Master of Computer Application (MCA) Credits of the Programme

Semester	No. of Courses		Total Credits
1	Theory	5	26
	Lab	3	
2	Theory	5	25
	Lab	3	
3	Theory	6	29
	Lab	2	
4	Major Project	1	20
	Theory	1	
Total Credits			**100**

Semester I				
Type	**Course Code**	**Course Name**	**Credits**	**Category**
Theory	CAMF0043	Mathematical Foundation for Computer Science	4	DC
	CAOTC0048	Theory of Computation	4	DC
	CAOOS0016	Operating Systems	4	DC
	CAODA0044	Data Structures and Algorithms	4	DC
	CAOPJ0018	Programming Through Java	4	DE
Lab	CAOOS6012	Operating Systems Lab	2	DC
	CAODA6033	Data Structures and Algorithms Lab	2	DC
	CAOPJ6014	Programming Through Java Lab	2	DE
Total Credits			**26**	
Semester II				
Theory	CAOSE0019	Software Engineering	4	DC
	CAOCC0045	Data Communication and Computer Networks	4	DC
	CAODM0046	Advanced Database Management Systems	4	DC
	CAOIT0022	Internet Technology and Applications	4	DC
	CAOSI0047	Sensor Networks and Internet of Things	3	DE
Lab	CAOCC6034	Data Communication and Computer Networks Lab	2	DC
	CAOIT6017	Internet Technology and Applications Lab	2	DE
	CAODM6035	Advanced Database Management Systems Lab	2	DC
Mandatory	CAOSL0200	Service Learning/Community Engagement	NC	IE
Total Credits			**25**	
Semester III				
Theory	CAOCL0033	Cyber Law and IT Security	4	DC
	CAOML0049	Machine Learning	4	DC
	CAOEP0024	Enterprise Resource Planning	4	DC
	ECRM0042	Research Methodology and IPR	2	DE
		ELECTIVE-I Specialization I: Artificial IntelligenceOR Specialization II: Data Science	4	DE
		ELECTIVE-II Specialization I: Artificial IntelligenceOR Specialization II: Data Science	4	DE
Lab	CAOML6036	Machine Learning Lab	2	DC

Semester I

CAOTC0048: THEORY OF COMPUTATION
(4 credits – 60 hours)

Objective

The objective of the Theory of Computation is to introduce and study abstract, mathematical models of computation (such as finite state, pushdown and Turing machines), and to use the abstract machine models to study the ability to solve computational problems. At the complete course students will be able to use regular expressions effectively and appropriately, construct derivations and parse trees, write simple programs for a Turing machine, understand the equivalence of grammars, languages and automata and translate between grammars, languages and automata.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Define basic terminology like Deterministic and Non deterministic automata, Pushdown Automata, Parse Tree, Regular Languages, Turing Machines etc. (Remembering)
- Make use of techniques, components and tools of a typical automated machine and apply it in designing new machines (Applying)
- Design deterministic and non-deterministic context-free grammars and understand their capabilities and limits. (Creating)
- Design deterministic and non-deterministic pushdown automata and Turing Machine. (Creating)
- Demonstrate the understanding of complexity classes and current unsolved problems in theoretical computer science. (Understanding).

Module I Theory of Automata (15 Hours)

Definition of an Automaton, Description of a Finite Automaton, Transition Systems, Properties of Transition Functions, Acceptability of a String by a Finite Automaton, Nondeterministic Finite State Machines, The Equivalence of DFA and NDFA, Mealy and Moore Models, Minimization of Finite Automata.

Module II Formal Languages, Regular Sets and Regular Grammars (15 Hours)

Definition of formal languages, Chomsky Classification of Languages, Languages and Their Relation, Recursive and Recursively Enumerable Sets, Operations on Languages, Languages and Automata; Regular Expressions, Finite Automata and Regular Expressions, Pumping Lemma for Regular Sets, Application of Pumping Lemma, Regular Sets and Regular Grammars.

Module III Context-free Languages (15 Hours)

Context-free Languages and Derivation tree, Ambiguity in Context-free Grammars, Simplification of Context-free Grammars, Normal Forms for Context-free Grammars, Pumping Lemma for Context-free Languages, Decision Algorithms for Context-free Languages.

Module IV Pushdown Automata Turing Machines and Linear Bounded Automata (15 Hours)

Basic Definitions, Acceptance by PDA, Pushdown Automata and Context-free Languages, Parsing and Pushdown Automata; Turing machine Model, Representation of Turing Machine, Language Acceptability by Turing Machines, Design of Turing Machines, Universal Turing Machine and Other Modification, The Model of Linear Bounded Automaton, Turing Machines and Type 0 Grammars, Linear Bounded Automata and Languages, Halting Problem of Turing Machines, NP-Completeness.

Suggested Readings

- K.L.P. Mishra, N. Chandrasekaran, Theory of Computer Science, BPB Publication, Prentice-Hall of India, Second Edition.
- H.R. Lewis and C.H.Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall of India.
- H.E. Hopcraft and J.D. Ullamn, Introduction to Automata Theory, Languages and Computation, Narosa Publications.
- J.C. Martin, Introduction to Languages and the Theory of Automata, Tata McGraw-Hill.
- C.H. Papadimitriou, Computation Complexity, Addison-Wesley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M	M	M	M
CO2	M	M	M	M
CO3			H	
CO4				H
CO5			M	H

CAOOS0016: OPERATING SYSTEMS

(4 credits – 60 hours)

Objective

The main objective of this course is to introduce the students to a layer of software called Operating Systems, whose job is to manage all the devices of a computer system and provide user programs with a simple interface to the hardware. This course will familiarize the students with the concepts of processes, memory management, file management, Input/Output management and the potential problem of deadlocks. The students will also learn about the Linux operating system, which is a full-blown Unix clone and is fast gaining popularity worldwide.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Elaborate what operating systems are, what they do and how they are designed and constructed. (Creating)
- Define process concepts like process scheduling, inter-process communication, process synchronization and concurrency. (Remembering)
- Explain different memory management schemes, relate various approaches to memory management and effectiveness of a particular algorithm. (Understanding)
- Identify different page replacement algorithms to solve problems. (Applying)
- Determine the concepts learned with case studies of Linux and Windows. (Evaluating)

Module I: Concepts, Processes and Threads (14 Hours)

Operating system as an Extended Machine and as a Resource Manager, Operating system concepts (Files, Deadlocks,Memory Management, Input/Output, Processes, The Shell, Security), The evolution of Operating Systems (Serial Processing, Simple Batch Systems, Multiprogrammed Batch Systems, Mainframe Operating Systems, Server Operating Systems, Time Sharing Systems, Multiprocessor Operating Systems, Real-Time Systems, Embedded Operating Systems, Smart Card Operating), System Calls (Process Management, File Management, Directory management), Introduction to Processes (The Process Model, Process Creation, Process Termination, Process Hierarchies, Process States, Implementation of Processes, Process Control Block), Threads (The Thread Model, Thread Usage, Implementing Threads(In User Space and Kernel), Scheduler Activation, Pop Up Threads, Interprocess Communication (Race conditions, Critical Sections, Mutual Exclusion with Busy Waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message Passing), Classical IPC problems (The DiningPhilosophers Problem, The Sleeping Barber Problem), Process Scheduling (Scheduling in Batch Systems, Scheduling in Batch Systems, Scheduling in Interactive Systems, Scheduling in Real-Time Systems, Thread Scheduling)

Module II: Deadlocks and Memory Management (14 Hours)

Resources, Deadlock (Conditions for Deadlock, Deadlock modeling), Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention, Memory management without swapping or paging (Monoprogramming without swapping or paging, Multiprogramming with fixed partitions, Relocation and Protection), Swapping, Virtual Memory (Paging, Page Tables), Page Replacement Algorithms (Not-recently-used, First in first out, Second Chance page replacement algorithm, The Clock Page Replacement Algorithm, Least Recently used page replacement algorithm, The Working Set Page Replacement Algorithm, Modeling Paging Algorithms (Belady's Anomaly, Stack Algorithms, Predicting page fault rates), Design issues for Paging Systems, Implementation issues, Segmentation (Implementation of pure segmentation, Segmentation with Paging: MULTICS)

Module III: Input/output and File Systems (16 Hours)

Principles of I/O hardware (I/O devices, Device Controllers, Direct memory access), Principles of I/O software, I/O Software Layers, Disks (Disk hardware, disk formatting, disk arm scheduling algorithms, Error handling, Track-at-atime caching, RAM disks) Clocks (Clock hardware, Clock software), Terminals (Terminal hardware, Input software, Output software)

Module IV: Introduction to Linux OS design – Case study (16 Hours)

Overview of Unix, Processes in Unix (Fundamental Concepts, Process Management System Calls in Unix, Implementation of Processes in Unix), Memory Management in Unix, Input/Output in Unix, The Unix File System, Security in Unix

Suggested Readings

- Andrew S Tanenbaum, Modern Operating Systems , (Second Ed.), Prentice Hall of India, New Delhi,
- William Stallings, Operating Systems, Fourth Edition, Prentice Hall of India, New Delhi.
- Silberschatz, Galvin, Operating System Concepts, Fifth Edition, John Wiley and Sons (Asia) Pte.
- HM Deitel, Operating Systems, Second Edition, Pearson Education.
- Pramod Chandra P. Bhatt, An Introduction to Operating Systems Concept, Prentice Hall of India.

- Maurice J. Bach, The Design of the Unix Operating System, Prentice Hall of India, New Delhi.
- Kernighan and Pike, The Unix Programming Environment, Prentice Hall of India, New Delhi.

Mapping of COs with Syllabus

Course Outcomes	Module1	Module2	Module3	Module4
CO1	H	M	L	
CO2	M	H	L	
CO3	M	H	M	
CO4		M	H	
CO5		L	H	M

CAOPJ0018: PROGRAMMING THROUGH JAVA
(4 credits–60 hours)

Objective

The course is designed to impart the knowledge and skill required to solve real world problems using an object-oriented approach utilizing Java language constructs. This course covers the two main parts of Java i.e. Java Language and Java Library (JDK 5). After completion of the course, a student is expected to be able to

- Do Object Oriented Programming using Java
- Implement Exception handling and Multithreading in Java.
- Create Java I/O Applications and Applets
- Set up a GUI using Swing components
- Do Network Programming in Java
- Access relational databases from the Java program and use Java Beans and Servlets.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Recall the various features of Object Oriented programming by utilizing the JAVA language construct. (Remembering)
- Explain the standard library, scope and lifetime of a variable and various control statements used in JAVA programs. (Understanding)

- Interpret the concept of classes and object in JAVA and apply exception handling to solve various exceptions (Applying)
- Contrast the different type of inheritance and polymorphism and Analyse it in resolving various problems (Analysing)
- Select the appropriate GUI and will be able to justify their decision to use a particular GUI by evaluating the required parameters depending on the domain and requirement. (Evaluating)
- Develop algorithms based on the knowledge they have gained to design cost effective and user friendly applications. (Creating)

Module I: Core Java Programming (14 Hours)

Java Overview: Genesis, Java Philosophy, Java and Internet, Object-Oriented Programming features, Java Applet and Application, Java Environment and Java Development Kit (JDK) and Java Standard Library (JSL),Java language fundamentals: The scope and lifetime of variable, Type conversion and casting, Control statements, Arrays, Classes and objects: The this keyword, Garbage collection, Overloading constructor, Using object as parameters, Argument passing, Returning objects, Recursion, Introducing Access control (public, private and protected), static, final, nested classes, String class, Command- line argument

Module II: Inheritance, Exception handling, Multithread and Applets (12 Hours)

Inheritance: Member access and inheritance, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance, the Object class; Packages, Interface, classpath Exception handling: Fundamentals, Exception types, Java's built-in exceptions, user defined exceptions, Multithreaded Programming: The Java thread model (thread priorities, synchronization and inter-thread communication),Deadlock, Thread Group I/O Basics: Streams, the stream classes, the predefined streams, Reading console input, writing console output, the transient and volatile modifiers, using instance of native methods

Module III String handling, Utility classes, java.lang and java.io (12 Hours)

String handling: String constructors, methods for character extraction, string searching and comparison, data conversion using valueof (), String Buffer,Exploring java. lang: Simple type wrappers, System class, class Class, Math functions,The utility classes: Vector, Stack, Hash Table, String Tokenizer, Bit set, Date, Calendar, Gregorian Calendar, Random, Observabled, Input/Output - Exploring java.io: The java.io classes and interface, File class and methods for creating, renaming, listing and deleting files and directories, I/O stream classes (File Input Sream, File Output Stream, Buffered Input Stream, Buffered Output Stream, Push Back Input Stream, Input Stream Reader, Buffered Reader, Buffered Writer, Print Stream, Random Access File)

Module IV: Networking, Images, Applet class and Swing (12 Hours)

Networking: Socket overview, Stream Sockets, Datagram sockets, Manipulating URLs, Establishing a simple Server/Client using Stream Sockets, Connectionless Client/Server Interaction with Datagrams, Images: File formats, image fundamentals, creating, loading and displaying images, ImageObserver, MediaTracker, The Applet class: applet architecture, passing parameters to applets, getDocumentBase, getCodeBase, and showDocument, AppletContext and AudioClip interfaces, Graphics class and methods for drawing lines, rectangles, polygons and ovals, Swing: Component and Container classes, Layout managers (Flow Layout, Grid Layout, Border Layout), Handling events, Adapter classes, Anonymous inner classes, Swing GUI components: JLabel, JTextField, JTextArea, JButton, JCheckBox, JRadioButton, JList, JComboBox, JScrollBar, JScrollPane, JToolTip, JPanel, JFrame, Menus: JmenuBar, JMenu, JMenuItem, JSeparator

Module V: Java Beans, JDBC, Java Servlets (10 Hours)

Java Beans: Introducing JavaBeans Concepts and Bean Development Kit (BDK), Using the Bean Box, Writing a simple Bean, Bean Properties (simple properties), Manipulating events in the Bean Box, Java database connectivity (JDBC): Introduction to JDBC, type of JDBC connectivity, Establishing database connections, Accessing relational database from Java programs

Suggested Readings

- Deitel, H. M.; P. J. Deitel, Java : How To Program (Sixth Edition), New Delhi: Prentice-Hall India, 2005
- Schildt, H., The Complete Reference Java 2 (Fifth Edition), New Delhi: Tata McGraw-Hill, 2005
- Moss, K., Java Servlets (Second Edition), New Delhi: Tata McGraw-Hill
- Russel, Java Programming for the absolute Beginner , New Delhi: Prentice-Hall India
- Hanagan D., Java Examples in a Nutshell (Third Edition), New Delhi: O' Reilly, 2001

Mapping of COs with Syllabus

Course Outcome	Module I	Module II	Module III	Module IV	Module V
CO1	H	H	M		
CO2	H	H	M		
CO3	H				
CO4		H			
CO5				H	H
CO6			M	M	M

CAOPA0030: PRINCIPLES OF ARTIFICIAL INTELLIGENCE

(4 credits – 60 hours)

Objective

Artificial Intelligence has embraced the larger scientific goal of constructing information-processing theory of intelligence. If such a science of intelligence could be developed, it could guide the design of intelligent machines as well as explicate intelligent behaviour as it occurs in humans and other animals. This paper describes the fundamental AI ideas that underlie many of the AI applications and provides a base for understanding natural intelligence.

Module I: General Issues and Overview of AI (12 Hours)

Introduction to AI: The AI problems, the underlying assumption, AI techniques, the level of the model, criteria for success, AI applications. Problem solving, search and control strategies: defining the problem as a state space search, production systems, control strategies, breadth-first search, depth-first search, problem characteristics, production system characteristics, issues in the design of search programs.

Module II: Search Strategies for AI Production Systems (16 Hours)

Heuristic search techniques: generate-and-test, hill climbing, simple hill climbing, steepest- ascent hill climbing simulated annealing, best-first search, OR-graphs, the A* algorithm, problem reduction, AND-OR graphs, the AO* algorithm, constraint satisfaction, means-end analysis. game playing: overview, the minimax search procedure, adding alpha-beta cutoffs, additional refinements, iterative deepening.

Module III: Knowledge Representation (16 Hours)

Knowledge representation issues: representations and mappings, representing simple facts in logic, knowledge representation attributes, computable functions and predicates, resolution, conversion to clause form, the basics of resolution, resolution in propositional logic, procedural vs. declarative knowledge, logic programming, forward vs. backward reasoning, matching, control knowledge. statistical reasoning: probability and Bayes' theorem, certainty factors and rule-based systems, Bayesian networks, Dempster-Shafer theory, basic notions and concepts of fuzzy sets, fuzzy set operations, information - based characterization of fuzzy sets, fuzzy relations and their calculus.

Module IV: Advanced AI (16 Hours)

Natural language processing: overview, morphological analysis, syntactic analysis, semantic analysis, discourse integration, pragmatic analysis, parsing techniques, top-down parsing, bottom-up parsing, augmented transition networks (ATN). Learning: rote learning, learning by taking advice, learning by induction, explanation-based learning. Expert system: representing and using domain knowledge, expert system shells, explanation, knowledge acquisition.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Recall and identify the need of incorporating human intelligence into machine and define the basic terms related to the concept of knowledge and representation, learning and reasoning, communication and language processing. (Remembering)
- Define problem state space, design algorithms to solve problems, generalized schema for knowledge interpretation and planning and language processing. (Understanding)
- Compute and demonstrate the problem in terms of state space and apply different AI algorithms to solve problems and construct logic to represent knowledge in the computational domain and also to interpret the natural language. (Applying)
- Compare and analyse the performance of algorithms based on problem domain. (Analysing)
- design and create new intelligent algorithms for application development by integrating experience based learning. (Creating)
- Judge and assess the algorithms based on completeness, optimality, and space and time complexity for solving a problem in an intelligent manner. (Evaluating)

Suggested Readings

- Rich, E.; K. Knight, Artificial Intelligence, (Second Edition), New Delhi: Tata McGraw-Hill, 1997
- Nilson, N. J., Principles of Artificial Intelligence, New Delhi: Narosa Publishing House, 2002
- Pedrycz, W.; F. Gomide, An Introduction to Fuzzy Sets: Analysis and Design, New Delhi: Prentice- Hall India, 2004.
- 2. Winston, P. H., Artificial Intelligence, New Delhi: Pearson Education Asia, 2002
- Charniak, E.; D. McDermott, Introduction to Artificial Intelligence, New Delhi: Pearson Education, 2002
- Russell, S.; P. Norvig, Artificial Intelligence: A Modern Approach (Second Edition), New Jersey: Prentice-Hall, 2003

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	L
CO 2	M	H	L	
CO 3	L	M	H	
CO 4		H	M	M
CO 5			H	M
CO 6		M	M	H

CAOCL0033: CYBERLAW and IT SECURITY (4-0-0)
(4 credits – 60 hours)

Objective:

- Understand Information Security Fundamentals: Introduce students to key concepts of information security, including threats, vulnerabilities, and appropriate security measures.
- Analyze Cyber Threats: Equip students with the ability to identify, determine, and analyze software vulnerabilities and assess security solutions to mitigate risks of exploitation.
- Explore Legal Frameworks: Familiarize students with the objectives and scope of the IT Act, emphasizing its relevance in cybersecurity and legal compliance.
- Comprehend Cryptographic Techniques: Provide an understanding of encryption methods, including symmetric and asymmetric cryptography, RSA algorithm, and public key encryption.
- Examine Digital Signatures: Educate students about digital signatures, their functions, and the legal implications of digital certificates in cybersecurity.
- Navigate Domain Name and Trademark Laws: Analyze the concepts of domain names, trademark jurisprudence, cybersquatting, and the legal challenges associated with digital identities.
- Identify Cybercrimes: Explore various types of cybercrimes, enhancing students' awareness of the legal and ethical dimensions of cybersecurity.
- Understand Regulatory Bodies: Study the establishment and composition of the Cyber Regulations Appellate Tribunal and the powers of adjudicating officers in awarding compensation and imposing penalties.
- Develop Practical Skills: Engage students in real-time scenarios and case studies to apply theoretical knowledge and develop practical skills in addressing cybersecurity challenges.
- Foster Critical Thinking: Encourage critical analysis and problem-solving regarding emerging security threats and the evolving landscape of information technology law.

COURSE/LEARNING OUTCOMES:

- Apply fundamental concepts of Information Security threats and vulnerabilities to adopt right security measures and design real time scenarios. (Applying)
- Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation. (Analyzing)
- Analyze and evaluate the cyber security needs of an individual/organization. (Analyzing, Evaluating)
- Design operational and strategic cyber security strategies and policies. (Creating)

- Analyze various types of cybercrime and formulate procedures for real world cybercrime Investigations. (Analyzing)

Module I: (12 hours)

Object and Scope of the IT Act - Genesis, Object, Scope of the Act. Encryption -Symmetric Cryptography, Asymmetric Cryptography, RSA Algorithm, Public Key Encryption

Module II: (14 hours)

Digital Signature- Technology behind Digital Signature, creating a Digital Signature, Verifying a Digital Signature, Digital Signature and PKI, Digital Signature and the Law. E-Governance and IT Act 2000- Legal recognition of electronic records, Legal recognition of digital signature, Use of electronic records and digital signatures in Government and its agencies, Certifying Authorities. Need of Certifying Authority and Power. Appointment, function of Controller. Who can be a Certifying Authority? Digital Signature Certifications. Generation, Suspension and Revocation of Digital Signature Certificate.

Module III: (12 hours)

Domain Name Disputes and Trademark Law: Concept of Domain Names, New Concepts in Trademark, Jurisprudence, Cybersquatting, Reverse Hijacking, Meta tags, Framing, Spamming, Jurisdiction in Trademark Dispute

Module IV: (12 hours)

Cyber Regulations Appellate Tribunal: Establishment & Composition of Appellate Tribunal, Powers of Adjudicating officer to Award Compensation, Powers of Adjudicating officer to impose Penalty.

Module V: (10 hours)

The Cyber Crimes (S-65 to S-74): Tampering with Computer Source Documents(S-65), Hacking with Computer System(S-66), Publishing of Information Which is Obscene in Electronic Form(s-67), Offences: Breach of Confidentiality & Privacy (S-72), Offences: Related to Digital Signature Certificate (S-73 & S-74)

Suggested Readings

- Farooq Ahmad, Cyber Law in India, Pioneer Books
- Vakul Sharma, Information Technology Law and Practice, Universal Law Publishing Co. Pvt. Ltd.
- Suresh T Vishwanathan, The Indian Cyber Law, Bharat Law house New Delhi.
- P.M. Bakshi and R.K.Suri, Hand book of Cyber and E-commerce Laws, Bharat Law house New Delhi.

- Rodney D. Ryder, Guide to Cyber Laws, Wadhwa and Company Nagpur.
- The Information Technology Act, 2000, Bare Act, Professional Book Publishers, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		M
CO 4				H	M
CO 5				M	H

CAOMF0043: MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE
(4 Credits)

Objective

- To introduce the concepts of mathematical logic.
- To introduce the concepts of sets, relations, and functions and relate practical examples to the appropriate set, function, or relation model, and interpret the associated operations and terminology in context.
- To perform the operations associated with sets, functions, and relations.
- To understand combinatorics and apply in solving problems.
- To use Graph Theory for solving problems

COURSE/LEARNING OUTCOMES

- Ability to apply mathematical logic to solve problems (Remembering, Understand)
- Recall some basic concept of set theory and understand the concept of graph theory and Group theory. (Remembering)
- Interpret logic sentence in terms of predicates, quantifiers, and logical Connectives (Understanding)
- For a given a discrete problem, classify its algebraic structure (Analyzing)
- Derive the solution of a problem using deductive logic and prove the solution based on logical inference (Applying)
- Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra (Evaluating)
- Develop the given problem as graph networks and solve with techniques of graph theory. (Creating)

Module I (13 hours)

Mathematical Logic: Statements and notations, Connectives, Well-formed formulas, Truth Tables, tautology, Logical equivalence: The Laws of logic, Logical Implication, Normal forms, Quantifiers, universal quantifiers. Predicates: Predicative logic, Free & Bound variables, Rules of inference, Consistency, proof of contradiction.

Module II (20 hours)

Set theory: Introduction, Basic Concepts of Set Theory, Representation of Discrete Structures, Relations and Ordering, Matrix representation of relations and partial ordered sets, representation of relations by Graphs; Lattices as Partially Ordered Sets, Boolean algebra; Functions. Algebraic Structures: Introduction, Algebraic Systems, Semi groups and Monoids; Groups,

Congruence Relation and Quotient Structures, permutation groups, Lagrange's Theorem; Normal subgroups. Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. (Definition, basic properties and examples)

Module III (12 hours)

Elementary Combinatorics: Basics of counting, Combinations & Permutations with repetitions, Constrained repetitions, Binomial Coefficients, Binomial and Multinomial theorem, Pigeonhole Principle, principles of Inclusion – Exclusion.

Module IV (15 hours)

Graph Theory: Basic Concepts, Sub graphs, Multi graphs Representation of Graphs, Isomorphism, Paths and Circuits, Traversing a Graph, DFS, BFS, Eulerian and Hamiltonian graphs, Shortest path algorithms, Planar Graphs, Chromatic Numbers. Tree and Spanning Trees. Applications of Graph Theory.

Suggested Readings

- Discrete Mathematical Structures with Applications to Computer Science by J. P. Tremblay and R Manohar, Tata McGraw- Hill Publications, 1997.
- Graph Theory by Narsingh Deo, Prentice-Hall of India publications, 2004.
- Discrete Mathematical Structures, Theory and Applications. D.S. Malik, Thomson Learning, I Edn
- Discrete Mathematics for Computer Science, Haggard, Thomson Learning, I Edn
- Discrete Mathematics and Its Applications by Kenneth H Rosen. Tata McGraw-Hill Publications
- Mathematical foundation of Computer Science by Y. N Sings. New Age international Publishers

- Bernard Kolman, Robert. C.Busby & Sharon Ross, "Discrete Mathematical structures" Prentice Hall of India,2001. Mapping of COs to Syllabus

Mapping of of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2		H		
CO 3	H			
CO 4		H		
CO 5		H		
CO 6		H	M	
CO 7				H

CAODA0044: DATA STRUCTURES AND ALGORITHMS
(4 Credits – 60 Hours)

Objectives

- To introduce first level topics covering basics in algorithms and data structures.
- To enable students to choose appropriate data structures, understand the ADT/libraries, and use of it to design algorithms for a specific problem.
- To understand the necessary mathematical abstraction to solve problems.
- To apply important algorithmic design paradigms and methods of analysis.

COURSE/LEARNING OUTCOMES

At the end of the course, students would be able to:

- Know the formal definition of algorithms, importance of analysis of an algorithm and get familiar with different types of problem and their solutions. (Remembering and Understanding)
- Choose appropriate data structure as applied to specified problem definition. (Applying)
- Understand different design strategies such as brute force, divide-and-conquer, dynamic programming, greedy technique and backtracking used for the design of algorithms. (Understanding)
- To design and analyse algorithms for given problems. (Applying)
- Compare and analyse different design strategies and assess an algorithm in terms of correctness, computation cost and memory space used. (Analysing and Evaluating) .
- Design new algorithms for given problems by using most appropriate algorithmic strategy considering the problem domain. (Creating)

Module I (14 Hours)

Introduction to Algorithms, Fundamentals Stages of Problem Solving, and Classification of Algorithms - Based on Implementation, Based on Design, Based on Area of Specialization, Based on Tractability, Basics of Algorithms Analysis, Asymptotic Analysis, Mathematical Analysis of Iterative and Recursive Algorithms, Empirical Analysis of Algorithms, Models of Computations - RAM model, Turing Machine.

Module II (12 Hours)

Data Structures: Abstract Data Types (ADTs), Stacks, Queues, Circular Queues, Implementation of Stacks using Queues,Implementation of Queues using Stacks, Priority Queues, Heaps, Linked Lists, Search and Update Operations on Varieties of Linked Lists, Graphs, Binary Trees, Tree Traversals, Binary Search Trees (BSTs), AVL Trees, Red Black Trees, Splay Trees, B-Trees, Disjoint Sets.

Module III (12 Hours)

Analysis of Sorting and Searching Algorithms: The sorting problem, Brute Force Approach - Sequential Search, Bubble Sort, Selection Sort, Decrease-and-Conquer Approach - Insertion Sort, Binary Search, Divide-and-Conquer Approach - Quick Sort, Merge Sort, Transform-and-Conquer Approach - Heap Sort, Linear Sorting Algorithms - Counting Sort, Radix Sort, Bucket Sort, Hashing - Hash Function, Collisions in Hashing, Separate Chaining, Open Addressing, Analysis of Search Operations.

Module IV (14 Hours)

Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques - Breadth First Search (BFS) and Depth First Search (DFS), Minimum Spanning Trees (MST), Greedy Techniques - Prim's and Kruskal's algorithms for MST, Dijkstra's Algorithm for Single Source Shortest Paths, Dynamic Programming - Warshall's Algorithm for finding Transitive Closure of a Graph, Floydd's Algorithm for All-Pairs Shortest Paths Problem. Algorithmic Design Techniques: Greedy Algorithms - Coin Change Problem, Scheduling Problem, Knapsack Problem, Huffman Trees, Divide-and-Conquer Approach - Strassen Matrix Multiplication, Closest-pair Problem, Tiling Problem, Dynamic Programming – Longest Common Subsequence (LCS) problem, Optimal Binary Search Trees, Travelling Salesperson Problem, Chain matrix multiplication.

Module V (8 Hours)

Tractable and Intractable Problems: Computability of Algorithms, Computability Classes – P, NP, NP-Complete, NP-Hard. Basics of Backtracking, Branch-and-bound methodologies for Algorithm design, Approximation algorithms, Randomized algorithms.

Suggested Readings

- Mark Allen Weiss, Data Structure and Algorithm Analysis in C++, Fourth Edition, Pearson, 2014.
- S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2014.
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, The MIT Press, 2009.
- Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Universities Press, 2008.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4			H	H	
CO 5		M	M	H	
CO 6					H

Semester II

CAOCC0045: DATA COMMUNICATION AND COMPUTER NETWORKS
(4 credits)

Objective

This course introduces students to computer networks and concentrates on building a firm foundation for understanding Data Communications and Computer Networks. It deals with the Data link layer, the Network layer, the Transport layer and the Application Layer. This course also introduces the concepts of network security and cryptography.

Module I: Digital Communications

Signals, noise, Nyquist rate, Shannon capacity; Analog transmission: modulation techniques, FDM; Digital transmission: PCM, TDM, line coding, xDSL,; Transmission media: Guided (twisted pair, coaxial, fiber optic) and unguided media; Local area networks: Ethernet, Fast Ethernet, introduction to Gigabit Ethernet and WLANs; Repeater, Hubs, Bridges, Switches, Router and Gateway.

Module II: Media Access Control and Data Link Layer

Data Link Layer Fundamentals: Framing, Error Control, Flow Control, Error Detection and Correction; Data link protocols: Stop&- Wait ARQ, Go-Back-NARQ, Selective Repeat ARQ, Piggybacking, Multiple Access Protocols: Advantages of Multiple-Access Sharing of Channel Resource, Pure ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), CSMA with Collision Detection (CSMA/CD), Asynchronous Transfer Mode (ATM)

Module III: Network Layer

IPv4 Addresses: Address space, Notations, Classful addressing, classless addressing, NAT; IPv6 Addresses: advantages, structure, address space, packet format, extension header; Transition from IPv4 to IPv6; Address Mapping, Delivery, Forwarding, Unicast Routing Protocols, Multicast Routing Protocols.

Module IV: Transport Layer and Application Layer

Process to Process Delivery: Client Server paradigm, Connectionless vs Connection Oriented Service, Services provided to upper layers, Transport Service primitives. UDP: Introduction, User Datagram, Checksum, UDP operations, use of UDP, Remote Procedure call TCP: Introduction, TCP Service Model, TCP Protocol, segment header, Connection Establishment and release, Transmission Policy, Congestion Control, Timer Management, Wireless TCP and UDP . Application Layer: Domain Name System, Simple Mail Transfer Protocol (SMTP), POP3, IMAP, File Transfer Protocol (FTP) Network Security: Cryptography, Symmetric Key Algorithms, Public Key Algorithms, Digital Signatures, Communication Security, Web Security

COURSE/LEARNING OUTCOMES:

At the end of the course the students will be able to:

- Understand and explain Data Communications System and its components (Understand, Explain)
- Understand and identify different networking terminologies and network architecture. Design issues in network and network transition. (understand)
- Students would be able to distinguish between IPV4 and IPV6 network together with MAC layer transmission and modulation schemes. (Analyze)
- Students would be able to understand and analyze what type of network to implement and decide what protocols to configure(Analyze)
- Students would be able to know why different layers are embodied with different protocols and different network architecture for different network needs. (Evaluate)
- Have a basic knowledge of the use of cryptography and network security; (Apply)

Suggested Readings

- Andrew S. Tenenbaum, Computer Networks (Fourth Ed.), Prentice Hall of India, 2002
- W Richard Stevens, UNIX Network Programming – Volume I (2nd Ed.), Prentice Hall of India, 2002
- William Stallings, Data and Computer Communications (Sixth Ed.), Prentice Hall of India, 2000
- Fred Halsall, Data Communication, Computer Networks and Opens Systems, (4th Ed.), Pearson Education, 2000
- William Stallings, Cryptography and Networking Security - Principles and Practice, Pearson

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4		M	M	M
CO 5			H	M
CO 6				H

CAODM0046: ADVANCED DATABASE MANAGEMENT SYSTEMS
(4 Credits - 60 hours)

Objective

The objective of this course is to introduce the basic conceptual background necessary to design and develop simple database systems. The course stresses on database modeling and design, physical file storage techniques and SQL query language facilities provided by database management systems. The course also presents some advanced database management concepts like query processing and optimization, transaction processing, concurrency control, recovery and security issues in database management systems.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Explain the core terms, concepts, and tools of relational database management systems (Understanding)
- Understand Normalization and Design ER-diagrams and corresponding schema diagrams for handling database projects (Creating)
- Recall and identify the techniques used by a DBMS to process, optimize and execute high level queries. (Remembering)
- Describe fundamentals of transaction processing system, including ACID properties of a transaction. (Understanding)
- Illustrate concurrency control & analyze several concurrency control techniques for ensuring serializability, locking, timestamping. (Analysing)
- Discuss some of the techniques that can be used for database recovery from failures and summarize the control measure for securing databases against a variety of threats. (Understanding)

Module I: Introduction (3 Hours)

Introduction: Introduction to databases, characteristics of the database approach, database users and designers, role of a DBA, advantages of using a DBMS, data models, schemas, instances, DBMS architecture (Three-Schema Architecture), Database systems- Network, Hierarchical, Relational, Data Independence

Module II: Relational Data Model and ER Models (12 Hours)

Relational Model: Domains, Attributes, Tuple and Relation; Super keys Candidate keys and Primary keys for the Relations. Relational Constraints: Domain Constraint, Key Constraint,

Integrity Constraint, Relational Algebra: basic relational algebra operations-SELECT, PROJECT, UNION, INTERSECTION, SET DIFFERENCE, Cartesian PRODUCT, JOIN, Aggregate functions.

Entity Relationship (ER) Model: Entities, Attributes, Relationships. More about Entities and Relationships, E-R Diagram, Conversion of E-R Diagram to Relational Database, Case Study.

Module III: Functional Dependencies and Normalization (10 Hours)

Functional Dependencies, First Normal Form, Second Normal Form, Third Normal Form, Boyce-Codd Normal Form, Multivalued Dependencies.

Module IV: Data Storage, Indexing, Query Processing and Query Optimization (11 Hours)

Overview of physical storage media, Magnetic Disks, RAID, File Organization: Fixed-length records, variable-length records. Organization of records in Files - Heap Files, Sequential File, Hashed Files. Indexing: Types of Single-level Ordered Indexes (Primary Indexes, Clustering Indexes, Secondary Indexes), Multilevel Indexes, Multilevel indexing using B tree and B+ tree, Indexing on multiple keys. Query Processing: Overview of query processing, Algorithms for query processing, Query Optimization

Module V: Transaction Processing and Concurrency Control (14 Hours)

Transaction Processing: Transaction, ACID properties of transaction, transaction states, schedules, serializability, tests for serializability, recoverability, transaction definition in SQL. Concurrency Control: Concurrent execution of transaction, Lockbased techniques for concurrency control, Graph-based protocol, Timestamp based protocol, Deadlock, Deadlock prevention methods, Deadlock detection Deadlock recovery.

Module VI: Recovery and Security (10 Hours)

Recovery system: Types of failure, types of storage, recovery and Atomicity, Log-based recovery, shadow paging, recovery with concurrent transactions, buffer management, logical undo logging, transaction rollback, checkpoints, restart recovery, fuzzy checkpointing ,Security: Security and Integrity-security violations, authorization and views, granting of privileges, security specifications in SQL, encryption, and statistical databases.

Suggested Readings

- Silberschatz, HF Korth, S Sudarshan, Database System Concepts, Tata- McGraw Hill, 1997.
- R Elmasri, SB Navathe, Fundamentals of Database Systems, Addisson, Wesley (Third Edition) 2000
- 3. DM Kroenke, Database Processing: Fundamentals, Design and Implementation, Prentice-Hall of India, (Eighth Edition) 2002.
- GW Hansen, JV Hansen, Database Management and Design, Prentice-Hall of India, (2nd Edition) 2001.

- Thomas M Connolly, Carolyn E Begg, Database Systems, A Practical Approach to Design, Implementation and Management, Addison Wesley Longman Ltd. 1999.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M	M	M	M	M
CO 2		H	H			
CO 3				H		
CO 4					H	
CO 5					H	
CO 6						H

CAOSI0047: SENSOR NETWORK AND INTERNET AND INTERNET OF THINGS
(3 Credits – 45 Hours)

Objective
This course will introduce the students to the Internet of Things(IoT) and basic structure of communication protocols in sensor networks. The course is designed to build up basic understanding of how to set up an application specific IoT network with better orientation and representation of sensor nodes.

Module I (8 hours) Introduction to IoT: Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics; IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs.

Module II (12 hours) M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, a use case example, Differing Characteristics. Definitions, M2M Value Chains, IoTValue Chains, An emerging industrial structure for IoT M2M vs IoT An Architectural Overview–Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. Reference Architecture and Reference Model of IoT.

Module III (18 hours) IoT Architecture: Introduction, Reference Model, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views, IoT with Arduino: Hands on Experience with Arduino (Firmware development & RTOS) - General Purpose I/O(GPIO), Serial Communication Interfaces: RS-232/485, Synchronous Peripheral Interfaces: I2C, SPI Sensors interfacing with Arduino, IoT with Raspberry PI: Hands on Experience with Raspberry PI (Firmware development) - Setting up Raspberry PI SD Card, Raspberry PI booting up & Initialization; General Purpose I/O(GPIO), Serial Communication Interfaces: RS-232/485, Synchronous Peripheral Interfaces: I2C, SPI; Sensors Interfacing with Raspberry

PIDomain specific applications of IoT:Home automation, Industry applications, Surveillance, applications, Other IoT applications.

Module IV (7 hours)

Wireless Sensor Networks & Protocols: Wireless Sensor Networks (WSNs), Introduction to WSNs Topologies in WSNs; Wired Communication Protocols – Ethernet, Serial Communications; Wireless Communication protocols Wifi, RF, IPV4/V6, 6LOWPAN, ZigBee(IEEE802.15.4), BLE, GSM(2G/3G/LTE).

COURSE/LEARNING OUTCOMES

- Explain the definition and usage of the term "Internet of Things" in different contexts and understand the key components that make up an IoT system (Remembering)
- Understand why it is necessary to build a separate model for IoT and what parameters influences the operation of IoT network. (Understanding)
- Apply the knowledge in designing IoT network for addressing real life issues for easing the day to day life activities. (Applying))
- Apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis. (Applying)
- Know what type of sensor protocols and architecture to adopt for efficient communication and what services offline and online to be used for problem solving. (Analyzing)

Suggested Readings

- Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.
- Qusay F. Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-Blackwell, 2018.
- Peter Waher, Mastering Internet of Things: Design and Create Your Own IoT Applications Using Raspberry Pi 3, Packt Publishing, 2018.
- Kazem Sohraby, Minoli Daniel and Znati Taieb, Wireless sensor networks: technology, protocols, and applications. John Wiley & Sons, 2007.
- Waltenegus Dargie, Christian Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice (Wireless Communications and Mobile Computing), Wiley-Blackwell, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	M
CO 4			H	

CO 5				H

CAOSE0019: SOFTWARE ENGINEERING
(4 credits–60 hours)

Objective

The field of software engineering aims to find answers to the many problems that software development projects are likely to meet when constructing large software systems. The objective of this paper is to make students aware of the problems incurred by large-scale software development and the solutions proposed. It covers a framework for studying and evaluating software tools, and stresses the importance of theory in the development of software.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Define the life cycle models of software. (Remembering)
- Explain, identify and differentiate various software life cycle models (Understanding)
- Analyse and design the software requirement specification and perform risk management and testing. (Analysing)
- Develop and create various design diagrams and find solutions to problems. (Creating)

Module I (10 Hours)

The Product and The Process: The Product - Evolving Role of Software, Software (Characteristics, Components and Applications;The Process – Software Engineering A Layered Technology, The Software Process, Software Process Models, The Linear Sequential Model, The Prototyping Model, The RAD Model, Evolutionary Process Models (The Incremental Model, The Spiral Model, The Component Assembly Model, The Concurrent Development Model), The Formal Methods Model, Fourth Generation Techniques; Project Management Concepts – The Management Spectrum (People, the Problem, the Process and the Project); Software Process and Project Metrics – Measures, Metrics and Indicators, Metrics in the Process and Project Domains, Software Measurement, Reconciling Different Metrics Approaches, Metrics for Software Quality; Software Project Planning – Observation on Estimating, Project Planning Objectives, Software Scope, Resources, Project Estimation Technique – Empirical estimation techniques (Expert Judgement Technique, Delphi Cost Estimation), Heuristic estimation techniques (COCOMO Model), Halstead Software Science (An Analytical Technique), The Make-Buy Decision;

Module II (10 Hours)

Project Scheduling and Tracking - Basic Concepts, The Relationship between People and Effort, Defining a Task set for the Software Project, Selecting Software Engineering Tasks, Defining a Task Network, Scheduling, The Project Plan; Software Projects Risks, Quality Assurance and Configuration Management: RiskManagement- Reactive Vs. Proactive Risk Strategies, Software Risk, Risk Identification, Risk Projection, Risk (Mitigation, Monitoring and Management), Safety Risks and Hazards, The RMMM Plan; Software Quality Assurance - Quality Concepts, The Quality Movement, Software Quality Assurance, Software Reviews, Formal Technical Reviews, Statistical Quality Assurance, Software Reliability, The SQA Plan, The ISO 9000 Quality Standards;Software Configuration Management - Software Configuration Management, The SCM Process, Identification of Objects in the Software Configuration, Version Control, Change Control, Configuration Audit, Status Reporting;System Engineering - Computer Based Systems, Product Engineering

Module III (20 Hours)

Analysis and Design: Analysis Concepts and Principles - Requirements Analysis, Communication Techniques, Analysis Principles, Software Prototyping, Specification, Specification Review; Analysis Modeling- The Elements of the Analysis Model, Data Modeling, Functional Modeling and Information Flow, Behavioral Modeling, the Mechanics of Structured Analysis, the Data Dictionary;Design Concepts and Principles - Software Design and Software Engineering, the Design Process, Design Principles, Design Concepts, Effective Modular Design, Design Heuristic for Effective Modularity, the Design Model, Design Documentation; Design Methods - Data Design, Architectural Design, the Architectural Design Process, Architectural Design Optimization, Interface Design, Human-Computer Interface Design, Interface Design Guidelines, Procedural Design; Design For Real Time systems - Real Time Systems;Case studies on diagram - Use case, Class, Activity, Sequence

Module IV (10 Hours)

Software Testing: Software Testing Methods - Software Testing Fundamentals, Test Case Design, White Box Testing, Basis Path Testing, Control Structure Testing, Black Box Testing, Testing for Specialized Environments; Software Testing Strategies - A Strategic Approach to Software Testing, Strategic Issues, Unit Testing, Integration Testing, Validation Testing, System Testing, The Art of Debugging; Technical Metrics For Software - Software Quality, A Framework For Technical Software Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance

Module V (10 Hours)

Object Oriented Software Engineering: Object Oriented Concepts and Principles - The Object Oriented Paradigm, Object Oriented Concepts, Identifying the Elements of an Object Model, Management of Object Oriented Software Projects, Object Oriented Analysis - Object Oriented Analysis, Domain Analysis, Generic Components of the Object Oriented Analysis Model, the OOA

Process, the Object Relationship Model, the Object Behavior Model, Object Oriented Design - Design for Object Oriented Systems, The Generic Components of the OO Design Model, The Systems Design Process, The Object Design Process, Design Patterns, Object Oriented Programming, Advanced Topics in Software Engineering: Cleanroom Software Engineering- The Cleanroom Approach, Functional Specification, Design Refinement and Verification, Cleanroom Testing Software Reuse - Management Issues, the Reuse Process, Domain Engineering, Building Reusable Components, Classifying and Retrieving Components, Economics of Software Reuse Reengineering - Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, Economics of Reengineering Computer Aided Software Engineering - Case Definition, Building Blocks of Case, Taxonomy of Case Tools, Integrated Case Environments, the Integration Architecture, the Case Repository

Suggested Readings

- Roger S. Pressman, Software Engineering A Practitioner's Approach, Fourth Edition, Tata McGraw Hill.
- Rajib Mall, Fundamentals of Software Engineering, Second Edition, Prentice Hall of India Private Limited.
- Ian Sommerville, Software Engineering, Sixth Edition, Addison Wesley, Pearson Education.
- Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals Of Software Engineering, Second Edition, Prentice Hall of India Private Limited, New Delhi, 2002.
- Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich, Modern Systems Analysis and Design, Second Edition, Pearson Education.
- Richard E Fairley, Software Engineering Concepts, Tata McGraw Hill Publishing Company Limited, New Delhi, 1997.
- Hans Van Vilet, Software Engineering Principles and Practice, Second Edition, John Wiley and Sons, Ltd.

Mapping of COs with Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H	L			
CO2	H	M	H		
CO3		H	M	H	
CO4			H		M

CAOIT0022: INTERNET TECHNOLOGY AND APPLICATIONS
(4 credits – 60 hours)

Objective

The objective of the course is to familiarize the students with a discussion on Internet and its growth. It also provides the students a study on the basic services provided by the Internet. A familiarization on the markup languages, scripting languages and web application development are also being discussed to make the student competent to design websites. It has been taken into consideration that this paper assumes that the students must know well in advance about the various protocols of the Internet and the knowledge of HTML and databases.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Recall and examine the growth of Internet and identify the history behind it. (Remembering)
- Identify and differentiate the various services provided by the internet. (Understanding)
- Experiment with various mark-up languages and scripting languages. (Applying)
- Analyse and design a website of their own and can also identify the faults in the design. (Analysing)
- Develop and create a website of their own. (Creating)
- Summarize and validate a practical solution towards a web application development and also deploy a website of their own. (Evaluating)

Module I: Introduction to Internet (10 Hours)

History of the Internet; History of the World Wide Web; W3C (World Wide Web Consortium); Levels of Internet Connectivity (Dial-up, Leased Line, DSL, VSAT); Requirements for Internet connectivity; Use of Browsers; Different types of browsers (IE, Opera, Netscape, Firefox); Search engines; FTP; Electronic Mail; Instant Messaging; DHCP; DNS; HTTP; URL; Proxy Servers.

Module II: Internet Markup Languages (12 Hours)

XHTML: What is XHTML? Components of XHTML; Elements of XHTML (Headers, Paragraphs, Linking, Images, Special Characters, Lists, Tables, Forms, Framesets),Cascading Style Sheets: Inline Styles; Embedded Style; Conflicting Style; Linking External Styles; W3C CSS Validation Service; Use of CSS (Positioning Elements, Backgrounds, Text flow) XML: What is XML? Structuring Data; XML Namespaces; Document Type Definitions and Schemas; XML Vocabularies; Document Object Model (DOM and its methods); Extensible Style Sheet Language (XSL)

Module III: Web servers, Databases and Scripting Languages (18 Hours)

Web servers: What is a web server; HTTP Request Types; System Architecture of a Web server; Client-side Scripting versus Server-side Scripting; Accessing Web servers; Apache Web Server, Databases: Introduction to each one of the following: SQL, MYSQL, DBI, Scripting Languages: Javascript: Operators, Data Types, Control Structures, Functions, Arrays, String Manipulation, Query, ASP.NET. Introduction to Perl and CGI (Common Gateway Interface). JSP: Introduction; JSP Overview; Scripting; Standard Actions; Directives, Java Servlets: Servlet overview and architecture, Servlet Interface and Servlet life cycle, HttpServlet Class, HttpServletRequest Interface, HttpServletResponse Interface, Handling HTTP get Requests, deploying a web application, Handling HTTP get requests containing data, Handling HTTP post requests.

Module IV: Web Application Development Using PHP (20 Hours)

Web Site Design Considerations: Using Logical Design: Planning your website, drawing a map, using a top-down approach, flexibility, other web design metaphors. Creating templates. Creating a Compatible Design: Designing for different color depths, resolutions, different browser considerations, accommodating limited bandwidth. Validating your work,PHP: Introduction to PHP; Data Types; Control Structures; Functions; Strings; Arrays; Querying Web Databases using PHP; Writing to Web Databases; Errors, Debugging and Deployment; Reporting in PHP; Validation Techniques in PHP.

Suggested Readings

- Deitel and Deitel, Internet and World Wide Web: How to Program, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi 2. Hugh E. Williams and David Lane, PHP and MySQL, 2nd Edition, O'Reilly, Shroff Publishers and Distributors Pvt. Ltd.
- Moss, K., Java Servlets (Second Edition), New Delhi: Tata McGraw-Hill
- Internet Complete, 2nd Edition, BPB Publications, New Delhi
- Douglas E. Comer, The Internet Book: Everything you need to know about Computer Networking and how the Internet works, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H			
CO 3			H	
CO 4		M		H
CO 5		M		H
CO 6		M		H

Semester III

CAOCL0033: CYBERLAW and IT SECURITY (4-0-0)
(4 credits – 60 hours)

Objective:

- Understand Information Security Fundamentals: Introduce students to key concepts of information security, including threats, vulnerabilities, and appropriate security measures.
- Analyze Cyber Threats: Equip students with the ability to identify, determine, and analyze software vulnerabilities and assess security solutions to mitigate risks of exploitation.
- Explore Legal Frameworks: Familiarize students with the objectives and scope of the IT Act, emphasizing its relevance in cybersecurity and legal compliance.
- Comprehend Cryptographic Techniques: Provide an understanding of encryption methods, including symmetric and asymmetric cryptography, RSA algorithm, and public key encryption.
- Examine Digital Signatures: Educate students about digital signatures, their functions, and the legal implications of digital certificates in cybersecurity.
- Navigate Domain Name and Trademark Laws: Analyze the concepts of domain names, trademark jurisprudence, cybersquatting, and the legal challenges associated with digital identities.
- Identify Cybercrimes: Explore various types of cybercrimes, enhancing students' awareness of the legal and ethical dimensions of cybersecurity.
- Understand Regulatory Bodies: Study the establishment and composition of the Cyber Regulations Appellate Tribunal and the powers of adjudicating officers in awarding compensation and imposing penalties.
- Develop Practical Skills: Engage students in real-time scenarios and case studies to apply theoretical knowledge and develop practical skills in addressing cybersecurity challenges.
- Foster Critical Thinking: Encourage critical analysis and problem-solving regarding emerging security threats and the evolving landscape of information technology law.

COURSE/LEARNING OUTCOMES:

- Apply fundamental concepts of Information Security threats and vulnerabilities to adopt right security measures and design real time scenarios. (Applying)
- Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation. (Analyzing)
- Analyze and evaluate the cyber security needs of an individual/organization. (Analyzing, Evaluating)
- Design operational and strategic cyber security strategies and policies. (Creating)
- Analyze various types of cybercrime and formulate procedures for real world cybercrime Investigations. (Analyzing)

Module I: (12 hours)

Object and Scope of the IT Act - Genesis, Object, Scope of the Act. Encryption -Symmetric Cryptography, Asymmetric Cryptography, RSA Algorithm, Public Key Encryption

Module II: (14 hours)

Digital Signature- Technology behind Digital Signature, creating a Digital Signature, Verifying a Digital Signature, Digital Signature and PKI, Digital Signature and the Law. E-Governance and IT Act 2000- Legal recognition of electronic records, Legal recognition of digital signature, Use of electronic records and digital signatures in Government and its agencies, Certifying Authorities. Need of Certifying Authority and Power. Appointment, function of Controller. Who can be a Certifying Authority? Digital Signature Certifications. Generation, Suspension and Revocation of Digital Signature Certificate.

Module III: (12 hours)

Domain Name Disputes and Trademark Law: Concept of Domain Names, New Concepts in Trademark, Jurisprudence, Cybersquatting, Reverse Hijacking, Meta tags, Framing, Spamming, Jurisdiction in Trademark Dispute

Module IV: (12 hours)

Cyber Regulations Appellate Tribunal: Establishment & Composition of Appellate Tribunal, Powers of Adjudicating officer to Award Compensation, Powers of Adjudicating officer to impose Penalty.

Module V: (10 hours)

The Cyber Crimes (S-65 to S-74): Tampering with Computer Source Documents(S-65), Hacking with Computer System(S-66), Publishing of Information Which is Obscene in Electronic Form(s-67), Offences: Breach of Confidentiality & Privacy (S-72), Offences: Related to Digital Signature Certificate (S-73 & S-74)

Suggested Readings

- Farooq Ahmad, Cyber Law in India, Pioneer Books
- Vakul Sharma, Information Technology Law and Practice, Universal Law Publishing Co. Pvt. Ltd.
- Suresh T Vishwanathan, The Indian Cyber Law, Bharat Law house New Delhi.
- P.M. Bakshi and R.K.Suri, Hand book of Cyber and E-commerce Laws, Bharat Law house New Delhi.
- Rodney D. Ryder, Guide to Cyber Laws, Wadhwa and Company Nagpur.
- The Information Technology Act, 2000, Bare Act, Professional Book Publishers, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		M
CO 4				H	M
CO 5				M	H

CAOML0049: MACHINE LEARNING
(4-0-0) (4 Credits – 60 Hours)

Objective:

The objective of this course is to provide students with a comprehensive understanding of machine learning principles, mathematical foundations, and practical applications. Through a structured exploration of various learning algorithms— including supervised and unsupervised methods, neural networks, and deep learning architectures—students will develop the ability to analyze, construct, and evaluate models for diverse problem domains. The course emphasizes both theoretical knowledge and hands-on experience, enabling students to preprocess data, build effective learning models, and apply advanced techniques such as convolutional and recurrent neural networks to real-world challenges.

COURSE/LEARNING OUTCOMES:

- Learn mathematical principles used in learning algorithms and relate them to learning principles. (Understanding)
- Construct and classify learning algorithms used in different problems. (Applying)
- Know what and how to perform pre-processing to make dataset ready for learning algorithms(Analysing)
- Create learning models and evaluate the effect of it in a given problem domain. (Evaluation)

Module I: (15 hours)

Mathematical Foundations of Machine Learning: Linear Algebra-Linear equations & vector spaces,matrix decomposition: determinant, Eigen values, singular value decomposition, matrix approximation, Calculus: Differentiation & partial differentiation, gradient of matrices, Probability & Distributions: Discrete and Continous probabilities, Gaussian distribution, Continous optimization:Gradient descent, Lagrange Multiplier.

Module II: (10 hours)

Learning: supervised and unsupervised learning,necessary of supervised learning, KNN, regression models,Naive Bayes' classifier, decision trees,random forest classifier, SVM:linear, non-linear.

Module III: (11 hours)

Data preprocessing & Scaling: Different kinds of preprocessing, Data transformations, Scaling: training data & testing data, Types of unsupervised learning, dimensionality reduction, clustering: k-Means, Fuzzy C -Means, DBSCAN, Comparing and evaluating clustering.

Module IV: (13 hours)

Neural Network: Biological to Artificial neurons, Logical computations with neurons, perceptron, MLP & backpropagation, Tuning neural network hyperparameters, vanishing and exploding gradient problems,momentum optimization:AdaGrad, Adam optimization, Regularization: L1 & L2, Convolutional property of neural network.

Module V: (11 hours)

Deep learning: Convolutional Neural Network: AlexNet, GoogleNet, ResNet, RNN: Training a RNN, deep RNN, LSTM cell, Auto encoders: stacked auto encoders, sparse auto encoder.

Suggested readings:

- Hands-On Machine Learning with Scikit-Learn & TensorFLow. Second edition, Aurelien Geron,2017, O' Reilly Media.
- Machine Learning-An Algorithmic Perspective, second edition, Stephen marshland,2015, CRC Press.
- Deep Learning, John D. Kelleher,2019, Massachusetts Institute of Technology(MIT).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H	M		
CO 3			H	M	
CO 4				H	H

CAOEP0024: ENTERPRISE RESOURCE PLANNING
(4 credits–60 hours)

Objective

To help the student understand the conceptual elements of ERP and its theory and implementation. This is especially poignant in view of large number of organizations implementing ERP applications in recent years. The student will appreciate the impact that ERP brings into the daily operations of firms with respect to their productivity, integration, communication, etc.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Recall the conceptual elements of ERP. (Remembering)
- Demonstrate the Influence of ERP in Large Organizations. (Understanding)
- Identify the impact of ERP into the daily operations of firms with respect to their productivity, integration, communication etc. (Applying)
- Analyse the practical side of ERP implementation with different vendors. (Analysing)
- Discuss and evaluate the best practices of ERP with various case studies and real time examples. (Creating, Evaluating)

Module I: ERP Basics (15 hours)

Evolution and structure of ERP, ERP concepts, growth of the ERP market, conceptual model of ERP, 2-tier and 3-tier architecture, elements in ERP architecture, advantages/benefits of ERP, overview of an enterprise, integrated management information, business modeling, integrated data model, ERP and related technologies: Business Process Reengineering (BPR), Management Information Systems (MIS), Decision Support Systems (DSS), Data Warehousing, Data Mining, Online Analytical Processing (OLAP), Supply Chain Management.

Module II: ERP Modules (15 hours)

Item types in ERP, Manufacturing, distribution and Financial requirements, item control module in ERP, Finance module, Manufacturing and Production Planning module, Sales and Distribution module, Plant Maintenance module, Quality Management module, Materials Management module, Capital Requirement Planning module, Purchase Control module, Human Resources modules; concept of Bill of materials, concept of formula management.

Module III: Profiling ERP Vendors (10 hours)

SAP AG: R/3 –, overview of R/3 system, R/3 modules, R/3 and the internet, BAAN: Baan ERP modules, Baan ERP Tools, Oracle: Oracle modules – Financials, Human Resources, Projects,

Manufacturing, Supply chain, PeopleSoft: Accounting and control, Treasury Management, Performance Management, Sales and Logistics, Procurement.

Module IV: ERP Implementation Lifecycle (10 hours)

Elements of implementation methodology, Pre-evaluation Screening, Package evaluation, project planning phase, Gap Analysis, Business Process Re-engineering, configuration, Implementation team training, testing, product migration and support, Problems in ERP implementation, cost of ERP.

Module V Best Practices in ERP (10 hours)

Concept of Best Practices, concept of Customer Order Decoupling Point(CODP), Demand Management – Sales and Operations Planning, ERP scenario in India, future directions in ERP, Case studies should also be introduced to highlight situations where ERP projects are implemented, and the success stories/benefits/difficulties of these implementations.

Suggested Readings

- O'Leary, Daniel E, Enterprise Resource Planning Systems: systems, life cycle, electronic commerce and risk, Cambridge University Press.
- Alexis Leon, Enterprise Resource Planning, 14th reprint, Tata McGraw Hill, New Delhi 2005
- Rahul V Altekar, Enterprise Resource Planning (Theory and Practice), Prentice Hall India, New Delhi 2004
- Alexis Leon, ERP Demystified, Tata McGraw Hill Pub. Co. Ltd, 2000
- Kent Sandoe, Enterprise Integration, John Wiley and Sons
- Garg and Venkitakrishnan, Enterprise Resource Planning : Concepts and Practice, 2nd edition, Prentice Hall India
- Garg and Venkitakrishnan, ERPWARE: ERP Implementation Framework, Prentice Hall India
- ERP – Concepts and Cases, ICFAI University Press, 2004

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		M	H		
CO 3		H	M		
CO 4		L		H	
CO5					H

ECRM0042 RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHT (L-T-P: 2-0-0) (2credits-30 hours)

Objective:

This course is designed to help students to identify research problems in various fields. It aims at giving potential researchers the knowledge of effectively analysing and interpreting results and presenting the findings to the scientific and technological community of the world. This course also aims at motivating students to bring about their creative ideas for innovation and establishing research impact in the global for a through intellectual ownership.

Course Outcomes

- Find research problems in various fields (Remembering).
- Illustrate the concepts related to patents, trademark and copyright (Understanding).
- Apply scientific investigations to find solutions for research problems of interest (Applying).
- Develop technical writing and presentation skills (Applying).
- Analyze the available literature and compile literature review for knowing the state of the art in the areas of interest (Analyzing/ Creating).
- Formulate a research problem for a given engineering domain (Creating)

Module I (12 Hours)

Meaning, sources, scope and objective of a research problem; Good research problem criteria and characteristics, errors in selecting a research problem; Research problem solutions– approaches for investigation; Approaches to effective literature studies; Data collection, analysis, interpretation and instrumentation; Plagiarism and ethical practices.

Module II (10 Hours)

Effective writing; Research proposal development and its format; Different report types.

Module III (8 Hours)

Nature of intellectual property: Patent, design, trade and copyright; Patenting and development process; Patent grant under PCT and procedure; Geographical indications, Patent rights: Administration of patent systems, scope, information and databases, technology licensing, New developments and case studies.

Suggested Readings

- Goddard Wayne, Melville Stuart, Research Methodology: An Introduction For Science And Technology Students, Juta & Co. Ltd.
- Kumar Ranjit, Research Methodology A Step By Step Guide For Beginners, SAGE publications Inc.
- Halbert J. Debora, Resisting Intellectual Property, CRC press.
- Menell S. Peter, Lemley A. Mark, Merges P. Robert, Intellectual Property In New Technological Age, Clause 8 Publishing.
- C.R. Kothari, Research Methodology Methods and Techniques, New Age International

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		L
CO 2	M		H
CO 3	H	L	
CO 4	L	H	M
CO 5	H	M	L
CO6	H	M	L

CAOPA0030: PRINCIPLES OF ARTIFICIAL INTELLIGENCE
(4 credits – 60 hours)

Objective

Artificial Intelligence has embraced the larger scientific goal of constructing information-processing theory of intelligence. If such a science of intelligence could be developed, it could guide the design of intelligent machines as well as explicate intelligent behaviour as it occurs in humans and other animals. This paper describes the fundamental AI ideas that underlie many of the AI applications and provides a base for understanding natural intelligence.

Module I: General Issues and Overview of AI (12 Hours)

Introduction to AI: The AI problems, the underlying assumption, AI techniques, the level of the model, criteria for success, AI applications. Problem solving, search and control strategies: defining the problem as a state space search, production systems, control strategies, breadth-first search, depth-first search, problem characteristics, production system characteristics, issues in the design of search programs.

Module II: Search Strategies for AI Production Systems (16 Hours)

Heuristic search techniques: generate-and-test, hill climbing, simple hill climbing, steepest-ascent hill climbing simulated annealing, best-first search, OR-graphs, the A* algorithm, problem reduction, AND-OR graphs, the AO* algorithm, constraint satisfaction, means-end analysis. game playing: overview, the minimax search procedure, adding alpha-beta cutoffs, additional refinements, iterative deepening.

Module III: Knowledge Representation (16 Hours)

Knowledge representation issues: representations and mappings, representing simple facts in logic, knowledge representation attributes, computable functions and predicates, resolution, conversion to clause form, the basics of resolution, resolution in propositional logic, procedural vs. declarative knowledge, logic programming, forward vs. backward reasoning, matching, control knowledge. statistical reasoning: probability and Bayes' theorem, certainty factors and rule-based systems, Bayesian networks, Dempster-Shafer theory, basic notions and concepts of fuzzy sets, fuzzy set operations, information - based characterization of fuzzy sets, fuzzy relations and their calculus.

Module IV: Advanced AI (16 Hours)

Natural language processing: overview, morphological analysis, syntactic analysis, semantic analysis, discourse integration, pragmatic analysis, parsing techniques, top-down parsing, bottom- up parsing, augmented transition networks (ATN). Learning: rote learning, learning by taking advice, learning by induction, explanation-based learning. Expert system: representing and using domain knowledge, expert system shells, explanation, knowledge acquisition.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Recall and identify the need of incorporating human intelligence into machine and define the basic terms related to the concept of knowledge and representation, learning and reasoning, communication and language processing. (Remembering)
- Define problem state space, design algorithms to solve problems, generalized schema for knowledge interpretation and planning and language processing. (Understanding)
- Compute and demonstrate the problem in terms of state space and apply different AI algorithms to solve problems and construct logic to represent knowledge in the computational domain and also to interpret the natural language. (Applying)
- Compare and analyse the performance of algorithms based on problem domain. (Analysing)
- design and create new intelligent algorithms for application development by integrating experience based learning. (Creating)
- Judge and assess the algorithms based on completeness, optimality, and space and time complexity for solving a problem in an intelligent manner. (Evaluating)

Suggested Readings

- Rich, E.; K. Knight, Artificial Intelligence, (Second Edition), New Delhi: Tata McGraw-Hill, 1997
- Nilson, N. J., Principles of Artificial Intelligence, New Delhi: Narosa Publishing House, 2002
- Pedrycz, W.; F. Gomide, An Introduction to Fuzzy Sets: Analysis and Design, New Delhi: Prentice- Hall India, 2004.
- Winston, P. H., Artificial Intelligence, New Delhi: Pearson Education Asia, 2002
- Charniak, E.; D. McDermott, Introduction to Artificial Intelligence, New Delhi: Pearson Education, 2002
- Russell, S.; P. Norvig, Artificial Intelligence: A Modern Approach (Second Edition), New Jersey: Prentice-Hall, 2003

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	L
CO 2	M	H	L	
CO 3	L	M	H	
CO 4		H	M	M
CO 5			H	M
CO 6		M	M	H

CAOHC0050: HUMAN COMPUTER INTERACTION (HCI)
(4-0-0) (4 Credits – 60 Hours)

Objective:

The objective of the Human Computer Interaction (HCI) course is to equip students with a comprehensive understanding of the principles, theories, and practices that govern the design and evaluation of user interfaces. By exploring the physiological, perceptual, and cognitive factors influencing human interaction with technology, students will learn to create user-centered designs that enhance usability and accessibility across various applications, including multimedia, e-commerce, and mobile platforms.

Through a blend of theoretical knowledge and practical skills, students will:

- Grasp foundational concepts in HCI, including human cognition, memory, and the history of interaction design.
- Analyze and evaluate user interfaces using established design principles and empirical methods.
- Apply iterative design processes to develop effective and meaningful user interfaces tailored to specific user needs.

- Understand and apply contemporary issues in HCI, such as mobile interaction and brain-computer interfaces, while considering ethical implications.

Ultimately, students will emerge from the course as competent designers who can critically assess and enhance the quality of user experiences across diverse technological environments.

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

- Learn the basic physiological, perceptual, and cognitive components of human learning and memory and gain theoretical knowledge of the fundamental aspects of designing and implementing user interfaces (Remembering)
- Explain the HCI implications for designing various applications such as multimedia/apps/ ecommerce/ e-learning Web sites. (Understanding)
- Design effective HCI for individuals. (Applying)
- Analyze the quality of user interface (Analyzing)
- Assess the importance of user feedback. (Evaluating)
- Develop meaningful user interface. (Creating)

Module I: Introduction to HCI And History (10 Hours)

What is HCI? Historical evolution of the field. Human brain and computer: The Human sensation and perception–Human Memory – Reasoning and problem solving; The computer and its I/O Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms- Problems and challenges.

Module II: Design and Software Process (22 Hours)

Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process– software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Design Evaluation Techniques – Experimental evaluation and Empirical Methods: Hypothesis testing, Choosing participants and sample size, Variables: independent and dependent measures, Types of experimental designs, Data analysis.

Module III: Models and Theories (9 Hours)

Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and Collaboration modelsHypertext, Multimedia and WWW. Design Case studies: Multi-Key press Hindi Text Input Method on a Mobile Phone, Employment Information System for unorganized construction workers on a Mobile Phone.

Module IV: Mobile HCI (7 Hours)

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Module V: Brain-Computer Interaction (BCI) and Neuroprosthetics/Sensory substitution (12 HOURS)What is BCI? BCI and brain plasticity-Neuroergonomics and Neurocognitive Engineering-Medical applications of BCI: Neuroprosthetics, Commercial Applications of BCI, Ethical implications of these interfaces, Neuroprosthetics vs. sensory substitution, Most sensory substitution devices compensate for loss of vision: discussion of visual to tactile and visual to auditory devices, Components of sensory substitution devices, Underlying theories and why it works?

Suggested Readings:

- "Human Computer Interaction", 3rd Edition , Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, 2004, Pearson Education.
- "Designing the User Interface: Strategies for Effective Human-Computer Interaction", 5th Edition, Shneiderman, Plaisant, Cohen, and Jacobs, 2009, Addison Wesley.
- "Introduction to Human Factors Engineering", 2nd Edition, Wickens, Lee, Liu, and Gordon-Becker, 2004, Pearson.
- "Human Computer Interaction", Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T., 1994, Addison-Wesley.
- "Designing the User Interface", B. Shneiderman; 2000, Addison Wesley(Indian Reprint).
- "Mobile Design and Development", First Edition, Brian Fling, 2009, O'Reilly Media Inc.
- "Designing Web Interfaces", First Edition, Bill Scott and Theresa Neil, 2009, O'Reilly.

Mapping of Course Outcomes

Course outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	L			H
CO 2	L	H	M	M	L
CO 3		H	H	M	
CO 4		H	H	L	
CO 5		M	H	H	
CO 6			H	H	M

CAOBI0051: BIOINFORMATICS
(4-0-0) (4 Credits – 60 Hours)

Objective:
The objective of the Bioinformatics course (CABI0051) is to equip students with a comprehensive understanding of the mathematical and computational principles essential for analyzing biological sequences and structures. Students will learn about different protein structure and use algorithm models for alignment analysis, Design phylogenetic tree for discovering pattern in sequence analysis and Analyze, predict and model protein structure and assess the structures in details.

Course Outcomes:

- Relate the different mathematical principles that are necessary in sequence analysis and searching. (Remembering).
- Explain the different protein structure and use algorithm models for alignment analysis. (Understanding)
- Design phylogenetic tree for discovering pattern in sequence analysis. (Creating)
- Analyze , predict and model protein structure and assess the structures.(Evaluating)

Module I: (16 hours)

Introduction to bioinformatics, opportunity and challenges in bioinformatics, protein sequence, analyzing protein sequences, analyzing DNA sequences, palindromes in DNA sequences, coding DNA sequences, RNA structures and sticky strands, pubmed, Expasy, Assessment of structure prediction, protein engineering.

Module II: (15 hours)

Genome organization, picking out genes in genomes, genome of homosapiens, database indexing, nucleic acid sequence database,genome database, protein sequence database, database of protein families, structures, protein identification resource, sequence alignments and dotplots, sequence similarity quantification, scoring schemes, dynamic programming for optimal pairwise alignment, multiple sequence alignment, editing and publishing alignments.

Module III: (14 hours)

phylogenetic tree, taxonomic relationships, clustering and cladistic methods, ancestral sequences and its reconstruction, evolution and varying rates of evolution, preparing data for phylogenetic tree, BLAST search, building the tree specific to a problem, phylip and open source tools for generating tree, maximum likelihood tree.

Module IV: (15 hours)

Folding and protein stability, sidechains, denaturation in relation to protein stability, coiled-coiled proteins, helical model, structural elements and superposition, mustang, dali, protein structure evolution, SCOP classification, prediction of protein structure and modeling, assessment of structure prediction,

secondary structure and prediction, homology modeling and fold recognition. Three dimensional profiles to assess quality of structures.

Suggested readings:

- Bioinformatics for dummies, second edition, Jean-Michel, Cedric Notredame, 2007, Wiley publishing
- Introduction to bioinformatics, fourth edition, Arthur M. Lesk,2014, Oxford University Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		M
CO 3			H	
CO 4				H

CAODL0052: DEEP LEARNING
(4-0-0) (4 Credits – 60 Hours)

Objectives:
The objective of the course is to introduce students to the basic concepts of deep learning and optimization algorithms, understand deep learning computation, CNNs and modern CNNs ,Study recurrent neural networks and its modern versions, learn computer vision, Comprehend GANs.

Course Outcomes:

- Recall the various deep learning related terms, tools, and technologies (Remembering)
- Compare and contrast the various types of neural networks (Analysing)
- Test, explore and estimate all the parameters for neural networks. (Evaluating)
- Illustrate the various deep unsupervised learning techniques for solving specific real-world problems. (Understanding)
- Experiment how to deploy neural network algorithm to solve real-world problems. (Applying)

Module I: Basics of Deep Learning (14 Hours)

Introduction: Basics of Artificial Intelligence, Machine learning, and Deep learning; History and Capabilities of Deep Learning, Deep Learning primitives – Soft Max Function, Sigmoid, Tanh and ReLU Neurons, Functions and Gradient Descent, Linear/Logistic regression, Vectorizing Logistic regression, Neural Network: Basic concepts of artificial neurons, single and multi-layer perceptrons, perceptron learning algorithm, perceptron convergence theorem, gradient descent and backpropagation algorithm, the vanishing gradient problem, gradient descent, regularization, dropout

Module II: Types of Neural Networks (18 Hours)

Convolutional Neural Networks (CNN): Introduction to CNN, CNN Architectures, Convolution / pooling layers, Correlation, Filtering, CNN architectures, Detection and Segmentation, Advanced CNNs for computer vision Advanced Deep Architectures: Recurrent Neural Networks, Long Short-Term Memory Units (LSTM), Gated Recurrent Unit (GRU), Encoder Decoder architectures, Generative Adversarial Networks (GANs)

Module III: (10 Hours)

Deep Unsupervised Learning: Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, clustering learning, Adversarial Generative Networks, Learn-from-data model, Autoencoder and DBM Attention and memory models, Maximum Entropy Distributions, Unsupervised learning of visual representations from image patches and locality, Unsupervised Learning of Visual Representations using Videos

Module IV: Deep Learning in Practice (18 Hours)

Deep Learning for Computer Vision: Introduction to convnets, training a convnet on small datasets, using a pretrained convnet, Applying Deep Learning for Object detection, face recognition, and automatic image classification, Deep Learning for Natural Language Processing (NLP): Introduction to NLP, Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning, Named Entity Recognition, Opinion Mining using Recurrent Neural Networks, Parsing and Sentiment Analysis using Recursive Neural Networks, Sentence Classification using Convolutional Neural Networks

Suggested Readings

- Nielsen, Michael A. Neural networks and deep learning. Vol. 25. San Francisco, CA: Determination press, 2015.
- Goodfellow, Ian, et al. Deep learning. Vol. 1. No. 2. Cambridge: MIT press, 2016.
- Deng, Li, and Yang Liu, eds. Deep learning in natural language processing. Springer, 2018.
- Wani, M. Arif, et al. Advances in deep learning. Springer, 2020.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3	L	H		M
CO 4			H	
CO 5		M		H

CAOSC0053: SOFT COMPUTING
(4-0-0) (4 Credits – 60 Hours)

Objectives:
The objective of the course is to introduce students to the soft computing concepts and techniques and foster their abilities in designing appropriate techniques for a given scenario, to implement soft computing based solutions for real world problems, to give students knowledge of non-traditional technologies and fundamentals of artificial neural network, fuzzy sets, fuzzy logic, genetic algorithms, to provide student hand-on experience on MATLAB to implement various strategies.

Course/Learning Outcomes

At the end of the course, students would be able to:

- Identify and describe soft computing techniques and their roles in the development of smart machines. (Remembering and Understanding)
- Apply fuzzy logic and reasoning to deal with uncertainty and solve various problems. (Applying)
- Analyze the architecture and algorithms of Neural networks to meet the challenges of soft computing problems. (Analyzing)
- Analyze genetic algorithms to combinatorial optimization problems. (Analyzing)
- Evaluate and compare solutions to a given problem using various soft computing approaches. (Evaluating and Creating)
- Effectively use existing software tools to solve real problems using a soft computing approach. (Applying)

Module I (6 Hours)

Introduction to Soft Computing, Characteristics of Soft Computing, Soft Computing Versus Hard Computing, Soft Computing Constituents, Applications of Soft Computing techniques, Evolutionary Computing, Machine Learning Basics.

Module II (11 Hours)

Fuzzy Logic: Introduction to Fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, Rules, Propositions, Implications and Inferences, Fuzzification and Defuzzification, Fuzzy ogic controller, Fuzzy Expert Systems, Fuzzy Decision Making, Applications of Fuzzy logic.

Module III (15 Hours)

Neural Networks: Biological neurons and its working, Introduction to Artificial Neural Network, Artificial Neural Networks Versus Biological Neural Networks, Activation functions, ANN architectures : McCulloch & Pitts model, Perceptron, ADALINE, MADALINE, Activation functions, Supervised Learning: Introduction, Neuron as a simple computing element, The perceptron, Backpropagation Networks: Architecture, Multilayer Perceptron, Back propagation learning-input layer, Radial Basis Function Networks. The Hopfield Network, Unsupervised Learning Neural Networks: Hebbian Learning, Self-Organizing Computational Maps: Kohonen Network, Applications of ANNs.

Module IV (13 Hours)

Genetic Algorithms: Introduction to Genetic Algorithm (GA), Working Principle, Difference between traditional algorithms and GA, Phases of Genetic Algorithm, Basic GA framework and different GA Architectures, Convergence of GA, Applications of GA case studies. Introduction to genetic programming-basic concepts.

Module V (15 Hours)

Deep Learning: Basics of Deep Learning, Convolutional Neural Network, Recurrent Neural Network. Matlab/Python Lib: Study of Neural Network Toolbox and fuzzy logic toolbox, Simple implementation of ANN and fuzzy logic.

Suggested Readings

- R. Rajasekaran and G. A Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, Prentice Hall of India. 2003.
- Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley, 2011.
- N.P.Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press. 2005.
- Simon O. Haykin, Neural Networks and Learning Machines, Pearson, 2009.
- MATLAB Toolkit Manual.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4				H	
CO 5	M		M		M
CO 6					M

CAODS0054: DATA SCIENCE
(4-0-0) (4 Credits – 60 Hours)

Objectives:
The objective of the course is to introduce students to the basic concepts of data science, use of tools in data science, use of models to find solutions to business challenges, interpretation of data findings in oral, visual and written formats.

Course/Learning Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the basic concepts and technologies related to Data Science. (Understanding)
- Obtain, clean/process, and transform data and analyze the transformed data using an ethically responsible approach (Applying and Analyzing)

- Relate which tools and methodologies can be applied to solve data science tasks. (Remembering)
- Integrate Data Science capabilities into the formation of a situation analysis (Evaluating)
- Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges (Creating)
- Interpret data findings effectively to any audience, orally, visually, and in written formats. (Understanding)

Module I: Introduction to Data Science, Preprocessing, and Data Visualization (14 Hours)

Introduction to Data Science: Why Learn Data Science, Data Analytics Life Cycle, Types of Data Analysis, Types of Jobs in Data Analytics, Data Science Tools, Fundamentals Areas of Study in Data Science, Data Preprocessing: Introduction to Data Preprocessing, Data Types and Forms, Possible Data Error Types, Various Data, Preprocessing Operations - Data Cleaning, Data Integration, Data Transformation, Data Reduction, and Data Discretization Data Plotting and Visualization: Introduction to Data Visualization, Visual Encoding, Data Visualization Libraries, Basic Data Visualization Tools (Histograms, Bar Charts, Scatter Plots, Line Charts, Area Plots, Pie Charts, Donut Charts); Specialized Data Visualization Tools (Box Plots, Bubble Plots, Violin Plots, Heat Map, Dendogram, Radar Chart, Venn Diagram, 3D Scatter Plots), Advanced Data Visualization Tools (Wordclouds, Chord Diagram, Waffle Charts, Choropleth Map, Bubble Map), Data Visualization Types

Module II: Statistical Data Analysis and Machine Learning (18 Hours)

Statistical Data Analysis: Role of Statistics in Data Science, Kinds of Statistics, Descriptive Statistics (Measures of Frequency, Central Tendency, Dispersion, and Position), Inferential Statistics, Parametric vs Non-Parametric Hypothesis Testing, Probability Theory, Four Perspectives on Probability, Bayesian Probability, Probability Distribution, Machine Learning for Data Science: Overview of Machine Learning, Supervised Machine Learning - Regression Methods (linear, polynomial, and logistic), Classification Methods (KNN Classification, Support Vector Machine (SVM) Classification, and Decision Tree Classification); Unsupervised Machine Learning - Clustering Methods (Fuzzy c-means Clustering and Principle Component Analysis (PCA) Clustering), Association Analysis - Apriori Algorithm and FP-Growth Analysis, Introduction to Reinforcement Learning

Module III: Time-Series Analysis and Deep Learning (12 Hours)

Time-Series Analysis: Overview of Time-Series Analysis, Components of Time-Series, Time-Series Forecasting Models using Stochastic Models (AR, MA, ARMA and ARIMA), Time-Series Forecasting using Support Vector Machines Based Models, Deep Learning for Data Science: Introduction to TensorFlow, Pytorch, Deep Learning Primitives, Convolutional Neural Network (Softmax, ReLU, Sigmoid or Logistic Activation function, and Pooling), TensorFlow and CNN, AutoEncoder (Convolutional Autoencoder and Sparse Autoencoder)

Module IV: Social Media Analytics, Business Analytics, and Big Data Analytics (16 Hours)

Social Media Analytics: Overview of Social Media Analytics, Seven Layers of Social Media Analytics, Social Network Analysis (Link Prediction, Community Detection, and Influence Maximization), Text Analytics/Mining (Text Categorization, Document or Text Summarization, and Sentiment Analysis), Trend Analytics, Business Analytics: An Overview of Business Analytics, The Business Analytics Life Cycle, Basic Tools Used in Business Analytics, Financial Analytics, Market Analytics, Customer Analytics, and Employee Analytics, Big Data Analytics: An Overview of Big Data, Hadoop, Hadoop Distributed File System, Interacting with HDFS from Python Applications, Introduction to Snake, Pig and Spark

Suggested Readings

- J. Grus, Data Science from Scratch: First Principles with Python, O'Reilly, 2nd Edition, 2019
- Silberschatz, H. F. Korth, S Sudarshan, Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, 1st Edition, Dreamtech, 2016
- C. Neil, R. Schutt, Doing Data Science: Straight Talk from the Frontline, O'Reilly, 1st Edition, 2019.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H			
CO 3		H	M	M
CO 4			M	M

CAOVS0055: DATA VISUALIZATION FOR DATA SCIENCE
(4-0-0) (4 Credits – 60 Hours)

Objectives:
The objective of the course is to introduce students to data visualization , tools used in visualization, visualization of numeric data and non-numerical data, multidimensional scaling, creation and interpretation of the visualization from the data set, and apply techniques from user-interface design to create an effective visualization system.

Course/Learning Outcomes

- Learn what data visualization is, how it's used, and how computers display information. Also explore different types of visualization and how humans perceive information. (Remembering)
- Apply principles of design and colour to make visualizations more engaging and effective. (Applying).
- Learn how to visualize graphs that depict relationships between data items. (Understanding)
- Designing your own visualization system for large datasets and dashboards. (Creating)

- Create and interpret the visualization from the data set, and apply techniques from user-interface design to create an effective visualization system. (Creating, Evaluating)

Module I: (12 hours)

Introduction to Data Visualization: Overview of Visualization, Defining data visualization; Visualization workflow: describing data visualization workflow, process in practice; Data representation: chart types: categorical, hierarchical, relational, temporal & spatial.

Module II: (15 hours)

Visualization Tools: 2-D: bar charts, clustered bar charts, dot plots, connected dot plots, pictograms, proportional shape charts, bubble charts, radar charts, polar charts, Range chart, Box-and-whisker plots, univariate scatter plots, histograms word cloud, pie chart, waffle chart, stacked bar chart, back-to-back bar chart, all relevant 2-D charts. 3-D: surfaces, contours, hidden surfaces, pm3d coloring, 3D mapping; multi-dimensional data visualization; manifold visualization; graph data visualization; Annotation; Word Clouds, Seaborn and Regression Plots.

Module III: (12 hours)

Visualization of Numerical Data: Data, Mapping, Charts, Glyphs, Parallel Coordinates, Stacked Graphs, Tufte's Design Rules.

Module IV: (10 hours)

Visualization of Non-Numerical Data: Graphs and Networks, Embedding Planar Graphs, Graph Visualization, Creating Maps and Visualizing Geospatial Data, Introduction to Folium, Maps with Markers, Choropleth Maps, Tree Maps, Principal Component Analysis, Multidimensional Scaling, Packing.

Module V: (11 hours)

The Visualization Dashboard: Introduction, Visualization Systems, the Information Visualization, Database Visualization, Visualization System Design.

Suggested Readings

- Andy Kirk, Data Visualization A Handbook for Data Driven Design, Sage Publications, 2016
- Philipp K. Janert, Gnuplot in Action, Understanding Data with Graphs, Manning Publications, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H	M		
CO 3			M	M	
CO 4				H	
CO 5					H

CAOBD0056: BIG DATA MANAGEMENT
(4-0-0) (4 Credits – 60 Hours)

OBJECTIVE:
This course aims to provide students with foundational knowledge and practical skills for managing and analyzing large datasets using big data tools and frameworks. Students will learn about key components of the Hadoop ecosystem, the structure and management of data in Hadoop Distributed File System (HDFS), and the functionality of MapReduce for processing extensive data. Additionally, the course introduces machine learning techniques for big data analytics using R and Python, fostering a comprehensive understanding of the methods and technologies used in business-driven big data solutions.

COURSE / LEARNIG OUTCOMES:

- List the components of Hadoop and Hadoop Ecosystem. (Remembering)
- Understanding of big data basics and problems over big data. (Understanding)
- Identify Big Data and its Business Implications. (Applying)
- 4. Make use of Hadoop and MapReduce programming to tackle big data problems. (Applying) 5. Demonstrate Machine Learning Techniques using R/Python. (Understanding)

Module I (12 Hours)

Introduction to Big Data and Hadoop Types of Digital Data: Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Ecosystem, IBM Big Data Strategy, Introduction to Infosphere Big, Insights and Big Sheets.

Module II (12 Hours)

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.

Module III (10 Hours)

Map Reduce: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Module IV (14 Hours)

Hadoop Ecosystem: Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. HBase : HBasics, Concepts, Clients, Example, HBase Versus RDBMS.

Module V (12 Hours)

Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Introduction to Big Data Analytics with BigR.

Suggested Readings

- Hadoop: The Definitive Guide, Third Edition, Tom White, 2012, O'reily Media.
- Big Data Analytics, Seema Acharya, Subhasini Chellappan, 2015, Wiley.
- Machine Learning (in Python and R), First Edition, J. P. Mueller, L. Massaron, 2016, Wiley.

Mapping of Course Outcomes:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H			H	
CO 2	H	M			
CO 3			M	H	
CO 4			H	H	
CO 5				M	H

CAOWA0057: WEB ANALYTICS AND DEVELOPMENT
(4-0-0) (4 Credits – 60 Hours)

OBJECTIVES:
This course aims to equip students with a comprehensive understanding of web analytics fundamentals, tools, and data collection methods critical for optimizing online presence and marketing strategies. Through the exploration of web data capture techniques, key web metrics, and advanced analytics tools such as Google Analytics, students will gain the skills needed to analyze website performance and user behavior. Additionally, the course covers competitive intelligence strategies and qualitative analysis, enabling students to make data-driven decisions and improve digital outcomes across e-commerce and non- e-commerce platforms.

Course Outcomes:

- Recall the various Web Analytics--related terms, tools, and technologies (Remembering)
- Illustrate the various web data capturing procedures and the various important web metrics (Understanding)
- Experiment how to deploy web intelligence to improve the outcomes of marketing or business plan. (Applying)
- Compare and contrast the various web analytics tools (Analysing)
- Analyze, test, and judge results based on search analytics, competitive intelligence analytics and Google analytics. (Analyzing, Evaluating)

Module I: Basic Concepts of web Analytics and Web Data Collection (14 Hours)

Introduction: Web Analytics – brief history, evolution, importance and need; advantages and limitations of web analytics, site references, Basic Terms - keywords and key phrases, onsite web, offsite web, visit characterization terms, content characterization terms, conversion metrics; Web analytics platform, Data Collection: Clickstream Data - Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: PanelBased measurement, ISP-based measurement, Search Engine data.

Module II: Web Data Capturing and Web Metrics (16 Hours)

Capturing data: Web logs, data capture, Type and size of data, Innovation, Integration, selecting optimal web analytic tool, Understanding click stream data quality, identifying unique page definition, Using cookies, Link coding issues, Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non-ecommerce sites): Improving bounce rates, optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Module III: Search Analytics and Qualitative Analysis of Web Data (12 Hours)

Search Analytics: Performing Internal Search Site Analytics, Search engine optimization, Measuring SEO Efforts, Analyzing Pay per Click effectiveness, Qualitative Analysis: Essence of customer eccentricity, Heuristic evaluations, Site Visits: Conducting a site visit, Benefits of site visits; Surveys - Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys .

Module IV: Web Analytics Tools, Competitive Intelligence and Google Analytics (18 Hours)

Web Analytics tools: Click Stream Analysis, A/B testing, Online Surveys, Competitive Intelligence (CI) analysis: CI data sources, Toolbar data, Panel data, ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Suggested Readings

- Kaushik, Avinash. Web Analytics: An Hour a Day. United States, Wiley, 2007.
- Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed
- Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.
- Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons
- Mapping of COs to Syllabus

CAOAW6053: ADVANCED WEB APPLICATION DEVELOPMENT TECHNIQUES
(30 Hours)
Objective

Objective of this course is to equip students with advanced knowledge and skills in modern web application development. The course emphasizes on client-server architecture, data validation, security measures, and contemporary architectural patterns such as micro services.

COURSE/ LEARNING OUTCOMES

- Explain the JavaScript and an introduce to the role in client server architecture.(Understanding)
- Explain the importance of data validation and understand the process of data sanitization. (Understanding)
- Address the threat handling mechanism while development. (Remembering)
- Creating User interface, service design pattern, and remote connection. (Creating)
- Learn about the recent trend in web development architecture based on micro service design pattern. Cover an overview of recent trend in management of load balancing and service scalability. (Applying)

Module I: (18 Hours)

JavaScript Overview: Form events, Client Side Validation (Length check, Numeric field check, Alphanumeric field check, Empty Field, special character, password format, All field entry check), Server Side validation (Data sanitization), SQL Injection, Overview of session management, Cross site scripting, URL validation, Importance of Asynchronous JavaScript and XML (Ajax), loading page content using AJAX, Database connection, Back end data update using AJAX.

Module II: (12 Hours)

Micro Service Applicability: Micro Service design pattern, Overview of Service Oriented Architecture, Principles of Web Service, SOAP / RESTful Web Service, Overview of Containerization: Kubernetes with Docker.

Suggested Readings

- Beginning JavaScript with DOM Scripting and Ajax – Russ Ferguson and Christian Heilmann, Publisher: Apress ; 2nd edition
- 2Ajax programming for the absolute beginner, Jerry Lee Ford,Jr. Publisher: Course
- Technology, 1st Edition
- Kubernetes Microservices with Docker by Deepak Vohra, Publisher: Apress, 1st

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO1	M	
CO2	M	

CO3		M
CO4		H
CO5		H

CAOBC6052: BLOCKCHAIN
(30 Hours)

Objective

This course will equip students with a foundational understanding of blockchain technology, its components, and its practical applications. Students will explore the significance of blockchain in various contexts and learn about its underlying mechanisms.

COURSE/ LEARNING OUTCOMES

- To understand what Blockchain is and why it is used. (Remembering)
- To be able to explain the different components involved within Blockchain. (Understanding)
- To know when and why you may want to use Blockchain within your environment. (Remembering)

Module I: (7 Hours)

Introduction to Blockchain Technology and its Importance; Evolution of the Blockchain Technology,

Module II: (7 Hours)

Elements of a Blockchain, Basic Crypto Primitives – Cryptographic Hash, Digital Signature

Module III: (16 Hours)

Blockchain Consensus I – Permissionless Models, Blockchain Consensus II – Permissioned Models, Smart Contract Hands On I – Ethereum Smart Contracts (Permissionless Model), Blockchain Applications

Suggested Readings

- Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Imran Bashir, Packt Publishing, 2020,
- Hyperledger Tutorials - https://www.hyperledger.org/use/tutorials
- Ethereum Development Resources - https://ethereum.org/en/developers

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO1	H		
CO2	M	H	
CO3		M	H

CAORP6051: ROBOTIC PROCESS AUTOMATION
(30 Hours)

Objective

Objective of the course is to provide students with a comprehensive understanding of Robotic Process Automation (RPA) concepts and practical skills necessary for developing RPA solutions. Through a combination of theoretical knowledge and hands-on experience, students will learn to navigate the RPA development journey, understand key constructs in software processes, and utilize various automation techniques.

COURSE/ LEARNING OUTCOMES

- Explain the RPA Developer enablement journey and an introduce to the role. (Understanding)
- Explain the three constructs that are fundamental in any software process: variables, arguments and control flow. (Understanding)
- Address what selectors are, the UI Explorer, the Property Explorer, Selector types, where to use them and how to finetune Selectors when encountering difficult situations. (Remembering)
- Creating UI input and output actions. (Creating)
- Learn about the many email tasks that can be automated to help you save valuable time. Cover an essential aspect of development, identifying and solving bugs in your projects and learn about how to get automation production-ready: how to anticipate, detect and resolve errors in your workflows. (Applying)

Module I: (8 Hours)

RPA Overview: Overview of Robotic Process Automation (RPA), Benefits of RPA in industries and business processes, Introduction to the RPA Developer Role, Variables, Data Types and Control Flow, Version Control, Data Manipulation, Excel and Data Tables, Selectors.

Module II: (22 Hours)

Bot Building: UI Automation, Introduction to Logging in Studio, IMDB Movie Rating, Contact Details, RPA Challenge. Amazon Data Scraping, Recording Demo, Calculate Client Hash, PDF Automation, Error and Exception Handling, Debugging, Email Automation, Connecting Robot to Orchestrator, Publishing workflow to Orchestrator, Orchestrator Demos.

Suggested Readings

- The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems by Tom Taulli, Publisher: Apress
- Learning Robotic Process Automation: Create Software Robots and Automate Business Processes with the Leading RPA Tool – UiPath by Alok Mani Tripathi, Publisher: Packt Publishing; 1st edition
- Robotic Process Automation Projects: Build Real-world RPA Solutions Using UiPath and Automation Anywhere by Arun Kumar Asokan and Nandan Mullakara, Publisher: Packt Publishing Limited

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO1	H	
CO2	H	
CO3		H
CO4		H
CO5		H

EGCS0110: COMMUNICATION SKILLS (Audit Course)

Objective:

The objective of this audit course is to prepare students to be effective in their career in the corporate world where they will use their professional expertise. This course enables students

- To understand the difference between hard skills and soft skills
- To learn the importance of communication skills as part of the soft skills,
- To be familiar with the various features of effective communication, which includes verbal, non-verbal, written communication and body language.

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:

CO 1: Recognise the difference between hard and soft skills CO 2: Understand the importance of communication skills CO 3: Analyse features of effective communication

CO 4: Apply the soft skills in the corporate world

Module I: Communication and Types of Communication

Introduction to Communication and Effective Communication, Communication Process, Difference between Communication and Effective Communication, Tips for Effective Communication, Importance and significance of Communication, Principles of Effective Communication, Flow of Communication, Types of Communication, Barriers of Effective Communication

Module II: Conversation and Conversational Tips

Formal Conversation, Introducing people, Thanking/ Thanks/ Expressing Gratitude, Requesting and Thanking, Granting permission, Warning, Formal Apology, Informal Apology, Do's and Don'ts of Telephonic Conversation, Telephonic Manners

Module III: Presentation Skills, Its Preparation and Practice

Presentation skills, Planning, Analyze the Audience, Choose the topic and the title, Preparation, Delivery Practice, Posture, Facial Expressions, Eye-contact

Module IV: Audio - Visual Aids, Group Communication and Leadership Qualities

Introduction to Audio - Visual Aids, Importance of Visual Aids, Suggestions for planning and using visuals effectively. Behaviour Pattern in Group Communication, Co-operative Behaviour, Analysis of a Given Topic, Avoidance of Interference and Rudeness of Language, Leadership Qualities, Adaptability, Composure, Persuasiveness

Module V: Writing Skills, Memos, Email

Writing Letters and its essentials, Job Applications, Preparing a Resume and Resume types, Introduction to Memos, Uses of Memos, Classification / Kinds of Memos, Email, Advertisement

CMES0023: ENTREPRENEURSHIP (AUDIT COURSE)

Objective: The objective of the course is to introduce students to the concept of entrepreneurship, entrepreneurial skills and their use in a variety of situations. The students are examined on the personal skills to help them define entrepreneurial opportunity and are taught to develop a criteria to judge a situation to develop into a venture, plan and prepare business plans considering the market, technical, financial and legal requirements.

COURSE OUTCOME/ LEARNING OUTCOMES

- Define key concepts of entrepreneurship and identify the characteristics and skills of successful entrepreneurs. (Remembering)
- Evaluate entrepreneurial opportunities in various contexts and articulate the factors influencing their viability. (Evaluating)
- Conduct preliminary project appraisals by analyzing market conditions, techno-economic feasibility, and financial options. (Applying)

- Identify the legal and regulatory requirements for starting a business and assess their impact on entrepreneurial ventures. (Understanding)
- Develop a comprehensive business model and business plan that incorporates market, technical, financial, and legal aspects. (Creating)
- Analyze the expected life cycle of a venture, perform break-even analysis, and identify strategies to mitigate common causes of business failure. (Analyzing)

The various topics that are generally covered in the course are:

- Meaning of entrepreneur and entrepreneurship and its relation with problem - solving, characteristics of an entrepreneur, factors influencing entrepreneurship
- Identify and explain entrepreneurial opportunities, generating a list of entrepreneurial opportunities in a number of commercial and non-commercial situations
- Preliminary Project appraisal methods - Selecting the right opportunity, market
- Survey and research, techno-economic feasibility, financial feasibility- sources of finance – identify various sources of capital, ways to access the capital. Legal environment – identify the types of the regulatory systems and predict their effects on the creation of the entrepreneurial venture, role of government and government agencies.
- Creating the business model – business plan preparation.
- Recognize and assess the expected life of a venture, break-even analysis, recognize the common causes of failure of business ventures, how to deal with seven business crisis- planning for survival and growth.

LABORATORY COURSES

CAOOS6012: OPERATING SYSTEMS LAB
(2 credits)

OBJECTIVES

This lab course is designed to provide hands-on experience with core operating system concepts and Linux commands. Through practical exercises, students will develop skills in shell scripting, process management, and inter-process communication. The course emphasizes working with system calls, handling processes and signals, and implementing synchronization mechanisms like semaphores and mutexes. Students will also apply their knowledge to simulate process scheduling, memory management, and file system organization, enabling them to analyze and construct foundational OS functionalities in a Linux environment.

COURSE / LEARNING OUTCOMES

At the end of the Lab experiments students will be able to:

- Recall and label the basic commands in Linux. (Remembering)
- Classify system calls, library functions calls to write on standard output device. (Understanding)
- Experiment with shell programs. (Applying)
- Construct programs on process scheduling, page replacement algorithms. (Creating)
- Evaluate free space management using programs. (Evaluating)

Module1

Introduction to Linux, File System (Types of file, Filename, parent-child relationship, absolute and relative pathname, file and directory permissions) Introduction to vi editor (start vi, the three modes, create, save and open a text file, positioning by character, positioning by line, positioning by word, positioning in the word, positioning on a numbered line, inserting text, deleting text), Simple Linux commands, Shell Programming

Module2:

Semaphores, Shared Memory and Message Queues: Semaphore (Binary semaphore, Linux Semaphore Facilities, Using Semaphores), Shared Memory, Message Queues

Module3:

Processes and Signals : Process Structure, Starting a new Process, Replacing a Process Image, Duplicating a Process Image, Waiting for a process, Zombie Processes, Terminating a Process, Signals (Signal handling, Sending signals, Signal interface, Signals sets).

Module4:

POSIX Threads: Creating threads, Simultaneous execution of threads, Synchronization and Critical sections, Synchronization with Semaphores, Synchronization with Mutexes, Thread Attributes, Cancelling

a thread. Inter-Process Communication: Pipes, Process Pipes, and The Pipe Call, Parent and Child processes, FIFOs (Accessing a FIFO, opening a FIFO, Reading and Writing FIFO).

Mapping of COs with Syllabus:

Course Outcomes	Module1	Module2	Module3	Module4
CO1	H	M		
CO2		H	M	
CO3		M	H	L
CO4	L	M	H	
CO5		L	M	H

CAODA6033: DATA STRUCTURES AND ALGORITHM LAB
(2 Credits)

Objectives

- To introduce first level topics covering basics in algorithms and data structures.
- To enable students to choose appropriate data structures, understand the ADT/libraries, and use of it to design algorithms for a specific problem.
- To understand the necessary mathematical abstraction to solve problems.
- To apply important algorithmic design paradigms and methods of analysis.

COURSE/LEARNING OUTCOMES

At the end of the course, students would be able to:

- Get introduced to existing algorithms and how to analyse them using graph notation. (Remembering)
- Demonstrate the existing standard algorithms. (Understanding)
- Apply existing algorithms in developing different applications. (Applying)
- Analyse the time complexity of standard algorithms. (Analysing and Evaluating)
- Create efficient applications by using the right algorithm depending on input pattern and size. (Creating).

List of Programs

- Implement the linear search and binary search algorithm to search for a given element e from a list of n numbers. Analyze the algorithms.
- Prove that the Bubble Sort algorithm has time complexity of O(n2) by showing the graph notation.
- Prove that the Selection Sort algorithm has time complexity of O(n2) by showing the graph notation.
- Implement the Insertion Sort algorithm and analyse the algorithm using the graph notation.

- Implement the Divide-and-Conquer technique and analyze the algorithm showing the graph notation.
- Implement the Greedy Programming technique and analyze the algorithm showing graph notation.
- Implement the Dynamic Programming technique and analyze the algorithm showing graph notation.
- Design a small file compressor and decompressor by using Huffman coding technique.

Suggested Readings

- Alfred V Aho, John E Hopcroft and Jeffrey D Ullman, The Design and Analysis of Computer Algorithms. Addision Wesley, 2001. (Modules I, II, III and IV)
- Alfred V Aho, John E Hopcroft and Jeffrey D Ullman, Data Structures and Algorithms.. Addision Wesley, 2000. (Modules I and V)
- Thomas H Corman, Charles E Leiserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, 2nd PHI, 2004
- V Manbar, Introduction to Algorithms - A Creative Approach, Addision Wesley, 2000.
- Ellis Harwitz, Sartaz Sahani, Fundamentals of Computer Algorithms.. ,Computer Science Press, 2000.
- Peter Linz, An Introduction to Formal Languages and Automata. Narosa Publishing House 2001

Mapping of COs with Syllabus

Course Outcomes	1	2	3	4	5	6	7	8
CO1	H	H	H	H				
CO2	H	H	H	H				
CO3					H	H	H	
CO4	H	H	H					
CO5								H

CAOPJ6014: PROGRAMMING THROUGH JAVA LAB
(2 credits)

OBJECTIVES

This lab course aims to develop students' foundational and advanced Java programming skills with an emphasis on practical applications in GUI development, data handling, and application design. Students will learn to create classes, manage objects, implement key concepts like polymorphism and exception handling, and develop Java programs that interact with files, databases, and networks. By the end of the course, students will be able to evaluate and apply various Java utility classes, design custom GUIs, and build multi-threaded applications, preparing them for real-world Java programming challenges.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- List various GUI and thus will be able to select the suitable GUI to resolve a given problem. (Remembering)
- Distinguish among the various utility class like vector, stack, Hash Table, String Tokenizer, etc. (Understanding)
- Apply their knowledge to solve practical problems like reading from a dataset, writing into a file and develop games using JAVA program. (Applying)
- Evaluate the performance of various swing GUI components and design various applications using Swings depending on the domain and requirement. (Evaluating)

At the end of the experiments, students will be able to

- Program to illustrate class, objects and constructors
- Program to implement overloading, overriding, polymorphism etc
- Program to implement the usage of packages
- Program to create our own exception
- Program for handling file operation
- Implement the concept of thread programming
- Program to implement Generic class and generic methods
- Program for event-driven paradigm in Java
- Program that uses Menu driven Application
- Program to implement JDBC in GUI and Console Application
- Socket programming to implement communications 12. Develop a multi-threaded GUI application of your choice.

E-resource for learning Java, www.spoken-tutorial.org

Mapping of COs with Syllabus:

Course Outcomes	1,2,3,4,5	6,7	8,9,10,11,12
CO1		M	H
CO2	H		
CO3		M	H
CO4	M	M	H

CAOCC6034: DATA COMMUNICATION AND COMPUTER NETWORKS LAB
(2 Credits)

Objective

Network programming involves writing programs that communicate with other programs across a computer network. Most operating systems provide pre-compiled programs that communicate across a network. This course envisages providing an introduction to such networking programming, whereby students will learn to write their own network programs. At the end of this course in network programming, the students are expected to have elementary ideas about the socket programming and their usage in setting up TCP and UDP communications.

COURSE / LEARNING OUTCOMES

At the end of the Lab experiments students will be able to:

- List various network related commands. They will get introduced to socket programming in TCP and UDP environments. (Remembering)
- Illustrate the functions used in TCP and UDP client server communication. (Understanding)
- Apply their knowledge of socket programming to perform various types of communications, address conversions and so on. (Applying)
- Analyze the efficiency of TCP and UDP client –server communication. (Analysing)
- Design and evaluate code for conducting chat or communication between client and server in UDP environment. (Creating, Evaluating)

Module I

Introduction to Network Programming: Introduction to Sockets; Address Structure – IPv4, IPv6; Value-Result Arguments; Byte Order Functions; Byte Manipulation Functions; inet_aton, inet_addr, inet_ntoa, inet_pton, inet_ntop, readn, written, readline, isfdtype functions, Elementary TCP Sockets: Introduction; socket, connect, bind, listen, accept, fork, exec, close, getsockname, getpeername functions; TCP Client Server example; signal, sigaction, wait, waitpid functions; Connection Termination; SIGPIPE signal, i/O Multiplexing: I/O models; select function; Batch input; shutdown, pselect, poll functions; Example – TCP Echo Server, Socket Options: getsockopt, setsockopt, fcult, ioclt functions; Socket status – generic socket options, Elementary UDP Sockets: Introduction; recvfrom, sendto functions; UDP Examples; connect function with UDP; UDP socket receive buffer; Example – UDP Echo Server

Module II

Elementary Name and Address Conversion: Introduction; gethostbyname function; RES_USE_INET6 resolver option; gethostbyaddr, uname, gethostname, getservbyname, getservbyport functions, IPv4 and IPv6 Interoperability: Introduction; IPv4 Client - IPv6 Server, IPv6 Client – IPv4Server; IPv6 Address Testing Macros, IPV6_ADDRFORM, Advanced Name and Address Conversions: Introduction; getaddrinfo, gai_strerror, freeaddrinfo, getnameinfo functions; Reentrant functions, Daemon Processes: Introduction; syslogd daemon; syslog, daemon_init functions; inetd daemon; daemon_inetd function.

Suggested Readings

- W Richard Stevens, UNIX Network Programming – Volume I, Second Edition, Prentice Hall of India Pvt. Ltd., 2002
- Douglas E Comer, Internetworking with TCP/IP: Principles, Protocols, and Architectures Volume I, Fourth Edition, Prentice Hall of India Pvt. Ltd.
- Douglas E Comer, David L Stevens, Internetworking with TCP/IP: Design, Implementation, and Internals – Volume II, Third Edition, Prentice Hall of India Pvt. Ltd.
- Douglas E Comer, David L Stevens, Internetworking with TCP/IP: Client Server Programming and Applications – Volume III, Second Edition, Prentice Hall of India Pvt. Ltd.

Mapping of COs with Syllabus

Course Outcomes	Module I	Module II
CO1	H	M
CO2	H	M
CO3	H	
CO4	H	
CO5		H

CAOIT6017: INTERNET TECHNOLOGY AND APPLICATIONS LAB
(2 credits)

OBJECTIVES

This lab course is designed to provide students with practical skills in designing, building, and deploying web applications. Through hands-on experience with markup languages (XHTML), styling with CSS, and web scripting languages such as JavaScript, PHP, and SQL, students will learn to create responsive and validated static and dynamic websites. The course covers client-side and server-side scripting, database integration, and web server management, enabling students to design and troubleshoot web applications, ensuring they meet usability, compatibility, and performance standards.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

- Utilise and experiment with mark-up languages such as XHTML and style sheets such as CSS to design static web pages. (Applying)
- Design and validate a website and can also identify the faults in the design. (Analysing)
- Create and develop a web application using various available frameworks and scripting languages such as JavaScript and PHP. (Creating)
- Validate and examine a dynamic web application using database handling and various other services and deploy them after proper validation (Evaluating and creating)

Module I

XHTML: Components of XHTML; Elements of XHTML (Headers, Linking, Images, Special Characters, Lists, Tables, Forms, Framesets), Cascading Style Sheets: Inline Styles; Embedded Style; Conflicting Style; Linking External Styles; W3C CSS Validation Service; Use of CSS (Positioning Elements, Backgrounds, Text flow), Web Site Design Considerations: Using Logical Design: Planning your website, drawing a map, using a top-down approach, flexibility, other web design metaphors. Creating templates. Creating a Compatible Design: Designing for different color depths, resolutions, different browser considerations, accommodating limited bandwidth. Validating your work.

Module II

Web servers: HTTP Request Types; System Architecture of a Web server; Client-side Scripting versus Server-side Scripting;Accessing Web servers; Apache Web Server. b) Databases: Introduction to each one of the following: SQL, MYSQL, DBI, Scripting Languages: JavaScript: Operators, Data Types, Control Structures, Functions, Arrays, String Manipulation. VBScript Introduction to Perl and CGI (Common Gateway Interface), PHP: Introduction to PHP; Data Types; Control Structures; Functions; Strings; Arrays; Querying Web Databases using PHP; Writing to Web Databases; Errors, Debugging and Deployment.

Suggested Readings

- Deitel and Deitel, Internet and World Wide Web: How to Program, 2nd Edition, Prentice Hall of India Pvt. Ltd. , New Delhi 2. Hugh E. Williams and David Lane, PHP and MySQL, 2nd Edition, O'Reilly, Shroff Publishers and Distributors Pvt. Ltd.
- Internet Complete, 2nd Edition, BPB Publications. , New Delhi
- Douglas E. Comer, The Internet Book: Everything you need to know about Computer Networking and how the Internet works, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	
CO 2	H	
CO 3	L	H
CO 4		H

CAODM6035: ADVANCED DATABASE MANAGEMENT SYSTEMS LAB
(2 Credits)

Objectives:

- Learn to create and use a database
- Be familiarized with a query language.
- Have hands on experience on DDL Commands
- Have a good understanding of DML Commands and DCL commands
- Familiarize advanced SQL queries.
- Be Exposed to different applications

COURSE / LEARNING OUTCOMES

At the end of the Lab experiments students will be able to:

- Identify basic SQL operations and fetch results with respect to specific requirement. (Remembering/Evaluating)
- Describe PL/SQL program structure like conditional constructs, iterative construct, and exception handling. (Understanding)
- Use different program structures and apply them to solve problems. (Applying)
- Apply and analyze PL/SQL procedures, functions, packages, triggers to practice assignments. (Analysing)
- Create applications using Oracle forms and Oracle report. (Creating)

Module I: Query handling with SQL in Oracle

Creation, altering and dropping of tables and inserting rows into a table (use of constraints while creating tables) examples using SELECT command.Queries using ANY, ALL, IN, EXISTS, NOTEXISTS, UNION, INTERSECT, Constraints, Queries using Aggregate functions (COUNT, SUM, AVG, MAX and MIN), GROUP BY, HAVING and Creation and dropping of Views.Queries implementing various joins (left,right,full). Implementation of complex queries: nested queries,sub queries, Queries using Conversion functions (to_char, to_number and to_date), string functions (Concatenation, lpad, rpad, ltrim, rtrim, lower, upper, initcap, length, substr and instr), date functions

Module II: PL/SQL Programming

Language fundamentals - PL/SQL block structure, character set, identifiers, literals, delimiters, comments, data types in PL/SQL, Program Structure - Conditional constructs, Iterative constructs, Exception handling, SQL in PL/SQL- DML and Transaction Management (Commit and Rollback), Data Retrieval, Cursors (Explicit and Implicit), error handling with Cursors, Procedures, Functions, packages, Triggers- creating and managing functions, procedures, packages and triggers, Built-in functions - String functions (ascii, chr, concat, greatest, instr, least, length, lower, lpad, ltrim, replace, rpad, rtrim, substr, trim, upper) Numeric functions (bitand, ceil, exp, floor, ln, mod, power, round, sign, sqrt, trunk) , Date and time functions (add_months, current_date, current_timestamp, last_day, months_between, next_day, round, sysdate, systimestamp, trunk) Conversion functions (to_number, to_char, cast, to_date, to_timestamp)

Module II: Forms Builder and Reports Builder

Components of application development in Oracle Forms (Form modules, menus, PL/SQL libraries, Object libraries, Database objects), Features of the Report Builder, defining a data model for a report, specifying the layout of the report using the Oracle Reports Wizard.

Suggested Readings

- Ivan Bayross, Commercial Application Development Using Oracle Developer 2000 Forms 6i, BPB Publications, 2nd Revised Edition, 2005
- John Day, Craig Van Slyke, Starting out with Oracle, Dreamtech Press, 2004
- Steven Feuerstein, Oracle PL/SQL Programming, O'Reilly Publications, 3rd Edition.

Mapping of COs with Syllabus

Course Outcomes	Module I	Module II
CO1	H	M
CO2	M	H
CO3	M	H
CO4	M	H
CO5	M	H

Semester IV

CAOMP6039: MAJOR PROJECT – MCA
(18 Credits)

Objective

The primary objective of the Major Project is to enable students to have a thorough understanding of the theoretical principles learnt in earlier five semesters through a prolonged practical experience. The major project is oriented towards developing requisite skills, knowledge of latest technologies and an entrepreneurial attitude in a student which are needed to make an effective start as a computer/IT professional.

COURSE / LEARNING OUTCOMES

At the end of Major Project students will be able to:

- Identify different API and development environment tools for building the project, research terminologies such as scaling, sampling, information gathering etc for research-based project. (Understanding, Applying)
- Learn different programming languages/research tools needed to meet different objectives of the project based on the company/institutional requirements. (Remembering)
- Apply the knowledge of programming to develop application specific but not limited to Web, Android, IoT etc. For research based projects, the different algorithm design techniques, classification & clustering techniques, etc. will be applied. (Applying)
- Analyse the advantages and limitations of different development languages, APIs, platforms, algorithms (for research) (Analysing)
- Create applications to meet real time needs. For research-based projects, students will be able to design novel or hybrid research techniques to meet the problem statement objectives (Creating)
- Judge the efficiency of the project using various evaluation parameters and testing methodologies, efficiency of the algorithm for research based (complexity measure) (Evaluating)