Four Year Under Graduate Programme for

B. Sc. Hons. Computer Science with Research

B. Sc. Hons. Computer Science with Research

Department of Computer Science

University of Kerala

www.keralauniversity.ac.in

Programme-Specific Outcome (PSO) – B.Sc Computer Science

PSO1	Students will demonstrate an in-depth understanding of core concepts and theories in computer science.
PSO2	Students should acquire programming skills for design and development of software applications.
PSO3	The basic theoretical understanding of machine learning, natural language processing, big data and computer vision, and their state-of-the-art system architectures.
PSO4	Acquire the skill set for implementing applications in artificial intelligence and machine learning to achieve knowledge for developing innovative solutions and intelligent systems.
PSO5	Engage in continuous learning, provide active contribution to socially significant research problems and embrace social responsibility, maintain a positive outlook, and uphold ethical principles
PSO6	Graduates will be proficient in applying problem-solving techniques utilizing mathematical and computational approaches to develop creative solutions.
PSO7	Graduates will possess strong communication and collaboration skills, capable of effectively communicating technical concepts to diverse stakeholders, collaborating with multidisciplinary teams, and contributing positively to projects in the software industry.
PSO8	Exposure to emerging trends and technologies in Computer Science, Artificial Intelligence and Machine Learning to mould the students as industry ready professionals.
PSO9	Generate a new breed of computer science graduates with a solid Artificial Intelligence background and project management skills.
PSO10	Apply engineering practices using open-source or commercial environment for software development.
PSO11	Demonstrate technical competency to analyse, comprehend, design and develop solutions in the field of Natural Language Processing, Robotics, Computer Vision, Artificial Intelligence applications.
PSO12	Students will demonstrate proficiency in applying advanced computational techniques and methodologies to effectively address challenges in cloud computing, cyber security, and bioinformatics domains.

FYUGP for 4 year – B. Sc. Computer Science

Course Code	Name of the Course	Credits
Semester I		
Discipline Specific Elective(DSC)		
UK1DSCDCS101	Discrete Mathematical Structures	4
Semester II		
Discipline Specific Core (DSC)		
UK2DSCDCS101	Computer Organization	4
Semester III		
Discipline Specific Core (DSC)		
UK3DSCDCS201	Data Structures	4
UK3DSCDCS202	Operating Systems	4
Discipline Specific Elective(DSE)		
UK3DSEDCS201	Microprocessors	4
UK3DSEDCS202	Embedded System	
UK3DSEDCS203	System Software	
UK3DSEDCS204	Introduction To Knowledge Based Systems	
Semester IV		
Discipline Specific Core (DSC)		
UK4DSCDCS201	JAVA Programming	4
Discipline Specific Elective(DSE)		
UK4DSEDCS201	Internet of Things	4+4 (Any Two)
UK4DSEDCS202	Finite Automata and Language Theory	
UK4DSEDCS203	Natural Language Processing	
UK4DSEDCS204	Digital Marketing	
UK4DSEDCS205	Data Communication	
UK4DSEDCS206	Computer Graphics	
UK4DSEDCS207	Intelligent Systems	
UK4DSEDCS208	Knowledge Representation and Reasoning	
UK4DSEDCS209	Introduction To Machine Learning	
Semester V		
Discipline Specific Core (DSC)		
UK5DSCDCS301	Computer Networks	4
UK5DSCDCS302	Data Base Management Systems	4
Discipline Specific Elective(DSE)		
UK5DSEDCS301	Cloud Computing	4+4 (Any Two)
UK5DSEDCS302	Cyber Security and Cyber Law	
UK5DSEDCS303	Data Science	
UK5DSEDCS304	Data Visualization Techniques	
UK5DSEDCS305	Social Network Analysis	
UK5DSEDCS306	Bioinformatics	
UK5DSEDCS307	Machine Learning	

UK5DSEDCS308	Soft Computing Techniques	
UK5DSEDCS309	Pattern Recognition	
UK5DSEDCS310	Statistical Learning Models	
Semester VI		
Discipline Specific Core (DSC)		
UK6DSCDCS301	Software Engineering	4
UK6DSCDCS302	Web Programming	4
Discipline Specific Elective(DSE)		
UK6DSEDCS301	Data Mining and Big Data Analytics	4+4 (Any Two)
UK6DSEDCS302	Information Retrieval	
UK6DSEDCS303	Block Chain Technology	
UK6DSEDCS304	Software Testing	
UK6DSEDCS305	Management Information System	
UK6DSEDCS306	Computer Vision	
UK6DSEDCS307	Expert Systems in Automation	
UK6DSEDCS308	Advanced Learning Models	
Research		
UK6RPHDCS301	Project	4
UK6INTDCS302	Internship	2
Semester VII		
Discipline Specific Core (DSC)		
UK7DSCDCS401	Design and Analysis of Algorithms	4
UK7DSCDCS402	Image Processing	4
Discipline Specific Elective(DSE)		
UK7DSEDCS401	Agent Technology	4
UK7DSEDCS402	Brain/ Human Computer Interface	
UK7DSEDCS403	Foundations of Robotics	
UK7DSEDCS404	AI Planning	
UK7DSEDCS405	Deep Architectures	
UK7DSEDCS406	Big Data Analytics	
Research		
UK7RPHDCS401	Research Methodology	4
Semester VIII		
Discipline Specific Core (DSC)		
UK8RPHDCS401	Comprehensive Viva Voce	4
UK8ABCDCS401	Academic Bank of Credits (ABC)	4
Research		
UK8RPHDCS401	Dissertation	12

Semester : 1	Course Code: UK1DSCDCS101	Credits: 4

DISCRETE MATHEMATICAL STRUCTURES

Preamble: The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Generating Functions, Recurrence Relations and Algebraic Structures eventually in practical applications.

Prerequisite: A sound background in higher secondary school Mathematics.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Check the validity of predicates in Propositional and Quantified Propositional Logic using truth tables, deductive reasoning and inference theory on Propositional Logic		PSO1, PSO6	Ap	P, C
CO2	Solve counting problems by applying the elementary counting techniques - Rule of Sum, Rule of Product, Permutation, Combination, Binomial Theorem, Pigeonhole Principle and Principle of Inclusion and Exclusion		PSO6	Ap	P
CO3	Classify binary relations into various types and illustrate an application for each type of binary relation, in Computer Science		PSO3, PSO6	U	C, P
CO4	Illustrate an application for Partially Ordered Sets and Complete Lattices, in Computer Science			Ap	P
CO5	Explain Generating Functions and solve First Order and Second Order Linear Recurrence Relations with Constant Coefficients		PSO3, PSO6	Ap	P, C
CO6	Illustrate the abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups		PSO3, PSO6	U	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M-Metacognitive)

COURSE CONTENT

MODULE I
Mathematical logic - Basic connectives and truth table, Statements, Logical Connectives, Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Substitution Rules. The implication - The Contrapositive, The Converse, The Inverse.

MODULE II
Logical Implication-Rules of Inference. The use of Quantifiers – Open Statement, Quantifier Logically Equivalent– Contrapositive, Converse, Inverse, Logical equivalences and implications for quantified statement, Implications, Negation

MODULE III
The Rule of Sum – Extension of Sum Rule. The Rule of Product - Extension of Product Rule. Permutations. Combinations. The Binomial Theorem (without proof). Combination with Repetition. The Pigeon hole Principle. The Principle of Inclusion and Exclusion Theorem (Without Proof) - Generalization of the Principle. Derangements.

MODULE IV
Cartesian Product - Binary Relation. Function – domain, range-one to one function, Image-restriction. Properties of Relations- Reachability Relations, Reflexive Relations, Symmetric Relations, Transitive relations, Anti-symmetric Relations, Partial Order relations, Equivalence Relations, Irreflexive relations.
Partially ordered Set – Hasse Diagram, Maximal-Minimal Element, least upper bound (lub), Greatest Lower bound(glb) (Topological sorting Algorithm- excluded). Equivalence Relations and Partitions - Equivalence Class.

MODULE V
Generating Function - Definition and Examples, Calculation techniques, Exponential generating function. First order linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Second order linear recurrence relations with constant coefficients, homogeneous, non-homogeneous Solution.

MODULE VI
Algebraic system-properties- Homomorphism and Isomorphism. Semi group and monoid – cyclic monoid, sub semi group and sub monoid, Homomorphism and Isomorphism of Semi group and monoids. Group- Elementary properties, subgroup, symmetric group on three symbols,The direct product of two groups, Group Homomorphism, Isomorphism of groups.

LEARNING RESOURCES

Reference

- Discrete and Combinatorial Mathematics (An Applied Introduction),RalphPGrimaldi, B V Ramana, 5thEdition, Pearson
- Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Seventh Edition, MGH,2011

- Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata Mc Graw Hill Pub. Co. Ltd., New Delhi,2003.
- Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures", Pearson Education Pvt Ltd., New Delhi,2003
- Kenneth H.Rosen, "Discrete Mathematics and its Applications", 5/e, Tata Mc Graw Hill Pub. Co. Ltd, New Delhi2003
- Richard Johnsonbaugh, "Discrete Mathematics", 5/e, Pearson Education Asia, NewDelhi, 2002.
- Joe L Mott, Abraham Kandel, Theodore P Baker,"Discrete Mathematics for Computer Scientists and Mathematicians", 2/e, Prentice-Hall India,2009.

Semester:2	Course Code: UK2DSCDCS101	Credits: 4

COMPUTER ORGANIZATION

Preamble: This course offers a thorough exploration of computer organization and architecture, covering essential topics such as functional units, memory operations, and addressing modes. It dissects the processing unit, including the instruction cycle and various organizational architectures. The study extends to register transfer logic, processor logic design, and control logic, providing a comprehensive understanding of micro-operations and intricate CPU structures. Additionally, it addresses I/O organization, interrupts, and memory systems, offering a holistic guide tailored for computer science aspirants.

Prerequisite: Digital Systems and Computer Programming

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the basic structure of computers and its operation and explain I/O organization, Memory Organization etc in a digital computer		PSO1	U	C
CO2	Apply machine instructions and demonstrate program execution		PSO2	Cr	P
CO3	Understand addressing modes for accessing register and memory operands		PSO1	Ap	P
CO4	Learn about transferring data between a processor and I/O devices and demonstrate the programmer's view of I/O transfers		PSO1	Ap	P
CO5	Develop the control logic for a given arithmetic problem		PSO6	Cr	P
CO6	Illustrate the design of Arithmetic Logic Unit and explain the usage of registers in it		PSO6	An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I: Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations, Instructions and instruction sequencing, addressing modes

MODULE II: Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization

MODULE III: Register transfer logic: inter register transfer – arithmetic, logic and shift micro-operations.

MODULE IV: Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.

MODULE V: Control Logic Design: Control organization – Hard _wired control-micro program control of processor unit – Microprogram sequencer, micro programmed CPU organization - horizontal and vertical micro instructions

MODULE VI: I/O organization: accessing of I/O devices – interrupts, interrupt hardware - Direct memory access. Memory system: basic concepts – semiconductor RAMs. memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions

LEARNING RESOURCES

References

- Hamacher C., Z. Vranesic and S. Zaky, Computer Organization ,5/e, McGraw Hill, 2011
- Mano M. M., Digital Logic & Computer Design, PHI, 2004
- KaiHwang, Faye Alye Briggs, Computer architecture and parallel processing McGraw- Hill, 1984
- Mano M. M., Digital Logic & Computer Design, 3/e, Pearson Education, 2013.
- Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013
- William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.
- Chaudhuri P., Computer Organization and Design, 2/e, Prentice Hall, 2008.
- Rajaraman V. and T. Radhakrishnan, Computer Organization and Architecture, Prentice Hall, 2011

Semester: 3	Course Code: UK3DSCDCS201	Credits: 4

DATA STRUCTURES

Preamble: This course gives students an overview of the common data structures used in computer science, including their structure and functions, and help to them solve basic issues by utilizing these data structures features.

Prerequisite: Programming basics in C or C++.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Remember purpose of Data Structures.		PSO1	U, R	C
CO2	Implement linear and non-linear data structures.		PSO2	U, Ap, An	C, P
CO3	Evaluate expressions using stack.		PSO1	An, Ap	C, P
CO4	Familiarize sorting and searching algorithms.		PSO2	An, Ap	C, P
CO5	Understand the concepts of hashing.		PSO2	U, Ap	C
CO6	Implement graph traversal algorithms.		PSO1	An, Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Elementary data organization, Definition of Data structures, Data type vs. data structure, Categories of data structures, Data structure operations, Applications of data structures, Algorithms complexity and time-space tradeoff, Big-O notation. Strings: Introduction, strings, String operations, Pattern matching algorithms.

MODULE II

Arrays: Introduction, Linear arrays, Representation of linear array in memory, Traversal, Insertion and Deletion in an array, Multidimensional arrays, Matrices, Sparse matrix.

MODULE III

Linked List: Introduction, Array vs. linked list, Representation of linked lists in memory, Traversal, Insertion, Deletion, Searching in a linked list, Header linked list, Circular linked list, Two-way linked list, Garbage Collection, Applications of linked lists, Algorithm of insertion/deletion in Singly Linked List (SLL).

MODULE IV

Stack: Introduction, Array and linked representation of Stacks, Prefix, Infix and Postfix expressions, Evaluating Arithmetic Expression; polish notation-Infix to Postfix Notation.- Evaluating a Postfix Notation, Recursion, factorial function, fibanocci sequence. Applications of stack; Queue: Introduction, array and linked list representation, Priority Queue, Dequeue.

MODULE V

Trees – Concepts, representation, Binary Trees, Tree Representations using Array & Linked List, Basic operations, Traversal of binary trees: In order, Pre-order & post-order. Binary Search Tree, Operation on Binary Search Tree, implementation using pointers, applications. Graph: Concept of Graph, Graph terminologies, Graph Traversal – BFS, DFS.

MODULE VI

Sorting: Bubble Sort, Selection Sort, and Insertion Sort. Searching: Sequential searching, binary searching. Hashing- hash table, types of hash functions, Collision Resolution Techniques-linear probing, quadratic probing, double hashing, chaining.

LEARNING RESOURCES

References

- Seymour Lipschutz, (2011). "Data Structures", Tata McGraw- Hill Publishing Company Limited, Schaum's Outlines, New Delhi.
- Goodrich, M. T., Tamassia, R., & Goldwasser, M. H. (2018). Data Structures and Algorithms in Python (1st ed.). Wiley.
- Malik, D. S. (2020). Data Structures Using C (1st ed.). Oxford University Press.
- Fundamentals of Computer Algorithms by Horowitz, Sahni, (2001). Galgotia Pub.
- Fundamentals of Data Structures in C++-By Sartaj Sahani.

Semester: 3	Course Code: UK3DSCDCS202	Credits: 4

OPERATING SYSTEMS

Preamble: This course focus on functions, types, and basic concepts including processes, CPU scheduling algorithms, file allocation techniques, and memory management of operating systems.

Prerequisite: Computer Fundamentals.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize the functions and types of Operating System.		PSO1	U	C
CO2	Understand basic concepts of process.		PSO1	U	C, P
CO3	Familiarize the functions and types of Operating System		PSO1	U	C
CO4	Understand different CPU scheduling algorithms.		PSO1	U, Ap	C, P
CO5	Familiarize file allocation methods.		PSO1	Ap, An	C, P
CO6	Discuss about memory management concepts.		PSO1	U, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Definition- Functions- OS as Resource Manager, Types – Structure, Evolution of Operating System, Concept of Batch processing, multi-programming, time sharing systems and Real-time system, Operating System Functions.

MODULE II

Process Management: The Process, Process State, PCB, Threads, Process Scheduling - Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

MODULE III

Process Coordination: Critical Section problems, Semaphores, Synchronization - Interprocess Communication Problems. Deadlock – Definition, Resource Allocation Graph, Conditions of deadlock, deadlock prevention, deadlock avoidance, deadlock detection, deadlock recovery.

MODULE IV

Memory Management: Basic Hardware, Address binding, Logical vs. physical address space, Swapping, Memory Allocation Methods, Paging, Structure of Page Table, Segmentation, Virtual Memory, Demand Paging, Page Replacement- Basic Page Replacement, FIFO Page Replacement, Optimal Page Replacement, LRU Page Replacement, Thrashing.

MODULE V

File system and interface: File Concept, Access Methods, Protection, Implementation- File System Structure, Allocation Methods, Recovery, and Secondary Storage.

MODULE VI

Disk Scheduling, Disk Management, RAID. I/O Systems- I/O Hardware, Application I/O Interface, Kernel I/O Subsystem. Device Management- types of devices-dedicated, shared, device scheduling and virtual devices - spooling, concept of device drivers.

LEARNING RESOURCES

References

- Abraham Silberschatz, Peter Baer Galvin, Greg Gagne-Operating System Concepts, 10th Edition.
- P. Balakrishna Prasad- Operating Systems and Systems Programming, 5th Edition.
- Achyut S Godbole and AtulKahate - Operating systems, McGrawhill. 2018.

Semester:3	Course Code: UK3DSEDCS201	Credits: 4

MICROPROCESSORS

Preamble: Aim to introduce internal architecture, programming model of Intel Microprocessors (8085, 8086).

Prerequisite: Computer Organization

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Employ the microprocessor fundamentals.		PSO1	Ap	C
CO2	Understand the microprocessor instruction cycle		PSO2	R, U	P, C
CO3	Analyze machine cycles in microprocessor architecture.		PSO6	An	P
CO4	Apply 8085 to solve real world problems.		PSO8	U,Ap	C, P
CO5	Illustrate the architecture of 8086.		PSO9	Ap	P, C
CO6	Apply programming principles to 8086.		PSO10	U,Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Microprocessor: Definition and Evolution of Microprocessor. Components of a Microprocessor: Registers, ALU, Memory, I/O devices and interfaces and control & timing, System bus (data, address and control bus). Bit-Slic Processors RISC and CISC Processor, Vector Processor Array processor, Embedded microprocessor.

MODULE II

Instruction Cycle and Microprocessor Operations: Introduction to the instruction cycle and its components, Importance of fetch and execute operations, Instruction fetch and opcode decoding, Overview of machine cycles and their classification, Execution of instructions: arithmetic, logic, and control operation. Data flow within the microprocessor: registers, buses, and ALU, Instruction formats and addressing modes, Flow of data between registers, memory, and I/O devices.

MODULE III

8085 Microprocessor: Introduction, Intel 8085 microprocessor architecture, instruction set architecture, Types of instructions: data, arithmetic, logical, control transfer, Stack organization and stack-related instructions.

MODULE IV

Assembly Language Programming: Introduction, Basics: syntax and conventions, assembly language programs for data movement and arithmetic operations, Debugging and testing assembly language programs using simulators or emulators, assembly language programs: 8-bit addition and subtraction,16-bit addition using 8085 instructions

MODULE V

8086 Microprocessor: Introduction, Functional block diagram of the 8086 microprocessor, Bus Interface Unit (BIU) and Execution Unit (EU): functions and interactions, Memory organization and segmentation in the 8086 architecture, PIN diagram of the INTEL 8086 microprocessor, Role of clock signals and control signals in microprocessor operation. Introduction to interrupts and interrupt handling mechanism, Types of Interrupt: Hardware, Software and Exception.

MODULE VI

8086 Instruction Sets: Classification of instructions: data transfer, arithmetic, logical, control transfer. Data transfer instructions: MOV, XCHG, PUSH, POP, Direct and indirect memory addressing modes. Arithmetic operations: ADD, SUB, INC, DEC. Logical operations: AND, OR, XOR, NOT. Unconditional and conditional jump instructions: JMP, JZ, JNZ, JC, JNC. Looping instructions: LOOP, LOOPZ, LOOPNZ. arrays and their representation in memory, finding the largest number in a data array.

LEARNING RESOURCES

References

- Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085/8080A", 5th edition, published 2002 by Prentice Hall.
- John Uffenbeck, "Microcomputers and Microprocessors: The 8080, 8085, and Z-80 Programming, Interfacing, and Troubleshooting",2nd edition,2019.
- Kenneth J. Ayala, "The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications",4th edition, Pearson Education.
- Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, "The 8086 Microprocessor: Programming and Interfacing the PC",3rd edition, Cengage Learning,2007.
- IvAvtar Singh and Walter A. Triebel, "The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications",4th edition, Pearson Education, 2003

Semester: 3	Course Code: UK3DSEDCS202	Credits: 4

EMBEDDED SYSTEMS

Preamble: Understanding the requirements of embedded systems, including processors, memory, operating systems, and programming languages, is essential for effective design and implementation, alongside a robust grasp of hardware architecture encompassing processors, microcontrollers, memory modules, and communication interfaces. Familiarity with microcontroller families, particularly 8-bit architectures, allows for informed comparisons with 16-bit and 32-bit counterparts, while delving into specific microcontrollers like the 8051 illuminates core components such as the CPU, ALU, and bus architecture. Proficiency in embedded operating systems, spanning from legacy platforms like Windows XP to real-time systems like RTLinux and mobile OSs, empowers students to tailor solutions to diverse application domains effectively.

Prerequisite: Digital Systems and Computer Programming, Computer Organization

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Differentiate between stand-alone and real-time embedded systems, and identify their applications in network appliances and mobile devices		PSO1	An	P
CO2	Identify specific requirements of embedded systems, including processors, memory, operating systems, programming languages, and tools.		PSO1	An	P
CO3	Develop a strong grasp of hardware architecture such as processors, microcontrollers, microprocessors, DSP processors, memory, ADC and DAC, as well as communication interfaces		PSO2	U	P
CO4	Familiarize microcontroller families, with a focus on 8-bit microcontroller architecture, and make informed comparisons between 8-bit, 16-bit, and 32-bit microcontrollers.		PSO1	An	P
CO5	Understand 8051 microcontroller, including the CPU, ALU, address, data, and control bus		PSO4	An, Cr	P
CO6	Gain proficiency in embedded operating systems, including Windows XP, open source OSs, real-time OSs such as RTLInux and eCOS, and mobile OSs.		PSO5	An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I
Introduction to Embedded Systems, Stand-alone and real-time embedded systems, network appliances and mobile devices, Requirements of embedded systems, Embedded processors, memory, OS, programming languages and tools

MODULE II
Hardware Architecture for embedded systems: Processors, micro-controller, microprocessor, DSP processor, memory, ADC and DAC, Display units and keypads, communication interfaces

MODULE III
Microcontroller Families, 8-bit Microcontroller architecture, comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers

Module IV
8051 Architecture: Internal Block Diagram, CPU, ALU, address, data and control bus, working registers

MODULE V
8051 Addressing modes, Instruction set, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Interrupts.Assembly language programming

MODULE VI
Embedded OS: Windows XP and open source OSs, Real-time OSs: RTLInux and eCOS, Mobile OSs, Programming in C and assembly for embedded systems. Emulators

LEARNING RESOURCES

References

- Hamacher C., Z. Vranesic and S. Zaky, Computer Organization ,5/e, McGraw Hill, 2011
- Mano M. M., Digital Logic & Computer Design, PHI, 2004
- KaiHwang, Faye Alye Briggs, Computer architecture and parallel processing McGraw-Hill, 1984
- Mano M. M., Digital Logic & Computer Design, 3/e, Pearson Education, 2013.
- Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013
- William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.
- Chaudhuri P., Computer Organization and Design, 2/e, Prentice Hall, 2008.
- Rajaraman V. and T. Radhakrishnan, Computer Organization and Architecture, Prentice Hall, 2011

Semester:3	Course Code: UK3DSEDCS203	Credits: 4

SYSTEM SOFTWARE

Preamble: Aim to provide you with a comprehensive understanding of the foundational principles, design concepts, and practical applications of system software in modern computing environments.

Prerequisite: Computer Organization, Operating System.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand System software.		PSO1	R,U	P,C
CO2	Identify Assembler.		PSO3	R	P
CO3	Explain macro processors		PSO6	Ap	P,C
CO4	Describe Compiler and Interpreter.		PSO3	U,Ap	C,P
CO5	Identify role of Linker.		PSO8	R	P,C
CO6	Discuss Loader functionalities.		PSO5	U,An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

System Software and software tools: Introduction, Fundamentals of Language Processing: Compilation vs. interpretation. Language Processor Development Tools: Phases of language processing: Lexical analysis, syntax analysis, semantic analysis, code generation, and optimization. Software Tools for Program Development: Editors, Debug Monitors, Programming Environments (IDE), User Interfaces: Graphical User Interfaces (GUIs), Command-Line Interfaces (CLI).

MODULE II

Assemblers: Introduction, Definition and purpose of assembler programming, Advantages and limitations of using assembly language, Role of assembly language in system software development. Assembly Language Programs: syntax and structure of assembly language programs, Data representation and manipulation.

MODULE III

Macros and Macro Processors: Introduction, Definition and significance of macros in software development, Advantages of using macros for code abstraction and reusability, Syntax and semantics of macro definition, Invoking macros in assembly language programs.

MODULE IV

Interpreters and Introduction of Compilers: Introduction, Definition and significance of interpreters and compilers in software development. Principles of interpretation: scanning, parsing, and execution. Structure and components of an interpreter. Compilers Phases and Techniques: Phases of compilation: lexical analysis, syntax analysis, semantic analysis, code generation, and optimization. Techniques for each compilation phase and their importance.

MODULE V

Linkers: Introduction, Role of linkers in creating executable programs, Overview of the linking process: compilation, assembly, and linking phases. Symbol resolution: resolving external and unresolved symbols. Linker directives and options.

MODULE VI

Loaders: Introduction, Loader Functionalities and Components: Memory allocation: allocating memory for code, data, and stack segments. Relocation: adjusting addresses and references for code and data segments. Program initialization: setting up runtime environment and global variables.

LEARNING RESOURCES

References

- Leland. L. Beck, D Manjula,"System Software", 3rd edition, 2012.
- Srimanta Pal, "Systems programming", Oxford university press, 2016.
- Alfred V Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman ,"Compilers-Principles, Techniques and Tools", Pearson, 2nd edition, 2007.
- Dhamdhere,"SystemProgramming",1st edition, McGraw Hill Publication,2011.

Semester: 4	Course Code : UK4DSCDCS201	Credits: 4

JAVA PROGRAMMING

Preamble: This course is designed to give the students an exposure to basic programming skills through java computer language. This course will train students to handle various data sets using the java platform and enrich technical /industrial soft skill

Prerequisite: Basic understanding of Programming Languages.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	To understand the basic concepts and fundamentals of platform independent language.		PSO2	U	C
CO2	Use the syntax and semantics of java programming language and basic concepts of OOP.		PSO2	E	C
CO3	Develop reusable programs using the concepts of inheritance, polymorphism, interfaces and packages		PSO7	An,Ap	P
CO4	Able to solve real world problems using OOP techniques		PSO7	Ap	P
CO5	To understand streams and efficient user interface design techniques.		PSO2	U	C
CO6	To introduce the implementation of packages and interfaces		PSO2	U,Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Java**:** History of Java, Features of Java, Java virtual machine, Reflection byte codes. Java Technology (JDK, JRE, JVM, JIT).

MODULE II

Java Basis: Variables and Data Types**-** Primitive data types (int, float, char, boolean), Declaring and initializing variables. Main method Structure, Statements, Operators and Expressions.

MODULE III

Fundamentals of java programming**:** First Java Program, Java Identifiers, Java Modifiers, Java Variables, Java Keywords. The naming convention of Java language **,** Comments **,**Statements**,** Literals, Expressions and Operator

MODULE IV

Arrays, Conditionals, and Loops: Arrays, Multidimensional Arrays Declaring Array Variables, Creating Array Objects, Accessing Array Elements, Block Statements.

MODULE V

Exception Handling: Understanding Exceptions, Types of exceptions, Exception hierarchy, Try-Catch Blocks, handling exceptions, Throwing exceptions. Java File Handling- Create and Write to Files

MODULE VI

Packages and Interfaces: Built-in Packages (java.awt, java.io, java.lang, java.math, java.sql, java.util), Creating User Defined Packages, Accessing a Package, Using a Package. Interfaces: Defining Interfaces, Extending Interfaces, Implementing Interfaces, Accessing Interface Variables.

LEARNING RESOURCES

References

- Herbert Schildt, Java The Complete Reference, 7th Edition, Tata McGraw Hill, 2007
- Mahesh Bhave and Sunil Patekar, "Programming with Java", First Edition, Pearson Education,2008, ISBN:9788131720806.
- Rajkumar Buyya,S Thamarasi selvi, xingchen chu, Object oriented Programming with java, Tata McGraw Hill education private limited.
- E Balagurusamy, Programming with Java A primer, Tata McGraw Hill companies
- Anita Seth and B L Juneja, JAVA One step Ahead, Oxford University Press, 2017
- Programming in Java, S. Malhotra, S. Chudhary, 2nd edition, Oxford Univ. Press

Semester: 4	Course Code: UK4DSEDCS201	Credits: 4

INTERNET OF THINGS (IOT)

Preamble: This course equips the learners with fundamental of the Internet of Things (IoT) and the IoT ecosystem. It covers the architecture of IoT, communication mechanisms, protocols, hardware, software, data analytics, and the cloud platforms for IoT. This course enables the students to design smart IoT applications for real world problems.

Prerequisite: Computer organization, knowledge in computer communication.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Illustrate the knowledge in IoT network.		PSO1	Ap	P, C
CO2	Identify different IoT applications.		PSO5	R, U	P
CO3	Interpret different types of smart objects.		PSO7	Ap	C, P
CO4	Apply security to an IoT environment.		PSO8	Ap	C, P
CO5	Experiment to an IoT applications.		PSO9	U,Ap	P
CO6	Discuss the public safety		PSO10	U,Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Internet of Things: Definition & Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, Communication Models, IoT Enabling Technologies, Wireless Sensor Networks.

MODULE II

Cloud Computing, Big Data Analytics, Communication Protocols Domain Specific IoTs: Home Automation, Smart Cities, Smart Surveillance, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Lifestyle.

MODULE III

Engineering IoT Networks: Smart Objects - Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects: Communications Criteria IoT Access Technologies.

MODULE IV

Securing IoT: A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary.

MODULE V

IoT Network Architecture and Design: - Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

MODULE VI

Public Safety: Introduction to potential applications in public safety. An IoT Blueprint for Public Safety, Designing and implementing an IoT architecture for emergency response systems. IoT Public Safety Information Processing, Addressing the unique challenges and safety considerations associated with school bus transportation.

LEARNING RESOURCES

References

- David Hanes, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things", Cisco Press, Pearson, 2017.
- Vijay Madisetti ,"Internet of Things-An Hands on Approach", ArshdeepBahga, 2014.
- Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013.
- Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 1st edition, 2005.
- Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications, 2013.

Semester: 4	Course Code: UK4DSEDCS202	Credits: 4

FINITE AUTOMATA AND LANGUAGE THEORY

Preamble: Formal languages and automata theory deal with the concepts of automata, formal languages, grammar, computability and decidability. Automata Theory possesses a high degree of permanence and stability, contrasting with the ever-changing paradigms ofcomputer systems technology, development, and management.

Prerequisite: Sets, relations - equivalence relations, functions, proof by Principle of Mathematical Induction.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable		PSO1, PSO2	U	C
CO2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation		PSO1, PSO2, PSO6	U	F, C
CO3	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language.		PSO1, PSO2, PSO6	Ap	C, P
CO4	Design Turing machines as language acceptors or transducers		PSO1, PSO2, PSO6	Ap	P
CO5	Explain the notion of decidability		PSO1	U	F, C
CO6	Develop a view on the importance of computational theory		PSO1, PSO2	U	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to theory of computation- Finite state automata – description of finite automata, Properties of transition functions, Designing finite automata, NFA, Equivalence of NFA and DFA, Conversion of NFA to DFA.

MODULE II

Converting DFA's to Regular Expressions, Converting Regular Expressions to DFA's, Converting Regular Expressions to Automata. Closure Properties of Regular sets and Regular grammars, Application of Finite Automata.

MODULE III

Regular sets and Regular grammars, Regular expressions. Chomsky Classification of Languages, Context Free Grammars, Derivation trees, Ambiguity, Simplification of CFLs, Normal forms of CFGs.

MODULE IV

Designing CFGs, PDA – Formal definition, Examples of PDA, Equivalence with CFGs, PDA and CFG, Chomsky hierarchy.

MODULE V

Turing machines basics and formal definition, Language acceptability by TM, examples of TM, and variants of TMs – multi tape TM, NDTM, and Universal Turing Machine.

MODULE VI

Compiler: Analysis-Synthesis model, phases of a Compiler. Lexical Analysis, Syntax Analysis, Semantic Analysis, Intermediate Code Generation, Code Optimization, Code Generation.

LEARNING RESOURCES

References

- Hopcroft J. E., R. Motwani and J. D. Ullman, "Introduction to Automata Theory, Languages and Computation", 2/e, Addison Wesley, 2001.
- Krithivasan K. and R. Rama, "Introduction to Formal Languages, Automata Theory and Computation", Pearson Education, 2009.
- Sipser M.," Introduction to the Theory of Computation", 2/e, Cenagage Learning, 2013.
- Manna Z., "Mathematical Theory of Computation, McGraw Hill", 1974.
- Linz P., "Introduction to Automata Theory and Formal Languages", Narosa, 2006.

Semester: 4	Course Code: UK4DSEDCS203	Credits: 4

NATURAL LANGUAGE PROCESSING

Preamble: Understand language processing with a focus on fundamental tools, such as regular expressions. Equip students with essential skills in text normalization, mastering tasks such as word segmentation, sentence segmentation, and stemming. Delve into world of language modelling, unravelling the significance of n-grams. Identify and comprehend the integral role of transducers in morphological generation. Finally, explore the myriad applications of Natural Language Processing (NLP) in cutting-edge research and development, uncovering the transformative impact of linguistic analysis in various domains

Prerequisite: Artificial Intelligence, Problem Solving with Python, Introduction to machine Learning

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand fundamental tool in language processing, the regular expression,		PSO1	U	P
CO2	Perform basic text normalization tasks including word segmentation and normalization, sentence segmentation, and stemming		PSO3	Cr	P
CO3	Explain language modelling and the n-gram, one of the most widely used tools in language processing		PSO8	Cr	P
CO4	Evaluate n-gram language models extrinsically in some task, or intrinsically using perplexity		PSO9	E	P
CO5	Identify the different models for computational Morphological analysis and the role of transducers in morphological generation		PSO11	An	P
CO6	List out the applications of NLP in research and development		PSO6	E	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I: Introduction - Natural Language Processing - phonology, morphology, syntax, semantics, and pragmatics – Issues - Applications - The role of machine learning

MODULE II: Regular expressions- Basic regular expression patterns, disjunctions, groupings and precedence, Operator precedence, words, tokenizing words

MODULE III : Word Normalization- Lemmatization, Stemming, Porter stemmer Algorithm, Sentence segmentation, NER

MODULE IV: Language models- N gram Language model-Unigram, bigram, trigram, chain rule of probability, Markov assumption, maximum likelihood estimation, Evaluating Language Models-Perplexity

MODULE V: Morphology and part of speech tagging: Finite State Transducers – Regular relations, Computational morphology -Part of speech Tagging - Tag set - Rule- Based Part of Speech Tagging

MODULE VI: Speech - Phonetics, Graphical Models for Sequence Labeling in NLP, Consonants (place and manner of articulation) and Vowels; Phonology: Speech Synthesis, Hidden Markov Model

LEARNING RESOURCES

References

- Dan Jurafsky and James H. Martin, Speech and Language Processing, 3rd Edition, October 16, 2019
- Dash, Niladri Sekhar Corpus Linguistics and Language Technology, New Delhi : Mittal Publications 2005.
- Jacob Eisenstein, Introduction to Natural Language Processing, 2019.
- Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, Steven 2016.
- James Allen, Natural Language Understanding (2nd Edition) 2nd Edition- 2017.
- Ruslan Mitkov, The Oxford Handbook of Computational Linguistics, Oxford University Press2003.
- Philipp Koehn, Statistical Machine Translation, 2016.
- Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics) 1st Edition

Semester: 4	Course Code: UK4DSEDCS204	Credits: 4

DIGITAL MARKETING

Preamble: This Digital Marketing syllabus is designed to introduce students to the fundamental concepts, tools, and strategies used in the field. Through a series of modules, participants will learn how digital marketing differs from traditional marketing, explore various digital marketing channels, and gain hands-on experience with search engine optimization (SEO), search engine marketing (SEM), web analytics, and social media marketing. The program aims to prepare students for effective digital marketing planning and execution, with a focus on real-world application.

Prerequisite: Basic understanding of marketing principles, Familiarity with the internet and online platforms, Basic computer skills and access to a computer with internet.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the basic principles of digital marketing process and differentiate between digital and traditional marketing strategies.		PSO1, PSO5	U	C, P
CO2	Develop a foundational digital marketing plan incorporating the 5 D's of digital marketing and content strategy.		PSO5	U, Cr	P
CO3	Understand information retrieval techniques and page ranking algorithms of search engines		PSO8	U,Ap	P
CO4	Perform keyword search and apply on-page and off page SEO strategies to optimize web content.		PSO8, PSO10	U,An	P
CO5	Design and manage SEM campaigns, including PPC and marketing strategies		PSO5, PSO8	U, An	P
CO6	Implementing digital marketing plans and optimizing resources, considering the impact of AI and machine learning.		PSO11	U, E	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I
Introduction to Digital marketing: Digital vs. Traditional Marketing- Understanding Digital Marketing Process- customer Centricity, Visibility, Digital Marketing Strategies, Strategy Templating.

MODULE II
The 5D's and Planning*:* 5D's in digital marketing, Digital Marketing Channels- Creating initial digital marketing plan - Content Strategy and brand story telling.

MODULEIII
Search Engine Ranking*:* Traditional Information Retrieval, Web Information Retrieval, Elements of the Web Search Process, Crawling, Content Index, Query Processing, Page Ranking

MODULE IV
Search Engine Optimization –fundamentals of SEO- search engines –working of search engines- Major functions of a search engine- keyword search- Different types of keywords- SEO Optimization.

MODULE V
Search Engine Marketing (SEM):definition of SEM-Introduction to Pay-Per-Click (PPC)- Display Advertising, Social Media Marketing, Email Marketing, Content Marketing, Web Analytics.

MODULE VI
Planning Digital Marketing Resources (Agency Vs Team)- Current trends in digital marketing- The role of AI and machine learning in digital marketing.

LEARNING RESOURCES

References

- Ryan, D. (2014). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited.
- The Beginner's Guide to Digital Marketing (2015). Digital Marketer. Pulizzi,J.(2014)
- Epic Content Marketing, Mcgraw Hill Education.
- The Art of SEO: Mastering Search Engine Optimization by Eric Enge, Stephan Spencer, and Jessie Stricchiola
- Social Media Marketing: A Strategic Approach by Melissa Barker, Donald I. Barker, Nicholas F. Bormann, and Debra Zahay

Online Resources

- HubSpot's Guide on Digital Marketing: HubSpot
- Google's Fundamentals of Digital Marketing: Google Digital Garage
- FutureLearn's Introduction to Digital Marketing: FutureLearn

Semester:4 **Course Code:** UK4DSEDCS205 **Credits: 4**

DATA COMMUNICATION

Preamble: This course introduces the basic principles for the exchange of data between various devices, systems, and networks, forming the backbone of our modern digital society. Students will be able to understand the various time domain and frequency domain concepts of data communication along with the concepts of encoding, multiplexing and spread spectrum.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Introduce fundamental communication models.		PSO1	U	P, C
CO2	Identify and list the various issues present in the design of a data communication system.		PSO1	An	P, C
CO3	Apply the time domain and frequency domain concepts of signals in data communication.		PSO1, PSO2	Ap	C, P
CO4	Compare and select transmission media based on transmission impairments and channel capacity.		PSO1	An	P
CO5	Select and use appropriate signal encoding techniques and multiplexing techniques for a given scenario.		PSO1, PSO2	U	P, C
CO6	Understand error detection and error correction algorithms to achieve error free data communication and explain different switching techniques.		PSO1, PSO2	U	P, C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Data Transmission: Communication model Simplex, half duplex and full duplex transmission - Periodic Analog signals: Sine wave, phase, wavelength, time and frequency domain, bandwidth – Digital Signals; Digital data Transmission: - Analog & Digital data, Analog & Digital signals,

Analog &Digital transmission – Transmission Impairments: Attenuation, Delay distortion, Noise – Channel capacity: Nyquist Bandwidth, Shannon's Capacity formula.

MODULE II

Transmission media*:* Guided Transmission Media: Twisted pair, Coaxial cable, optical fibre, Wireless Transmission, Terrestrial microwave, Satellite microwave. Wireless Propagation: Ground wave propagation, Sky Wave propagation, LoS Propagation.

MODULE III

Signal Encoding techniques: Digital Data Digital Signals: NRZ, Multilevel binary, Bi phase - Digital Data Analog Signals: ASK, FSK, PSK - Analog Data Digital Signals: Sampling theorem, PCM, Delta Modulation - Analog Data Analog Signals: AM, FM, PM.

MODULE IV

Multiplexing: Space Division Multiplexing-Frequency Division Multiplexing: Wave length Division Multiplexing - Time Division multiplexing: Characteristics, Digital Carrier system. Statistical time division multiplexing: Cable Modem – Code Division Multiplexing. Multiple Access– CDMA.

MODULE V

Digital Data Communication Techniques: Asynchronous transmission, Synchronous Transmission-Detecting and Correcting Errors-Types of Errors-Error Detection: Parity check, Cyclic Redundancy Check (CRC) - Error Control Error Correction: Forward Error Correction and Hamming Distance.

MODULE VI

Spread Spectrum Techniques: Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS).

Basic principles of switching: Circuit Switched Networks, Structure of Circuit Switch - Packet Switching: Datagram Networks, Virtual Circuit Networks, Structure of packet switches.

LEARNING RESOURCES

References

- Curt M. White, "Fundamentals of Networking and Communication", 7/e, Cengage learning.
- Forouzan B. A., "Data Communications and Networking", 5/e, Tata McGraw Hill, 2013.
- Schiller J., "Mobile Communications", 2/e, Pearson Education, 2009. [Chapters:2,3]
- William Stallings, "Data and Computer Communication", 9/e, Pearson Education, Inc.
- Tanenbaum A. S. and D. Wetherall, "Computer Networks", Pearson Education, 2013.

Semester: 4	Course Code: UK4DSEDCS206	Credits: 4

COMPUTER GRAPHICS

Preamble: Computer graphics play a fundamental role in various fields, including entertainment, design, simulation, virtual reality, and scientific visualization. This course will serve as your gateway to understanding the principles, techniques, and applications of computer graphics.

Prerequisite: Basic Mathematics

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Compare the display devices in Computer Graphics		PSO1	An	P, C
CO2	Explain the Bresenham Circle Drawing Algorithm		PSO2	Ap, U	P
CO3	Compare Boundary fill and Flood Fill		PSO1	An	C,P
CO4	SolveProblemson2Dand3D transformations		PSO2	Ap	P
CO5	Compare Gour and shading and Flat Shading		PSO2	Ap	P
CO6	Implement programs in Open GL		PSO2	An, Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Computer graphics- Raster Scan- Random Scan- application of computer graphics- Display Devices- LED- OLED, Flexible Displays.

MODULE II

DDA algorithm -Bresenhams Line drawing algorithm- midpoint circle algorithm, polygon filling algorithms-boundary fill, flood fill, scan line algorithm. Polygon clipping- Sutherland Hodgeman algorithm

MODULE III

Basic 2D transformations: Translation, Rotation, Scaling, homogenous coordinates foruniform matrix operations, composite transformation.

MODULE IV

3D concepts and techniques: 3D object representations, basic 3D transformations, Projections: parallel and perspective projections, vanishing points, visible surface detection algorithms-scan line method, Z buffer algorithm, A- buffer algorithm, depth sorting.

MODULE V

Illumination model- Ambient Illumination- Diffuse Reflection - Specular Reflection, Polygon rendering :Flat Shading- Gour and Shading, Phong Shading, Ray Tracing.

MODULE VI

Animation- Design of Animation Sequences- Key Frame Systems. Open GL:- Advantages of Open GL, OpenGL programming language, Implement computer graphics programs using OpenGL

LEARNING RESOURCES

References

- Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, Kurt Akeley (Publisher: Addison-Wesley, Year: 2013)
- "OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.5" by John Kessenich, Graham Sellers, Dave Shreiner (Publisher: Addison-Wesley, Year: 2016)
- "Introduction to Computer Graphics: A Practical Learning Approach" by David M. Bourg, Keith L. Miller (Publisher: CRC Press, Year: 2014)
- "Fundamentals of Computer Graphics" by Peter Shirley, Steve Marschner (Publisher: A K Peters/CRC Press, Year: 2017)
- OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.5" by John Kessenich, Graham Sellers, Dave Shreiner (Publisher: Addison-Wesley, Year: 2016)

Semester: 5	Course Code: UK5DSCDCS301	Credits: 4

COMPUTER NETWORKS

Preamble: This course is a foundation course covering major concepts from data communication and computer networks. The students are poised to develop the analytical, conceptual solutions for internetworking skills required to navigate the complexities of computer networks, contributing to their success in a rapidly evolving technological landscape.

Prerequisite: Basic understanding of Data Structures.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the basics of data communication.		PSO1, PSO3	U	C
CO2	To familiarize the student with the basic taxonomy and terminology of computer networks		PSO1, PSO3	R	C
CO3	Differentiate between various types of computer networks and their topologies		PSO3	An	P
CO4	To prepare the student for advanced courses in computer networking		PSO3, PSO4	U	C
CO5	To understand data transmission across the network		PSO1, PSO3	U	C
CO6	Familiarity with the essential protocols of computer networks, and how they can be applied in network design and implementation.		PSO1, PSO3, PSO11	U,Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Data Communication: Data Communication System: Data & Information, Data Communication, Components of Data Communication, Data Representation, Data Flow.

MODULE II

Data & Signals: Analog Signal-Amplitude, Frequency, Phase, Wavelength, Digital Signal-Level, Bit Interval, Bit Rate, Baud Rate.

MODULEIII

Networks: Definition, Categories of Networks, Protocol, Standards In Networking. Network Topologies- Bus, star, ring, mesh, and tree, hybrid topologies with their features, advantages and disadvantages of each type.

MODULE IV

Network Models: Principles of Protocol Layering, Reference Models –Understanding OSI and TCP/IP Model

MODULE V

Introduction to Physical layer: Digital and Analog Transmission, Digital-to-digital conversion, Analog-to-Digital conversion, transmission modes, Digital-to-Analog conversion, Analog-to-Analog conversion.

MODULE VI

Switching Devices: Repeaters, hubs, switches, bridges, routers, gateways. Multiplexing: (FDM, WDM, TDM), Bandwidth Utilization: Multiplexing and Spectrum Spreading: Multiplexing

LEARNING RESOURCES

References

- Forouzan, B. A., &Fegan, S. C. New York: "Data communications and networking", McGraw-Hill Higher Education.
- Upper Saddle River, NJ: Stallings, William. "Data and Computer Communications", Pearson/Prentice Hall, 2007. Print.
- Andrew Tanenbaum ."Computer Networks" , ,Pearson Fifth 2013.
- Douglas E. Comer, "Computer Networks and Internet", 6th edition, Pearson Publication, 2015.
- Behrouz A. Forouzan." TCP/IP Protocol Suite", Tata McGraw Hill, 4thEdition,2010.
- J. F. Kurose and W. R. Ross, *Computer Networking: A Top-Down Approach Featuring the Internet.*
- D. Bertsekas& R. Gallager, *Data Networks*.

Semester: 5	Course Code: UK5DSCDCS302	Credits: 4

DATABASE MANAGEMENT SYSTEMS

Preamble: This course offers students an introduction to the design and programming of database system. The ER method to data modelling, the use of SQL query language and transaction processing concepts are covered in this course.

Prerequisite: Computer Fundamentals.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the concepts, need, working and architecture of DBMS.		PSO1	U, An	C
CO2	Familiarize the concepts of various data models.		PSO2	U	C, P
CO3	Develop skills to design an ER diagram.		PSO7	U, Ap	C, P
CO4	Create database using SQL and perform operations in SQL.		PSO10	Ap, An	C, P
CO5	Familiarize the management of concurrent transactions.		PSO7	U, An	C, P
CO6	Apply the design concepts and normalization in database easily.		PSO1	An, Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Database system – Concepts, Purpose, Applications, View of data. Database languages, Database design, Database architecture, Database Languages, Database Users, Data Dictionary, and Functional Components of a DBMS.

MODULE II

Data models - Hierarchical model, Network model, Entity Relationship model, Object oriented data model, Relational model.

Database design using ER model: Overview, Entity sets, Relationship sets, Attributes, Mapping cardinalities, Removing redundant attributes in entity sets, Sample ER diagrams.

MODULE III

Introduction to relational model: Structure of relational database, Database schema, Keys, Integrity constraints.

Relational algebra: Introduction, Fundamental operations, Additional operations and Extended operations. Tuple Relational Calculus and Domain Relational Calculus.

MODULE IV

Problems of Un-Normalized Database, Features of good relational design, Update anomalies, Functional Dependencies, Characteristics, Inference rules, Normal forms (1NF, 2NF, 3NF, BCNF, 4NF).

MODULE V

Introduction to SQL: SQL data definition, Basic structure of SQL queries, Additional basic operations, Set operations, Null values, Aggregate functions, Nested subqueries, Modification of the database, Intermediate SQL: Join expressions, Views, Integrity constraints, Authorization.

MODULE VI

Transactions: Transaction concept, A simple transaction model, ACID property, Transaction States, Serializability (Conflict and View), Recoverability, Test for Serializability. Concurrency control: Lock based protocol, Deadlock handling, Multiple granularity, Timestamp based protocols, and Validation based protocols.

LEARNING RESOURCES

References

- Silberschatz, Hentry F. Korth, S. Sudarshan, Database System Concepts, Seventh Edition. 2019.
- Fundamentals of Database Systems 6th Edition, R. Elmasri, S.B. Navathe, Pearson Education.
- Date, C. J. (2020). An Introduction to Database Systems (9th ed.). Pearson Education.
- SQL and Relational Theory: How to Write Accurate SQL Code, Christopher J. Date, O'Reilly Media. 2015.
- Atul Kahate, Introduction to Database Management Systems.

Semester: 5	Course Code: UK5DSEDCS301	Credits: 4

CLOUD COMPUTING

Preamble: Aim is to equip students with the skills to independently manage software components within a computer and become proficient programmers.

Prerequisite: Operating System, Computer Networks

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the basic of cloud computing.		PSO1	U	C
CO2	Describe the state of the cloud architecture.		PSO2	U,R	P,C
CO3	Identify the types of cloud computing services.		PSO1	R	C, P
CO4	Explore different types of data storage.		PSO3	U,Ap	C, P
CO5	Identify the risk factors in cloud.		PSO1	R,An	P
CO6	Compare data security for protecting information.		PSO5	U,Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Cloud Computing foundation: Understanding cloud computing, characteristics of Cloud computing, basic concepts and terminologies, benefits and limitations of Cloud computing, Cloud infrastructure framework.

MODULE II

Types of Cloud: public, private, and hybrid clouds. Working principle of Cloud Computing. Cloud Computing Architecture: Overview of the architecture of cloud computing systems, Design principles for building scalable, resilient, and secure cloud-based systems.

MODULEIII

Cloud computing service models Infrastructure-As-A-Service, Platform-As-A-Service, Software-As-A Service, Storage-As-A-Service. Data Storage and Cloud Computing: Fundamentals of data storage, storage devices, file systems, and storage architectures.

MODULE IV

Types of data storage solutions such as direct-attached storage (DAS), network-attached storage (NAS), and storage area networks (SANs). Cloud Storage, Cloud storage architectures and technologies: object storage, block storage, and file storage. Cloud Storage from LANs to WANs, Cloud Computing Services: Cloud Services, Cloud Computing at Work.

MODULE V

Risks in Cloud Computing: Identifying and analyzing the various risks and vulnerabilities inherent in cloud computing, including data breaches, data loss, and service outages. Data Security in Cloud: Overview of cloud security services and technologies designed to enhance the security. Cloud Computing Tools: Tools and Technologies for Cloud.

MODULE VI

Cloud Applications: Moving Applications to the Cloud: benefits and challenges of migrating applications to the cloud. Microsoft Cloud Services: Microsoft Azure cloud platform and its core services for infrastructure, platform, and software. Google Cloud Applications: Amazon Cloud Services, Cloud Applications

LEARNING RESOURCES

References

- A.Srinivasan and J.Suresh, "Cloud Computing –A Practical Approach for Learning and Implementation", Pearson India Publications2014.
- Thomas Erl, "Cloud Computing: Concepts, Technology & Architecture" (The Prentice Hall Service Technology Series from Thomas Erl) Hardcover – May 20, 2013
- Rajkumar Buyya, James Broberg, Andrzej, "Cloud Computing: Principles and Paradigms",Wiley India Publications2011.
- ArshdeepBahga and Vijay Madisetti, "Cloud Computing –A Hands on Approach", Universities Press (India) Pvt Ltd. 2014.

Semester: 5	Course Code: UK5DSEDCS302	Credits: 4

CYBER SECURITY AND CYBER LAW

Preamble: Cyber Security is a critical and foundation component of several computing applications. This course gives the students exposure to various security concepts and their vulnerabilities in real life problems. With this in curriculum students will aware the cyber space and its extensions.

Prerequisite: An overview of information security and computer networks.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identifying the key terms and concepts in Cryptography		PSO1	U	C
CO2	Develop cyber security strategies and policies		PSO2	R	C
CO3	Analyzing the nature of attacks through cyber/computer forensics software tools.		PSO9	An	P
CO4	Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.		PSO7	U	C
CO5	Analyze Cyber Law in the context of breach of cyber security.		PSO12	An	F,C
CO6	Discuss IT Act & its Amendments		PSO7	U	F,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Information System Threats and attacks, Classification of Threats and Assessing Damages, Security in Mobile and Wireless Computing- Security Challenges in Mobile Devices. Elementary Cryptography concepts.

MODULE II

Introduction to Cyber Security: Types of Attacks, Unauthorized Access, Impersonation, Denial of Service, Malicious Software, Viruses, Worms, Trojan Horses. Malware and Its Type, Adware, Spyware, Browser hijacking software.

MODULE III

Introduction to Cyber Crime: Definition, Cyber Crimes and Information Security, Classification of Cyber Crimes- Cyber Stalking, Child Pornography, Forgery and Counterfeiting.

MODULE IV

Creating and distributing viruses over internet: Spamming, Cross Site Scripting, Online Auction Fraud, Cyber Squatting, Web Jacking, e-mail Spoofing, Spanning.

MODULE V

Intellectual Property Issues in Cyber Space Interface with Copyright Law - Interface with Patent Law- trademarks & Domain Names Related issues. Indian Context of Jurisdiction and IT-Act, 2000. , International Law and Jurisdictional Issues in Cyberspace.

MODULE VI

Cyber Crimes & Legal Framework: Cyber Crimes against Individuals ,Institution and State ,Hacking ,Digital Forgery ,Cyber Stalking/Harassment ,Cyber Pornography , Identity Theft & Fraud Cyber terrorism , Cyber Defamation , Different offences under IT Act, 2000

LEARNING RESOURCES

References

- Forouzan, B. A., &Fegan, S. C. New York: "Data communications and networking", McGraw-Hill Higher Education.2015
- Upper Saddle River, NJ: Stallings, William. "Data and Computer Communications", Pearson/Prentice Hall, 2007.
- Andrew Tanenbaum ."Computer Networks" , Pearson Fifth 2013.
- Douglas E. Comer, "Computer Networks and Internet", 6th edition, Pearson Publication, 2015.
- Behrouz A. Forouzan." TCP/IP Protocol Suite", Tata McGraw Hill, 4thEdition,2010.
- J. F. Kurose and W. R. Ross, Computer Networking: A Top-Down Approach Featuring the Internet.2007
- D. Bertsekas& R. Gallager, Data Networks,Wiley2000

Semester: 5	Course Code: UK5DSEDCS303	Credits: 4

DATA SCIENCE

Preamble: Aim to serves as a gateway to the dynamic and rapidly evolving world of data science, offering students the opportunity.

Prerequisite: Data structures and algorithms, Basic understanding of mathematics and statistics.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Describe the fundamental concepts of data science		PSO1	U, R	CO1
CO2	Identify various data sources.		PSO2	R, U	CO2
CO3	Analyze data along with practical skills		PSO3	An	CO3
CO4	Develop skills in data processing, and transformation to ensure data quality and consistency.		PSO5, PSO7	An	CO4
CO5	Examine the properties of distributions and their significance in data analysis.		PSO8, PSO9	U, R	CO5
CO6	Experiment the real-world datasets.		PSO10	An	CO6

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Data Science: Introduction to data, information, and knowledge. Definition of data science and its applications, Impact of Data Science, Data Analytics Life Cycle, Data Science Toolkit, Data Scientist. Facts of Data: Structured data, unstructured data, natural language, machine generated data, network data, audio, images and video streaming data.

MODULE II

Introduction to data sources: Introduction to Time Series Data, Transactional Data: Characteristics and Applications, Biological Data: Types and Challenges, Spatial Data: Geospatial Analysis and Visualization, Social Network Data: Structure and Analysis, Data Evolution: Temporal Analysis and Trends.

MODULE III

Understanding data: Introduction to Data and its Importance. Types of Data: Numeric, Categorical, Graphical, High Dimensional Data. Characteristics of Numeric Data and Analysis Techniques. Classification of digital Data: Structured, Semi-Structured and Unstructured Example Applications.

MODULE IV

Data Collection methods: Introduction to data collection techniques such as surveys, experiments, observations, and web scraping. Data cleaning and pre-processing techniques: Introduction to data cleaning tools and libraries-processing methods including normalization, scaling, and data transformation. Handling missing data and outliers, Data Integration and Transformation, Data Reduction.

MODULE V

Data analysis: Introduction, Terminology and concepts. Overview of data analysis techniques and their applications in various fields. Introduction to statistics: Basic principles of statistics and its role in data analysis, Central tendencies and distributions, Variance, Distribution properties and arithmetic.

MODULE VI

Data visualization: Importance of data visualization, Historical overview of data visualization techniques and tools, type of visualization (e.g., charts, graphs, maps, diagrams), types of data visualization techniques. Overview of data encodings and their significance, Introduction to retinal variables and their role in encoding data.

LEARNING RESOURCES

References

- Cathy O'Neil, Rachel Schutt, "Doing Data Science", Straight Talk from The Frontline. O'Reilly, 2013.
- Davy Cielen, Arno D. B. Meysman, Mohamed Ali, "Introducing to Data Science", Manning Publications Co., 1st edition, 2016
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to Statistical Learning: with Applications in R" Springer, 1st edition, 2013.
- Jeffrey Stanton, "An Introduction to Data Science", SAGE publications, 2017.
- Lillian Pierson, "Data Science for Dummies", John Wiley & Sons, 2017.
- Wickham, H., Çetinkaya-Rundel, M., & Grolemund," *R for data science* (2nd ed.)", O'Reilly Media, 2023, Inc. https://r4ds.hadley.nz.

Semester: 5 **Course Code:** UK5DSEDCS304 **Credits: 4**

DATA VISUALIZATION TECHNIQUES

Preamble: This course serves as a guiding beacon to illuminate the significance of data visualization techniques. Helps students to communicate findings effectively, identify outliers, or uncover hidden relationships in their research works. The arsenal of visualization empowers them to present insights in a manner that transcends the limitations of textual or numerical representation.

Prerequisite: Python Programming

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Design and create data visualization		PSO2, PSO3	Ap	CO1
CO2	Explain the directory of visualization		PSO2, PSO3	U	CO2
CO3	Describe the principles of figure design		PSO2, PSO3	U	CO3
CO4	Implement basic plotting using matplotlib		PSO2, PSO3,PSO11	Ap	CO4
CO5	Implement basic plotting using pandas		PSO3,PSO11	Ap	CO5
CO6	Learn about different Visualization Techniques		PSO2, PSO3	U	CO6

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Visualizing data: Mapping data onto aesthetics, Aesthetics and types of data, Scales map data values onto aesthetics, Coordinate systems and axes, Colour scales.

MODULE II

Introduction to Visualization: Visualization stages – Experimental Semiotics based on Perception – Gibson's Affordance theory – A Model of Perceptual Processing – Costs and Benefits of Visualization – Types of Data.

MODULE III

Amount, Distributions, proportions, x-y relationships, geospatial data, uncertainty, visualizing amounts, proportions, trends, geospatial data and uncertainty.

MODULE IV

Visualizations along linear axes, Visualizations along logarithmic axes, Direct area visualizations, Handling Overlapping points Partial transparency and jittering, 2D histograms, Contour lines.

MODULE V

Line plots-titles, labels and legends, plotting using CSV and TSV data source, scatter plot, Bar plots, Histograms, pie charts, stack plots.

MODULE VI

Loading datasets with Pandas, plotting Histograms with Pandas, Pandas Line plots, Pandas Scatter plots, Pandas Box plots, hexagonal plots, Kernel Density plots, time aeries data visualization.

LEARNING RESOURCES

References

- Claus O. Wilke, "Fundamentals of Data Visualization", Reilly' publishers, 2019.
- Mario Dobler Tim Gromann, "Data Visualization with Python: Create an impact with meaningful data insights using interactive and engaging visuals", Packt Publishing, 2019.
- AI Publishing, "Python for Data Preprocessing for Beginners", AI publishers, 2020.

Semester: 5	Course Code: UK5DSEDCS305	Credits: 4

SOCIAL NETWORK ANALYSIS

Preamble: In this course we will unravel the importance of meaning, syntax, semantics, and the transformative power of the Semantic Web and social networks. From understanding the emergence of the Social web to exploring ontology-based knowledge representation, RDF vocabulary, and the nuances of network analysis, this study aims to equip the student with a profound understanding of the social web.

Prerequisite: Data Structures

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the evolution and identify the basic concepts of semantic web and social networks		PSO4	U	F
CO2	Explain how semantic web and ontology related		PSO5	A	C
CO3	Describe about the basic concepts and measures of Social Network Analysis including ego networks		PSO1	E	P
CO4	Discuss about the basic metrics used in social network analysis		PSO6	Ap	P
CO5	Illustrate degree distribution, clustering coefficient, clique, k-core, k-plex and network motifs		PSO6	Cr	C
CO6	Apply different centralities		PSO9	Cr	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Knowledge Engineering and the web of Data-Importance of meaning-Syntax, semantics, context, pragmatics, and experience -Understanding content on the web. Limitations of the current web. Introduction to Semantic Web and social networks

MODULE II

Emergence of Social web, Ontology based knowledge Representation, Resource Description Framework, RDF vocabulary, Graphical representation of RDF documents

MODULE III

Network Analysis-Key concepts and measures in network analysis, global structure of networks, 2Dimensional lattice, tree graph, random graph model, alpha model, beta model, BA model,

MODULE IV

Degree distribution for undirected graph**,** Clustering coefficient, Cliques, k-core, 1-core, 2-core, 3-core, k-clans, k-plex, network motifs, subgraphs

MODULE V

Representing relations as networks, entering data on a directed graph, Ego networks and whole networks, adding weights to edges, homophily, transitivity and bridging

MODULE VI

Paths and shortest paths, betweenness centrality, closeness centrality, eigen vector centrality, reciprocity, density, clustering, average and longest distance

LEARNING RESOURCES

References

- Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
- Dion Goh and Schubert Foo, "Social information Retrieval Systems: EmergingTechnologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
- Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking Techniques and applications", First Edition Springer, 2011.
- Maksim Tsvetovat, Alexander Kouznetsov; "Social Network Analysis for Startups: Finding Connections on the Social Web"; O'Reilly Media, Inc., ISBN 1449306462, 9781449306465
- Peter J. Carrington, John Scott, Stanley Wasserman; "Models and Methods in Social Network Analysis"; Cambridge University Press; ISBN 1139443437, 9781139443432
- Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
- Song Yang, Franziska B. Keller, Lu Zheng; "Social Network Analysis:

Semester: 5	Course Code : UK5DSEDCS306	Credits: 4

BIOINFORMATICS

Preamble: This syllabus is meticulously designed to provide a comprehensive understanding of fundamental principles in life science, molecular biology, and their intersection with the dynamic field of bioinformatics. Over the course of five modules, we will explore the characteristics of life, the organization of biological systems, the structure of cells, and delve into the intricacies of DNA and RNA. Additionally, the course will venture into the history, definition, and practical applications of bioinformatics, incorporating various analytical tools and databases.

Prerequisite: Basic knowledge about human DNA and Biology

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Demonstrate the basic knowledge in Life science		PSO7	U, Ap	F
CO2	Compare RNA and DNA			U, An	P
CO3	Analyse the DNA sequence and perform matching		PSO7, PSO11	U,An	P
CO4	Illustrate the working of pair wise alignment method		PSO6	U,Ap	P
CO5	Identify the bioinformatics databases		PSO7	U	P
CO6	Perform sequence alignment in DNA sequences		PSO7	U, Ap	P
CO7	Understand the significance of Bioinformatics as a multidisciplinary research area		PSO7	U, Cr	MC

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to life Science: Characteristics of life, Levels of biological Organization, cell as basic MODULE of life, cell theory, structure of Prokaryotic cell and Eukaryotic cell, Primary and secondary structure of DNA, Chargaff's Rules, Different forms of DNA, RNA, structural organization of DNA, Gene and genetic information

MODULE II

Bioinformatics: History of Bioinformatics, Definition of Bioinformatics, Bioinformatics versus Computational Biology, Goals of Bioinformatics analysis, Bioinformatics technical tool box, Biological data, File format, conversion of file format, Data retrieval system, Genome browsers.

MODULEIII

Analyzing DNA sequence, IUPAC code for DNA sequence, ORF, palindromes in DNA sequence, RNA sequence analysis; FASTA format. Sequence analysis/Alignment: DNA sequence, RNA sequence.

MODULE IV

Protein sequence, sequence alignment classifications, Scoring Matrices – PAM, BLOSUM; Sequence Alignment: Introduction to Sequence Comparison - Pairwise Alignment Method (DOT PLOT method) and Multiple Analyses of Protein Structures

MODULE V

Databases: Bioinformatics databases, Types of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, Gene Bank, DDBJ; Secondary nucleotide databases, Protein sequence databases- SwissProt/TrEMBL, Protein structure databases- Protein Data Bank

MODULE VI

Human Genome Project, Importance of Perl language in Bioinformatics, Applications of Bioinformatics in Biodiversity, Human Genetics, Gene Therapy, Agriculture, Computer-Aided Drug Design, DNA Fingerprinting.

LEARNING RESOURCES

References

- P S Verma, V K Agarwal, Cell Biology, enetics, Molecular Biology, Evolution and
- Ecology, S. Chand Publications.
- S C Rastogi, N Mendiratta, P Rastogi, Bioinformatics Methods and Applications, PHI
- JinXiong, Essential Bioinformatics, Cambridge University Press
- Jean-Michel Claverie, Cedric Notredame, Bioinformatics: A Beginner's Guide, Wiley,
- 2006
- Dr. K Mani & N Vijayaraj, Bioinformatics: A practical approach, Aparna Publications

Online Resources

- https://nptel.ac.in/courses/102/106/102106065
- https://nptel.ac.in/courses/102103044

Semester: 6 **Course Code:** UK6DSCDCS301 **Credits: 4**

SOFTWARE ENGINEERING

Preamble: Aim to prepare students to be successful professionals in the field with solid fundamental knowledge of software engineering.

Prerequisite: Problem solving skills, Database Systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Apply the software engineering lifecycle		PSO2	U, R	C, P
CO2	Ability to Work as an individual and a team		PSO4	Ap	P, C
CO3	Identify the Requirements of Software.		PSO8	An	P
CO4	Use effective software design		PSO6	U, Ap	C, P
CO5	Understand Coding and testing.		PSO9	An	P, C
CO6	Develop and deliver quality software.		PSO10	U, An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: The Nature of Software, Software Engineering, Evolution. Software Development Projects, Program versus product, Emergence of Software Engineering. Software Life cycle models: Waterfall model, Rapid Application Development (RAD), Agile Model, Spiral Model.

MODULE II

Software Project Management: Introduction, Phases of Project Management Process,
Principles of Project Planning, Metrics for Project Size Estimations, Project Estimation Techniques.

MODULEIII

Requirement Analysis and Specification: Requirements Engineering, Gathering and Analysis, Software Requirements Specification (SRS), Characteristics of SRS, Formal System Specification.

MODULE IV

Software Design: Overview, Characteristics, Cohesion & Coupling, layered design, Approaches. Function Oriented Design: Structured Analysis, developing the DFD model of a system, Structured Design, Detailed design.

MODULE V

Coding and Testing: Introduction, Code Review Process: Importance of code reviews in software development, Documentation Standards: Types of documentation: Code documentation, User manuals, technical specifications. Testing: Functional vs. non-functional testing, Black-box, White-box, Integration, OO Testing, Smoke testing.

MODULE VI

Software Reliability and quality management: Definition, Relationship between reliability and quality management, Software Reliability: Metrics, Techniques for reliability prediction and estimation, Error prevention and fault tolerance techniques. Software Maintenance: Characteristics of software maintenance, Corrective vs. adaptive vs. perfective maintenance.

LEARNING RESOURCES

References

- Roger S Pressman, "Software Engineering "VII Edition, PRESSMAN Publishers TATA McGRAW - HILL International Edition.
- Rajib Mall, "Fundamentals of Software Engineering", Fourth Edition, PHI.
- Pressman," Software Engineering's Approach", TMH.
- Rex Black, "Foundations of Software Testing: ISTQB Certification"

Semester: 6	Course Code: UK6DSCDCS302	Credits: 4

WEB PROGRAMMING

Preamble: Aim to explore the fundamental concepts, languages, and frameworks that power the modern web. Web development is the work involved in developing web page for the intranet or an Internet.

Prerequisite: Programming Concepts, JavaScript, HTML.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Employ web design techniques.		PSO8	U,Ap	P,C
CO2	Analyze the structure of web pages and CSS		PSO10	Ap	P
CO3	Develop knowledge of server-side programming.		PSO7	Ap	P,C
CO4	Construct JavaScript program.		PSO8	U,An	C,P
CO5	Describe the Learn PHP.		PSO5	U,An	P,C
CO6	Identify types of cookies and their usage scenarios.		PSO10	R,An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

HTML - General Introduction to Internet and WWW; HTML: Structured language, Document types, Rules of html, Html tags, Head tags, Body tags, Headings, Divisions and Centering, Quotations, Preformatted text, Lists, Horizontal Rules, Block level elements, Text level elements, Character entities, Comments, Fonts, Tables: Table tags, Colors, Color names, Color values, Marquee tag.

MODULE II

Advanced HTML - Linking in html: Anchor tags, Layer tags, Link relationships, URL: Relative, Absolute, Image, Image maps, Frames: Layouts, Targeting, No frame tag, Floating frames, Audio, Embed tag, Forms: form tag and its attributes.

MODULE III

CSS: Style sheet Basics, Adding Style to a Document, CSS (Cascading Style Sheet) and HTML Elements, Selectors, Document Structure and Inheritance. JavaScript - Introduction to JavaScript,

Variables and data types, Declaring Variables, Operators, Control Structures, Conditional Statements, Loop Statements, Functions, Objects, Dialog Boxes, Alert Boxes, Confirm Boxes, Prompt Boxes.

MODULE IV

JavaScript with HTML, Events. Introduction to DHTML-Components, Uses, Features. Arrays: Creating arrays (associative & multidimensional), Array related functions. Working with Objects, Working with string functions: Formatting strings, Using Date and Time functions.

MODULE V

Forms in PHP: Form elements, adding elements to a form, creating a simple input form, combining HTML & PHP code on a single page, redirecting the user, creating a send mail form, File upload form, working with files and directories.

MODULE VI

Cookies: Introduction, Definition and purpose of cookies in web development, Privacy concerns and limitations of cookies. Different types of cookies: Session cookies vs. persistent cookies, First-party cookies vs. third-party cookies. Setting a cookie with PHP: setcookie() function and its parameters, deleting a cookie, session function overview: starting a session, working with session variables.

LEARNING RESOURCES

References

- V.K. Jain, "Advanced Programming in Web Design", Cyber Tech Publications,2008.
- Julie C.Meloni, " PHP, MySQL and Apache", Pearson Education,2012.
- Ivan Bayross," Web Enabled Commercial Application Development: HTML, DHTML, JavaScript", PHP for Beginners, PHI,2005.
- DT Editorial Services, "HTML 5 Black Book, Covers CSS 3, JavaScript, XML, XHTML, AJAX, PHP and jQuery", 2ed 2nd Edition, Kindle Edition,2016.
- Vikram Vaswani, "PHP: A Beginners Guide", 1st edition, TMH Hill,2010.
- Steven M. Schafer," HTML, XHTML, and CSS Bible", 5th edition, Wiley Publisher, 2011.
- Robin Nixon," Learning PHP, MySQL, JavaScript, CSS & HTML5", O'Reilly,2014.

Semester: 6	Course Code: UK6DSEDCS301	Credits: 4

DATA MINING AND BIG DATA ANALYTICS

Preamble: This course provides a thorough examination of data mining, covering the basic ideas and methods needed to get insightful information from big databases. Students will gain knowledge of how to recognize and handle data for mining purposes from a variety of sources, analyze large datasets to extract valuable business insights, and assess mathematical techniques essential for successful data mining applications. The course introduces student's ideas like Map Reduce and the Hadoop Distributed File System, giving them a strong foundation in using big data technologies for analysis and decision-making.

Prerequisite: Database Management Systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand basic concepts of Data mining.		PSO1	R, U	F
CO2	Identify sources of data and process it for data mining.		PSO5	U	F
CO3	Analyze large sets of data to gain useful business understanding.		PSO4	An	P
CO4	Evaluate mathematical methods underlying the effective application of data mining.		PSO6	Ap	C
CO5	Understand the key issues in big data management.		PSO3	R	F
CO6	Familiarize the concepts of Hadoop Distributed file system and Mapreduce.		PSO3	U, An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Data Mining: Data Mining: Definitions, KDD vs Data Mining, DBMS vs Data Mining, Data Mining Techniques, Issues and Challenges, Applications.

MODULE II

Data mining Functionalities, Introduction to Data Warehousing -Characteristics, Data Pre-processing- Data cleaning, Data Integration and Transformation, Data reduction.

MODULE III

Association rule mining – Market Basket Analysis- Apriori Algorithm- Mining Frequent Patterns, Associations Mining various Kinds of Association Rules

MODULE IV

Clustering: Types of Data in Cluster Analysis - Dendrogram- Partitioning Methods – K-means, Hierarchical Clustering methods-- Single Linakge Algorithm, Complete Linkage Algorithm-Average Linkage

MODULE V

Big data: Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Hadoop features, Analyzing Data with Hadoop, Hadoop Streaming and pipes.

MODULE VI

Hadoop Ecosystem: Learning the HDFS and MapReduce Architecture, Hadoop Pig, Hive, Hive Query Language, HBase.

LEARNING RESOURCES

References

- Alex Berson and Stephen J.Smith, "Data Warehousing, Data Mining and OLAP", TataMcGraw – Hill Edition, Thirteenth Reprint 2008.
- Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012.
- Tom White " Hadoop: The Definitive Guide" Third Edit on, O"reily Media, 2012.
- SeemaAcharya, SubhasiniChellappan, "Big Data Analytics" Wiley 2015.

Semester: 6	Course Code: UK6DSEDCS302	Credits: 4

INFORMATION RETREIVAL

Preamble: This course will cover algorithms, design, and implementation of modern information retrieval systems. The main objective of this course is to present scientific support in the information search and retrieval field. This course explores the fundamental relationship between information retrieval, hypermedia architectures, and semantic models, thus deploying and testing several important retrieval models.

Prerequisite: Mathematical foundations and Web Programming.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Compare Boolean and vector-space retrieval models		PSO3	An	C, P
CO2	Provide the ability to solve novel and practical information retrieval problems		PSO4, PSO10	Ap	C, P
CO3	Illustrate the process of Document clustering in information retrieval		PSO10	U, An	C,P
CO4	Evaluate the information retrieval algorithms using precision and recall		PSO11	E	P, C
CO5	Implement Document ranking algorithm using TF-IDF algorithm		PSO11	An	P, C
CO6	Provide the knowledge of searching and indexing in information retrieval		PSO4, PSO12	U, An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Information Retrieval:Early Developments – The IR Problem – The Users Task – Information versus Data Retrieval - The IR System – The Software Architecture of the IR System – The Retrieval and Ranking Processes - The Web – The e-Publishing Era – How the web changed Search – Practical Issues on the Web – How People Search – Search Interfaces Today – Visualization in Search Interfaces.

MODULE II

Basic IR Models: Boolean Model - TF-IDF (Term Frequency/Inverse Document Frequency) Weighting - Vector Model – Probabilistic Model – Latent Semantic Indexing Model – Neural Network Model – Retrieval Evaluation – Retrieval Metrics – Precision, Recall.

MODULE III

Characterization of Text Classification: Unsupervised Algorithms: Clustering – Naïve Text Classification – Supervised Algorithms – Decision Tree – k-NN Classifier – SVM Classifier – Feature Selection or Dimensionality Reduction – Indexing and Searching – Inverted Indexes – Sequential Searching – Multi-dimensional Indexing.

MODULE IV

Web Retrieval: Web – Search Engine Architectures – Cluster based Architecture – Distributed Architectures – Search Engine Ranking – Link based Ranking – Simple Ranking Functions – Learning to Rank – Evaluations - Search Engine Ranking – Search Engine User Interaction – Browsing – Applications of a Web Crawler – Taxonomy – Architecture and Implementation – Scheduling Algorithms – Evaluation.

MODULE V

Recommender Systems Functions: Data and Knowledge Sources – Recommendation Techniques – Basics of Content-based Recommender Systems – High Level Architecture – Advantages and Drawbacks of Content-based Filtering – Collaborative Filtering –– Neighborhood models.

MODULE VI

Information Retrieval applications: Document Retrieval using Boolean Model and Vector Space Model - Product recommender system - Text Classification using clustering- Document ranking algorithm using TF-IDF algorithm.

LEARNING RESOURCES

References

- Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, 2008.
- R. Baeza-Yates, B. Ribeiro-Neto", Addison-Wesley, 2011.
- D.A. Grossman, O. Frieder. "Information Retrieval: Algorithms and Heuristics ", Springer, 2004.
- B. Croft, D. Metzler, T. Strohman, "Information Retrieval in Practice", Pearson Education, 2009.
- Ricci, F, Rokach, L. Shapira, B. Kantor, "Recommender Systems Handbook", Springer, 2011.

Semester: 6 **Course Code:** UK6DSEDCS303 **Credits: 4**

BLOCK CHAIN TECHNOLOGY

Preamble: This course aims to empower students with a profound knowledge of Blockchain, enabling them to navigate the complexities of decentralized systems, cryptographic foundations, and cutting-edge applications in the digital era. This curriculum also serves as a foundational guide to develop blockchain applications using the Ethereum blockchain.

Prerequisite: Operating systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	To learn and understand the history, technology, and applications of Blockchain.		PSO1	U	F
CO2	Understand Consensus and emerging abstract models for Blockchain Technology.		PSO3, PSO4	U, R	F, C
CO3	Understand the concept of cryptographic hashing, signature and encryption of secure cryptocurrency systems.		PSO3, PSO4	U	F
CO4	Understand the foundational principles of Bitcoin, including its architecture, key components such as wallets and blocks.		PSO4, PSO8	U, R	C, P
CO5	Illustrate the working of Ethereum Virtual Machine.		PSO6, PSO12	Ap, An	C
CO6	Analyse advanced cryptographic techniques.		PSO12	An	C, M

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Overview of Blockchain: Evolution and Technology of Blockchain, Core technological components of blockchain, Blockchain architecture and structure, Cryptographic principles in blockchain, Use Cases and Applications of Blockchain Technology, Overview of various industries adopting blockchain, Real-world applications, Comparison of Private and Public Block chain Networks.

MODULE II

Consensus Mechanisms and Abstract Models*:* The Consensus Problem, Challenges in achieving consensus, Solutions for decentralized consensus, Nakamoto Consensus, Exploration of the Nakamoto consensus algorithm, Abstract Models for Blockchain, GARAY Model, Proof of Work (PoW) as a random oracle, Proof of Stake (PoS) based Chains, Hybrid models (PoW + PoS).

MODULE III

Cryptographic Foundations for Cryptocurrency, Overview of Cryptographic Basics: Hashing, Signature schemes, Encryption schemes, Elliptic Curve Cryptography.

MODULE IV

Bitcoin - Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks - double spending - mathematical analysis of properties of Bitcoin. Smart Contracts and Ethereum: Introduction to Ethereum, Ethereum Virtual Machine (EVM), Smart Contracts Development in Solidity, Ethereum Wallets.

MODULE V

Ethereum - Ethereum Virtual Machine (EVM) - Wallets for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts - (Trends and Topics) - Zero Knowledge proofs and protocols in Blockchain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves - Zcash.

MODULE VI

Advanced Topics in Blockchain*:* Zero Knowledge Proofs and Protocols, Overview and Applications, Succinct Non-Interactive Argument for Knowledge (SNARK), Pairing on Elliptic Curves, Zcash and Privacy-focused Crypto currencies.

LEARNING RESOURCES

References

- R.Pass et al, Fruitchain, a fair block chain, PODC 2017 (eprint.iacr.org/2016/916).
- R.Pass et al, Analysis of Blockchain protocol in Asynchronous networks, EUROCRYPT 2017, (eprint.iacr.org/2016/454). A significant progress and consolidation of several principles).
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin
- and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
- Blockchain by Melanie Swa, O'Reilly
- Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos
- Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits

Online References

- https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
- https://www.hyperledger.org/projects/fabric

Semester: 6 **Course Code:** UK6DSEDCS304 **Credits: 4**

SOFTWARE TESTING

Preamble: This course offers a thorough introduction to software testing, covering the basic ideas, approaches, and methods needed to guarantee the quality of the product. Students will investigate the differences between validation and verification, look at the many stages of the Software Testing Life Cycle (STLC), and learn about test case preparation and software test designs. The course also provides students with practical skills to improve and expedite software testing by acquainting them with a variety of automation test tools.

Prerequisite: Software Engineering.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize the basic concepts of Software testing.		PSO7	U	C
CO2	Differentiate verification and validation.		PSO8	U	C
CO3	Identify various phases in STLC.		PSO10	U	C, P
CO4	Analyze software test designs.		PSO8	An	C, P
CO5	Prepare test cases.		PSO7	U, Cr	P
CO6	Familiarize different automation test tools.		PSO7	U, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Software Testing: Introduction, Basic Terminologies, Software 'Quality', Software errors, Common bugs, Bugs or error finding, Verification vs Validation, Principles of testing.

MODULE II

Software Testing Life Cycle (STLC), Software Testing Methodologies, Various Types of Testing Methods.

MODULE III

Software test levels, Software test design techniques: Static and Dynamic, Software Quality standards, Software test documents: Test plan, test strategy, Test case, Scenario.

MODULE IV

Test Cases: Design Entry and Exit Criteria for Test Case, Test Case Design techniques, Types of Test Cases, Sample Structure, Design Test Cases in Excel.

MODULE V

Defect Report: Introduction, Defect Life Cycle, Defect Life Cycle Stages, Classification of Defect, Write Defect Report.

MODULE VI

Testing Tools: Introduction, Automation Testing Tool, Uses of Automation Tools, Types of Testing Tools, Types of Automation Testing, Comparison between Tools, Familiarization of latest testing tools.

LEARNING RESOURCES

References

- Software Testing Principles and Practices, Srinivasn desikan, Goplaswamy Ramesh, Pearson. 2014.
- Software Engineering: A Practitioner's Approach" by Roger S. Pressman. McGraw-Hill Education. 9. Ed. 2021.
- Software Testing Tools, Dr. K.V.K.K. Prasad, Wiley- Dreamtech Press.
- Software Testing Concepts and Tools, Nageshwara Rao Pusuluri, DreamTech.

Semester: 6	Course Code: UK6DSEDCS305	Credits: 4

MANAGEMENT INFORMATION SYSTEMS

Preamble: In this course syllabus, explore Information Systems and Business Management. Students learn about new digital companies and how information systems help them achieve goals. Throughout the modules, course cover topics like business processes, computer programs for businesses, and how companies work. Syllabus also discuss about teamwork, keeping information safe, and new tech trends. By the end of the course, students understand how information systems shape modern businesses and how to use them effectively.

Prerequisite: Basic Understanding of Business Concepts, Proficiency in Computer Skills, Critical Thinking and Analytical Skills

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the Business Objectives of Information Systems		PSO1	R,U	F
CO2	Analyze Dimensions and Levels in Information Systems		PSO2	U,A	C
CO3	Evaluate Enterprise Application Architecture and Collaboration Tools		PSO6	E	C
CO4	Apply Systems for Business Intelligence and Social Business Technologies		PSO7	U,A	C
CO5	Analyze the Impact of Information Systems on Organizational Structure		PSO7	A	F
CO6	Evaluate Ethical and Social Implications in Information Systems		PSO12	E,U	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I: Information Systems and Business: Management Information Systems- The Emerging Digital Firm- Business Objectives of Information Systems- Functions of an Information System- Dimensions of Information Systems- Levels In A Firm- The Business Information Value Chain

MODULE II: Business Processes: Transaction Processing Systems- Systems for Business Intelligence- ENTERPRISE Application Architecture- E-business, E-commerce, and E-government- Collaboration- Social Business

MODULE III : Organizations, and Strategy: The Behavioral View of Organizations- Features of Organizations- Organizational Structure- impact of information systems on organizations- Porter's Competitive Forces Model- The Internet's Impact on Competitive Advantage- The Value Web

MODULE IV: Ethical and Social Issues in Information Systems: The Dark Side of Big Data- Ethical, Social, and Political Issues- NORA Alerts- Ethical Analysis- Candidate Ethical Principles

MODULE V: IT Infrastructure and Emerging Technologies: Defining IT Infrastructure- Evolution of IT Infrastructure - The IT Infrastructure Ecosystem- The Mobile Digital Platform- Software Outsourcing and Cloud Services

MODULE VI: Securing Information Systems: Security Challenges and Vulnerabilities- Malicious Software- Hackers and Computer Crime- Software Vulnerability- Legal and Regulatory Requirements for Electronic Records Management

LEARNING RESOURCES

References

- Kenneth C. Laudon , Jane P. Laudon, Management Information Systems Managing the Digital Firm Fifteenth Edition, Pearson Education Limited
- Management Information Systems, C Laudon and Jane P. Laudon, et al, 9/e, PHI and Pearson 2. Stair, R. M. & Reynolds, G. W. (2001).
- Principles of Information Systems, 5e, Singapore: Thomson Learning.
- Management Information Systems, Gordon B. Davis & Margrethe H. Olson, Tata McGraw- Hill, 2006.
- Management Information Systems Text & Cases, W S Jawadekar, Tata McGraw-Hill , 2009
- Introduction to Information Systems, Rainer, Turban, Potter, WILEY-India, 2006.
- Management Information Systems, James A. O brein, Tata McGraw-Hill , 10/e, 2009.
- Management Information Systems, Dharminder and Sangeetha, 1/e, Excel books, 2006

Semester: 6	Course Code: UK6DSEDCS306	Credits: 4

COMPUTER VISION

Preamble: This program aims to equip the students with the essential skills to decipher visual information, enabling them to contribute meaningfully to fields such as Artificial Intelligence, robotics, autonomous systems, and image analysis.

Prerequisite: Image Processing, Linear algebra, Probability and Statistics

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Explain the fundamental theories and techniques of human vision with computer vision		PSO3	U	C, P
CO2	Explain the process of image formation in the camera		PSO3	U, Ap	C
CO3	Explore the significance of morphological operations		PSO3	U	C,P
CO4	Apply different region properties in an image		PSO3, PSO11	U	C,P
CO5	Apply different texture, color-based feature extraction methods used for computer vision		PSO3, PSO11	U, Ap	C,P
CO6	Discuss content based image retrieval and motion from Image sequences		PSO3	U,An,Ap	P,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Cameras: Pinhole cameras, cameras with lenses, Human eye, Imaging and Image Representation-Imaging Devices, 3D structure from 2D images, Five frames of reference

MODULE II

Binary image analysis: Pixels and Neighborhoods, Applying masks to images, Counting the objects in an image, Connected components labeling. Binary image morphology, Region properties, Region adjacency graphs.

MODULE III

Feature detection and matching: Points and patches, SIFT, Edges-Edge detection and linking, Lines-Hough transforms. Corner detection, Color and Shading: Color bases, Color histograms, Color segmentation, Shading.

MODULE IV

Texture: Texture, Texels and Statistics, Texel based Texture Descriptions, Quantitative texture measures, Texture Segmentation.

MODULE V

Content based image retrieval: Image distance measures: Color similarity, Texture similarity, Shape similarity, Database organization.

MODULE VI

Motion from 2D image sequences: Computing Motion Vectors, Using point correspondences, Computing paths of moving points, Detecting significant changes in video

LEARNING RESOURCES

References

- Linda G. Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, 1st Ed., 2001
- Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 1st Ed., 2010.
- David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", 2nd Ed., 2011
- Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 1st Ed., 2012.

Semester: 6	Course Code: UK6RPHDCS301	Credits: 4

PROJECT

Preamble: The project serves as a stepping stone in applying the techniques and skills that the students learned and acquired during the programme. Hence students should plan and organize their projects meticulously and necessary discussions and planning should be done so as to achieve this objective.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Plan And Estimate a Project		PSO2	Ap	P, C
CO2	Design And Analysis of a Problem		PSO2,PSO10	Ap	P
CO3	Coding / Implementation of a Software		PSO6,PSO10	An	C, P
CO4	Apply Programming Skills for Implementation		PSO2,PSO9	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

Project course is designed to provide students with practical experience in applying the concepts and skills learned in their academic coursework to a real-world project within their field of study. Through this course, students will have the opportunity to work on a small-scale project, either individually or in groups (max team size of 3), under the guidance of a faculty supervisor.

Semester: 6	Course Code: UK6INTDCS302	Credits: 2

INTERNSHIP

Preamble: The course summer internship is designed to provide you with practical, hands-on experience in research or industry, allowing you to apply your academic knowledge to real-world scenarios and gain valuable insights into your chosen field.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Apply technical knowledge gained.		PSO1	Ap	P, C
CO2	Develop practical skills and work culture		PSO8	Ap	P
CO3	Gain industry experience in developing projects		PSO7	An	C, P
CO4	Demonstrate the Adaptability to implement projects		PSO4, PSO6	An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

During the sixth semester (it can be done during the vacation or semester break period), the students must complete the summer internship programme from the industry or R&D organizations. The students can identify industries and undergone industry training or workshop. A minimum of one month of internship is compulsory to complete Semester VI successfully. Each student should submit an internship certificate along with a detailed study report.

Semester: 7	Course Code: UK7DSCDCS401	Credits: 4

DESIGN AND ANALYSIS OF ALGORITHMS

Preamble: This course gives students the opportunity to learn efficient computer problem-solving methods. The use of different paradigms of problem solving will be used to illustrate efficient way to solve a given problem. Each time, the analysis of the algorithm will be utilized to demonstrate the algorithm's effectiveness.

Prerequisite: Programming basics in C or C++, Data Structures.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Develop and analyze new algorithms.		PSO1	U, Ap	C, P
CO2	Analyze the asymptotic performance of algorithms.		PSO2	An	C, P
CO3	Familarize with major algorithm design techniques.		PSO1	U, R	C, P
CO4	Differentiate Greedy and dynamic programming		PSO1	U, An	C, P
CO5	Implement some typical algorithms.		PSO4	Ap, An	C, P
CO6	Understand basic concepts of P and NP problems.		PSO6	U, An	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Algorithms: Definition, Characteristics, Recursive and Non-recursive algorithms. Analysis of Algorithms - Space and Time Complexity, Efficiency of an algorithm, Growth of Functions, Asymptotic Notations, Best case/worst case/average case analysis.

MODULE II

Algorithm design techniques: Divide and conquer method - binary search, finding maximum and minimum, Merge sort, Quick sort, Heap sort, Strassen's matrix multiplication and their analysis.

MODULEIII

Greedy method: Elements of Greedy strategy, Knapsack problem, Job sequencing with deadlines, Dijkstra's algorithm, minimum cost spanning trees, Prim's algorithm, Kruskal's algorithm.

MODULE IV

Dynamic Programming: Concepts, Principle of Optimality, Greedy method vs Dynamic Programming, Dynamic Programming and memoization, 0/1 Knapsack problem, Multi stage graphs, All pairs shortest paths, Travelling Salesman Problem.

MODULE V

Backtracking: General method, Implicit and explicit constraints, 8-Queens problem, Sum of subsets, Graph coloring algorithm. Branch and bound- LC Search.

MODULE VI

Deterministic and non-deterministic algorithms, P and NP classes, NP- hard and NP complete- basic concepts.

LEARNING RESOURCES

References

- Levitin, A. (2018). Introduction to the Design and Analysis of Algorithms (3rd ed.). Pearson.
- Introduction to Algorithms, Cormen, Leiserson, Rivest and Stein, TMH.
- Goodrich, M. T., & Tamassia, R. (2018). Algorithm Design and Applications (1st ed.). Wiley.
- The Design and Analysis of Algorithms, Aho, Hopcroft and Ullman, Pearson Education.
- Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekharan–Computer Algorithms/C++, Second Edition- Universities Press.

Semester: 7	Course Code: : UK7DSCDCS402	Credits: 4

IMAGE PROCESSING

Preamble:This course endeavours to cultivate a profound understanding of the theoretical foundations and practical applications of image processing in various fields .It enables the students to understand analyse and process images properly depends on the application areas.

Prerequisite: Mathematics for Computer Science

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Discuss the basics of Image Processing		PSO1	U	C
CO2	Acquire Knowledge in Image Enhancement		PSO2	U, Ap	C,P
CO3	Knowlwdge of Image restoration and Denoising techniques		PSO3	U, Ap	C,P
CO4	Ability to process Binary and Colour Images		PSO5	U, Ap, An	C,P
CO5	Understand the relevance of Image Segmentation		PSO3	U, An	P,C
CO6	Identifying Apllication of Digital Image Processing in various Domains		PSO6	U	P,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Image Processing: Basic steps in image processing, Image Sampling, Quantisation, human vision, classification of digital images, Image types and file formats, Applications.

MODULE II

Image Enhancement: Spatial domain, point operation, types of point operation, Histogrammanipulation, LinearGrey-Level transformation, median filter, Bit-plane slicing, Zooming operation.

MODULE III

Image Restoration and Denoising:Image degradation, types of Image Blur, Classification of Image-restoration Techniques,Image-restoration model, Image Denoising, Classification of noise in Images, Performance Metrics in Image Restoration.

MODULE IV

*Binary Image Processing:*Binarisation, Mathematical Morphology, Structuring of Elements, Morphological Image Processing, Dialation and Erosion based Operations.

MODULE V

*Image Segmentation:*Classification of Image Segmentation Techniques, Region approach, Clustering Techniques, Image segmentation based on thresholding, Edge-based segmentation, Classification of Edges, Edge detection ,Edge linking.

MODULE VI

*Colour Image Processing:*Colour Formation, Colour Model, The Chromaticity Diagram, Colour-Image Quantisation, Histogram of a Colour Image, Colour-Image Filtering.

LEARNING RESOURCES

References

- S Jayaraman,SEsakkirajan,TVeerakumar , "Digital Image Processing" 3rd Edition
- Rafael C Gonzalez & Richard E Woods, "Digital Image Processing", 3rd Edition
- Anil K Jain "Fundamentals of Digital Image Processing".
- William K Pratt, "Digital Image Processing"

Semester: 7	Course Code: UK7DSEDCS401	Credits: 4

AGENT TECHNOLOGY

Preamble: This course provides an introduction to agent technology, a rapidly evolving field at the intersection of artificial intelligence, distributed systems, and robotics. This course also discusses about the principles, architectures, and applications of software agents, enabling them to design, develop intelligent agents

Prerequisite: Knowledge Representation and Reasoning

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Analyse the relevance of agents in the technological world		PSO1	Ap	P, C
CO2	Explore various agent architectures and communication models.		PSO1	Ap	P
CO3	Identify the components and functions of intelligent agents.		PSO1	An	C, P
CO4	Gain proficiency in agent programming languages and development frameworks.		PSO2	An	P
CO5	Explain the problem solving and planning among agents		PSO6	Ap	P, C
CO6	Illustrate Agent oriented methodologies including GAIA Methodology and Tropos		PSO4	Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Overview of agent technology: Definition, characteristics, and applications. Historical perspective: Evolution of agent-based systems. Types of agents: Reactive, deliberative, hybrid, and learning agents. Agent-based vs. traditional software systems

MODULE II

Introduction What are agents- Abstract architectures for intelligent agents' Concrete architecture for intelligent agents Agent Programming languages Multi-agent Systems and Societies of Agents Introduction Agent Communications Agent Interaction Protocols Societies of Agents

MODULEIII

Agent Architectures - Reactive architectures: Reflex agents, finite state machines.
Deliberative architectures: Goal-based agents, utility-based agents. Agent communication languages: KQML

MODULE IV

Multi-Agent Systems (MAS)- Introduction to multi-agent systems: Coordination, cooperation, and negotiation. MAS architectures: Centralized, decentralized, and distributed approaches.

MODULE V

Agent Programming Languages and Tools - JADE, BDI (Belief-Desire-Intention) architecture. Agent Oriented methodologies - Agent oriented analysis and design

MODULE VI

Agent Oriented Methodologies: Gaia Methodology – working principle, MASE- working principle, OPEN process framework, Tropos- working principle, Agent UML- working principle.

LEARNING RESOURCES

References

- Agent-based Modelling and Simulation" by Simon J. E. Taylor, Juan A. Rodriguez-Aguilar
- "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations" by Yoav Shoham, Kevin Leyton-Brown
- "Programming Multi-Agent Systems in Agent Speak using Jason" by Rafael H. Bordini, Jomi F. Hübner, Michael Wooldridge
- "An Introduction to Multiagent Systems" by Michael Wooldridge
- "Agent-Oriented Software Engineering: Reflections on Architectures, Methodologies, Languages, and Frameworks" by Paolo Ciancarini, Michael Wooldridge

Semester: 7	Course Code: UK7DSEDCS402	Credits: 4

BRAIN / HUMAN COMPUTER INTERFACE

Preamble: Human-computer interfaces (HCI)allows to communicate or control external devices using brain signals rather than the brain's normal output pathways of peripheral nerves and muscles. HCI review the HCI-relevant signals from the human brain, and describe the functional components of HCIs. This course emphasis is on electroencephalogram (EEG) signals, which is the most common source for brain-computer interfaces and the kind of signals.

Prerequisite: Pattern Recognition, Introduction to Machine Learning.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the overview of a Brain-Computer Interface, related hardware and brain sensing devices (EEG, fMRI, etc).		PSO11, PSO12	U	C, P
CO2	Analyze and understand different brain activation patterns and potentials		PSO11, PSO12	U,An,Ap	C, P
CO3	Use of different data processing methods and techniques for effective Brain-computer interfaces		PSO11, PSO12	An,Ap	C, P
CO4	Acquiring skill set in implementing Machine Learning and Artificial intelligence algorithms for Brain-computer interface		PSO12	U,Ap	C, P
CO5	Identify and familiarize the brain activation functions		PSO12	U,Ap	P, C
CO6	Research on open areas of Brain-Computer Interfaces		PSO11, PSO12	Ev,Ap	P, M

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Brain structure, functionand mapping techniques, Basics of neural signals, communication,Overview of Human Computer Interface Systems-Definition, history, and applications.

MODULE II

Human Computer InterfaceHCI:Structure of HCI System, Types of HCI-Synchronous and Asynchronous -Invasive HCI -Partially Invasive HCI – Non-Invasive HCI, HCI Monitoring Hardware

MODULEIII

Signal processing for HCI:EEG, EcoG, MEG, fMRI, Signal acquisition methods-Electrodes, sensors, and data preprocessing.

MODULE IV

Data Processing:Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA)

MODULE V

Human activation patterns: Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery

MODULE VI

Stimulus related potentials:Visual Evoked Potentials – P300 and Auditory Evoked Potentials**,** HCI applications.

LEARNING RESOURCES

References

- Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2013.
- Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.
- Guger C, Allison BZ, Gunduz A. Brain-computer interface research: a state-of-the-art summary Springer International Publishing; 2021

Semester: 7	Course Code: UK7DSEDCS403	Credits: 4

FOUNDATIONS OF ROBOTICS

Preamble: The objective of this course is to deliver the crucial importance in relation to understand the role of artificial intelligence and machine coordination. This course provides the elementary concepts of programming and various disciplines in Robotics.

Prerequisite: Multivariable Calculus, Linear Algebra, Introduction To Computing.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand and discuss the fundamental elementary concepts of Robotics		PSO1	U	C
CO2	Provide insight into different types of robots		PSO11	An,U	C
CO3	Familiarize with Basic robotic technologies used across various applications		PSO11	R	C
CO4	Explain intelligent module for robotic structure		PSO8	Ap	P
CO5	To understand the major components of Robotic system		PSO1	U	P
CO6	Identifying the evolution of computer programming to robotic science		PSO2	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Evolution of Automation**:** Introduction to automation and Robotics, Motivation, History of robotics, fundamentals of automation-reprogramming, Multi-Functioning, Machine Manipulators.

MODULE II

Introduction to robotics: 3 H in Robotics,Basic components of a robot-Power Supply,Actuators ,Electric motors (DC/AC),Sensors ,Controller, Robot Specifications.

MODULE III

Classification of Robots:(Size, Application, Domain, Purpose, Number),Nanorobots or Nanobots, Microbots, Millibots and Minibots,Personal robots and Industrial robots.

MODULE IV

Human System And Robotics: safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots.

MODULE V

Mathematical Foundations: Linear Algebra for Robotics, Coordinate Systems and Transformations, Homogeneous Transformations.

MODULE VI

Introduction to Computer Numerical Control (CNC):Numerical control,Functions of a machine tool, Concept of Numerical Control ,Historical Development, Definition, Advantages of CNC machine tools.

LEARNING RESOURCES

References

- Ganesh S Hegde, "A textbook on Industrial Robotics", University science press, 3rdedition, 2017.
- S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education,2009.
- Mikell P. Groover et. al., "Industrial Robots - Technology, Programming andApplications", McGraw Hill, Special Edition, (2012).
- Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – AnIntegrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
- Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence",McGraw Hill, 1987. https://www.robots.com/applications.

Semester: 7 **Course Code:** UK7RPHDCS401 **Credits: 4**

RESEARCH METHODOLOGY

Preamble: This course introduces the procedures and techniques adopted by the research, methods for research design, data collection and discusses the methods used to analyze the data. The salient aspects of publication and patenting along with the crucial role of ethics in research are discussed.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Illustrate the basic outline of a research process.		PSO5	C	M
CO2	Critically analyze and prepare a literature review.		PSO5	An	C, P
CO3	Analyse the research articles and reports		PSO5, PSO11	An	C
CO4	Illustrate the categories of research methodologies		PSO5	An	P
CO5	Develop professional ethics and code of ethics in research		PSO5	C	C, P
CO6	Formulate viable research problems		PSO5, PSO11	Ap	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction–Needforresearch-objectivesandmotivationsinresearch-Significanceofresearch-needforinteractionbetweenacademicinstitutions, industrial and research establishments–research and innovation. ResearchFormulation-Identifyingaresearchproblem-literaturereview–confirmingtoaresearchproblembasedonliteraturereview.

MODULE II

Data collection- Primary and Secondary data, data collection methods, data preprocessing, classification of data. Research design- Need for research design, Features of good research design, types of research designs.

MODULEIII

Data analysis: Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software(e.g.SPSSetc.),statistical inference, Interpretation

of results.

MODULE IV

Publication Ethics-Best Practices/Standards Setting, Initiatives & Guidelines: COPE, WAME, Conflict of Interest; Publication Misconduct Violation of Publication Ethics, Authorship and Contributor ship; Identification of Publication Misconduct, Complacent & Appeals Predatory Publishers& Journals

MODULE V

Research Ethics– Environmental impacts – Ethical issues - Intellectual Property Rights – Patents – legal formalities in filing patent in India – Copy right– Copyleft- Open access-Reproductionofpublishedmaterial-royalty-plagiarism–citationandacknowledgement.

MODULE VI

Analyse: Analyse the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how differentitis from previous works. Analyze the chosen papers and study the methods of data collection used. - Data ProcessingandAnalysisstrategiesused–Studythetoolsusedforanalyzingthedata.

LEARNING RESOURCES

References

- Kothari, C.R. Research Methodology: Methods and Techniques. 2nd Edition, New Age International Publishers, New Delhi, 2004.
- R.Paneersalvam,"Research Methodology",PrenticeHall of IndiaPvt.Ltd.,2011
- MikeMartin,RolandSchinzinger," EthicsinEngineering",McGrawHillEducation,FourthEdition,.2014
- VinodChandraSS,AnandHS- "ResearchMethodology",PearsonEducation,Chennai,2017

Semester:8	Course Code: UK8RPHDCS401	Credits: 4

COMPREHENSIVE VIVA VOCE

Preamble: The course aims to equip the students to enhance the soft skills to attend a technical interview. The understanding of different concepts that have attained through different academic activities are assessed in the viva voce.

Prerequisite: Nil.

COURSE CONTENT

Course Outcomes		PO	PSO	CL	KC
CO1	Apply critical thinking for queries		PSO1	Ap	C
CO2	Develop communication skills		PSO7	Ap	C
CO3	Enhance soft skills for effectively managing interviews		PSO4	Ap	C
CO4	Attain the ability to abstract and present the complex concepts		PSO1	Ap Ap	C

(CL-CognitiveLevel:R-remember,U-understand,Ap-Apply,An-Analyse,E-Evaluate,Cr-Create, KC-KnowledgeCategory:F-Factual,C-Conceptual,P-Procedural,M-Metacognitive)

COURSE CONTENT

All students need to attend a comprehensive viva at the end of the eighth semester. The assessment will primarily consist of viva voce examinations conducted by panel of faculty members. Students will be evaluated based on their understanding of core concepts of different courses in the programme, ability to apply theoretical knowledge to practical scenarios, problem-solving and communication skills.

Semester:8	Course Code: UK8ABCDCS401	Credits: 4

ACADAMEIC BANK OF CREDITS(ABC)

Preamble: ABC enable access to quality education for the students by providing additional courses in different disciplines and areas other than covered in the general curriculum of a program. ABC can be effectively used to attain additional skills and values for different employability.

Prerequisite: Nil

COURSE CONTENT

Academic Bank of Credits (ABC) can be obtained through either online resources or from an institute other than the parent department. ABC provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale. Millions of people worldwide use MOOCs to learn for various reasons, including career development, changing careers, college preparations, supplemental learning, lifelong learning, corporate eLearning and training, and more. For instance, SWAYAM provides an integrated platform for online courses, using information and communication technology (ICT) and covering courses for post-graduate subjects, including skill sector courses, to ensure that every student benefits from learning material through ICT. In otherwise the candidate can bag the same credit from other institution while doing their dissertations or other courses. The Department Council will announce the sources of MOOC at the time of the semester beginning. Students can choose the course from MOOC as per their choice and inform the course coordinator before joining the course.

The credit and weightage of the course will be decided as per the regulations in force.

LEARNING RESOURCES

On-line Sources

- https://www.ugc.gov.in/pdfnews/8449573_Intruction-Manual.pdf

Semester: 8	Course Code: UK8RPHDCS401	Credits: 12

DISSERTATION

Preamble: This course is designed to provide you with the guidance, support, and resources necessary to undertake and complete a rigorous research project that contributes new knowledge to your field of study.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Formulate a research question		PSO3, PSO4	An	P, C
CO2	Conduct a literature study		PSO1	Ap	P
CO3	Design the methodology for solving the research problem		PSO2, PSO6	An, Ap	C, P
CO4	Develop Academic Writing and Communication skills		PSO7, PSO8	An, Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

The Dissertation is intended to challenge students' intellectual and innovative abilities. It allows students to synthesize and apply the knowledge and analytical skills learned in the different disciplines. All the students must do a project on a problem with industry or research potential as part of this course.

The project work can be done in any of the following - R&D institutions, MNCs – IT, companies and departments. At the end of the course, all the students should submit a project report with the details of the work done, findings and suggestions for evaluation. There will be internal and external evaluations of the work.

Four Year Under Graduate Programme for

B. Sc. Hons. Computer Science with Research

B. Sc. Hons. Computer Science with Research

Department of Computer Science

University of Kerala

www.keralauniversity.ac.in

FYUGP for 4 year – B. Sc. Computer Science

Course Code	Name of the Course	Credits
Semester I		
Multidisciplinary Course(MDC)		
UK1MDCDCS101	Scientific Programming with Python	3
Value Added Course (VAC)		
UK1VACDCS101	Programming Skills and Practices	3
Semester II		
Multidisciplinary Course(MDC)		
UK2MDCDCS101	AI for Sustainability	3
Skill Enhancement Course(SEC)		
UK2SECDCS101	Computer Hardware troubleshooting and maintenance	3
Value Added Course (VAC)		
UK2VACDCS101	Computational Thinking for Problem Solving	3
Semester III		
Skill Enhancement Course(SEC)		
UK3SECDCS201	Soft Skills	3
Value Added Course (VAC)		
UK3VACDCS201	Community Services	**3**
Semester IV		
Multidisciplinary Course(MDC)		
UK4MDCDCS201	Machine Learning for All	3
Skill Enhancement Course(SEC)		
UK4SECDCS201	Entrepreneurship and Professional Development	3
		27

Semester: 1	Course Code: UK1MDCDCS101	Credits: 3

SCIENTIFIC PROGRAMMING WITH PYTHON

Preamble: Python language is designed for beginners who have little to no prior experience in hardcore programming. The course aims to provide students with a foundational understanding of the core concepts and techniques of programming principles and their implementation using the Python programming language.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the fundamentals of problem solving and programming		PSO1	U	F, C
CO2	Understand basic concepts of python programming		PSO2	U	C, P
CO3	Familiarization in datatypes and functions		PSO2	U, Ap	C, P
CO4	Apply Python programming language and relevant libraries for data manipulation		PSO2	An, Ap	C,P
CO5	Data processing and file handling in python		PSO6	An,Ap	C,P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E-Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to programming languages – Types of programming languages – high level – assembly language – low level language – Compilers and interpreters. Problem solving concepts– problem solving cycle, flow charts and algorithms

MODULE II

Introduction to Python: Features of Python - Identifiers - Reserved Keywords, comments in python, identifiers, keywords, constants, variables, types of operators, precedence of operators, data types, mutable and immutable data types, statements, expressions, evaluation and comments, input and output statements, data type conversion

MODULE III

Python Data Types- Strings, Lists, Dictionaries, Tuples and Sets, Mutable and immutable objects, Execution Control Structures, Python Standard Library

User-Defined Functions- passing arguments to a function, Parameter Passing, returning values from functions, scope of variables, Standard library:, using built-in functions, importing modules-math, random, statistics, creating and importing user defined module

MODULE IV

Searching- Sequential search, Binary search, Sorting Algorithms: Insertion Sort, Selection Sort. NumPy- Creating Arrays (array and arange), reshape(), sum(), min() and max() methods, Item wise arithmetic operations

LEARNING RESOURCES

References

- Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
- Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd Beazley, D. M. (2009). Python essential reference. Addison-Wesley Professional.
- Barry, P. (2010). Head First Python. " O'Reilly Media, Inc.".
- Punch, W. F., &Enbody, R. (2010). The practice of computing using python. Addison- Wesley Publishing Company.
- Mark, S. (2009). Programming in Python 3. Pearson Education India.
- JubomirPerkovic, "Introduction to Computing Using Python: An Application Development Focus", Wiley, 2012.
- Allen B Downey, "Think Python" ,Oreilly, 2012
- Dr.Varghese Paul, Dr.AnjanaS.Chandran,"Introduction To Computing And Problem Solving Using Python",Educational Publishers And Distributors, 2016

Online Resources

- https://realpython.com/
- https://docs.python-guide.org/

Semester: 1	Course Code: : UK1VACDCS101	Credits: 3

PROGRAMMING SKILLS AND PRACTICES

Preamble: This course will provide students with the skills and practices of computer programming. Hands-on experiments with various aspects of programming will provide a practical knowledge to the students.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Impart problem solving capabilities		PSO6	U, Ap	C
CO2	Understanding of Data Types and Variables, Mastery of Control Structures		PSO2	U, Ap	C,P
CO3	Describe about Functions, Arrays, Pointers etc.		PSO1	U, Ap	C,P
CO4	Implement basic programs in C.		PSO2	U, Ap, An	C,P
CO5	Impart problem solving capabilities Proficiency in Basic Syntax		PSO6	U, An	P,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to programming languages – types of programming languages – high level – assembly language – low level language – Compilers and interpreters. Problem solving concepts– flow charts and algorithms – Features of C language. Introduction to C programming – variables and arithmetic expressions- Formatted output- printf()

MODULE II

The For statement- Symbolic constants - Character input and output - Operators and Expressions – Formatted input-scanf – Control Flow. Functions and program structure – function definition – function prototypes – function call – recursion.

MODULE III

Structures – structures and functions - Array of structures – Unions.

Arrays: Defining simple arrays, Multi-dimensional arrays, declaration, initialization and processing. Memory Allocation Strategies. Pointers: The & and * Operators, pointer declaration, visualizing pointers, call by value; call by reference. Types of Linked Lists and its operations.

MODULE IV

File handling- text and binary files, file operations, Functions for file handling, Modes of files. Introduction to Graphics, basic functions.

LEARNING RESOURCES

References

- Balagurusamy – Programming in ANSI C – 5th ed- TMH
- Keringhan, Ritchie. The C Programming language
- Reema Thareja, Computer Fundamentals and Programming in C, Second Edition, Oxford publication.

Semester: 2	Course Code: UK2MDCDCS101	Credits: 3

AI FOR SUSTAINABILITY

Preamble: In this course, we learn how Artificial Intelligence (AI) can be harnessed as a powerful tool for promoting sustainable development, preserving natural ecosystems, and mitigating the impacts of climate change.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Analyse the significance of sustainable development through the eyes of AI		PSO4	An	P, C
CO2	Explain Artificial Intelligence and Machine Learning		PSO3	U	P
CO3	Apply AI techniques for Environmental Modelling		PSO8	Ap	C,P
CO4	Apply AI techniques for address the challenges of Climate Change		PSO6	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Sustainability and AI: Overview of sustainability concepts and goals, Introduction to artificial intelligence and machine learning, Role of AI in addressing sustainability challenges

MODULE II

AI Techniques for Environmental Modelling: Regression and classification for predicting environmental variables, Time series analysis for climate and weather forecasting, Spatial analysis and GIS applications in sustainability

MODULE III

Applications of AI in Sustainable Agriculture: Precision farming and crop yield optimization, Pest detection and management using AI, Monitoring and mitigation of deforestation and land degradation

MODULE IV

AI for Conservation Biology and Biodiversity: Species identification and tracking using AI Habitat modelling and conservation planning, Predictive modelling for assessing species vulnerability to climate change, AI for Energy Efficiency and Renewable Resources

LEARNING RESOURCES

References

- "Artificial Intelligence: A Guide to Intelligent Systems" by Michael Negnevitsky
- "Sustainability Science" by Bert J. M. de Vries
- Online Courses:
- "Machine Learning for Sustainability" by Coursera
- "Introduction to Environmental Science" by edX

Semester: 2	Course Code: UK2SECDCS101	Credits: 3

COMPUTER HARDWARE TROUBLESHOOTING ANDMAINTENANCE

Preamble: This course aims to equip you with the knowledge and skills necessary to diagnose, troubleshoot, and maintain computer hardware effectively. This course offers a thorough understanding Hardware Components, Diagnosis Techniques, Troubleshooting Procedures, Repair and Maintenance, Safety and Precautions

Prerequisite: Basic Computer Literacy, Familiarity with Tools and Software and Familiarity with Tools and Software

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identify and describe the function of various hardware components within a computer system,		PSO1	Ap	p
CO2	Develop proficiency in diagnosing hardware-related issues using both software-based and hardware-based diagnostic tools and techniques.		PSO2	Ap	P
CO3	Learn systematic troubleshooting methodologies to isolate and resolve common hardware problems		PSO10	Ap	P
CO4	Acquire the skills necessary to perform hardware repairs, replacements, and upgrades		PSO1	Ap	P
CO5	Understand safety protocols and precautions necessary when handling computer hardware		PSO1	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I: Basic safety procedures, Computer Hardware – BIOS, firmware, CPU, Motherboard, Storage Devices and Peripheral components.

MODULE II: Hardware Installation and configuration – installing and upgrading hardware components, BIOS/UEFI settings and configuration, device driver installation and management.

MODULE III: Installation of Application Software, Preventive Maintenance and Troubleshooting of PC. Printer, Scanner- Installation and troubleshoot.

MODULE IV: Assemble and repair of Desktop Computer – motherboard components, connectors, slots, ports, cables and Connectors. different Operating Systems, Application software, Customize Operating System.

LEARNING RESOURCES

References

- PC Hardware in a Nutshell: A Desktop Quick Reference" by Robert Bruce Thompson and Barbara Fritchman Thompson, Orieally, 2000

- The Complete PC Upgrade and Maintenance Guide" by Mark Minasi and Faithe Wempen
- James, K. L. (2013). Computer Hardware: Installation, Interfacing, Troubleshooting And Maintenance. PHI Learning Pvt. Ltd..

Semester: 2	Course Code: UK2VACDCS101	Credits: 3

COMPUTATIONAL THINKING FOR PROBLEM SOLVING

Preamble: Throughout this course, students will embark on a journey to enhance their problem solving skills and explore computational skills using Python programming. This course will provide students with a solid foundation in problem Solving**.**

Prerequisite: Basic Understanding of Computer Programming, Familiarity with a Text Editor or Integrated Development Environment (IDE), Basic Knowledge of Command-Line Interface (CLI)

COURSE OUTCOMES & TAGGING

	Course Outcomes	PO	PSO	CL	KC
CO1	Understand basics of computational thinking		PSO1, PSO6	U,Ap	C
CO2	Develop algorithm designing skills for problem solving		PSO6	An,Ap	P
CO3	Explore the programming skills of students by imparting both procedural and objectoriented concepts		PSO2, PSO6	Ap	P
CO4	Analyse how to find solutions to real world problems using Python		PSO5, PSO10	An	C
CO5	Explore the packages and modules in Python		PSO6, PSO10	U, Ap	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Computational Thinking, Logical and Algorithmic Thinking- Objectives and Approach. Problem Solving and Decomposition-Defining the problem, Problem decomposition, Patterns and generalisation.

MODULE II

Abstraction and Modelling, Algorithmic Thinking Algorithm and Flowchart, Name binding, Selection, Repetition. Data organization: List and Arrays, Modularization, Problem Solving: Factoring and Recursion Techniques.

MODULE III

Introduction to Python: Features, Tokens, Data types, Expression Evaluation, Execution Control Structures, Python Standard Libraries, User-Defined Functions, Two Dimensional Lists, Character Encoding and Strings. Files and Exceptions

MODULE IV

Objects and Classes, Inheritance, Operator Overloading, NumPy arrays, Database Programming in Python. Searching and Sorting techniques, Text processing, Graph Colouring, Database Manipulation.

LEARNING RESOURCES

References

- David Riley and Kenny Hunt , Computational thinking for modern solver, Chapman & Hall/CRC, 2014
- Davies R, Computational Thinking: Beginners Guide to Problem Solving and Programming, BCS Learning & Development Ltd, 2017
- Dr.Varghese Paul, Dr.AnjanaS.Chandran,"Introduction To Computing And Problem Solving Using Python",Educational Publishers And Distributors, 2016
- Barry, P. (2010). Head First Python. " O'Reilly Media, Inc.".
- Punch, W. F., &Enbody, R. (2010). The practice of computing using python. Addison- Wesley Publishing Company.
- JubomirPerkovic, "Introduction to Computing Using Python: An Application Development Focus", Wiley, 2012.
- Allen B Downey, "Think Python" ,Oreilly, 2012

Online Resources

- https://realpython.com/
- https://docs.python-guide.org/

Semester : 3	Course Code: UK3SECDCS201	Credits: 3

SOFT SKILLS

Preamble: In today's fast-paced and interconnected world, technical expertise alone is often not enough to succeed in life. We need to recognize the crucial importance of soft skills – those interpersonal, communication, and emotional intelligence abilities that enable us to work effectively with others, adapt to change, and lead fulfilling lives.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Analyse the relevance of soft skills in daily life		PSO5	U, An	P, C
CO2	Explain the concept of spaced repetition		PSO7	Ap	P
CO3	Assess yourself through SWOC Analysis		PSO5	An	C,P
CO4	Prepare students for idea generation through brain storming		PSO5	Ap, Cr	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to soft skills– Significance of Soft Skills in daily life, Interpersonal Skills: Communication Skills- Verbal and Nonverbal Communication - Leadership Skills- Public Speaking.

MODULE II

Learning Skills: Principles of study skills- Chunking - Spaced Repetition- 3 Rs of memory- Mind Mapping- Team Building Skills- Team Work

MODULE III

Life Skills: SWOC Analysis- Self Awareness- Stress Management- Time management- Procrastination- Pomodoro technique – Emotional Intelligence

MODULE IV

Career Skills: Resume Preparation- Brain Storming- Idea generation, Group Discussion- Facing Interviews- Planning and Goal Setting

LEARNING RESOURCES

References

- Jonsthan Hancock, Cheryl Buggy, "Effective Memory techniques in a week", Hodder and Stoughton, 2003
- Cecile Niewwenhuizen, "Entrepreneurial Skills", 2ed., JUTA, 2008
- J. W. Bames- "Statistical Analysis for Engineers and Scientists", Tata McGraw-Hill, New York, 1994
- Katherine Carpenter, "Introduction to Entrepreneurship", University of Victoria, 2021
- Michael Laverty, Global Chris Littel, "Entrepreneurship" OpenStax, 2019

Semester: 3	Course Code: UK3VACDCS201	Credits: 3

COMMUNITY SERVICES

Preamble: As social beings, we are interconnected, and our collective well-being depends on the strength of our communities. This course recognizes the importance of fostering inclusive and supportive environments in student life. When you aspire to work in non-profit organizations, social services agencies, or community development projects, this course will provide you with the tools to effect meaningful change and empower individuals and communities.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Analyse the significance of NSS and NCC in social well being of students			An	P, C
CO2	Illustrate the disaster management techniques for rescue and control operations			Ap	P
CO3	Understand the constitution of India			An, Ap	C,P
CO4	Develop time management skills and set priority matrix for daily tasks			Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

NSS: Introduction: Basic Concepts, History, aims, Objectives-Emblem, Flag, motto, badge etc. Organizational structure, roles and responsibilities of various NSS functionalities, NSS Programmes and activities-regular activities, special camping Day camps, Coordination with different agencies, Maintenance of the Diary. Additional Life Skills: Positive thinking, self-confidence and self-esteem, setting life goals and working to achieve them, management of stress including Time management.

MODULE II

NCC: History, NCC–functions and duties, committees, aims, Moto, flag, organization–RDC, CATC, NIC, Advanced leadership course, Army attachment camp, Hiking and trekking camps, ThalSainik Camp, VayuSainik Camp, NauSainik camp, All Indian Yachting regatta, rock climbing camps, Naval Wing activities, Air Wing Activities, Youth exchange programme.

MODULE III

Disaster Management: Introduction to disasters– concepts, and definitions– disaster, hazard, vulnerability, resilience, risks-bomb threat. Earthquake, Explosion, Hazardous materials pill/release, Disaster classifications, causes, impacts–social, economic, political, environmental, health, psychosocial etc, Financial emergency, Unexpected loss of income,

Death in the family or other family emergency, National disaster, Different impacts–gender, age, location.

MODULE IV

Constitution of India - Salient features of Indian Constitution, Preamble, fundamental rights.- Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies.

LEARNING RESOURCES

References

1. National Service Scheme–A Youth Volunteers Programme for Under Graduate students as per UGC guidelines J. D. S. Panwaret al. Astral International. New Delhi.
2. Govt. of India Disaster Management act 2005
3. Govt. of India 2009, National Disaster Management Policy
4. Gupta AnilK, Sreeja S Nair, 2011, Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.
5. Dr. J. N. Pandey, The constitutional Law of India, Central Law Agency Allahabad. PP
6. Maheendrapal Singh, Constitution of India, Eastern Book Company Lucknow

Semester: 4	Course Code: UK4MDCDCS201	Credits: 3

MACHINE LEARNING FOR ALL

Preamble: In this course, the fundamentals of machine learning, from understanding key algorithms and techniques to practical applications in real-world scenarios is discussed. This beginner-level course is designed to introduce participants to the fundamentals of machine learning, equipping them with the knowledge and skills to understand basic concepts, algorithms, and applications.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Explain the applications of Machine Learning			An	P, C
CO2	Apply the Machine Learning Techniques in our daily life.			Ap	P
CO3	Illustrate the workflow of Machine Learning algorithms			An, Ap	C,P
CO4	Demonstrate the working of machine learning algorithm			An, Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Overview of Machine Learning- Machine Learning applications, Introducing to do applications in Machine Learning.

MODULE II

Machine Learning Process – Data Preparation- Data Pre-processing- Training- Testing - Types of Machine learning: Supervised, Unsupervised, and Reinforcement learning

MODULE III Supervised Learning: Regression and Classification, Unsupervised Learning- Clustering- K-Means Clustering- Association Rules

MODULE IV

Demonstration of working of Machine learning algorithms-Tools for Machine Learning

LEARNING RESOURCES

References

- Andreas C. Müller and Sarah Guido, "Introduction to Machine Learning with Python" , O'reilly, 2016
- AurélienGéron "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" , O'reilly, 2022
- Online Course: Machine Learning for Beginners" by Coursera

Semester :4	Course Code: UK4SECDCS201	Credits: 3

ENTREPRENEURSHIP AND PROFESSIONAL DEVELOPMENT

Preamble: This programme aims to inspire students and help them imbibe an entrepreneurial mindset. The students will learn what entrepreneurship is and how it has impacted the world and their country. They will be introduced to the critical traits of an entrepreneur and be allowed to assess their strengths and identify gaps that need to be addressed to become a successful entrepreneur.

Prerequisite: Nil

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Develop communication competence in prospective students			Ap	C, P
CO2	Demonstrate the ability to plan, organize, and execute a project or new venture with the goal of bringing new products and service			Ap	C, P
CO3	Possess the professional skills including learning skills and career skills			U, Ap	C,P
CO4	Provide critical thinking process within students			Ap	P, M
CO5	Inculcate the soft skills competence in prospective students			App	P, C
CO6	Equip the students to face interview and Group Discussion			Ap, An, E	P
CO7	Able to work in Group and Teams			Ap	C, P
CO8	Prepare the students to become an entrepreneur			Ap, E	C, P
CO9	Promote Brain Storming and Idea Generation to solve real life problems			Ap, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Entrepreneurship: Definition of Entrepreneurship, Entrepreneurship and Enterprise, Phases of Entrepreneurship Development, Role of Entrepreneurship, Characteristics of Entrepreneurship, Entrepreneurial Process: Venture Life Cycle and Product Life Cycle-Business Life Cycle.

MODULE II

Entrepreneurship skills: Types of Entrepreneurship Skills: Business management skills, Teamwork and leadership skills, Problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Time management and organizational skills- Entrepreneurial Imagination and Creativity.

MODULE III

Interpersonal Skills: Communication skills- Verbal and Nonverbal Communication- Brain storming- Leadership skills- Team Building Skills- Team Work - Public Speaking. *Learning Skills:* Principles of study skills- Memory Techniques- Pomodoro technique- Improving your memory for studying- 3 Rs of memory- Mind Mapping.

MODULE IV

Life Skills: SWOC Analysis- Self Awareness- Stress Management- Time management- Procrastination- Making Schedules - Interview Skills –Preparation for the Interview - Planning and Goal Setting. *Career Skills:* CV and Resume Writing, Brain Storming- Idea generation, Group Discussion, Facing Interviews - Long Term and Short-Term Goal Setting - Portfolio Preparation

LEARNING RESOURCES

References

- Jonsthan Hancock, Cheryl Buggy, "Effective Memory techniques in a week", Hodder and Stoughton, 2003
- Cecile Niewwenhuizen, "Entrepreneurial Skills", 2ed., JUTA, 2008
- J. W. Bames – "Statistical Analysis for Engineers and Scientists", Tata McGraw-Hill, New York, 1994
- Katherine Carpenter, "Introduction to Entrepreneurship", University of Victoria, 2021
- Michael Laverty, Global Chris Littel, "Entrepreneurship" OpenStax, 2019

Four Year Under Graduate Programme for

B. Sc. Hons. Computer Science with Research

B. Sc. Hons. Computer Science with Research

With Specialization in Artificial Intelligence

Department of Computer Science

University of Kerala

www.keralauniversity.ac.in

FYUGP for 4 year – B. Sc. Computer Science

Course Code	Name of Course	Credits
Semester I		
UK1MNADCS101	Introduction To Knowledge Based Systems	4
Semester II		
UK2MNADCS101	Intelligent Systems	4
Semester III		
UK3MNADCS201	Knowledge Representation and Reasoning	
Semester IV		
UK4MNADCS201	Machine Learning	4
Semester V		
UK5MNADCS301	Pattern Recognition	4
Semester VI		
UK6MNADCS301	Expert Systems in Automation	4
Semester VII		
UK7MNADCS401	AI Planning	4
UK7MNADCS402	Big Data Analytics	

Semester: 1	Course Code: UK1MNADCS101	Credits: 4

INTRODUCTION TO KNOWLEDGE BASED SYSTEMS

Preamble: This course gives an overview of the field of knowledge based systems, exploring formalisms such as propositional and first-order logic, knowledge acquisition techniques, and advanced topics such as uncertainty handling and agents.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize the concepts of Knowledge Based Systems		Pso1,Pso3	U	F, C
CO2	Acquiring the ability to handle different types of KBS		Pso3	U, An	P,C
CO3	Analyze the techniques used for Knowledge Acquisition		Pso3,Pso11	An	C,P
CO4	Familiarize with the Knowledge Representation and Reasoning techniques		Pso3	An	P,C
CO5	Understand the basics of Knowledge Management		Pso3	U	F,C
CO6	Discuss the features and types of Agent Based Systems		Pso3	U	F,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Knowledge Based Systems – Objectives of KBS , Components, Categories, Difficulties with the KBS. Knowledge Based System Architecture. Knowledge Representation Languages.

MODULE II

Source of Knowledge, Types of Knowledge, Basic Structure, Knowledge Bases, Inference Engine, Self Learning, Reasoning, Explanation, Applications. Limitations of Knowledge Based Systems.

MODULE III

Developing Knowledge Based Systems – Knowledge Based System development Model, Knowledge Acquisition, Techniques for Knowledge Acquisition, Sharing Knowledge, Updating Knowledge.

MODULE IV

Knowledge Representation and Reasoning – The propositional calculus and Resolution, Predicate calculus and Resolution, Representing Procedural Knowledge, Reasoning with Uncertain Information, Learning and Acting with Bayes Nets.

MODULE V

Knowledge Management - Introduction, Perspectives, Evolution, Elements of Knowledge

Management, Knowledge Management Process, Tools and Technologies.

MODULE VI

Knowledge Management Roles and Responsibilities, Knowledge Management Models. Agent Based Systems – Characteristics, Types of Agents, Agent Communication Language, Multi Agent Systems.

LEARNING RESOURCES

References

- Rajendra Akerkar, Priti Sajja, "Knowledge-Based Systems", Jones & Bartlett Learning, 1 st Ed., 2010.
- Nils J Nilsson "Artificial Intelligence – A New Synthesis", Morgan Kaufman Publishers 1 st Ed., 2003.
- Cornelius T Leondes, "Knowledge-Based Systems: Techniques and Applications", Academic Press, 1st Ed., 2000.
- Elias M Awad, Hassan M Ghaziri, "Knowledge Management", Pearson Education, 1st Ed., 2007.

Semester: 2	Course Code: UK2MNADCS101	Credits: 4

INTELLIGENT SYSTEMS

Preamble: Intelligent systems are going to drive our society. An immense collection of technologies and AI applications are coming from R&D institutions to support the daily and regular routine of individuals and organizations. In this context, the content of this particular course has been designed to create an awareness of the principles and ethics while you are thinking about designing an application or technique with the help of AI. The things which are done by a human being and sometimes beyond that can be possible with AI, so understanding the challenges, principles, and ethics are unavoidable.

Prerequisite: Digital system and computer programming, Basic idea about the working and services provided by different AI applications in the market.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize the stages and development of various intelligent systems.		PSO3, PSO4	U	C,P
CO2	Identifytheharmsthat canbecausedby AIapplications.		PSO5	U,An	C
CO3	The concepts of knowledge representation system		PSO3	U,An	C,P
CO4	Familiarize AI techniques in Game Theory		PSO4	U	P
CO5	Understand learning concepts that propagate to the machine learning		PSO3	U,An	P,C
CO6	Understanding of different machine learning techniques		PSO3, PSO8	U	C,P
CO7	Explorethescopeofmoralvaluesindesigning scientificinventions.		PSO5	An	P,C
CO8	Familiarize real world AI applications connected with human life.		PSO9, PSO11	Cr	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Characteristics of Intelligent System, Introductory note on Artificial Intelligence, Timelines of Artificial Intelligence, Branches of Artificial Intelligence, Applications of Artificial Intelligence. Potential Harms Caused by AI Systems, Intellectual Background of AI.

MODULE II

Autonomous systems and characteristics, intelligent agents - structure, types of agents. Production Systems, Knowledge representation structures.

MODULE III

Introduction to Game theory- Two player game, Min Max procedure, Alpha Beta Cut off

MODULE IV

Designing a learning system- choosing the training experience- choosing the target function – choosing the representation for the target function- choosing a function approximation algorithm- Types of learning methods. Introduction to Machine Learning: Steps in machine learning process, Types of machine learning – Supervised, unsupervised and reinforcement.

MODULE V

Artificial Intelligence and Ethics-need of Ethics in AI, Codes of Ethics, Epistemic Strategies: Precision and the Reduction of Uncertainty, Technological Strategies to Ensure Safe and Beneficial AI, Moral Strategies in the Pursuit of Beneficial AI.

MODULE VI

AI in real life- Expert system, NLP, AI based planning, Recommender system, GPT, Sentimental Analysis, Intelligent Traffic system.

LEARNING RESOURCES

References

- Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach, Pearson,2020.
- Vinod Chandra S S, Anand H S - "Artificial Intelligence: Principles and Applications", Prentice Hall of India, New Delhi, 2020
- Boddington, P. (2017). Towards a Code of Ethics for Artificial Intelligence. Germany: Springer International Publishing.
- World Health Organization. Ethics and governance of artificial intelligence for health: WHO guidance, 2021.
- Müller, Vincent C. (forthcoming 2021), "Ethics of artificial intelligence", in Anthony Elliott (ed.), The Routledge social science handbook of AI

Online Resources

- https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf

Semester: 3	Course Code: UK3MNADCS201	Credits: 4

KNOWLEDGE REPRESENTATION AND REASONING

Preamble: Knowledge acquisition and management is one of the critical phases in the artificial intelligence system design. The effectiveness of the AI-based system will depend on the systematic approach to knowledge management. This course is designed to introduce the different strategies to represent knowledge in AI systems. The different knowledge representation and manipulation strategies are introduced through the working of agents and expert systems.

Prerequisite: Probability and Statistics, Problem solving with Python.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Discuss Knowledge ,types and acquisition methods		PS01,PSO3	U U	F C,F
CO2	Explain the use of first order and prepositional logic in knowledge representation		PSO3	U	C,F,P
CO3	Understand knowledge representation and its structures.		PSO3		
CO4	Compare different reasoning methods and Bayesian networks.		PSO3,PSO11	An	C, P
CO5	Discuss different association rule mining algorithms.		PSO3,PSO11	U	C ,P
CO6	Illustrate knowledge representation using RDF		PSO3,PSO11	An	C,P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Key concepts to Knowledge Representation and reasoning, Knowledge Management, Types of Knowledge- declarative , procedural ,inheritable ,relational and inferential, Knowledge acquisition techniques.

MODULE II

First Order logic: syntax-symbols-predicate ,functional ,constant, ,atomic formulas ,universal and existential quantifiers ,List notation ,sentence ,semantics ,interpretations

MODULE III

propositional logic: Language ,syntax ,semantics ,reasoning ,arguments and proof system

,rules of inference, Forward and Backward Chaining ,The Resolution Refutation Method

MODULE IV

Knowledge representation: Bases and structures-Unification algorithm, Frames -Description Logics and the Web Ontology Language, Conceptual Dependency, Scripts, Semantic network

MODULE V

Reasoning: Types of reasoning, Non-monotonic reasoning ,Rule Based reasoning, Case Based reasoning, Model based reasoning systems. - Bayes rule, Bayesian networks, probabilistic inference

MODULE VI

RDF: Triple structure, triple store, URI, resource description, blank nodes, RDF serialization formats and schema, OWL, Linked data principles, Inference in RDF.

LEARNING RESOURCES

References

- Stuart Russell and Peter Norvig - "Artificial Intelligence: A Modern Approach", 3rd Edition Pearson, Chennai, 2015
- Thomas H. Corman, Charles E. Leiserson and Ronald L. Rivest - "Introduction to Algorithms", 3rd Eed., Prentice Hall of India, New Delhi, 2009
- Vinod Chandra S S, Anand H S - "Artificial Intelligence: Principles and Applications",Prentice Hall of India, New Delhi, 2020
- Ronald J. Brachman, Hector J. Levesque: "Knowledge Representation and Reasoning, Morgan Kaufmann", 2004.
- Deepak Khemani. "A First Course in Artificial Intelligence", McGraw Hill Education (India), 2013.
- John F. Sowa: "Knowledge Representation: Logical, Philosophical, and Computational Foundations", Brooks/Cole, Thomson Learning, 2000.

Semester: 4	Course Code: UK4MNADCS201	Credits: 4

MACHINE LEARNING

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular learning algorithms such as linear regression, logistic regression, decision trees, tree classifiers, support vector machines and kernels, basic clustering algorithms and basics of reinforcement learning. This course helps the students to provide machine learning-based solutions to real-world problems.

Prerequisite: Basic understanding of probability theory, linear algebra and Python Programming.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Differentiate between various learning approaches, and to interpret the concepts of learning		PS03,PSO4	U	F, C
CO2	Demonstrate supervised and unsupervised learning concepts		PS03,PSO4	Ap	P,C
CO3	Analyze the clustering algorithms and its importance		PS03,PSO4	Ap	C,P
CO4	Implement Support Vector Machineand identify its applicability in real life problems		PS03,PSO4	Ap	P,C
CO5	Familiarize with the concepts of Reinforcement learning		PS03,PSO4	U	F,C
CO6	Solve real life problems using appropriate machine learning models and evaluate theperformance measures		PS03,PSO4	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Machine Learning: Basic concepts in machine learning, Types of Learning and Examples- Learning Associations, Classification ,Regression, Semi-supervised, Unsupervised Learning, Reinforcement Learning , Batch learning and online learning, Instance based learning Versus Model Based learning, Challenges of Machine Learning.

MODULE II

Supervised vs. Unsupervised learning: Overview, distinction between supervised and unsupervised Learning, real-world case studies involving supervised and unsupervised learning.

MODULE III

Classification and Prediction: Binary and Multiclass Classification, Multi label classification, Training, testing and validation datasets, cross validation, Performance evaluation of ML models- confusion matrix and allied metrics- accuracy, precision, recall, F1 Score.

MODULE IV

Regression - linear regression, model selection, linear regression with one variable, linear regression with multiple variables, practical issues in regression, logistic regression, evaluation metrics for regression problems.

MODULE V

Clustering: Similarity measures, Clustering criteria ,k-Means clustering, Facts about k-means, weakness of k-Means clustering, Best and worst cases in k-Means clustering implementation, improving k-means clustering, Hierarchical Clustering –Agglomerative and Divisive Clustering, Evaluation Metrics for Clustering.

MODULE VI

Support Vector Machines: Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels, Applications of SVM.

LEARNING RESOURCES

References

- Ethem Alpaydin, "Introduction to Machine Learning", 2nd edition, MIT Press 2010.
- Vinod Chandra S S, Anand H S, "Artificial Intelligence and Machine Learning", Prentice Hall of India, New Delhi, 2014.
- Mohammed J. Zaki and Wagner Meira, "Data Mining and Analysis: Fundamental Conceptsand Algorithms", Cambridge University Press, First South Asia edition, 2016.
- Jake VanderPlas, "Python Data Science Handbook", O'Reilly Media, 2016.
- Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
- Ryszard S. Michalski, Jaime G. Carbonell, and Tom M. Mitchell, "Machine Learning : AnArtificial Intelligence Approach", Tioga Publishing Company.

Semester: 5	Course Code: UK5MNADCS301	Credits: 4

PATTERN RECOGNITION

Preamble: The course focuses on applications of pattern recognition techniques to machine vision problems. The course covers feature extraction techniques and the representation of patterns in feature space. Statistical, nonparametric and neural network techniques for pattern recognition have been discussed in this course. Techniques for the recognition of time-varying patterns have also been covered.

Prerequisite: Knowledge of Probability, vectors and basic linear algebraic operations, Introduction to Machine Learning.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Solve linear algebra problems		PSO1,PSO6	U, Ap	C, P
CO2	Compute Eigen values and Eigen vectors which are significant in dynamic problems		PSO8	U, Ap	C
CO3	To introduce and familiarize Bayesian decision theory		PSO6,PSO8	U,Ap	C, P
CO4	Analyse the significance feature selection and dimensionality reduction in pattern recognition		PSO6	U,An	C, P
CO5	Identify the relevance of classification and clustering algorithms		PSO3,PSO8	U	C, P
CO6	Discuss Pattern design cycle and approaches		PSO3	U	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Essential Review: Linear algebra- Vectors, matrices, eigen values, eigenvectors. Probability Theory, Conditional Probability, Bayes Rule, Random Vectors, Expectation, Correlation, Covariance and Linear Transformations.

MODULE II

Basics: Introduction to pattern recognition, Pattern recognition systems- Design LeaalLearning and adaptation, Pattern recognition approaches – Syntactical PatternRecognition-Statistical Pattern Recognition

MODULE III

Bayesian decision theory: Minimum error rate classifier; Classifiers, Discriminant, functions, Decision surfaces, Parameter estimation: Maximum likelihood and Bayesian, Estimation.

MODULE IV

Problem framing: feature selection, Forward, backward search, dimensionality reduction- Principal component analysis, Fisher linear discriminant

MODULE V

Linear Discriminant : Basics of Perceptron Learning, Optimization by Gradient Descent, Support Vector Machines, K-Nearest-Neighbor Classification

MODULE VI

Generalization ability of learning methods: Bias and variance, Regularization; Bootstrapping, Boosting, Bagging; Unsupervised learning and clustering: k-Means methods.

LEARNING RESOURCES

References

- Gilbert Strang, "Linear Algebra and It's Applications", 4th edition, Cengage Learning,2006.
- Papoulis and S.U. Pillai , "Probability, Random Variable And Stochastic Processes", ,4/e, TMH.
- R. O. Duda, P. E. Hart and D. G. Stork, "Pattern classification", John Wiley & Sons,2002.
- JDuda, Richard O., Peter E. Hart, and David G. Stork. "Pattern classification". 2nded. New York, NY: Wiley, 2001. ISBN: 0471056693.
- Ernest Davis, "Linear Algebra and Probability for Computer Science Applications", CRC Press, 2012.

Semester: 6	Course Code: UK6MNADCS301	Credits: 4

EXPERT SYSTEMS IN AUTOMATION

Preamble: This course offers techniques for constructing expert systems, including computer inference and knowledge acquisition, knowledge representation schemes, conceptual data analysis, plausible reasoning techniques, validation and measurement methods, and production-rule programming.

Prerequisite: Artificial Intelligence, Knowledge Representation and Reasoning.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Introducing expert systems and its components		PSO4,PSO6	U	F, C
CO2	Tools used in expert system		PSO8, PSO6	An	C
CO3	Knowledge acquisition from a domain expert		PSO11,PSO8	An	C, F
CO4	Use of Expert system in engineering, business and manufacturing		PSO3,PSO4, PSO10	U,An	F
CO5	Rule generation and conflict solving		PSO11,PSO4	Ap	F, C
CO6	Problems and limitations of Expert system		PSO11	An	F, C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Expert Systems: Architecture of expert system, Representation and organization of knowledge, Basics characteristics. Characteristics of Expert System- Components of an Expert System, Building Blocks of Expert Systems.

MODULE II

Expert System Tools: Techniques of knowledge representations in expert systems, knowledge engineering, system-building aids, support facilities, stages in the development of expert systems.

MODULE III

Expert System building: Expert system development, Selection of the tool, Acquiring Knowledge, Building process. Expert System Development: Rule Based Expert Systems, Meta Rules and Meta Knowledge. Knowledge Engineering.

MODULE IV

Problems with Expert Systems: Difficulties, common pitfalls in planning, dealing with domain experts, difficulties during development. Pitfalls in development process. Limitations of Expert Systems.

MODULE V

Expert system in market place: Expert system in universe, research organizations, engineering companies. High performance system in research organizations, business and companies. Expert system for Engineering, Self-learning expert systems, Expert systems in robotics and manufacturing.

MODULE VI

Expert Systems and tools: Applications of Expert System, Simple Medical Expert System, ORTESS - Expert System Shell for Power Plants, Successful Expert Systems, Engineering Expert Systems.

LEARNING RESOURCES

References

- Elain Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw-Hill, 2009
- Waterman D.A., "A Guide to Expert Systems", Addison Wesley Longman, 2009
- Stuart Russel and other Peter Norvig, "Artificial Intelligence – A Modern Approach", 4ed.,Prentice Hall of India, 2020.
- Vinod Chandra S S, Anand H S - "Artificial Intelligence: Principles and Applications", 2ed., Prentice Hall of India, 2020
- Patterson, Artificial Intelligence and Expert System, Prentice Hall India,1999.
- Hayes-Roth, Lenat, and Waterman: Building Expert Systems, Cambridge University Press, 2009 •
- Weiss S.M. and Kulikowski C.A., "A Practical Guide to Designing Expert Systems", Rowman and Allanheld, New Jersey, 1984

Semester: 7	Course Code: UK7MNADCS401	Credits: 4

AI PLANNING

Preamble: In this course, the challenges of building autonomous agents must continuously plan, execute their actions, and learn from their interactions with the environment. This course will cover in depth the main issues and algorithms in AI planning and learning, namely action and task modeling and representation, plan generation algorithms, heuristic learning and reuse of experience, and largely open research topics, such as dynamic integration of planning, scheduling, and execution, and multi agent planning.

Prerequisite: Linear algebra, Artificial Intelligence, Knowledge Representation and Reasoning.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Knowledge in AI based plan design and execution		PSO4, PSO9	U	C, P
CO2	Planning problems design using STRIPS,ADL,PDDL		PSO4, PSO11	An	C, P
CO3	Problems and solutions in HTN		PSO8, PSO11	Ap	C, P
CO4	Knowledge of different types of planning		PSO3, PSO9	U	P, M
CO5	KnowingtheconnectionbetweenKnowledgerepresentationandplanningapproaches		PSO3, PSO4	U	P, C
CO6	Discuss plan representations and controlling search		PSO4, PSO3	U	P, C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Overview of AI Planning: History, key milestones, Types of learning, problems, Applications of AI planning in real-world scenarios

MODULE II

Introduction: Elements - States, goals, actions, plans. Situation calculus, representing change, STRIPS-Operators: preconditions, add and delete effects, planning as search - Means-ends analysis.

MODULE III

Planning Problem: STRIPS, ADL, PDDL. Planning with State Space Search - Forward State Space Search, Backward State Space Search, Lifting, Suss man Anomaly

MODULE IV

Planning approaches: Partial Order Planning, Planning Graphs, Hierarchical Planning, Plan

generation and causal link planning, Hierarchical task network (HTN)planning Skeletal planning, case-based planning.

MODULE V

Plan Representations: Knowledge representation for planning, ontologies, description logics, Reasoning about time: temporal reasoning and scheduling

MODULE VI

Controlling Search: Complexity of planning problems, Abstraction, macros, hierarchical planning, Learning search control knowledge

LEARNING RESOURCES

References

- Nilsson,N."PrinciplesofArtificialIntelligence",ElsevierScience,2014.
- Rich,E.andKnight,K."ArtificialIntelligence",McGrawHill,1991.
- Russell,S.andNorvig,P."ArtificialIntelligence:AModernApproach",4ed.,Prentice HallofIndia,NewDelhi,2020
- VinodChandraSS,AnandHS- "ArtificialIntelligence:PrinciplesandApplications",2ed.,PrenticeHallofIndia,NewDelhi,2020

Semester: 7	Course Code: UK7MNADCS402	Credits: 4

BIG DATA ANALYTICS

Preamble: This course offers a thorough introduction to big data ideas, including an analysis of several big data sources as well as topics such as types, features, handling strategies, and databases. The Hadoop technological stack will be thoroughly examined by the students, who will also get in-depth explanations of HDFS and the Map Reduce framework. Furthermore, the course delves into data processing tools like PIG and HIVE, culminating in a big data analysis employing BigR, providing students with useful abilities for handling and interpreting extensive datasets.

Prerequisite: Database Management Systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize big data concepts, its types, features, big data handling techniques and databases.		PSO3	U, R	F
CO2	Identify the various sources of Big Data.		PSO3	U	F
CO3	Discuss about Hadoop technology and Ecosystem components.		PSO3	U, An	C, P
CO4	Explain in detail about HDFS and Map reduce framework.		PSO3		C, P
CO5	Illustrate the concepts of PIG and HIVE.		PSO1, PSO3	An, Ap	C, P
CO6	Analyse big data using BigR.		PSO10	An, Ap	An

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Big Data, types of data, big data features, challenges, sources and databases. Big data architecture and applications, Big data handling techniques.

MODULE II

Hadoop technology: Introduction, features, core components, HDFS –concepts, architecture, Data node, name node, check-pointing.

MODULE III

Map reduce framework and programming model- Architecture, Splitting, Map, Shuffle and Reduce, Map reduce types and features, file formats. Apache Spark.

MODULE IV

Hadoop ecosystem tools: YARN- Resource management, Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin.

MODULE V

Hive: Hive Shell, Hive Services, Hive Meta store, HiveQL, Tables, Querying Data and User Defined Functions.Hbase:HBasics, Concepts, Clients, Example, HBase Versus RDBMS.

MODULE VI

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

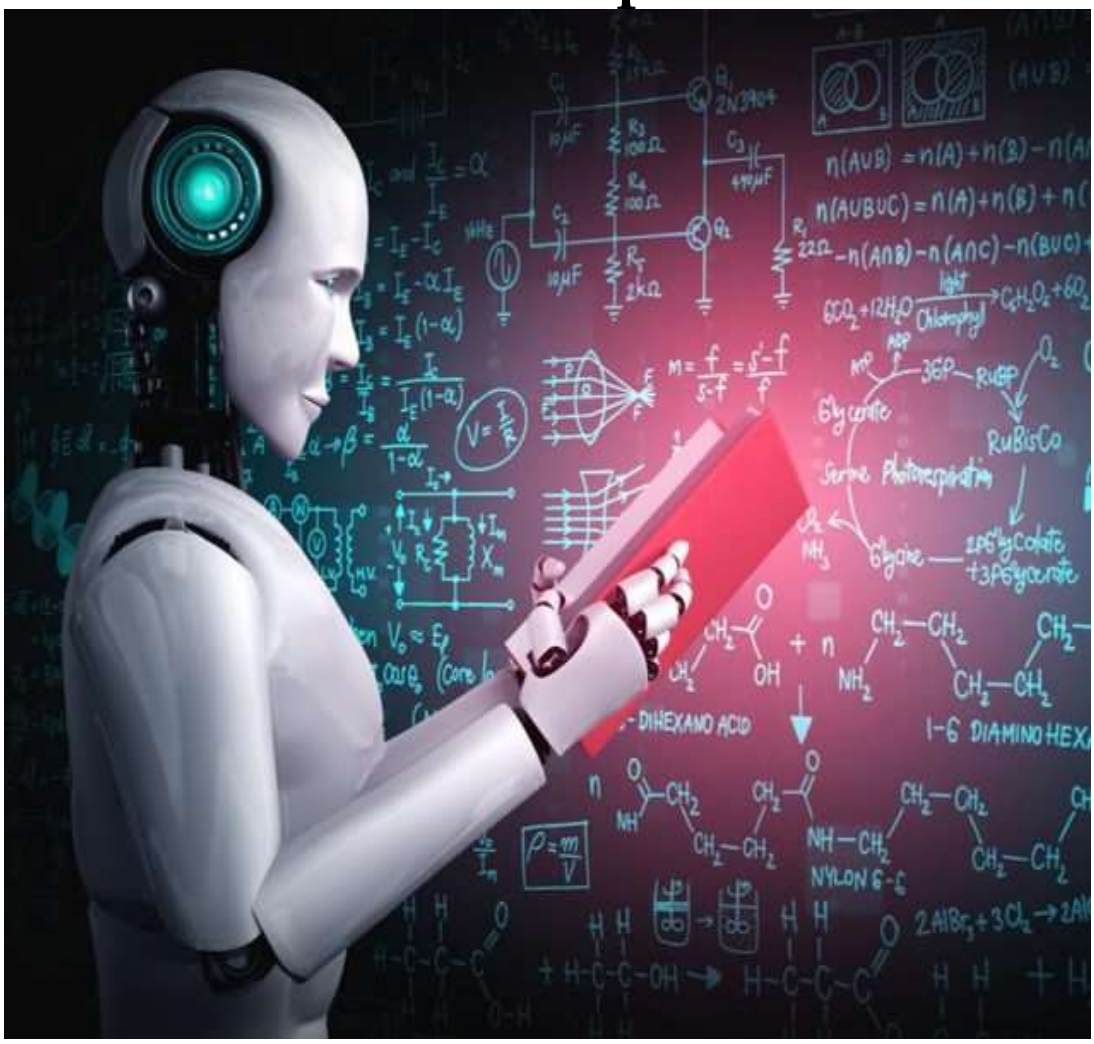
LEARNING RESOURCES

References

- Tom White "Hadoop: The Definitive Guide" Third Edition, O¨reily Media, 2012.
- Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
- Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.
- Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.

Four Year Under Graduate Programme for

B. Sc. Hons. Computer Science with Research



B. Sc. Hons. Computer Science with Research

With Specialization in Machine Learning

Department of Computer Science

University of Kerala

www.keralauniversity.ac.in

FYUGP for 4 year – B. Sc. Computer Science

Course Code	Name of Course	Credits
	Semester I	
UK1MNMDCS101	Introduction to Knowledge Based Systems	4
	Semester II	
UK2MNMDCS101	Intelligent Systems	4
	Semester III	
UK3MNMDCS201	Introduction To Machine Learning	4
	Semester IV	
UK4MNMDCS201	Soft Computing Techniques	4
	Semester V	
UK5MNMDCS301	Statistical Learning Models	4
	Semester VI	
UK6MNMDCS301	Advanced Learning Models	4
	Semester VII	
UK7MNMDCS401	Deep Architectures	4
UK7MNMDCS402	Big Data Analytics	

Semester: 1	Course Code: UK1MNMDCS101	Credits: 4

INTRODUCTION TO KNOWLEDGE BASED SYSTEMS

Preamble: This course gives an overview of the field of knowledge based systems, exploring formalisms such as propositional and first-order logic, knowledge acquisition techniques, and advanced topics such as uncertainty handling and agents.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize the concepts of Knowledge Based Systems		Pso1,Pso3	U	F, C
CO2	Acquiring the ability to handle different types of KBS		Pso3	U, An	P,C
CO3	Analyzethe techniques used for Knowledge Acquisition		Pso3,Pso11	An	C,P
CO4	Familiarize with the Knowledge Representation and Reasoning techniques		Pso3	An	P,C
CO5	Understand the basics of Knowledge Management		Pso3	U	F,C
CO6	Discuss the features and types of Agent Based Systems		Pso3	U	F,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Knowledge Based Systems – Objectives of KBS , Components, Categories, Difficulties with the KBS. Knowledge Based System Architecture.Knowledge Representation Languages.

MODULE II

Source of Knowledge, Types of Knowledge, Basic Structure, Knowledge Bases, Inference Engine, Self Learning, Reasoning, Explanation, Applications. Limitations of Knowledge Based Systems.

MODULE III

Developing Knowledge Based Systems – Knowledge Based System development Model, Knowledge Acquisition, Techniques for Knowledge Acquisition, Sharing Knowledge, Updating Knowledge.

MODULE IV

Knowledge Representation and Reasoning – The propositional calculus and Resolution, Predicate calculus and Resolution, Representing Procedural Knowledge, Reasoning with Uncertain Information, Learning and Acting with Bayes Nets.

MODULE V

Knowledge Management - Introduction, Perspectives, Evolution, Elements of Knowledge Management, Knowledge Management Process, Tools and Technologies.

MODULE VI

Knowledge Management Roles and Responsibilities, Knowledge Management Models. Agent Based Systems – Characteristics, Types of Agents, Agent Communication Language, Multi Agent Systems.

LEARNING RESOURCES

References

- Rajendra Akerkar, Priti Sajja, "Knowledge-Based Systems", Jones & Bartlett Learning, 1 st Ed., 2010.
- Nils J Nilsson "Artificial Intelligence – A New Synthesis", Morgan Kaufman Publishers 1 st Ed., 2003.
- Cornelius T Leondes, "Knowledge-Based Systems: Techniques and Applications", Academic Press, 1st Ed., 2000.
- Elias M Awad, Hassan M Ghaziri, "Knowledge Management", Pearson Education, 1st Ed., 2007.

Semester: 2	Course Code:UK2MNMDCS101	Credits: 4

INTELLIGENT SYSTEMS

Preamble: Intelligent systems aregoing to drive our society. An immense collection of technologies and AI applications are coming from R&D institutions to support the daily and regular routine of individuals and organizations. In this context, the content of this particular course has been designed to create an awareness of the principles and ethics while you are thinking about designing an application or technique with the help of AI. The things which are done by a human being and sometimes beyond that can be possible with AI, so understanding the challenges, principles, and ethics are unavoidable.

Prerequisite: Digital system and computer programming, Basic idea about the working and servicesprovidedbydifferentAIapplicationsinthemarket.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarizethestages and developmentof various intelligent systems.		PSO3, PSO4	PSO3, PSO4	PSO3, PSO4
CO2	Identifytheharmsthat canbecausedby AIapplications.		PSO5	PSO5	PSO5
CO3	The concepts of knowledge representation system		PSO3	PSO3	PSO3
CO4	Familiarize AI techniques in Game Theory		PSO4	PSO4	PSO4
CO5	Understand learning concepts that propagate to the machine learning		PSO3	PSO3	PSO3
CO6	Understanding of different machine learning techniques		PSO3, PSO8	PSO3, PSO8	PSO3, PSO8
CO7	Explorethescopeofmoralvaluesindesigning scientificinventions.		PSO5	PSO5	PSO5
CO8	Familiarize real world AI applications connected with human life.		PSO9, PSO11	PSO9, PSO11	PSO9, PSO11

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Characteristics of Intelligent System, Introductory note on Artificial Intelligence, Timelines of Artificial Intelligence, Branches of Artificial Intelligence, Applications of Artificial Intelligence. Potential Harms Caused by AI Systems, Intellectual Background of AI.

MODULE II

Autonomous systems and characteristics, intelligent agents - structure, types of agents. Production Systems, Knowledge representation structures.

MODULE III

Introduction to Game theory- Two player game, Min Max procedure, Alpha Beta Cut off

MODULE IV

Designing a learning system- choosing the training experience- choosing the target function – choosing the representation for the target function- choosing a function approximation algorithm- Types of learning methods. Introduction to Machine Learning: Steps in machine learning process, Types of machine learning – Supervised, unsupervised and reinforcement.

MODULE V

Artificial Intelligence and Ethics-need of Ethics in AI, Codes of Ethics, Epistemic Strategies: Precision and the Reduction of Uncertainty, Technological Strategies to Ensure Safe and Beneficial AI, Moral Strategies in the Pursuit of Beneficial AI.

MODULE VI

AI in real life- Expert system, NLP, AI based planning, Recommender system, GPT, Sentimental Analysis, Intelligent Traffic system.

LEARNING RESOURCES

References

- Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach, Pearson,2020.
- Vinod Chandra S S, Anand H S - "Artificial Intelligence: Principles and Applications", Prentice Hall of India, New Delhi, 2020
- Boddington, P. (2017). Towards a Code of Ethics for Artificial Intelligence. Germany: Springer International Publishing.
- World Health Organization. Ethics and governance of artificial intelligence for health: WHO guidance, 2021.
- Müller, Vincent C. (forthcoming 2021), "Ethics of artificial intelligence", in Anthony Elliott (ed.), The Routledge social science handbook of AI

Online Resources

- https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf

Semester: 3	Course Code: UK3MNMDCS201	Credits: 4

INTRODUCTION TO MACHINE LEARNING

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular learning algorithms such as linear regression, logistic regression, decision trees, tree classifiers, support vector machines and kernels, basic clustering algorithms and basics of reinforcement learning. This course helps the students to provide machine learning-based solutions to real-world problems.

Prerequisite: Basic understanding of probability theory, linear algebra and Python Programming.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Differentiate between various learning approaches, and to interpret the concepts of learning		PSO3	U	F, C
CO2	Demonstrate supervised and unsupervised learning concepts		PSO3, PSO11	Ap	P,C
CO3	Analyze the clustering algorithms and its importance		PSO3, PSO11	Ap	C,P
CO4	Implement Support Vector Machineand identify its applicability in real life problems		PSO3, PSO4	Ap	P,C
CO5	Familiarize with the concepts of Reinforcement learning		PSO3,	U	F,C
CO6	Solve real life problems using appropriate machine learning models and evaluate theperformance measures		PSO4, PSO10, PSO11	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Machine Learning: Basic concepts in machine learning, Types of Learning and Examples- Learning Associations, Classification ,Regression, Semi-supervised, Unsupervised Learning, Reinforcement Learning , Batch learning and online learning, Instance based learning Versus Model Based learning, Challenges of Machine Learning.

MODULE II

Supervised vs. Unsupervised learning: Overview, distinction between supervised and unsupervised Learning, real-world case studies involving supervised and unsupervised learning.

MODULE III

Classification and Prediction: Binary and Multiclass Classification, Multi label classification, Training, testing and validation datasets, cross validation, Performance evaluation of ML models- confusion matrix and allied metrics- accuracy, precision, recall, F1 Score.

MODULE IV

Regression - linear regression, model selection, linear regression with one variable, linear regression with multiple variables, practical issues in regression, logistic regression, evaluation metrics for regression problems.

MODULE V

Clustering: Similarity measures,Clustering criteria,k-Means clustering, Facts about k-means, weakness of k-Means clustering,Best and worst cases in k-Means clustering implementation, improving k-means clustering, HierarchicalClustering –Agglomerative and Divisive Clustering, Evaluation Metrics for Clustering.

MODULE VI

Support Vector Machines: Introduction, Maximum Margin Classification, Mathematics behind Maximum MarginClassification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM,Kernels, Applications of SVM.

LEARNING RESOURCES

References

- Ethem Alpaydin, "Introduction to Machine Learning", 2nd edition, MIT Press 2010.
- Vinod Chandra S S, Anand H S, "Artificial Intelligence and Machine Learning", Prentice Hall of India, New Delhi, 2014.
- Mohammed J. Zaki and Wagner Meira, "Data Mining and Analysis: Fundamental Conceptsand Algorithms", Cambridge University Press, First South Asia edition, 2016.
- Jake VanderPlas, "Python Data Science Handbook", O'Reilly Media, 2016.
- Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
- Ryszard S. Michalski, Jaime G. Carbonell, and Tom M. Mitchell, "Machine Learning : AnArtificial Intelligence Approach", Tioga Publishing Company.

Semester: 4	Course Code: UK4MNMDCS201	Credits: 4

SOFT COMPUTING TECHNIQUES

Preamble: This course will provide students with the basic concepts of different methods and tools for processing uncertainty in intelligent systems, such as fuzzy models, neural networks, and probabilistic models, and the foundations of their use in real systems. This course covers the main concepts of the philosophy of artificial intelligence, hybrid intelligent systems, classification and architecture of hybrid intelligent systems.

Prerequisite: No specific technical or numerical background is required, but students are expected to be willing to hone their computational skills.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understanding the concept of Neural Networks		PSO3	U, Ap	C, P
CO2	Prepare the students to apply Neural Networks to solve problems		PSO3, PSO9	Ap	C, P
CO3	Familiar the various rules and models used in NN		PSO3, PSO4	U	C
CO4	Implement the perceptron for classification		PSO4	Ap	C, P
CO5	Analyse the working of Backpropagation Algorithms		PSO4, PSO11	Ap, An	C, P
CO6	Equip the students to apply fuzzy techniques in research problems		PSO11	Ap, An, E	C, P
CO7	Familiar the Genetic algorithm concepts with different operations		PSO3	U, Ap	C, P
CO8	Implement and evaluate different application using soft computing techniques		PSO10, PSO11	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M-Metacognitive)

COURSE CONTENT

MODULE I

Structure of biological neuron, Artificial neural networks, applications of neural network, Models of ANNs; Feedforward and feedback networks, Activation functions, Neuron Models, Learning rules, Hebbian learning rule, perception learning rule, delta learning rule, Widrow-Hoff learning rule, correction learning rule, Winner –lake all learning rule

MODULE II

Biases and thresholds, linear seperability, HEBB NET- Algorithm, Implementing logic functions. Perceptron, Architecture, Algorithm, implementing logic functions. Perceptron learning rule convergence theorem, Adaline

MODULE III

Neural network architectures: Linear inseparability, Multi-layer Perceptron, Back propagation Network – Architecture, Algorithm, Learning factors, RBF Networks

MODULE IV

Fuzzy networks: Classical Sets, Operations and properties, Fuzzy sets – Operations and Properties, Crisp Relations, Fuzzy Relations, Fuzzy Equivalence Relations, Features of Membership Functions, Various forms, Fuzzification and Defuzzification, λ-cuts for Fuzzy Relations, Classical Logic, Fuzzy Logic – Approximate reasoning. Fuzzy Rule-based Systems.

MODULE V

Genetic Algorithms: Introduction, Biological background, genetic algorithm Vs. Traditional algorithms, Basic terminologies, Genetic algorithm steps, Operators in gnetic algorithm-Encoding, Selection, Crossover, Mutation, stopping crieteria, Problem solving using Genetic algorithm

MODULE VI

Neural network Applications: Character recognition, Speech recognition, signature verification, Fuzzy based applications- microwave oven, washing machine, Genetic algorithm-based applications.

LEARNING RESOURCES

References

- Fausett, Laurene V., "Fundamentals of neural networks: architectures, algorithms and applications", Pearson Education, 2006.
- Rajasekaran, Sanguthevar, and GA Vijayalakshmi Pai. "Neural networks, fuzzy logic and genetic algorithm: synthesis and applications", PHI Learning Pvt. Ltd., 2003.
- McAllister, Marialuisa N. "Fuzzy logic with engineering applications", SIAM review, 1996
- Haykin, Simon. Neural networks: a comprehensive foundation. Prentice Hall PTR, 1998.
- Liang, Ping, and N. K. Bose. "Neural network fundamentals with graphs, algorithms, and applications." Mac Graw-Hill, 1996.
- Lamba, V. K., "Neuro fuzzy systems", University Science Press, 2008.
- Goldberg, David E. "Genetic algorithms in search, optimization and machine learning", Addsion-Wesley, 1989
- Sivanandam, S. N., and S. N. Deepa., "Principles of soft computing", John Wiley and Sons, 2007.
- Vinod Chandra S S, Anand H S, "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020
- Karr, Charles, and L. Michael Freeman, "Industrial applications of genetic algorithms", CRC press, 1998.

Online resources

- https://link.springer.com/book/10.1007/978-3-319-04693-8
- https://link.springer.com/book/10.1007/978-3-030-75657-4
- https://link.springer.com/book/10.1007/978-981-16-8364-0
- https://pg.its.edu.in/sites/default/files/MCAKCA032-PRINCIPALES%20OF%20SOFT%20COMPUTING-SN%20SIVNANDAM%20AND%20DEEPA%20SN.pdf

Semester: 5	CourseCode:UK5MNMDCS301	Credits: 4

STATISTICAL LEARNING MODELS

Preamble: The course aims to provide students with basic knowledge of how Machine Learning methods work and how statistical model scan be brought to bear in computer systems. The analysis of large data sets and to let computers perform tasks that traditional computer science methods are addressed. This course first introduces the statistical methods and mathematical concepts that make such technologies possible.

Prerequisite: Introduction to Machine Learning, Statistical concepts and Programming in Python.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand basic concepts of statistics and probability		PSO6	U	C, P
CO2	Explain the basics of Convergence and Regression		PSO4, PSO6	An	C, P
CO3	Knowledge in EM		PSO3	U, An	C, P
CO4	Explain Statistical learning and its different learning methods		PSO6	U, An	P, M
CO5	Compare different Naïve Bayes		PSO3	U	P, C
CO6	Practice Markov models and HMM		PSO11	An	P
CO7	Implement HMM and its variants		PSO9	Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.

Probability Distribution: Discrete and continuous random variables and their probability distributions-Probability distribution (density) functions-Distribution Functions-Mean and Variance - Simple problems.

MODULE II

Convergence and Regression:Formal Learning Model, Learning via Uniform Convergence, Uniformly Convergent Series, Linear Regression, Types of Regression, Polynomial regression, regularization methods.

MODULE III

Nearest Neighborhood: Distance Measure, Hamming Distance, Euclidean Distance, City Block Distance (Manhattan), Euclidean and Manhattan Distances, Square Distance, KNN Algorithm, KNN Algorithm Implications, Nearest Neighborhood Applications.

MODULE IV

Expectation Maximization: General EM, EM algorithm, Features of EM, Mathematics of EM.

MODULE V

Markov Models: Stochastic Processes - Definition, Classification of Stochastic Processes, Markov Process, Transition Probability Matrix. Hidden Markov Models: Types of HMM, Three Basic Problems for HMMs, Forward - Backward Procedure, Baum-Welch Algorithm, Applications of HMM

MODULE VI

Statistical Classifiers: Linear Classifiers, Linear Discriminant Analysis, Probability Density Function Modelling, Naive Bayes Classifier.

LEARNINGRESOURCES

References

- Miller, Irwin and Miller, Marylees(2006): John E.Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
- K. Murphy-"Machine Learning: aProbabilisticPerspective",MITPress,2012.
- VinodChandraSS, AnandHS- "MachineLearning:APractitionersApproach",PrenticeHallofIndia, NewDelhi,2020
- Vinod Chandra S S, Anand H S- "Artificial Intelligence and Machine Learning", Prentice Hall of India, NewDelhi,2014

Semester: 6	Course Code: UK6MNMDCS301	Credits: 4

ADVANCED LEARNING MODELS

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular learning algorithms such as linear regression, logistic regression, decision trees, tree classifiers, support vector machines and kernels, basic clustering algorithms and basics of reinforcement learning. This course helps the students to provide machine learning-based solutions to real-world problems.

Prerequisite: Introduction to Machine Learning,Linear algebra, Knowledge probability.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the classification models in decision trees		PSO3, PSO4	U, Ap	F
CO2	Demonstrate fundamental concepts of dimensionality reduction		PSO4, PSO10	U, Ap	C, F
CO3	Understand working principles of reinforcement learning		PSO6, PSO11	U, Ap	C, F
CO4	Evaluate learning models with Performance metrics		PSO11	Ap, E	F
CO5	Familiarize with advanced neural networks architectures		PSO12	U	C
CO6	Illustrate the concepts of pre-training and representation learning		PSO3, PSO11	Ap, Cr	M, C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Decision Trees- Decision tree construction, Decision tree algorithms - C4.5 algorithms, ID3 algorithm, Random Forest, kNN algorithm.

MODULE II

Curse of Dimensionality, Need of dimensionality reduction, Principal Component Analysis. Performance evaluation of ML models- Confusion matrix and allied matrices, Accuracy, Precision and Recall, F1_Score, Specificity and Sensitivity, ROC and AUC.

MODULE III

Reinforcement Learning, Definition and basic architecture, Reward, Agent, Environment, History, States, Information State and Markov Model, Q Function and learning, Action Space, Policy(π) Learning.

MODULE IV

ANN: Structure of biological neuron, Artificial neural networks, applications of neural network, Models of ANNs; Feedforward and feedback networks, Activation functions, Neuron Models, learning rules, Hebbian learning rule, perceptron learning rule.

MODULE V

Neural network architectures: Linear inseparability, multi-layer perceptron, Back propagation Network – Architecture, Algorithm, Learning factors.

MODULE VI

Representation Learning: Pre-training, Transfer learning, Domain adaptation. Basics of Convolution Neural Network- Convolutional Layer, Pooling Layer, Fully Connected Layer, Pretrained CNN Models- Alex Net, VGGNet, ResNet.

LEARNING RESOURCES

References

- C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
- K. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
- Vinod Chandra S S, Anand H S, "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020
- Vinod Chandra S S, Anand H S, "Artificial Intelligence and Machine Learning", Prentice Hall of India, New Delhi, 2014
- Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
- Sutton, R. S., &Barto, A. G. (2018). Reinforcement learning: An introduction (2nd ed.). The MIT Press.

Semester: 7	Course Code: UK7MNMDCS401	Credits: 4

DEEP ARCHITECTURES

Preamble: Students will learn how to correctly apply, interpret results. Iteratively refine and tune supervised and unsupervised machine learning models to solve diverse problems on real-world datasets. Application is emphasized over theoretical content. The main aim of the course is to provide skills to apply machine learning algorithms to real applications.

Prerequisite: Machine learning and Programming in Python.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the deep learning concepts		PSO3, PSO6	U	C, P
CO2	Familiarize with parameter tuning in deep neural networks		PSO9	U, Ap	C
CO3	Familiarize with Convolution Neural Networks		PSO8, PSO9	U	C,P
CO4	Understand fundamentals of sequential models		PSO3, PSO6	U	C,P
CO5	Implement Q-learning model in networks		PSO8, PSO10	U, Ap	C,P

CO6	Compare different Generative deep neural architectures	PSO11, PSO12	U, An	C,P
CO7	Implement different deep frameworks like Tensorflow, Keras, Caffe	PSO12	U	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr-Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Universal Approximation Theorem, Deep and shallow networks, Optimization of Deep Neural Networks, Gradient Descent.

MODULE II

Effective training in Deep Neural Networks- Regularization - Dropout and Batch normalization, Early stopping, Instance Normalization, Group Normalization, Adam Optimizer.

MODULE III

Convolution Neural Networks: Architecture, Working.Image Classification and Hyper-parameter Tuning, Convolutional Layer, Pooling Layer, Fully Connected Layer.

MODULE IV

Sequential Neural Networks- Architectures, Recurrent and Recursive networks, Recurrent Neural Network- Building Recurrent NN, Memory Cells, Long Short-Term Memory, Gated Recurrent Units.

MODULE V

Generative Networks- Auto-encoders and Representation learning, Variational auto-encoders, Semi-supervised learning, Generative Adversarial Network, Deep Reinforcement learning- Q-Learning, Geometric stability, Deep Q Network

MODULE VI

Implementing object classification and detection using CNN networks using deep libraries like Tensorflow, Keras. Instance recognition, Category recognition, Context and scene understanding.

LEARNING RESOURCES

References

- Aggarwal, Charu C. "Neural networks and deep learning." Springer 10.978 (2018).
- Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. " O'Reilly Media, Inc.", 2022.
- Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.
- Mike Krebbs - "Deep Learning with Python", CreateSpace Independent Publishing Platform, 2018.
- Weidman, Seth. “Deep Learning from Scratch” O’ Reily. 2019
- Vinod Chandra S S, Anand H S - “Machine Learning: A Practitioners Approach”, Prentice Hall of India, New Delhi, 2020.

Semester: 7	Course Code: UK7MNMDCS402	Credits: 4

BIG DATA ANALYTICS

Preamble: This course offers a thorough introduction to big data ideas, including an analysis of several big data sources as well as topics such as types, features, handling strategies, and databases. The Hadoop technological stack will be thoroughly examined by the students, who will also get in-depth explanations of HDFS and the MapReduce framework. Furthermore, the course delves into data processing tools like PIG and HIVE, culminating in a big data analysis employing BigR, providing students with useful abilities for handling and interpreting extensive datasets.

Prerequisite: Database Management Systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize big data concepts, its types, features, big data handling techniques and databases.		PSO3	U, R	F
CO2	Identify the various sources of Big Data.		PSO3	U	F
CO3	Discuss about Hadoop technology and Ecosystem components.		PSO3	U, An	C, P
CO4	Explain in detail about HDFS and Map reduce framework.		PSO3		C, P
CO5	Illustrate the concepts of PIG and HIVE.		PSO1, PSO3	An, Ap	C, P

CO6	Analyse big data using BigR.	PSO10	An, Ap	An

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Big Data, types of data, big data features, challenges, sources and databases. Big data architecture and applications, Big data handling techniques.

MODULE II

Hadoop technology: Introduction, features, core components, HDFS –concepts, architecture, Data node, name node, check-pointing.

MODULE III

Map reduce framework and programming model- Architecture, Splitting, Map, Shuffle and Reduce, Map reduce types and features, file formats. Apache Spark.

MODULE IV

Hadoop ecosystem tools: YARN- Resource management, Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin.

MODULE V

Hive: Hive Shell, Hive Services, Hive Metastore, HiveQL, Tables, Querying Data and User Defined Functions.Hbase:HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

MODULE VI

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

LEARNING RESOURCES

References

- Tom White “Hadoop: The Definitive Guide” Third Edition, O‟reily Media, 2012.
- Seema Acharya, SubhasiniChellappan, "Big Data Analytics" Wiley 2015.
- Tom Plunkett, Mark Hornick, “Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop”, McGraw-Hill/Osborne Media (2013), Oracle press.
- Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.