (2006)
3. T. H. Byers, R. C. Dorf, A. Nelson, "Technology Ventures: From Idea to Enterprise", McGraw Hill (2013)
4. Osterwalder, Alex and Pigneur, Yves (2010) "Business Model Generation".
5. Kachru, Upendra, "India Land of a Billion Entrepreneurs", Pearson
6. Bagchi, Subroto, (2008), "Go Kiss the World: Life Lessons for the Young Professional", Portfolio Penguin
7. Bagchi, Subroto, (2012). "MBA At 16: a Teenager's Guide to Business", Penguin Books
8. Mitra, Sramana (2008), "Entrepreneur Journeys (Volume 1)", Booksurge Publishin
9. Abrams, R. (2006). "Six-week Start-up", Prentice-Hall of India
10. Verstraete, T. and Laffitte, E.J. (2011). "A Business Model of Entrepreneurship", Edward Elgar Publishing.
11. Johnson, Steven (2011). "Where Good Ideas comes from", Penguin Books Limited.
12. Gabor, Michael E. (2013), "Awakening the Entrepreneur Within", Primento.
13. Guillebeau, Chris (2012), "The $100 startup: Fire your Boss, Do what you love and work better to live more", Pan Macmillan
14. Kelley, Tom (2011), "The ten faces of innovation, Currency Doubleday"
15. Prasad, Rohit (2013), "Start-up sutra: what the angels won't tell you about business and life", Hachette India.

Semester: 5th			
Paper code: AIDS351/AIML351	**L**	**T/P**	**Credits**
Subject: Operating Systems Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To apply the concepts of storage management, process scheduling using programming languages.
2.	To study Several Operating systems and their commands to analyze the memory management, process scheduling concepts.

Course Outcomes:

CO1	Apply the techniques used to implement processes and threads as well as the different algorithms for process scheduling.
CO2	Implement the basic commands of the OS and will execute the various system calls, process synchronization problems using semaphore.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	1	1	-	-	-	1	1	1	1
CO2	3	2	2	1	1	-	1	-	2	1	2	1

List of Experiments:

1. Write a C program to implement FCFS scheduling algorithm.
2. Write a C program to implement a round robin scheduling algorithm.
3. Implementation of the following Memory Allocation Methods for fixed partition a) First Fit b) Worst Fit c) Best Fit.
4. Write a program to implement reader/writer problems using semaphore.
5. Write a program to implement Banker's algorithm for deadlock avoidance.
6. To study of basic UNIX commands and various UNIX editors such as vi, ed, ex and EMACS

7. Process Management a) fork() b) execv() c) execlp() d) wait() and e) sleep()
    A. Program to implement the fork function using C.
    B. Program to implement execv function using C.
    C. Program to implement execlp function.
    D. Program to implement wait function using C.
    E. Program to implement sleep function using C.
8. To write simple shell programs by using conditional, branching and looping statements.
9. Write a Shell Program to swap the two integers.

Semester: 5th			
Paper code: AIDS353/AIML353	**L**	**T/P**	**Credits**
Subject: Design and Analysis of Algorithms Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:	
1.	To teach students how to analyses solution space of problems
2.	To design algorithms based on dynamic programming and greedy algorithms.

Course Outcomes:	
CO1	Apply important algorithmic design paradigms and methods of analysis in problem solving.
CO2	Design and develop dynamic programming and greedy algorithms.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. Sort a given set of elements using the quick sort algorithm and find the time complexity for different values of n.
2. Implement merge sort algorithm using divide & conquer method to sort a given set of elements and determine the time and space required to sort the elements.
3. Write a program to implement knapsack problem using greedy method.
4. Program to implement job sequencing with deadlines using greedy method.
5. Write a program to find minimum cost spanning tree using Prim's Algorithm.
6. Write a program to find minimum cost spanning tree using Kruskal's Algorithm.
7. Implement 0/1 Knapsack problem using dynamic programming.
8. Write a program to perform Single source shortest path problem for a given graph.
9. Program for finding shortest path for multistage graph using dynamic programming.
10. Program to implement 8-queens problem using backtrack method.

Semester: 5th			
Paper code: AIDS355	**L**	**T/P**	**Credits**
Subject: Data Mining Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To perform preprocessing on real world datasets.
2.	To develop models using different data mining techniques on complex datasets.

Course Outcomes:

CO1	Analyze and apply pre-processing techniques to prepare and process real life datasets.
CO2	Implement different clustering or classification techniques for varying sets of problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	-	2	3	-	1	-	-	1	-	-
CO2	2	2	-	3	3	-	-	-	-	-	1	2

List of Experiments

1. Introduction and installation of WEKA tool.
2. Perform data pre-processing including cleaning, integration and transformation on ARFF files using WEKA.
3. Apply association rule mining on ARFF files using WEKA.
4. Implementation of Visualization technique on ARFF files using WEKA.
5. Implementation of Clustering technique on ARFF files using WEKA.
6. Study of DBMINER tool.
7. Apply pre-processing and classification/regression techniques on a real-world dataset.
8. Evaluate the performance of classification techniques using different parameters.
9. Implementation of Bagging and Boosting techniques on ARFF files using WEKA.
10. Apply the concept of Voting ensemble method to ARFF files and compare the results with single classifiers.

Semester: 5th			
Paper code: AIML355	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Implementation of deep learning models in Python and train them with real-world datasets.
2.	Implementation of Convolution Neural Network (CNN), Recurrent Neural Network (RNN) and Deep Learning NLP in Python.

Course Outcomes:

CO1	Design and Implement Convolution Neural Network for object classification from images or video.
CO2	Implement Autoencoder, Recurrent Neural Network, LSTM, its variants and Deep NLP.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	2	1	1	1	2	1	2	2
CO2	2	1	1	1	2	1	1	1	2	1	2	2

List of Experiments:

1. To explore the basic features of Tensorflow and Keras packages in Python
2. Implementation of ANN model for regression and classification problem in Python.
3. Implementation of Convolution Neural Network for MRI Data Set in Python.
4. Implementation of Autoencoders for dimensionality reduction in Python.
5. Application of Autoencoders on Image Dataset.
6. Improving Autocoder's Performance using convolution layers in Python (MNIST Dataset to be utilized).
7. Implementation of RNN model for Stock Price Prediction in Python
8. Using LSTM for prediction of future weather of cities in Python

9. Implementation of transfer learning using the pre-trained model (MobileNet V2) for image classification in Python.
10. Implementation of transfer learning using the pre-trained model (VGG16) on image dataset in Python.
11. NLP Analysis of Restaurant Reviews in Python.
12. Building a NLP model for Spam Detection using TFIDF (Term Frequency Inverse Document Frequency Vectorizer).

Semester: 5th			
Paper code: AIDS357/AIML357	**L**	**T/P**	**Credits**
Subject: Introduction to Internet of Things Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To teach students how to analyse different controller boards, simulation platforms and applications of IoT
2.	To design IoT based systems and applications to solve real time problems.

Course Outcomes:

CO1	Apply IoT principles to design programs using a software and hardware to using variety of available resources to create IoT ecosystem
CO2	Implement applications based on IoT for solving different problems using Arduino and Node MCU – ESP 8266

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	2	2	2	-	1	1	-	-	1	1
CO2	1	1	2	2	3	1	1	1	1	1	1	1

List of Experiments:

1. Introduction to Arduino platform and programming and Introduction to various actuators & its applications.
2. Introduction with running a blinking LED and fading LED with PWM
   A. Arduino IDE and Operators in IDE.
   B. Frequently used Functions in Arduino IDE
3. Control Structure writing programs for if else, for and while
4. Custom functions that can be created for specific Needs.
5. Reading and writing digital and analog values. Digital and analog read/write demonstration.
6. Measuring light with Lux and a photoresistor demonstration

7. Measuring temperature and humidity.
8. Adding an LCD screen and sketch walkthrough.
9. Create an echo server with the Ethernet Shield over Arduino.
10. Upload data from a single sensor to ThingSpeak using ESP8266 (NodeMCU),
11. Upload data from multiple sensors to ThingSpeak using ESP8266 (NodeMCU).
12. Setting up logging and visualizing data on ThingSpeak.
13. Making Project- on real-world Problems.
14. Introduction to Arduino platform and programming and Introduction to various actuators & its applications.

Syllabus of 3rd Year,

6th Semester

for

BACHELOR OF TECHNOLOGY

for

Artificial Intelligence and Data Science
Artificial Intelligence and Machine Learning
Industrial Internet of Things

Semester: 6th			
Paper code: AIDS302/AIML302/IOT302	**L**	**T/P**	**Credits**
Subject: Digital Image Processing	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To study basic image processing techniques of spatial and frequency domains for filtering applications.
2.	To understand digital image acquisition tools and basic operations for image enhancement.
3.	To analyze techniques such as image denoising, image segmentation, Image enhancement and edge detection.
4.	To design image compression and image segmentation algorithms.

Course Outcomes:

CO1	Understanding of the fundamental concepts of image processing, including image representation, enhancement, restoration, compression, and segmentation.
CO2	Analyze various segmentation techniques for image analysis
CO3	Outline the various feature extraction techniques for image analysis
CO4	Design image compression and image segmentation algorithms.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	-	2	3	-	-	-	3	-	-	2
CO2	2	1	-	-	3	-	2	-	3	-	-	-
CO3	2	1	-	2	3	3	2	-	-	-	-	2
CO4	2	2	-	2	3	3	2	-	-	-	-	3

Course Overview:

To introduce the student to various image processing techniques and image fundamentals. To describe the main characteristics of digital images, how they are represented. Mathematical transforms such as such as Fourier, Cosine transforms, Singular value

decomposition, 2D Wavelet transform, image enhancement techniques. Image restoration and denoising, segmentation, lossy and lossless data compression algorithms, binary and color image processing.

UNIT-I **[8]**

INTRODUCTION TO IMAGE PROCESSING: Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, recent applications of digital image processing, image sampling and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian. Need for transform, Fourier, Cosine transforms, 2D Wavelet transform, Different properties of image transform techniques.

UNIT II **[8]**

Concept of image compression: Concept of Image compression, lossless techniques (Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Enhancement in spatial and transform domain**,** histogram equalization, Directional Smoothing, Median, Geometric mean, Harmonic mean, Homo-morphic filtering

UNIT III **[8]**

Image degradation: Image degradation, Type of image blur, Classification of image restoration techniques, image restoration model, Linear and nonlinear restoration techniques, Image denoising, Median filtering.

Classification of image segmentation techniques: Boundary detection-based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Thresholding, Iterative thresholding, Otsu's method, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

UNIT IV **[8]**

Binarization and Basic Set theory: Binarization, Basic Set theory, Binary morphological operations and its properties, Color Image Representation, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space, Applications of digital image processing**:** Case studies

Text Books:

1. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989.

Reference Books:

1. Digital Image processing, S Jayaraman, TMH, 2012
2. William K. Pratt, Digital Image Processing, 3rd Edition, John Wiley, 2001.

Semester: 6th			
Paper code: AIDS354/AIML354/IOT354	**L**	**T/P**	**Credits**
Subject: Digital Image Processing Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To introduce the concepts of image processing and basic analytical methods to be used in image processing.
2.	To familiarize students with image enhancement and restoration techniques, different image compression techniques

Course Outcomes:

CO1	Analyze techniques such as image denoising, image segmentation, Image enhancement and edge detection.
CO2	Apply spatial and frequency domain filters on an image data set.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	2	2	2	-	-	2	-	-	2
CO2	2	2	1	2	3	3	-	-	2	-	-	3

List of Experiments:

1. Create a program to demonstrate Geometric transformations- Image rotation, scaling, and translation.
2. Display of FFT (1-D & 2-D) of an image and apply Two-dimensional Fourier transform to represent the content of an image using the discrete Fourier transform (DFT) and masking with DFT.
3. Write a Program of Contrast stretching of a low contrast image, Histogram, and Histogram Equalization and Display of bit planes of an Image.
4. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image
5. Implementation of Image Smoothening Filters (Mean and Median filtering of an Image)
6. Implementation of image sharpening filters and Edge Detection using Gradient Filters.
7. Implementation of Image Compression by DCT, DPCM, HUFFMAN coding.

8. Implementation of image restoring techniques.
9. Implementation of Image Intensity slicing technique for image enhancement.
10. Study and implement Canny edge detection Algorithm to images and compare it with the existing edge detection algorithms.

Artificial Intelligence & Data Science

Subject Basket

6th Semester

Semester: 6th			
Paper code: AIDS304T	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:	
1.	To understand the intuition and mathematical principles behind deep learning.
2.	To identify the common applications of deep learning for computer vision and NLP.
3.	To explain the strength and challenges of deep learning as compared to the other forms of machine learning.
4.	To generate images with various forms of auto-encoders
Course Outcomes:	
CO1	Apply the basic building blocks and general principles for designing deep learning algorithms.
CO2	Analyze the working of Convolution Neural Network for the given application.
CO3	Implement Autoencoder, Recurrent Neural Network, LSTM and its variants for real life data-sets.
CO4	Implement concepts of Genetic Adversial Networks and text classification algorithms

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	2	1	2	1
CO2	3	1	1	1	2	1	1	1	2	1	2	2
CO3	3	1	1	1	2	1	1	1	2	1	2	2
CO4	3	1	1	1	2	1	1	1	2	1	2	2

Course Overview:

The main objective of this course is to develop the understanding of key mathematical principles which are used behind the working of neural networks. Convolution Neural Networks and Recurrent Neural Networks have also been covered in this course. This course also provides the details for usage of Deep Learning for Natural Language Processing.

UNIT I: **[8]**

Introduction to Deep Learning: Introduction to Deep Learning, Bayesian Learning, Overview of Shallow Machine Learning, Difference between Deep Learning and Shallow Learning, Linear Classifiers ,Loss Function and Optimization Techniques -Gradient Descent and batch optimization.

UNIT II: **[8]**

Introduction to Neural Network: Introduction to Neural Network, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation through time. Architectural Design Issues.

UNIT III: **[8]**

Training Deep Neural Networks: Difficulty of training deep neural networks, Activation Function, Evaluating, Improving and Tuning the ANN. Hyper parameters Vs Parameters, Greedy layer wise training, Recurrent Neural Networks, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

UNIT IV: **[8]**

Convolutional Neural Networks: Convolutional Neural Networks, Building blocks of CNN, Transfer Learning , Pooling Layers , Convolutional Neural Network Architectures.Well known case studies: LeNet, AlexNet, VGG-16, ResNet, Inception Net.Applications in Vision, Speech, and Audio-Video.

Text Books:

1. Richard O. Duda," Pattern classification, Wiley, 2022
2. Adam Gibson and Josh Patterson, "Deep Learning: A Practical approach", 2017
3. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Reference Books :

1. Charu C. Aggarwal, "Neural Networks and Deep Learning", 2018
2. Duda, R.O. and Hart, P.E., Pattern classification. John Wiley & Sons, 2006.

Semester: 6th			
Paper code: AIDS304P	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Implementation of deep learning models in Python and train them with real-world datasets.
2.	Implementation of Convolution Neural Network (CNN), Recurrent Neural Network (RNN) and Deep Learning NLP in Python.

Course Outcomes:

CO1	Design and Implement Convolution Neural Network for object classification from images or video.
CO2	Implement Autoencoder, Recurrent Neural Network, LSTM, its variants and Deep NLP.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	2	1	1	1	2	1	2	2
CO2	2	1	1	1	2	1	1	1	2	1	2	2

List of Experiments:

1. To explore the basic features of Tensorflow and Keras packages in Python
2. Implementation of ANN model for regression and classification problem in Python.
3. Implementation of Convolution Neural Network for MRI Data Set in Python.
4. Implementation of Autoencoders for dimensionality reduction in Python.
5. Application of Autoencoders on Image Dataset.
6. Improving Autocoder's Performance using convolution layers in Python (MNIST Dataset to be utilized).
7. Implementation of RNN model for Stock Price Prediction in Python
8. Using LSTM for prediction of future weather of cities in Python
9. Implementation of transfer learning using the pre-trained model (MobileNet V2) for image

classification in Python.

10. Implementation of transfer learning using the pre-trained model (VGG16) on image dataset in Python.
11. NLP Analysis of Restaurant Reviews in Python.
12. Building a NLP model for Spam Detection using TFIDF (Term Frequency Inverse Document Frequency Vectorizer).

Semester: 6th			
Paper code: AIDS306T	**L**	**T/P**	**Credits**
Subject: Big Data Analytics	**3**	**0**	**3**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper. 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.			

Course Objectives:	
1.	To introduce the concept of big data and its types.
2.	To analyze different types of virtualizations to work with big data
3.	To apply different analytics in big data
4.	To familiarize the students with Hadoop ecosystem and its distribution

Course Outcomes:	
CO1	Understand the concept of big data and its types.
CO2	Analyze different types of virtualizations to work with big data
CO3	Apply Map Reduce fundamentals and different analytics in big data
CO4	Design the Hadoop ecosystem and its distribution

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1							1	2
CO2	2	2	2	2	1						1	2
CO3	3	2	2	2	2	1			1		2	3
CO4	3	3	2	2	3	1	1	1	2		2	3

Course Overview:

Big data analytics is a field of study that focuses on the use of various analytical and statistical methods to extract insights, patterns, and trends from large and complex data sets. The goal of this course is to help businesses and organizations make more informed decisions, improve operational efficiency, and identify new business opportunities.

UNIT I: **[8]**

Introduction to Big Data- The Evolution of Data Management, Defining Big Data, Understanding the Waves of Managing Data, building a Successful Big Data Management Architecture, Examining Big Data Types: Structured Data, Unstructured Data. Putting Big Data Together. Brief History of Distributed Computing, Basics of Distributed Computing for big data.

UNIT II: **[8]**

Exploring the Big Data Stack- Layer 0: Redundant Physical Infrastructure, Layer 1: Security Infrastructure, Layer 2: Operational Databases, Layer 3: Organizing Data Services and Tools, Layer 4: Analytical Data Warehouses. Big Data Analytics, Big Data Applications.

Virtualization: Basics of Virtualization, Server virtualization, Application virtualization, Network virtualization, Processor and memory virtualization, Data and storage virtualization, Managing Virtualization with the Hypervisor, Implementing Virtualization to Work with Big Data.

UNIT III: **[8]**

Analytics and Big Data- Basic analytics, Advanced analytics, Operationalized analytics, Monetizing analytics, Text Analytics and Big Data, Social media analytics, Text Analytics Tools for Big Data, Attensity, Clarabridge, OpenText.

MapReduce Fundamentals- Understanding the map function, Adding the reduce function.
Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

UNIT IV: **[8]**

Exploring Hadoop- Hadoop & its Features, Hadoop Ecosystem, Hadoop 2.x Core Components, Hadoop Storage: Understanding the Hadoop Distributed File System, Hadoop Processing: MapReduce Framework, Different Hadoop Distributions. Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Textbooks:

1. Judith S. Hurwitz, Alan F. Nugent, Fern Halper, Marcia A. Kaufman, “Big Data For Dummies”, John Wiley & Sons, Inc.(2013)
2. Robert D. Schneider, “Hadoop For Dummies”, John Wiley & Sons, Inc. (2012)
3. Tom White “Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.

4. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference Books:

1. Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw Hill (2012).
2. Nathan Marz, James Warren, “Big Data: Principles and best practices of scalable realtime data systems”, Manning Publications (2015)
3. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, “Learning Spark: Lightning-Fast Big Data Analysis”, O. Reilly Media, Inc. (2015).

Semester: 6th			
Paper code: AIDS306P	**L**	**T/P**	**Credits**
Subject: Big Data Analytics Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To analyse and implement different framework tools by taking sample data sets.
2	To illustrate and implement the concepts by taking an application problem.

Course Outcomes:

CO1	Analyse the Big Data using Map-reduce programming in Hadoop framework.
CO2	Apply concepts of big data analytics to conduct experiments, as well as to analyze and interpret big data.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	2		1		1			2
CO2	2	2	2	2	2			1	1	1	2	3

List of Experiments:

1. Install Apache Hadoop.
2. Develop a map reduce program to calculate the frequency of a given word in a given file.
3. Develop a map reduce program to find the maximum temperature in each year.
4. Develop a map reduce program to find the grade of students.
5. Develop a map reduce program to implement matrix multiplication.
6. Develop a map reduce program to find the maximum electrical consumption in each year given electrical consumption for each month in each year.
7. Develop a map reduce program to analyze weather data set and print whether the day is shiny or cool day.
8. Develop a map reduce program to find the tags associated with each movie by analyzing movie lens data.
9. Develop a map reduce program to analyze Uber data set to find the days on which each basement has more trips using the following data set. The uber data set consists of four

columns they are:
Dispatching, base, no. date active, vehicle trips.

10. Develop a map reduce program to analyze titanic dataset to find the average age of the people (both male and female) who died in the tragedy. How many people survived in each class.
11. Develop a program to calculate the maximum recorded temperature year wise for the weather data set in Pig Latin.
12. Write queries to sort and aggregate the data in a table using HiveQL.

Semester: 6th			
Paper code: AIDS308T	**L**	**T/P**	**Credits**
Subject: Next Generation Databases	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required

Course Objectives:

1	To introduce the different database revolutions.
2	To analyze different types of relational and non-relational databases.
3	To apply different types of consistency models in MongoDB and Hbase.
4	To familiarize the students with different data models and programming languages for database revolutions.

Course Outcomes:

CO1	Understand the concepts of database revolutions and the need of Hadoop ecosystem.
CO2	Analyze different types of relational and non-relational databases.
CO3	Apply different types of consistency models
CO4	Design different databases using Spark SQL and Apache Drill.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1	2	1						2
CO2	2	2	2	2	1				1		1	2
CO3	2	2	2	2	1			1	1		1	2
CO4	3	2	2	3	2			1	1	1	2	3

Course Overview:

The subject gives a detailed overview on the next generation databases introducing the different database revolutions including the Big Data revolution and NoSQL. The students are introduced to various data models for Storage. Languages and programming interfaces like NoSQL, Spark SQL and Apache Drill are also discussed in the subject.

UNIT I: **[8]**

Database Revolutions: Early Database Systems, The First Database Revolution, The Second Database Revolution, The Third Database Revolution.

The Big Data Revolution: Cloud, Mobile, Social, and Big Data. Google: Pioneer of Big Data. Hadoop: Open-Source Google Stack: Hadoop's Origins, The Power of Hadoop, Hadoop's Architecture, HBase, Hive, Pig. The Hadoop Ecosystem.

Scaling Web 2.0: Sharding, CAP Theorem

UNIT II: **[8]**

Document Databases: XML and XML Databases, JSON Document Databases, Data Models in Document Databases, MongoDB

Graph Databases: RDBMS Patterns for Graphs, RDF and SPARQL, Property Graphs and Neo4j, Gremlin, Graph Database Internals, Graph Compute Engines

Column Databases: Data Warehousing Schemas, The Columnar Alternative, Sybase IQ, C-Store, and Vertica, Column Database Architectures

UNIT III: **[8]**

Distributed Database Patterns: Distributed Relational Databases, Nonrelational Distributed Databases, MongoDB Sharding and Replication, HBase, Cassandra.

Consistency Models: Types of Consistency, Consistency in MongoDB, HBase Consistency

UNIT IV: **[8]**

Data Models and Storage: Review of the Relational Model of Data, Key-value Stores, Data Models in BigTable and HBase, Cassandra, JSON Data Models. Typical Relational Storage Model, Log-structured Merge Trees, Secondary Indexing.

Languages and Programming Interfaces: SQL, NoSQL APIs, Impala, Spark SQL, Couchbase N1QL, Apache Drill.

Text Books:

1. Guy Harrison, "Net Generation Databases", Apress 2015

Reference Books:

1. Abraham Silberschatz, Henry F. Korth , S. Sudarshan, "Database System Concepts", McGraw Hill Education, 2013.
2. Adam Fowler, "NoSQL For Dummies", Wiley, 2015.

Semester: 6th			
Paper code: AIDS308P	**L**	**T/P**	**Credits**
Subject: Next Generation Databases Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To create NOSQL databases using proper rules.
2	To implement projection and indexing in databases.

Course Outcomes:

CO1	Use the basics of MongoDB commands and construct queries for database creation and interaction.
CO2	Apply database principles for NOSQL databases to implement database connectivity with programming languages.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	2	1			1		2	2
CO2	3	3	2	2	2	1		1	2	1	1	3

List of Experiments:

1. Study of Open Source NOSQL Database: MongoDB (Installation, Basic CRUD operations, Execution).
2. Demonstrate how to create and drop database in MongoDB.
3. Creating the Collection in MongoDB.
4. a. Creating collection with options before inserting the documents and drop the collection created.
   b. Insert Documents in MongoDB collections.
5. To show limit () ,skip(), sort() methods in MongoDB.
6. To implement MongoDB projection.
7. MongoDB indexing.

a. Create index in MongoDB
b. Finding the indexes in a collection
c. Drop indexes in a collection
d. Drop all the indexes

8. Create simple objects and array objects using JSON
9. Implement Map reduce operation with suitable example using MongoDB.
10. Write a program to implement MongoDB database connectivity with PHP/ python/Java Implement Database navigation operations (add, delete, edit etc.) using ODBC/JDBC.

Semester: 6th			
Paper code: AIDS310T	**L**	**T/P**	**Credits**
Subject: Social Network Analytics	**3**	**0**	**3**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper. 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.			

Course Objectives:	
1.	To Understand the components and entities of the social network
2.	To analyze social media data to comprehend user sentiments and recommend the essential information appropriately.
3.	Model and visualize the social network
4.	Detect and analyze the communities in social networks
Course Outcomes:	
CO1	Understand the key concepts and theories of social network analysis.
CO2	Analyze social network data: Students should be able to collect, preprocess, and analyze social network data using various tools and software packages, such as Gephi, NetworkX, and R
CO3	Design a system to assimilate information available on the web to model and build Social Network Application
CO4	Apply social network analysis to real-world problems in various fields and develop strategies and recommendations based on their findings.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	1	-	-	-	-	1	-
CO2	2	1	2	1	3	1	-	1	1	1	1	1
CO3	2	1	2	1	-	1	-	1	-	1	1	-
CO4	2	1	2	1	2	2	1	1	1	1	1	1

Course Overview:

This course explores the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales-ranging from small groups to the World Wide Web. It examines how we create social, economic, and technological networks, and how these networks enable and constrain our attitudes and behavior. The course will discuss how social network concepts, theories, and visual-analytic methods are being used to map, measure, understand, and design a wide range of phenomena such as social networking sites, recommender systems, trust and reputation systems, search engines.

UNIT-I **[8]**

Fundamentals of Social Network Analysis: Social Network Perspective, Fundamentals concepts in Network Analysis: Sociogram, Sociometry. Social Network Data: Types of Networks: One-Mode, Two-Mode, Affiliation, Ego-centered and Special Dyadic Networks, Network Data, Measurement and Collection, Notations for Social Network Data: Graphs, Directed, Singed, Valued graphs, Multigraph, Relations and Matrices.

UNIT-II **[8]**

Centrality and Prestige: Prominence: Actor-Centrality, Prestige, Group-Centrality, Prestige, Non directional Relations-Degree, Closeness, Betweenness, Eigen Vector Centrality, Directional Relations-Centrality, Prestige.

Structural Balance and Transitivity: Structural Balance: Signed Non directional, Signed Directional Relations, Checking for Balance, Index for Balance, Clusterability-Theorems, Clustering Coefficient and Transitivity.

UNIT-III **[8]**

Cohesive Subgroups: Social Group and Subgroup-Notation, Subgroups Based on Complete Mutuality: Clique, Reachability and Diameter: n-cliques, n-clans and n-clubs, Subgroups Based on Nodal Degree: k-plexes, k-cores, Measures of Subgroup Cohesion, Community detection using Subgroups and Betweenness. Roles and Positions: Structural Equivalence: Definition, Social Roles and, Positional Analysis, Measuring Structural Equivalence, Representation of Network Positions, Block Models-Introduction, Network Positions and roles-Introduction

UNIT-IV **[8]**

Dyadic and Triadic Methods: Dyads: Definitions, Dyad Census, Index, Simple Distributions, Triads: Random Models and Substantive Hypotheses, Triad Census, Distribution of a Triad Census- Mean and Variance, Testing Structural Hypotheses.

Models in Social Network: Small world network- Watt Strogatz networks - statistical models for social networks - network evaluation model - Preferential attachment - power law - Random

Model: Erdos -Renyi model - Barabasi Albert model - Epidemic model - Case study: Text and opinion Analysis

Textbooks:

1. Wasserman Stanley, and Katherine Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences. Cambridge University Press, 2012 Online Edition.
2. Albert-László Barabási, Network Science, Cambridge University Press, 1st edition, 2016.

Reference Books:

1. John Scott, "Social Network Analysis", Sage Publications Ltd., Fourth Edition, 2017.
2. David Knoke & Song Yang, "Social Network Analysis", Sage Publishing, Third Edition, 2020

Semester: 6th			
Paper code: AIDS310P	**L**	**T/P**	**Credits**
Subject: Social Network Analytics Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	Understand the components of the social network
2	Analyze social media data to understand user sentiment and recommend the requisite information accordingly
3	Model and visualize the social network
4	Apply algorithms to solve research problems on social network and analyze the communities in social networks.

Course Outcomes:

CO1	Develop social network applications using visualization tools.
CO2	Design a system to harvest information available on the web to model and build Social Network Application

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	1	-	1	-	1	1	-
CO2	2	2	2	2	3	2	1	1	1	1	1	1

List of Experiments:

1. Study and demonstrate to find the basic properties of a Graph/Social Network.
2. Demonstrate the calculation of Centrality measures.
3. Demonstrate the ranking of web pages in a web graph.
4. Find divisions in a Social Network.
5. Implement Community Detection algorithms on a Social Network.
6. Demonstrate modeling of Social Networks.
7. Visualize a multidimensional Social Network.
8. Applications of Classification and Clustering on a Social Network.
9. Design and implement a Sentiment Analyzer.

10. Design and implement a Social Network.

Semester: 6th			
Paper code: AIDS312T	**L**	**T/P**	**Credits**
Subject: Network Science	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the underlying behaviour and properties of various types of networks with the help of mathematical tools.
2.	To apply network science principles to predict the dynamics and the topology a wide area of real networks.
3.	To understand the laws governing the error and attack tolerance of complex networks and the emergence of cascading failures.
4.	To analyze network epidemics to quantify and forecast the spread of infectious diseases.

Course Outcomes:

CO1	Identify the governing mathematical principles behind the architecture of networks emerging in various domains of science, nature and technology.
CO2	Apply the knowledge of network science to classify various types of networks to gain important inferences.
CO3	Apply relevant measures to classify the structure of networks and shows how these measures can differentiate between different types of random and real-world networks.
CO4	Analyse the network data associated with information that changes over time.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	1	1	2	2	-	1	1	1	1
CO2	1	1	-	1	2	2	1	-	1	2	1	2
CO3	2	3	1	2	2	1	2	-	1	1	2	2

CO4	3	3	1	2	2	2	1	1	1	2	2	2

Course Overview:

Network science course covers the topology and dynamics of complex networks, aiming to better understand the behaviour and properties of the underlying systems. In this course, algorithmic, computational, and statistical methods of network science, as well as its diverse applications are also covered. Concept implementation using NetworkX in Python is also the integral part of the syllabus. Various case studies have also been covered to understand the impact of networks and also to model epidemic and its prediction by studying the network.

UNIT I: **[8]**

Introduction: Vulnerabilities due to Interconnectivity, Networks and Complex Systems, Emergence of Network Science, Characteristics of Network Science, Societal and Scientific Impact of Networks, Case Studies of Various Real-World Networks and their societal/scientific impact. Graph Theory: Bridges of Konigsberg, Networks and Graphs, Degree Distribution, Network Representations, Representing Networks in NetworkX, Networks: Path Length, and Components. Drawing Directed/Undirected graphs with Weighted/Unweighted Edges in NetworkX.

UNIT II: **[8]**

Random Networks: Introduction, Random Network Model, Number of Links, Degree Distribution, Small World and Computing Clustering Coefficient in NetworkX. The Scale Free Property: Introduction, Power Laws and Scale Free Networks, Hubs, Universality, Ultra Small Property, Degree Exponent, Generating Networks with Arbitrary Degree Distribution. Generating random network in NetworkX.

UNIT III: **[8]**

The Barabasi-Albert Model: Introduction, Growth and Preferential Attachment, Degree Dynamics, Degree Distribution, Measuring Preferential Attachment, Non-Linear Preferential Attachment, Diameter and Clustering Coefficient, Evolving Networks: Introduction, Bianconi-Barabasi Model, Measuring Fitness, Bose-Einstein Condensation, Degree Correlations: Assortativity and Disassortativity, Measuring Degree Correlations, Structural Cutoffs, Correlation in Real Networks, Generating Correlation Networks.

UNIT IV: **[8]**

Network Robustness: Percolation Theory, Robustness of Scale Free Networks, Attack Tolerance, Modelling Cascading Failures and Building Robustness, Identifying Network Robustness using NetworkX, Communities, Spreading Phenomena: Introduction, Epidemic Modeling, Contact Networks, Immunization and Epidemic Prediction. Creating Partitions and Identifying the Modularities of Partitions, Implementation of SIS Spreading Model.

Text Books:

1. Menczer, Filippo, Santo Fortunato, and Clayton A. Davis. A First Course in Network Science. Cambridge University Press, 2020.

2. A-L. Barabási , Network Science , available online, 2015.

Reference Books:

1. M.E.J. Newman, Networks - An introduction, Oxford Univ Press, 2010.

Semester: 6th			
Paper code: AIDS312P	**L**	**T/P**	**Credits**
Subject: Network Science Lab		**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To understand the underlying behaviour and properties of various types of networks with the help of mathematical tools.
2	To apply network science principles to predict the dynamics and the topology a wide area of real networks.

Course Outcomes:

CO1	Apply relevant measures to classify the structure of networks and shows how these measures can differentiate between different types of random and real-world networks.
CO2	Analyse the network data associated with information that changes over time.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	1	2	2	1	2	-	1	1	2	2
CO2	3	3	1	2	2	2	1	1	1	2	2	2

List of Experiments:

1. Understanding NetworkX API basics.
2. Performing network analysis of directed graphs (Weighted/Unweighted) using NetworkX in Python
3. Performing network analysis of undirected graphs ((Weighted/Unweighted)) using NetworkX in Python.
4. Computing degree centrality for a node in a network.
5. Generating subset of network using NetworkX.
6. Drawing network using matplot libraries and measuring degree of assortativity.

7. Generating networks with arbitrary degree distribution using NetworkX.
8. Finding shortest path from single node to all distant nodes using NetworkX.
9. Computing clustering coefficients of different nodes using NetworkX.
10. Computing clustering coefficients of different networks using NetworkX.
11. Implementing the model for spreading dynamics using NetworkX.

Semester: 6th			
Paper code: AIDS314T	**L**	**T/P**	**Credits**
Subject: AI & Sustainable Computing	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	To understand how to distill a real-world challenge as an artificial intelligence problem, involving explicit representation and learning of symbolic and numeric models; reasoning about such models; and using such models for decision making, action selection, and interaction with humans.
2	To design, analyze, implement, and use state-of-the-art AI and machine learning techniques for dealing with real-world data, including data involving vision, language, perception, and uncertainty.
3	To recognize the social impact of artificial intelligence and the underlying responsibility to consider the ethical, privacy, moral, and legal implications of artificial intelligence technologies.
4	To inculcate the responsibilities to use AI and ethical decisions about the tools they designed.

Course Outcomes:

CO1	Understand the significance of artificial intelligence in the society
CO2	Analyze the social and cultural aspects and implications of artificial intelligence
CO3	Attain knowledge about the potential transformative effects of the emerging technologies
CO4	Gain insights about the role of artificial intelligence in different verticals.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1		1	-	1	-	1	-	-	2	1	-	1
CO2	1	2	1	1	1	1	2	1	2	2	2	1
CO3	2	2	1	1	1	1	2	1	2	2	2	2

CO4	2	2	2	2	2	2	2	2	3	2	3	2

Course Overview:

The course will help students in exploring the relationship between Artificial Intelligence and Humanity on an overall premise. It reflects upon how the world is changing with the advent and exponential increase of Artificial Intelligence in all verticals of society. This course will assist you in students in attaining wisdom regarding the potential effects of the emerging technologies in Artificial Intelligence. Role of Artificial Intelligence in business domain, governance and marketing shall be explored in this course.

UNIT I: **[10]**

AI & Society: Relation of AI with Knowledge, Culture and Communication. Implications of AI: Cultural, Social, Cognitive, Economic, Ethical and Philosophical. Societal and cultural impacts of AI, New Media Technologies: Design, Use, Management, Policy of Information and Communication. Impact of AI: Impact of AI on governance, Impact of AI on information security, Impact of AI in the corporate sector and community welfare. AI in information technologies, humanities, social sciences, arts, and sciences.

UNIT II: **[10]**

Potential and Transformative Impacts: Critical consequences of AI, Latest technological innovations. Applications of emerging technologies in day-to-day life. Societal dimension of research: benefits, impacts, and implications on society. AI and research ethics. Forces influencing AI: trust, biases, privacy, reliability, responsibility, and competence.

UNIT III: **[10]**

Encashing AI: AI for Business, AI in the Organization Structure, AI-based data infrastructure, Impact of recommenders on markets Applications in Finance: Fraud Detection and Stock Market Prediction, Market adoption, and barriers. AI & Gaming Industry. AI Strategy and Governance: AI Strategy and Governance Agenda, AI-Driven Business Transformation. Developing a Portfolio of AI Projects, Lowering Barriers to AI Use

UNIT IV: **[10]**

Green IT and sustainability: Green IT and sustainability, ecological footprint of IT, and the issues of lifecycle, sustainability, life cycle assessment and code of conducts; energy measurement and other useful metrics for Green IT, Usage of software tools and hardware to measure and estimate energy consumption

Sustainable software: Ecological design, applying good practices to write energy efficient software; **e**nergy footprint of data centers and cloud computing, standards and good practices for energy efficiency in servers,

Text Books:

1. AI for People and Business, by Alex Castrounis, 2019, O'Reilly Media, Inc.
2. Green Computing: Tools and Techniques for Saving Energy, Money, and Resources, Bud E. Smith, Auerbach Publications
3. 2084: Artificial Intelligence, the Future of Humanity, and the God Question: Artificial Intelligence and the Future of Humanity, 2020, by John C. Lennox, Zondervan

Reference Books:

1. The Age of AI: And Our Human Future (B PB) Paperback – Import, 4 August 2022 by Daniel Huttenlocher, III Schmidt, Eric, Henry A Kissinger
2. Green Internet of Things and Machine Learning, Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar, Chuan-Ming Liu, John Wiley & Sons, 10-Jan-2022.

Semester: 6th			
Paper code: DS316T	**L**	**T/P**	**Credits**
Subject: Biomedical Data Analysis	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	To familiarize students with Fundamentals of Biomedical Image Processing
2	To use image processing techniques in different biomedical applications
3	To analyze Multi-Scale and Multi-Orientation Medical Image
4	To apply Feature Extraction and Selection for Decision Making in biomedical applications

Course Outcomes:

CO1	Understand the fundamentals of biomedical data analytics
CO2	Analyze image processing techniques in different biomedical applications
CO3	Apply Texture Features in biomedical applications
CO4	Design decision making based solutions for medical diagnosis

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1		1	-	1	-	1	-	-	2	1	-	2
CO2	1	2	1	1	1	1	2	1	2	2	2	2
CO3	2	2	1	1	1	1	2	1	2	2	2	2
CO4	2	2	2	2	2	2	2	2	3	2	3	3

Prerequisite: Fundamentals of Machine Learning and Data Mining Concepts.

Course Overview:

The aim of Biomedical Data Analysis is to equip students with the necessary skills and knowledge to analyze and interpret complex biomedical data. The course aims to provide students with a solid understanding of the different types of biomedical data and the methods and techniques used for their analysis.

UNIT I: **[10]**

Fundamentals of Biomedical Image Processing: Introduction, Medical Image Formation, Image Enhancement, Image Data Visualization, Visual Feature Extraction, Segmentation, Classification, Quantitative Measurements and Interpretation, Image Management

Fusion of PET and MRI for Hybrid Imaging: Positron Emission Tomography, Magnetic Resonance Imaging, Hybrid PET Fusion System

UNIT II: **[10]**

Cardiac 4D Ultrasound Imaging: The Role of Ultrasound in Clinical Cardiology, Principles of Ultrasound Image Formation, Limitations of 2D Cardiac Ultrasound, Approaches Towards 3D Cardiac Ultrasound, Validation of 3D Cardiac Ultrasound Methodologies, Remaining Challenges in 4D Cardiac Ultrasound.

Morphological Image Processing Applied in Biomedicine: Introduction, Binary Morphology, Gray-Scale Operations, Watershed Segmentation, Segmentation of Diffusion MRI

UNIT III: **[10]**

Texture in Biomedical Images: Characterizing the Texture of Swatches, Simultaneous Texture Segmentation, Examples of the Use of Texture Features in Biomedical Applications.

Multi-Scale and Multi-Orientation Medical Image Analysis: The Necessity of Scale, Differential Invariants, Second Order Image Structure and Features, Third Order Image Structure: T-Junctions, Adaptive Blurring and Geometry-Driven Diffusion, Edge Focusing, Orientation Analysis.

UNIT IV: **[10]**

Feature Extraction and Selection for Decision Making: Introduction, Image Representation, Image Features and Distance Functions, Feature Selection, Association Rule Mining. Case Study: Improving Computer-Aided Diagnosis by Association Rule Mining.

Melanoma Diagnosis: The Cutaneous Melanoma, State of the Art in CM Diagnosis, Dermoscopy Image Analysis, Commercial Systems, Evaluation Issues.

Text Books:

1. Thomas M. Deserno, “Biomedical Image Processing”, ei Springer.
2. G.R. Sinha, B.C. Patel, “Medical Image Processing: Concepts and Applications”, PHI, 2014.

3. Christo_El_Morr, Hossam_Ali-Hassan, “Analytics in Healthcare A Practical Introduction” , Springer Briefs in Health Care Management and Economics.

Reference Books:

1. Peter White, “Data-Handling in Biomedical Science”, Cambridge University Press.
2. Peter Langkafel (Ed.), “Big Data in Medical Science and Healthcare Management”, De Gruyter.
3. Kerstin Denecke, “Health Web Science: Social Media Data for Healthcare”, Springer.

Semester: 6th			
Paper code: AIDS318T	**L**	**T/P**	**Credits**
Subject: Optimization Algorithms and its Applications	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide students with an understanding of optimization approaches and its types.
2.	To enable students to develop proficiency in solving optimization problems using classical techniques.
3.	To develop proficiency in solving optimization problems using meta-heuristics techniques.
4.	To provide understanding of heuristic and hybrid optimization approaches and develop proficiency in solving optimization problems using heuristic and hybrid optimization techniques.

Course Outcomes:

CO1	Students will be able to identify and comprehend the different optimization problems in real-world applications.
CO2	Students will be able to comprehend, analyze and solve the classical optimization problems including linear, quadratic, and integer programming problems.
CO3	Students will be able to apply and analyze the performance of meta-heuristics optimization techniques to solve different optimization problems
CO4	Students will be able to apply heuristics and hybrid optimization techniques to solve different optimization problems and analyze their performance for different problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	3	1	1				1		1
CO2	3	3	3	3	2	1				1		1
CO3	3	3	3	3	3	2	1			1		1
CO4	3	3	3	3	3	2	1	3		1		1

Course Overview:
The course covers developments of advanced optimization models and solution methods for technical and economical planning problems. The basis in the course is the optimization process, from a real planning problem to interpretation of the solutions of the underlying optimization problem. In the modeling part we focus on problems with discrete elements, but also knowledge about important classes of optimization problems and their properties will be highlighted

UNIT I **[10]**
Introduction to Optimization Approaches and Types: Introduction to optimization problems and their significance, Types of optimization problems: continuous, discrete, and combinatorial, Objective functions and constraints, Classification of optimization approaches, Overview of mathematical programming, heuristic, and meta-heuristic techniques

UNIT II **[8]**
Classical Approaches in Optimization: Unconstrained optimization: methods of steepest descent and Newton's method, Constrained optimization: Lagrange multipliers and KKT conditions, Linear programming: formulation, simplex method, and duality, Integer programming: branch and bound, cutting plane, and branch and cut algorithms

UNIT III **[12]**
Meta-Heuristic Approaches: Overview of meta-heuristic optimization, Genetic algorithms: representation, selection, crossover, and mutation operators, Particle swarm optimization: movement rules and parameter settings, Simulated annealing: cooling schedules and neighborhood search, Ant colony optimization: pheromone trails and decision-making, Tabu search: tabu list and aspiration criteria

UNIT IV **[10]**
Heuristics and Hybrid Approaches: Greedy algorithms and local search, Simplicial decomposition and cutting plane methods, Hybrid algorithms: combining meta-heuristics with classical approaches, Nature-inspired optimization: swarm intelligence, artificial bee colony, and harmony search

Text Books:
1. Edwin K.P. Chong and Stanislaw H. Zak, Introduction to Optimization, Wiley
2. Xinyu Ye and Ding-Zhu Du, Optimization Methods and Applications
3. Xinjie Yu, Introduction to Evolutionary Algorithms
4. Fred Glover and Gary A. Kochenberger, Handbook of Metaheuristics

Reference Books:
1. David G. Luenberger and Yinyu Ye, Linear and Nonlinear Programming
Mokhtar S. Bazaraa, Hanif D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms Jorge Nocedal and Stephen J. Wright, Numerical Optimization

Semester: 6th			
Paper code: AIDS320T	**L**	**T/P**	**Credits**
Subject: Cognitive Computing	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	Identify how the concept of cognitive computing evolved.
2	Analyze the working of hardware and software technologies behind the cognitive computing.
3	Interpretation of how Artificial Intelligence, Natural Language Processing and Big Data Analytics contribute towards cognitive computing solutions.
4	Identify new use cases and applications of cognitive computing.

Course Outcomes:

CO1	To identify how the concept of cognitive computing evolved.
CO2	To analyze the elements that make up a cognitive computing system.
CO3	To conceptualize how Artificial Intelligence, Natural Language Processing and Big Data Analytics contribute towards cognitive computing solutions.
CO4	To implement the cognitive models that apply to different real-life scenarios.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	-	-	-	-	-	1	-
CO2	2	1	2	1	3	-	-	-	1	1	1	1
CO3	2	1	2	1	-	-	-	-	-	1	1	-
CO4	2	1	2	1	2	-	-	-	1	1	1	1

Course Overview:

This course has been designed to make students understand cognitive computing's underlying technologies. This course covers knowledge representation techniques and natural language

processing algorithms and dynamic learning approaches based on accumulated evidence rather than reprogramming. Number of case studies have also been covered as part of this course to help the students go through step-by-step design and testing of cognitive systems. The IBM's Watson cognitive platform has also been covered in the syllabus.

UNIT I **[10]**

Introduction: Foundations of cognitive computing, Elements of cognitive system, Two systems of judgement and choice, Understanding complex relationship between systems, Design principles for cognitive systems, NLP in support of cognitive systems, Applying NLP to business problems.

UNIT II **[10]**

Relationship between big data and cognitive computing: Dealing with human generated data, Analytical data warehousing, Data in motion and streaming data, Integration of big data with traditional data, Knowledge representation models.

UNIT III **[10]**

Advanced analytics to cognitive computing: Key capabilities in advanced computing, Using advanced analytics to create value, Impact of open source tools on advanced analytics, Role of cloud and distributed computing in cognitive computing: Cloud computing models, Delivery models of cloud, Managing workloads, Security and governance, Data integration and management in cloud.

UNIT IV **[10]**

Business implications of cognitive computing: Business implications of cognitive computing, IBM's watson as a cognitive system, Process of building a cognitive application, Emerging cognitive areas and future applications, Case Studies: Cognitive healthcare application and smarter cities: cognitive computing in government.

Textbooks:

1. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley, 2015.
2. Rob High and Tanmay Bakshi, Cognitive Computing with IBM Watson: Build Smart Applications Using Artificial Intelligence as a Service (1 ed.), 2019.

Reference Books:

1. José Luis Bermúdez, Cognitive Science: An Introduction to the Science of the Mind (3 ed.), Cambridge University Press, 2020. ISBN 978-1108440349.
2. Adnan Masood and Adnan Hashmi, Cognitive Computing Recipes
3. Artificial Intelligence Solutions Using Microsoft Cognitive Services and TensorFlow, Foreword by Matt Winkler, Apress

Open Area Elective subject Basket

6th Semester

AIDS/ AIML/ IIOT

Semester: 6th			
Paper code: OAE304T	**L**	**T/P**	**Credits**
Subject: Blockchain Technology	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To articulate the fundamentals of blockchain and able to explain cryptographic concepts underlying blockchain technology.
2.	To make use of wallet transactions, crypto tokens, analyse the block details and Ethereum blockchain transactions.
3.	To study smart contracts and to examine various types of Blockchain networks and consensus algorithms.
4.	To study and implement solidity.

Course Outcomes:

CO1	Study the concept of money, fundamentals of blockchain and to explain cryptographic concepts underlying blockchain technology.
CO2	Apply the central concept of the blockchain ecosystem and PoW, and to study the advanced concepts of Ethereum
CO3	Design and build smart contracts and examine various types of Blockchain networks and consensus algorithms
CO4	Apply the concept of Solidity (language used in Ethereum)

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:
The widespread popularity of digital cryptocurrencies has led the foundation of Blockchain, which is fundamentally a public digital ledger to share information in a trustworthy and secure way. This course includes the fundamental design and architectural primitives of Blockchain, consensus protocols, types of the Blockchain system and the security aspects, methods to deploy smart contracts on different platforms, along with various use cases from different application domains in real life.

UNIT I **[8]**

Background leading blockchain, Shortcoming of current transaction system, The emergence of Blockchain, Bitcoin blockchain, Blockchain Architecture, Conceptualization, Blockchain components, Cryptocurrencies, Characteristics of cryptocurrencies, Alt coins, Crypto wallets, Creation of Blocks, Wallet Transactions, Transaction details in a Block, Merkle Tree, Hash functions, pseudo random numbers, public key cryptosystem, Generation of keys, Digital signatures.

UNIT II **[8]**

Blockchain types: Public Blockchain, Private Blockchain, Federated Blockchain, Ethereum blockchain, Go Ethereum, Gas, Gas price, Gas Limit, ETH, MetaMask, Public Test Networks, set up a Ethereum node using Geth, Mining in Blockchain, Double spending, Consensus algorithms: Proof of Work, Proof of Stake, Attacks on Bitcoin (Sybil Attacks, 51% Attack, etc.), Byzantine fault, Node failure.

UNIT III **[8]**

Byzantine General Problem: Byzantine General Problem, BFT (Byzantine fault tolerance), PBFT (Practical Byzantine fault tolerance), Delegated Proof of Stack, Paxos Consensus algorithm, Raft Algorithm, Solo Miner, Pool Miners, Deployment of Smart contracts in Blockchain, Remix, Compilation of smart contracts, Deployment environments, JavaScript Environment

UNIT IV **[8]**

Solidity: Data types in solidity, Operators, State variables, Global Variables, Local variables.
Solidity arrays, Solidity functions, Structs in solidity, Inheritance, Special variables, Solidity mapping, Function overloading, Personal Blockchain network, Ganache, Contract deployment to Ganache network, Modifiers in solidity, Events, Emerging applications of Blockchain.

Text Books:

1. Bettina Warburg, Bill Wanger and Tom Serres, Basics of Blockchain (1 ed.), Independently published, 2019. ISBN 978-1089919445.
2. Holbrook and Joseph, Architecting enterprise blockchain solutions (1 ed.), John Wiley & Sons, 2020. ISBN 978- 00000000.

3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.

Reference Books:

1. Bashir and Imran, Mastering blockchain: “Distributed ledger technology, decentralization, and smart contracts explained (1 ed.), Packt Publishing Ltd, 2018. ISBN 978- 11111111.
2. Andreas M. Antonopoulos. 2017. Mastering Bitcoin: Unlocking Digital Crypto-Currencies (2nd. ed.). O'Reilly Media, Inc.

Semester: 6th			
Paper code: OAE304P	**L**	**T/P**	**Credits**
Subject: Blockchain Technology Lab	**0**	**2**	**1**
Marking Scheme			
Teachers Continuous Evaluation: As per university examination norms from time to time End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1	To study Remix, how to design and build smart contracts on various platforms
2	To understand the concept of Solidity (language used in Ethereum)
3	To study installation of Ganache suit and deploy various applications of Blockchain
4	Perform and defend blockchain analysis of realworld systems and present relevant findings and arguments in a structured, logical and compelling manner.
Course Outcomes:	
CO1	To work with Remix, design and build smart contracts
CO2	To make use of Solidity, work with ethers and study about Metamask

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:

1. Study and implementation of hash functions and digital signatures
2. Conversion of Byte Code to Op-Code using etherscan.io
3. Deployment of Solidity Smart Contracts and Viewing Transaction Status on etherscan
4. Working with Remix IDE and Execution of Solidity Code
5. Execution of Smart Contracts on Goerli Testnet after getting Test ETHERS from Faucet
6. Creating a New Cryptocurrency and Importing in Metamask
7. Transferring new cryptocurrency to other accounts
8. Installation of Ganache Suite and Deployment of Smart Contracts on Ganache
9. Using Web3 GUI to interface Ganache and importing methods of smart contracts
10. Study of Metaverse and NFT in Blockchain

11. Setup of Testnets and Integration with Metamask.

Semester: 6th			
Paper code: OAE306T	**L**	**T/P**	**Credits**
Subject: Human Computer Interaction	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn basics concepts of Human Computer Interaction.
2.	To design the features of an interactive system- usability from the human perspective.
3.	To develop various HCI models and techniques.
4.	To apply different data gathering and analysis techniques.

Course Outcomes:

CO1	Apply core theories, models and framework from the field of HCI
CO2	Gather, Analyze and Interpret the data
CO3	Design, Develop and Evaluate user interface
CO4	Create Interactive Prototypes

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	-	-	-	-	1	1	1	1	-	-	1
CO2	1	3	-	2	-	1	1	1	1	-	-	1
CO3	1	-	3	-	1	1	1	1	1	1	1	1
CO4	1	2	3	2	2	1	1	1	1	1	1	1

Prerequisites: Critical Reasoning and Problem solving, Web designing

Course Overview:

This course will focus on how we can design human-centered systems that people find useful and usable. This course provides an introduction to designing, prototyping, and evaluating user interfaces. It will involve understanding the foundation elements of human computer interaction, understanding the design process and various design issues, performing contextual inquiry and task analysis, using sketching and prototyping tools, fundamentals of visual design, usability engineering, usability evaluation.

UNIT I **[10]**

Introduction to basic concepts of Human Computer Interaction: Understanding Design Issues, User Needs and User Experience (UX), Process of Interaction Design, Usability goals, User Experience Goals, Principles of Usability Design Conceptualizing Interaction, Conceptual Models, Framework, Cognitive models, Interaction Types, Paradigm for Interaction.

UNIT II **[10]**

Understanding Stakeholder Requirements: Social Interaction, Understanding Stakeholder Requirements, Emotional Interactions, Cognitive Models, Design Principles, Design frameworks, Design processes

UNIT III **[10]**

Natural User Interface (UI): Interface Types, Natural User Interface (UI), Data Gathering Issues, Data Recording, Interviews, Questionnaires, Observation, Choosing and Combining Data Gathering Techniques. Quantitative and Qualitative Data Analysis, Tools to support Data Analysis, Interpret and Presenting the Finding Approaches for collecting and analyzing data, Visualizing and Exploring Data, Ethical Design Concerns.

UNIT IV: **[10]**

Introduction to Design Requirements: Introduction to Design Requirements, Establish Requirements, Data Gathering for Requirements, Task Analysis, Task Decomposition, Comparison between Task Analysis Techniques, Prototyping, Tools for Interaction Designs, Evaluation Techniques, Usability Testing, Create Interactive Prototypes using proto.io, Case Studies on Usability and User experience.

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, —Human Computer Interaction‖, 3rd Edition, Pearson Education, 2004.
2. H. Sharp, Y. Rogers and J. Preece – Interaction Design Beyond Human-Computer Interaction, 3rd Edition, John Wiley & Sons.

Reference Books:

1. J. M. Caroll (ed.), HCI Models, Theories and Frameworks: Towards a Multidisciplinary Science (Interactive Technologies), Morgan Kauffman 2003.
2. C. Stephanidis (ed.), User Interface for All: Concepts, Methods and Tools, Lawrence Erlbaum Associates, 2001.
3. B. Shneiderman, Designing the User Interface, Addison Wesely,2000.

4. S. Bhattacharya, Human-Computer Interaction, MC Graw Hill India, 2019.

Semester: 6th			
Paper code: OAE308T	**L**	**T/P**	**Credits**
Subject: Quantum Computing	**4**	**0**	**4**
Marking Scheme			
Teachers Continuous Evaluation: As per university examination norms from time to time **End term Theory Examination: As per university examination norms from time to time**			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.			

Course Objectives:	
1.	To enable the students to understand the quantum computing and quantum information in depth.
2.	To analyze quantum algorithms and compare effectiveness versus classical algorithm
3.	To impart knowledge about the quantum-mechanical phenomena such as superposition and entanglement to perform computation
4.	To apply elementary operations to develop more sophisticated applications of quantum computing.

Course Outcomes:	
CO1	Analyse the behavior of basic quantum algorithms.
CO2	Implement simple quantum algorithms and information channels in the quantum circuit model.
CO3	Simulate a simple quantum error-correcting code.
CO4	Gain insights into quantum security.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	1	-	-	-	-	1	-
CO2	2	1	2	1	3	1	-	1	1	1	1	1
CO3	2	1	2	1	-	1	-	1	-	1	1	-
CO4	2	1	2	1	2	2	1	1	1	1	1	1

Course Overview:
The course will help students not only in specialising in the existing and changing technologies but also in various fields of R&D and electronic manufacturing. Since Quantum computers can solve computational problems faster than classical computers, Quantum Computing will help you surge ahead in your career. Quantum Computing course will help you solve problems above a specific size and complexity.

UNIT I: **[10]**
Introduction to Quantum Measurements: Introduction to Quantum Mechanics and Quantum Computing, Applications and Future of Quantum computing, Quantum Gates and Circuits. Optical approaches to Quantum Computing. Limits of approaches

UNIT II: **[10]**
Quantum Basics and Principles: No cloning theorem & Quantum Teleportation, Bell's inequality and its implications, Quantum Algorithms & Circuits. Quantum Measurements Density Matrices, Fragility of quantum information: Decoherence, Quantum Superposition, and Entanglement

UNIT III: **[10]**
Algorithms: Deutsch and Deutsch–Jozsa algorithms, Grover's Search Algorithm, Quantum Fourier Transform, Shore's Factorization Algorithm. Quantum Computing Models: NMR Quantum Computing, Spintronics, Linear Optical MODEL, Nonlinear

UNIT IV: **[10]**
Performance, Security and Scalability: Performance, Security and Scalability, Quantum Error Correction: Fault tolerance; Quantum Cryptography, Implementing Quantum Computing: issues of fidelity; Scalability in quantum computing.

Text Books:
1. Eric R. Johnston, Nic Harrigan, Mercedes and Gimeno-Segovia "Programming Quantum Computers: Essential Algorithms and Code Samples, SHROFF/ O'Reilly.
2. V.K Sahni, Quantum Computing (with CD), TATA McGraw-Hill.

Reference Books:
1. Chris Bernhardt, Quantum Computing for Everyone (The MIT Press).
2. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge (2002).
3. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd (2012).
4. Scott Aaronson, "Quantum Computing since Democritus", Cambridge (2013).
5. P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing", Cambridge.

Semester: 6th			
Paper code: OAE310T	**L**	**T/P**	**Credits**
Subject: Cryptography and Network Security	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the fundamentals of cryptography
2.	To acquire knowledge on standard algorithms used to provide confidentiality. Integrity and authenticity
3.	To analyze concepts, issues, principles of security related properties and validate using model checking
4.	To apply knowledge of a range of computer security technologies as well as Design techniques to achieve differential privacy for linear queries

Course Outcomes:

CO1	Understand the knowledge about security services, data privacy and mechanisms.
CO2	Analyse about Symmetrical and Asymmetrical cryptography.
CO3	Analyse and Understand about the concept of Data integrity, Authentication, Digital Signatures.
CO4	Investigate Various network security applications and Design mechanisms for query release problem using online learning algorithms.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:

Cryptography and Network Security is a comprehensive course covering the fundamentals of secure communication and information protection in computer networks. Students will explore encryption techniques, cryptographic algorithms, and protocols used to ensure confidentiality, integrity, and authentication. The course also delves into network security concepts such as firewalls, intrusion detection systems, and secure network design. Practical applications and case studies are included to enhance understanding of securing data transmission, securing network infrastructure, and addressing emerging security challenges.

UNIT - I **[12]**

Security Concepts: Introduction, The need for security and Data Privacy, Security approaches, Principles of security, Types of Security attacks, Security services and mechanisms, A model for Network Security, Social Aspects of Privacy, Legal Aspects of Privacy and Privacy Regulations, Database Security, Statistical Database security, Inference Control, Hippocratic databases.

Cryptography Concepts and Techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, steganography, key range and key size, possible types of attacks.

UNIT - II **[8]**

Symmetric key Ciphers: Block Cipher principles, DES, AES, RC5, IDEA, Block cipher operation, Stream ciphers, RC4.

Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange.

UNIT-III **[10]**

Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme.

Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure

UNIT-IV **[10]**

Anonymization: Linkage and re-identification attacks, k-anonymity, I-diversity, t-closeness, implementing anonymization, Anonymizing complex data, Privacy and anonymity in mobile environments, Database as a service, Privacy in Cloud infrastructure

Differential Privacy (DP): Formalism and interpretation of DP, Fundamental DP mechanisms and properties, Interactive and non-interactive DP, DP for complex data Local Differential Privacy (LDP)

Text Books:

1. Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 6th Edition
2. Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition
3. C. Dwork and A. Roth, The Algorithmic Foundations of Differential Privacy, now Publishers, 2014.

Reference Books:

1. Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan, Wiley India, 1st Edition.
2. Cryptography and Network Security: Forouzan Mukhopadhyay, Mc Graw Hill, 3rd Edition
3. Information Security, Principles, and Practice: Mark Stamp, Wiley India.
4. Charu C. Aggarwal, Privacy-Preserving Data Mining: Models and Algorithms, 1st Edition, Springer, 2008.

Semester: 6th			
Paper code: OAE312T	**L**	**T/P**	**Credits**
Subject: Mobile Application Development	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand the fundamentals of mobile application development, including the different platforms, frameworks, and tools available.
2.	Apply programming languages and technologies commonly used in mobile app development, such as Java/Kotlin for Android and Swift/Objective-C for iOS.
3.	Implement mobile app features like user authentication, social media integration, push notifications, and location-based services.
4.	Develop skills in integrating APIs and web services into mobile applications to enable data retrieval and real-time functionality.

Course Outcomes:

CO1	Understand the fundamentals of mobile application development, including the different platforms, frameworks, and tools available.
CO2	Analyze emerging trends and technologies in the field of mobile application development.
CO3	Implement core functionalities in mobile applications, such as data storage, network communication, and integration with external services.
CO4	Design and develop mobile applications for specific platforms (Android or iOS) using appropriate programming languages and frameworks.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

The Mobile Application Development course provides comprehensive knowledge and practical skills required to design, develop, and deploy mobile applications for various platforms, such as Android and iOS. This course covers the entire mobile app development lifecycle, including user interface design, programming languages, frameworks, data storage, integration with web services, testing, and deployment.

UNIT – I **[8]**

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.

UNIT – II **[8]**

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.

UNIT – III **[8]**

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

UNIT – IV **[8]**

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

Text Books:

1. Lauren Darcey and Shane Conder, “Android Wireless Application Development”, Pearson Education, 2nd ed. (2011)

Reference Books:

1. Reto Meier, “Professional Android 2 Application Development”, Wiley India Pvt Ltd
2. Mark L Murphy, “Beginning Android”, Wiley India Pvt Ltd
3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

Semester: 6th			
Paper code: OAE312P	**L**	**T/P**	**Credits**
Subject: Mobile Application Development Lab	**0**	**2**	**1**
Marking Scheme			
Teachers Continuous Evaluation: As per university examination norms from time to time End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			
Course Objectives:			
1	To provide hands-on experience in designing, developing, and testing mobile applications for various platforms.		
2	To apply the concepts and techniques learned in the theoretical aspects of mobile application development and gain proficiency in mobile app development tools and technologies.		
Course Outcomes:			
CO1	Integrate mobile applications with web services and APIs to enhance functionality and access remote data.		
CO2	Design and develop mobile applications that demonstrate efficient data storage and retrieval using various techniques, such as local storage, databases, and cloud storage		

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:

1. Design a simple user interface for a mobile application using a design tool or framework like Sketch, Adobe XD, or Flutter.
2. Hello World Application: Create a basic "Hello World" application for a mobile platform of your choice (Android or iOS) using the respective development environment.

3. Implement data storage functionality in your mobile application using local storage options like SQLite database or shared preferences.
4. Develop a mobile application that interacts with a RESTful API to fetch and display data from a remote server.
5. Integrate sensors such as accelerometer, gyroscope, or GPS into your mobile application to capture and utilize sensor data.
6. Add multimedia functionality to your mobile application, such as capturing photos/videos, playing audio files, or integrating with social media sharing.
7. Implement user authentication and authorization features in your mobile application, allowing users to register, log in, and access personalized content.
8. Incorporate push notifications into your mobile application, enabling the delivery of real-time alerts or messages to users.
9. Develop a mobile application that utilizes location services to provide location-based information, such as finding nearby places or tracking user movements.
10. Mobile App Testing and Debugging: Learn and apply various testing techniques, including unit testing, integration testing, and debugging, to ensure the quality and stability of your mobile application.

Semester: 6th			
Paper code: OAE314T	**L**	**T/P**	**Credits**
Subject: Virtual and Augmented Reality	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand how the design of VR technology relates to human perception and cognition
2.	Discuss applications of VR to the conduct of scientific research, training, and industrial design
3.	Learn the fundamental aspects of designing and implementing rigorous empirical experiments using VR.
4.	Learn about multimodal virtual displays for conveying and presenting information and techniques for evaluating good and bad virtual interfaces.

Course Outcomes:

CO1	Understanding the fundamental concepts and technologies of AR and VR.
CO2	Designing and developing AR and VR applications using appropriate software and hardware.
CO3	Analyzing and evaluating the usability and effectiveness of AR and VR applications.
CO4	Applying AR and VR to solve real-world problems in different fields such as education, Healthcare, entertainment, and training.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-

Course Overview:
The aim of the course is to provide students with the necessary skills and knowledge to understand, design, develop, and apply AR and VR technologies in various fields. This Course aims to introduce students to the fundamental concepts and technologies of AR and VR, including the hardware and software used to create and experience these immersive environments.

UNIT I **[10]**

Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality - Primary Features and Present Development on Virtual Reality - Multiple Models of Input and Output Interface in Virtual Reality: Input - Tracker - Sensor - Digital Glove - Movement Capture - Video-based Input - 3D Menus & 3DScanner – Output - Visual /Auditory / Haptic Devices.

UNIT II **[10]**

Visual Computation in Virtual Reality: Fundamentals of Computer Graphics - Software and Hardware Technology on Stereoscopic Display - Advanced Techniques in CG: Management of Large-Scale Environments & Real Time Rendering.

UNIT III **[10]**

Interactive Techniques in Virtual Reality: Body Track - Hand Gesture - 3D Manus - Object Grasp. Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega - MultiGen - Virtools.

Application of VR in Digital Entertainment: VR Technology in Film & TV Production - VR Technology in Physical Exercises and Games - Demonstration of Digital Entertainment by VR.

UNIT IV **[10]**

Augmented and Mixed Reality: Taxonomy - technology and features of augmented reality - difference between AR and VR - Challenges with AR - AR systems and functionality - Augmented reality methods - visualization techniques for augmented reality - wireless displays in educational augmented reality applications - mobile projection interfaces - marker-less tracking for augmented reality - enhancing interactivity in AR environments - evaluating AR systems.

Text Books:

1. Burdea, G. C., P. Coffet., “Virtual Reality Technology”, Second Edition, Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann, 2013.

Reference Books:

1. Alan Craig, William Sherman, Jeffrey Will, “Developing Virtual Reality Applications, Foundations of Effective Design”, Morgan Kaufmann, 2009.

Semester: 6th			
Paper code: OAE316T	**L**	**T/P**	**Credits**
Subject: Cloud Computing	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	This course introduces about the cloud environment.
2.	Building software systems and components that scale to millions of users in modern internet.
3.	Cloud concepts capabilities across the various cloud service models including IaaS, PaaS, SaaS, and developing cloud based software applications on top of cloud platforms.
4.	This course also introduces about the data intensive computing and studies about different cloud applications.

Course Outcomes:

CO1	Understands the basic concepts and terminologies in cloud computing, parallel and distributed computing
CO2	Demonstrate the knowledge in virtualization and different technology examples of virtualization
CO3	Understands the cloud computing architecture and how to build Aneka clouds.
CO4	Able to design data intensive applications using Map-Reduce programming.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:
This course explains various cloud computing and virtualization concepts and goes on to discuss the popular cloud providers.

UNIT I **[6]**

Introduction: Cloud Computing at a Glance, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies.

Principles of Parallel and Distributed Computing: Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing, Elements of Distributed Computing, Technologies for Distributed Computing

UNIT II **[8]**

Virtualization: Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples.

Cloud Computing Architecture: Introduction, Cloud Reference Model, Types of Clouds, Economics of the Cloud, Open Challenges

UNIT III **[10]**

Cloud Application Platform: Anatomy of the Aneka Container, Building Aneka Clouds, Cloud Programming and Management High-Throughput Computing: Task Programming: Task Computing, Task-based Application Models, Aneka Task-Based Programming.

Data Intensive Computing: Map-Reduce Programming: What is Data-Intensive Computing? Technologies for Data-Intensive Computing.

UNIT IV **[8]**

Cloud Applications: Scientific Applications, Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Biology: Gene Expression Data Analysis for Cancer Diagnosis, Business and Consumer Applications, Multiplayer Online Gaming.

Advanced Topics in Cloud Computing: Energy Efficiency in Clouds, Market Based Management of Clouds

Text/Reference Books:

1. Mastering Cloud Computing: by Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, McGraw Hill Education.
2. Cloud Computing: by Rajkumar Buyya, TMH

Semester: 6th			
Paper code: OAE316P	**L**	**T/P**	**Credits**
Subject: Cloud Computing Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To demonstrate the use of virtualization and cloud computing
2.	Understanding of virtualization technologies such as hypervisors, virtual machines, and containers used in cloud computing.

Course Outcomes:

CO1	Deploy and manage virtual machines and containers on a cloud platform.
CO2	Configure and manage cloud storage, network, and security services.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	-	-	-	-	1	-	-
CO2	2	2	2	2	1	1	1	-	1	1	1	2

List of Experiments:

1. Install virtualbox/vmware workstation 45 5 install a c compiler in the virtual machine and execute a sample program
2. Create type 2 virtualization in vmware. Allocate memory and storage space as per requirement. Install guest os on that vmware.
3. Adding a new virtual disk to a virtual machine. Convert basic disc to dynamic disc and vice versa
    a. Shrink and extend virtual disk
    b. Create, manage, configure and schedule snapshots
    c. Create spanned, mirrored and striped volume
    d. Create raid 5 volume

4. Sharing and data transfer between the virtual machines
5. Create type 2 virtualization on esxi 6.5 server
6. Create a vlan in cisco packet tracer
7. Create a vpn from one virtual machine to another virtual and pass data secure way
8. Find procedure to set up the one node hadoop cluster
9. Simulate a cloud scenario using cloudsim and run a scheduling algorithm that is not present in cloudsim.
10. Data analytics in the cloud: Perform data analytics and processing in a cloud environment using services such as AWS EMR, Google Cloud Dataproc, or Azure Hdinsight.
11. Implement cloud security controls such as encryption, access management, and network security using cloud-native services.

Semester: 6th			
Paper code: OAE318T	**L**	**T/P**	**Credits**
Subject: Software Project Management	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of fundamental concepts of software project management and explain the differences between software projects and other types of projects.
2.	To familiarize students with project selection criteria and identify project scope, objectives, infrastructure, products, and activities.
3.	To introduce students develop skills in activity planning, network diagramming, and critical path analysis to create project schedules and identify the critical path.
4.	To understand the nature of resources, identify resource requirements, and use visual tools and tracking mechanisms to monitor project progress..

Course Outcomes:

CO1	Understand the principles and practices of software project management, including project planning, estimation, scheduling, risk management, team collaboration, and quality assurance.
CO2	Apply various techniques for project estimation, evaluation, and cost-benefit analysis to make informed decisions in software project management.
CO3	Develop skills in activity planning, including sequencing and scheduling activities using network planning models such as CPM, Bar Charts, Gantt Chart, and PERT.
CO4	Gain knowledge and techniques for resource allocation, monitoring, and control to effectively manage project progress, track milestones, and ensure efficient resource utilization.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	1	1	1	1
CO2	3	3	3	3	2	-	-	-	1	2	1	2
CO3	3	3	3	3	2	-	-	-	1	1	1	1
CO4	3	3	3	3	3	-	-	-	1	1	1	1

Course Overview:

This course focuses on principles and practices for effectively managing software development projects. Topics covered include project planning, estimation, scheduling, risk management, team collaboration, and quality assurance. Students will gain practical knowledge in managing software projects through case studies and hands-on exercises.

UNIT I **[10]**

Introduction to Software Project Management (SPM): Definition of a Software Project (SP), SP Vs. other types of projects activities covered by SPM, categorizing SPs, project as a system, management control.

Software Project scheduling and planning: Basic concepts, project scheduling, defining a task set and task network, scheduling, earned value analysis indicators, Project elements, WBS [Work Breakdown Structure]. Selecting a project, identifying project scope and objectives, identifying project infrastructure, analyzing project characteristics, identifying project products and activities

UNIT II **[10]**

Project Estimation and Evaluation: software project estimation, decomposition techniques,empirical estimation models, estimation for object oriented projects, estimation for Agile development and Web engineering projects. Cost benefit analysis, cash flow forecasting, cost

benefit evaluation techniques, risk evaluation. Selection of an appropriate project report; choice of process model, structured methods, rapid application development, water fall, spiral models, Prototyping delivery, Albrecht function point analysis.

UNIT III **[10]**

Activity planning: Objectives of activity planning, project schedule, projects and activities, sequencing and scheduling activities, Network planning model; Network Diagrams : CPM, Bar Charts, Gantt Chart , PERT [Activity-on-arrow network; Activity on Node network Precedence network; Forward pass; Backward pass; Critical path.

Risk Analysis and Management: Risk and risk types, Risk Break down Structure, Risk management process, Evaluating schedule risk using PERT.

UNIT IV **[10]**

Resource allocation & Monitoring the control: Introduction, the nature of resources, identifying resource requirements, visualizing progress, Project Tracking, Status Reports, Milestone Analysis, Actual Versus Estimated Analysis of Effort and Schedule.

Software quality and project closure: Defining software quality attributes, ISO 9126, Software quality measures, Project Closure Analysis, The Role of Closure Analysis, Performing Closure Analysis.

Text Books:

1. Software Project Management (2nd Edition), by Bob Hughes and Mike Cottrell, 1999, TMH
2. Software Project Management, Walker Royce, 1998, Addison Wesley.

Reference Books:

1. R. S. Pressman, Software Engineering, TMH, 7th ed.
2. Pankaj Jalote, Software project management in practice, Addison-Wesley
3. Robert T. Futrell, Donald F. Shafer, and Linda I. Shafer, “Quality Software Project Management”, 2002, Pearson Education Asia.
4. Ramesh Gopalaswamy, “Managing Global Software Projects”, 2003, Tata McGraw-Hill
5. S. A. Kelkar, “Software Project Management”

Semester: 6th			
Paper code: OAE320T	**L**	**T/P**	**Credits**
Subject: Nature Inspired Algorithm	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of bio sensors and the principles of nature-inspired computing.
2.	To familiarize students with evolutionary algorithms and their application in nature-inspired computing
3.	To introduce students to swarm intelligence and its application in nature-inspired computing
4.	To explore non-swarm intelligence bio-inspired algorithms and their applications in nature-inspired computing.

Course Outcomes:

CO1	Students will be able to explain the concepts of bio sensors and apply nature-inspired computing techniques to solve computational problems.
CO2	Students will be able to design and implement evolutionary algorithms for solving optimization problems
CO3	Students will be able to apply swarm intelligence algorithms to solve optimization problems
CO4	Students will be able to design and implement bio-inspired algorithms for solving optimization problems.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	-	-	3	-	-	2
CO2	2	2	3	3	3	-	2	-	3	-	-	-
CO3	2	2	3	3	3	3	2	-	-	-	-	2
CO4	3	3	3	3	3	3	2	-	-	-	-	3

Course Overview:

The Course focuses on introducing the principles and applications of computational algorithms that are inspired by natural processes and phenomena. These algorithms draw inspiration from biological systems, physical processes, and social interactions in nature to solve complex optimization, decision-making, and prediction problems

Unit I **[10]**

Introduction to Bio Sensors and Nature-Inspired Computing Techniques: Introduction to bio sensors, Principles of nature-inspired computing, Applications of nature-inspired computing techniques, Bio-inspired algorithms overview, Introduction to optimization problems, Optimization techniques inspired by natural systems.

Unit II **[10]**

Evolutionary Algorithms based Nature-Inspired Algorithms: Introduction to evolutionary algorithms, Genetic algorithm, Evolutionary strategies, Differential evolution, Multi-objective optimization using evolutionary algorithms

Unit III **[10]**

Swarm Intelligence based Nature-Inspired Algorithms: Introduction to swarm intelligence, Particle swarm optimization, Ant colony optimization, Artificial bee colony algorithms, Firefly algorithms, Applications of swarm intelligence algorithms

Unit IV **[10]**

Bio-inspired (Non-Swarm Intelligence) Nature-Inspired Algorithms: Artificial immune systems Neural networks and Neurocomputing, Memetic algorithms, Immune-inspired algorithms, Applications of non-swarm intelligence bio-inspired algorithms

Human Activities or Scientific Laws based Nature-Inspired Algorithms: Introduction to nature-inspired algorithms based on human activities or scientific laws. Applications of nature-inspired algorithms based on human activities or scientific laws.

Text Books :

1. "Nature-Inspired Optimization Algorithms" by Xin-She Yang
2. "Introduction to Bio-inspired Computing" by Bernadette Murgue
3. Swarm Intelligence: From Natural to Artificial Systems" by Eric Bonabeau, Marco Dorigo, and Guy Theraulaz

Reference Books:

1. "Bio-Inspired Computation in Telecommunications" by Xin-She Yang and Richard Everson
2. "Nature-Inspired Computing: Algorithms, Applications, and Emerging Applications" by Khaled F. Hussain, Abdulrahman H. Altalhi, and Adel A. M. S. Abdelaziz

Semester: 6th			
Paper code: OAE320P	**L**	**T/P**	**Credits**
Subject: Nature Inspired Algorithms Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			
Course Objectives:			
1	Develop basic knowledge of Nature Inspired Computing Techniques and their working principle.		
2	Generate the possible ways of solution to a certain real world problem using Nature Inspired Computing Techniques		
Course Outcomes:			
CO1	Design and modify different Nature Inspired algorithms in terms of Initialization, Processing and Stopping Criteria		
CO2	Apply Nature Inspired algorithms to different set of practical problems.		

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	2	2	2		-	1	-	-	2
CO2	3	3	3	3	3	2		-	2	-	-	2

List of Experiments:

1. Programs based on Concept of Optimization
2. Programs based on Concept of Meta heuristics
3. Implementing reproduction techniques such as crossover and mutation.
4. Programs showing Implementation of GA
5. Programs using Problem solving approach of GA
6. Programs showing Implementation of ACO algorithm
7. Programs using Problem solving approach of ACO algorithm
8. Programs showing Implementation of PSO algorithm

9. Programs using Problem solving approach of PSO algorithm
10. Programs showing Implementation of Honey-bee algorithm
11. Programs using Problem solving approach of Honey-bee algorithm
12. Programs showing Implementation of Bat algorithm
13. Programs using Problem solving approach of Bat algorithm
14. Programs showing Implementation of Harmony Search
15. Programs using Problem solving approach of Harmony Search
16. Implementing basic DNA computing algorithms such as Adleman's experiment and test tube programming language.

Semester: 6th			
Paper code: OAE322T	**L**	**T/P**	**Credits**
Subject: Introduction to Robotics	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Ability of students to implement the mechanisms of robot along with its grippers. Furthermore to understand kinematics of robot using DH representation
2.	Ability of students to utilize the differential motion and velocities of robot using jacobian.
3.	Ability of students to use the dynamic analysis of forces using Lagrangian and Newtonian method.
4.	Ability of students to implement the online and offline programming of robots.

Course Outcomes:

CO1	Student will be able to implement the mechanisms of robot along with its grippers and understand kinematics of robot using DH representation
CO2	Student will be able to utilize the differential motion and velocities of robot using jacobian.
CO3	Student will be able to use the dynamic analysis of forces using Lagrangian and Newtonian method.
CO4	Student will be able to implement the online and offline programming of robots

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	3	3	2	1	-	1	3	1	2
CO2	3	3	3	3	3	1	1	-	2	3	1	2
CO3	3	3	3	3	3	1	1	-	3	3	2	3
CO4	3	3	3	3	3	3	2	-	3	3	2	3

Course Overview:
This course provides an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, 3D graphic simulation; control design, actuators, and sensors; wireless networking, task modeling, human-machine interface, and embedded software.

UNIT I **[10]**

Fundamentals of Robot Technology: Robot definition, automation and robotics, Robot anatomy, Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission

End effectors: Mechanical and other types of grippers, Tools as end effectors, Robot and effector interface, Gripper selection and design.

Sensors and actuators used in robotics: Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots

UNIT II **[10]**

Kinematics of Robots: Transformation Matrices, Inverse transformation matrices, Forward and Inverse kinematic equation for position and orientation, Denavit-Hartenberg representation of robot, inverse kinematic solution for articulated robot, Numericals.

Differential Motions and velocities: Jacobian, Differential motions of a frame, Differential motion between frames, Calculation of the Jacobian, Inverse Jacobian, Numericals.

UNIT III **[10]**

Dynamic analysis of Force: Lagrangian and Newtonian mechanics, Dynamic equations form multiple –DOF Robots, Static force analysis of Robots, Transformation of forces and moments between coordinate frames, Numericals.

Trajectory Planning: Basics of Trajectory planning, Joint space trajectory planning, Cartesian Space trajectories, Numericals.

UNIT IV **[10]**

Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

Off-line programming systems: Introduction, central issues in on-line and offline programming, Programming examples.

Application of robots: Typical applications of robots in material transfer, machine loading/unloading; processing operations; assembly and inspection.

Text Books:

1. Saha, S. K. (2014). *Introduction to robotics*. Tata McGraw-Hill Education.
2. Mittal, R. K., & Nagrath, I. J. (2003). *Robotics and control*. Tata McGraw-Hill.
3. Fu, K. S., Gonzalez, R., & Lee, C. G. (1987). *Robotics: Control Sensing. Vis*. Tata McGraw-Hill

Education.
4. Niku, S. B. (2001). *Introduction to robotics: analysis, systems, applications* (Vol. 7). New Jersey: Prentice hall.

Reference Books:

1. Spong, M. W., & Vidyasagar, M. (2008). *Robot dynamics and control*. John Wiley & Sons.
2. Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G. A., & Burgard, W. (2005). *Principles of robot motion: theory, algorithms, and implementations*. MIT press.
3. Bhaumik, A. (2018). *From AI to robotics: mobile, social, and sentient robots*. CR Press