DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF CALICUT

OBE Based Course Structure, Scheme of Evaluation and
Detailed Syllabus for

MASTER OF SCIENCE (M.Sc.)
in
COMPUTER SCIENCE

Choice Based Credit Semester System (CCSS)
(Effective from the 2024 Admission Onwards)

Under the
FACULTY OF SCIENCE

BOARD OF STUDIES IN COMPUTER SCIENCE AND APPLICATIONS (PG)
University of Calicut, Kerala 673 635

REGULATIONS

The existing regulations of Choice-based Credit Semester System (U.O. No. 3459/2024/Admn. Dated 27.02.2024, University of Calicut) which are applicable for University Teaching Departments are also applicable for this programme.

A: PROGRAMME OUTCOME (PO)

At the completion of Master of Science Programme in Computer Science from the Department of Computer Science, University of Calicut, a student would have:

Sl. No.	Outcome
PO11	**Research and Inquiry:** Develop, design, conduct, and evaluate research. Apply appropriate research methodologies and techniques to generate original and meaningful knowledge. Use statistical /analytical tools and techniques to execute and report the results of experiments or investigations.
PO12	**Innovation and Creativity**: Apply critical thinking, creativity, and innovation to identify and solve problems. Develop new ideas, make original contributions to their field, and solve interdisciplinary problems.
PO13	**Professionalism and Ethics:** Exercise professional judgment, ethical conduct, and social responsibility in their work. Demonstrate awareness of the moral implications of their research and professional practice and interactions.
PO14	**Social responsibility:** Develop social responsibility in their work. Participate in actions to address environmental and sustainable development issues. Act with integrity and communicate scientific information and ideas effectively to a wide range of audiences, including policymakers, the public, and non-specialists. Translate scientific knowledge into practical applications that benefit society.

B: PROGRAMME SPECIFIC OUTCOME (PSO)

Sl. No.	Outcome
PSO1	Acquire the ability to design and analyze efficient algorithms for solving computational problems.
PSO2	Evaluate complex real-world problems by applying principles of theoretical computing, engineering, and Mathematical models.
PSO3	Develop, construct, implement, and validate software systems according to specific requirements.
PSO4	Identify, analyze, and synthesize scholarly literature relating to the field of Computer Science to attain the necessary skills to tackle research challenges.
PSO5	Develop Project management expertise to solve practical industry problems within defined time constraints.
PSO6	Attain Knowledge and practical skills in the field of Computer Science viz. Computational Intelligence, Machine Learning, Web Technology, Data Analytics, Communication and Networking.
PSO7	Prepare to address the challenging requirements coming from the enterprise applications.
PSO8	Innovate, experiment, and analyze research findings and practice the process of scientific publishing.

C: Mapping of PSOs to POs

	PO11	PO12	PO13	PO14
PSO1		✓		✓
PSO2	✓	✓		✓
PSO3		✓		✓
PSO4	✓	✓	✓	✓
PSO5		✓	✓	✓
PSO6		✓		
PSO7		✓	✓	✓
PSO8	✓	✓	✓	

UNIVERSITY OF CALICUT

Department of Computer Science

M.Sc. Computer Science

Under CCSS (Effective from 2024 Admission Onwards)

COURSE STRUCTURE AND SCHEME OF EVALUATION

SEMESTER - 1 (Total Credit-24)

Sl. No.	Course Code	Type	Course	Instructional Hrs./week	Marks			Credit
				Lect./Lab/ Tutorial	ESA	CA	Total	
1	CSC7C501	DSC	Discrete Mathematical Structures	4+0+1	50	50	100	4
2	CSC7C502	DSC	Advanced Data Structures and Algorithms	3+2+1	50	50	100	4
3	CSC7C503	DSC	Python Programming	3+2+1	50	50	100	4
4	CSC7E501-CSC7E505	DSE	Elective 1	4+0+1 or 3+2+1	50	50	100	4
5	CSC7E506-CSC7E507	DSE	Elective 2 (Open Elective)	4+0+1 or 3+2+1	50	50	100	4
6	CSC7M501	–	Online/MOOC - 1	–	–	–	–	4
	Total				–	–	500	24

Elective 1		
Course Code	**Course**	**Credit**
CSC7E501	Theory of Computation	4
CSC7E502	Advanced Operating Systems	4
CSC7E503	Computer Organization and Architecture	4
CSC7E504	Computer Graphics	4
CSC7E505	Bioinformatics	4

Elective 2 (Open Elective)		
Course Code	**Course**	**Credit**
CSC7E506	Introduction to Data Science	4
CSC7E507	Introduction to Web Technology	4

Online/MOOC - 1		
Course Code	**Course**	**Credit**
CSC7M501	Programming in C (Students can enroll for the courses from SWAYAM/NPTEL/Online Courses offered by the Department/ Any other MOOC approved by the Department Council)	4

SEMESTER - 2 (Total Credits - 20)

Sl.No.	Course Code	Type	Course	Instructional Hrs./week	Marks			Credit
				Lect./Lab/ Tutorial	ESA	CA	Total	
1	CSC8C504	DSC	Design and Analysis of Algorithms	4+0+1	50	50	100	4
2	CSC8C505	DSC	Data Communication and Networking	3+2+1	50	50	100	4
3	CSC8C506	DSC	Advanced Database Management Systems	3+2+1	50	50	100	4
4	CSC8E508 - CSC8E512	DSE	Elective – 3	4+0+1 or 3+2+1	50	50	100	4
5	CSC8M502	–	Online/MOOC 2	–	–	–	–	4
	Total				**–**	**–**	**400**	**20**

Elective – 3		
Course Code	**Course**	**Credit**
CSC8E508	Artificial Intelligence	4
CSC8E509	Big Data Technologies	4
CSC8E510	Principles of Compiler Design	4
CSC8E511	Quantum Computing	4
CSC8E512	Mobile Communication	4

Online/MOOC - 2		
Course Code	**Course**	**Credit**
CSC8M502	Object Oriented Programming with Java (Students can enroll for the courses from SWAYAM/NPTEL/Online Courses offered by the Department/Any other MOOC approved by the Department Council)	4

SEMESTER - 3 (Total Credits - 20)

Sl.No.	Course Code	Type	Course	Instructional Hrs./week	Marks			Credit
				Lect./Lab/ Tutorial	ESA	CA	Total	
1	CSC9C601	DSC	Data Analytics Using Python	4+0+1	50	50	100	4
2	CSC9C602	DSC	Advanced Machine Learning	3+2+1	50	50	100	4
3	CSC9C603	DSC	Digital Image Processing	3+2+1	50	50	100	4
4	CSC9E601-CSC9E605	DSE	Elective 4	4+0+1 or 3+2+1	50	50	100	4
5	CSC9E606-CSC9E610	DSE	Elective 5	4+0+1 or 3+2+1	50	50	100	4
	Total				–	–	500	20

Elective 4		
Course Code	**Course**	**Credit**
CSC9E601	Stream Processing	4
CSC9E602	Android Application Programming	4
CSC9E603	Cyber Physical Systems	4
CSC9E604	Blockchain Technology	4
CSC9E605	Cryptography and Network Security	4

Elective 5		
Course Code	**Course**	**Credit**
CSC9E606	Data Mining	4
CSC9E607	Pattern Recognition	4
CSC9E608	Internet of Things	4
CSC9E609	Natural Language Processing	4
CSC9E610	Digital Signal Processing	4

SEMESTER – 4 (Total Credits - 24)

Sl.No.	Course Code	Type	Course	Instructional Hrs./week	Marks			Credit
				Lect./Lab/ Tutorial	ESA	CA	Total	
1	CSC10C604	DSC	Software Engineering	3+2+1	50	50	100	4
2	CSC10C605	DSC	Web Technology	3+2+1	50	50	100	4
3	CSC10C606	DSC	Project Work & Dissertation	16 Weeks	100	–	100	12
4	CSC10M601	–	Online/MOOC-3	–	–	–	–	4
	Total				–	–	300	24

Online/MOOC - 3		
Course Code	**Course**	**Credit**
CSC10M601	Courses related to any of the following specialized areas 1. Full Stack Development 2. Social Network Analysis 3. Cyber Security 4. Cloud Computing 5. Robotics (Students can enroll for the courses from SWAYAM/NPTEL/Online Courses offered by the Department/Any other MOOC approved by the Department Council)	4

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF CALICUT

DETAILED SYLLABUS

for

MASTER OF SCIENCE (M.Sc.)
in
COMPUTER SCIENCE

Choice Based Credit Semester System (CCSS)
(Effective from 2024 Admission Onward)

Semester - 1

CSC7C501: Discrete Mathematical Structures

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Verify the validity of an argument using propositional and predicate logic
CO2: Understand the basic concepts of set theory and apply operations on set
CO3: Apply operations of relations and functions in discrete structures
CO4: Identify Group, Ring and Field in Group Theory
CO5: Understand applications of Graph Theory and Tree
CO6: Employ the concepts of graph theory and trees to formulate problem solving

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓		✓		✓		
CO2	✓	✓			✓			
CO3		✓	✓	✓		✓		
CO4		✓		✓		✓		✓
CO5	✓	✓		✓		✓		✓
CO6	✓	✓		✓		✓		✓

Unit I

Propositional Logic: Statement Formulas and Truth Tables, Well Formed Formulas-Tautologies-Equivalence of Formulas-Duality Law-Tautological Implications - Normal Forms, Theory of Inference for the Statement Calculus. Predicate Calculus, Quantifiers, Free and Bound Variables, Inference Theory of the Predicate Calculus.

Unit II

Set Theory - Sets and subsets -Set operations and their properties- Cartesian Products, Relations-Relation matrices- Properties of relations-Composition of relations, Equivalence relations and partitions-Partial Ordering.

Unit III

Functions and Relations: Functions-Types of Functions, Composition of Functions and Inverse Functions. Relations -Relations and Their Properties, Functions as relations, Closure of Relations, Composition of relations, Equivalence Relations and Partitions. Partial Ordering, Hasse Diagram. The Pigeonhole Principle.

Unit IV

Group Theory-Definition and Elementary Properties-Cyclic Groups- Homomorphism and Isomorphism-Subgroups-Cosets and Lagrange's Theorem, Rings and Fields-Definitions and examples of Rings, Integral Domains and Fields.

Unit V

Graph Theory-Paths and Cycles, Graph Isomorphism, Bipartite Graphs, Subgraphs, Representation of Graphs, Eulerian and Hamiltonian Properties of Paths-Trees-Spanning Trees, Cayley's theorem, Kruskal's Algorithm, Prim's Algorithm. Dijkstra's Algorithm to Find Shortest Path in Weighted Graphs.

References:

1. Trembley J.P. & Manohar R.P, Discrete Mathematical Structures with Application to Computer Science, Mcgraw Hill, 2007
2. R.P.Grimaldi, Discrete and Combinatorial Mathematics: An applied Introduction, 3/e, Addision-Wesley, New Delhi, 1994
3. J.K.Truss, Discrete Mathematics for Computer Scientists, Addison Wesley, 1999
4. B.Kolman and R.C.Busby, Discrete Mathematical Structures for Computer Science, PHI, 1994
5. C.L.Liu. Elements of Discrete Mathematics, 2/e, McGraw Hill, 1985
6. John O. Clark, Derek A. Holton, A First Look at Graph Theory, world scientific publishing, 1995.

CSC7C502: Advanced Data Structures and Algorithms

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Understand the knowledge about different categories of data structures, their representations, and applications.
CO2: Acquire the knowledge of various searching and sorting Techniques.
CO3: Gain familiarity with the utilization and implementation of both linear and non-linear data structures.
CO4: Analyze the time and space complexity of algorithms utilizing advanced data structures.
CO5: Develop proficiency in solving complex problems using advanced data structures and algorithms.
CO6: Gain hands-on experience with a variety of advanced data structures such as AVL trees, B-trees, graphs, and advanced sorting algorithms.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓				✓		✓
CO2	✓	✓		✓		✓		
CO3	✓		✓		✓	✓	✓	
CO4	✓	✓				✓		
CO5	✓		✓		✓	✓	✓	✓
CO6	✓		✓			✓		

Unit I

Overview of Data Structures, Data Abstraction & Abstract data types. Data Structure operations: Traversing, Inserting and deleting, sorting and searching. Linear Search & Binary Search- Complexity. Sorting techniques: Insertion sort- Selection sort- Bubble sort- Quick Sort-Heap sort- Merge sort- Comparison of sorting algorithms.

Unit II

Linear Data structures: Array- operations, polynomial representation with arrays. Stack-operations and its implementations-Parsing arithmetic expressions, translating and evaluating; Recursion. Queue- operations and its implementations-Circular queue-dequeue - priority queues, Linked Lists- Operations and implementations- doubly Linked Lists and Circular Lists-Sparse matrix representation.

Unit III

Non-linear Data Structures: Trees-basic terminologies and properties-representation of the binary tree, operations on the binary tree; type of binary tree-Tree traversals algorithms- Binary search Trees- balanced trees-AVL, Red-Black Trees. Graphs-representation of graphs-operations- traversals and their implementation- Applications of graphs-minimum spanning tree – Prim's and Kruskal's algorithms- shortest-path algorithm – Dijkstra's algorithm.

Unit IV

Hashing: Overview of hashing-Hash tables- hash functions and their computations-open addressing-Linear probing- quadratic probing-double hashing algorithms and their implementations-Separate chaining-hashing efficiency.

Unit V

Implementation of Different types of Data Structures (Arrays, Linked Lists, Stack, Queue, trees, graphs, and hash tables, and algorithms including sorting, searching, and graph traversal, etc.) using C Programming.

References:

1. Balagurusamy, E. *Data Structures Using C*. Tata McGraw-Hill Education, 2014.
2. La Rocca, Marcello. *Advanced Algorithms and Data Structures*. Simon and Schuster, 2021.
3. Alfred V.Aho, John E.Hopcroft and Jeffrey D.Ullman, Data structures and Algorithms, Pearson Education Asia, 2002.
4. Horowitz E & Sahni S, Fundamentals of data structures, Universities press, 2018.
5. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clif Ford Stein, Introduction to Algorithms, Third Edition, PHI, 2010.
6. Seymour Lipschutz and GAV Pai, Data Structures, Indian Adapted Edition, Schaum's Outlines Series, TMH, 2006.
7. Tremblay, Jean-Paul, and Paul G. Sorenson. An introduction to data structures with applications. McGraw-Hill, 2nd Edition, 2017

CSC7C503: Python Programming

Contact Hours per Week: 3 Lecture +2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Illustrate the use of various Python programming constructs in solving problems.
CO2: Analyse the properties and operations associated with different datatypes to use in programming.
CO3: Differentiate and integrate various statements in python code to solve problems effectively.
CO4: Organize and apply efficient exception handling to develop robust Python programs.
CO5: Implement Python programs with effective data management through files and file operations.
CO6: Design, develop, implement, test, and document well-structured and reliable computer programs using the Python programming language.

	PSO1	PSO 2	PSO3	PSO 4	PSO 5	PSO 6	PSO7	PSO8
CO1	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓		✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓		✓			✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓
CO6	✓	✓		✓	✓	✓	✓	✓

Unit I

Python Language Basics: Overview of Python syntax and semantics. Python code structure- indentation, comments. Identifiers - Naming conventions and rules. Keywords in Python. Input-Output operations. Basic data types- int, float, bool, str. String operators and operations. Type conversions and casting. Basic operators: Arithmetic operators, Assignment operators, Comparison operators, Logical operators, Identity operators, Membership operators, Bitwise operators. Statements and Expressions.

Unit II

Control Structures: Conditional statements - if, else, elif. Looping constructs - while, for. Nested loops. Loop control- break, continue, pass. Built-in Data Structures: Lists - Creating, Accessing, and Modifying Lists. List operations: Slicing, Appending, Removing. Tuples-Creating and accessing tuples, Tuple operations and Immutability. Dictionaries - Creating, accessing, and modifying dictionaries. Dictionary operations: Keys, Values, Items. Sets -Creating and using sets, Set operations: Union, Intersection, Difference. FrozenSets - Immutability, Creating and using FrozenSets, Operations on FrozenSets - Union, Intersection, Difference.

Unit III

Built-in functions. User defined Functions: Defining and calling functions, Function arguments: positional, keyword, default, variable-length. Return values and scope: Local and Global variables.

Lambda Functions- Creating and using Lambda functions. Higher-Order Functions – Using functions as arguments and returning functions. Introduction to Modules: Importing, creating and using them.

Unit IV

File Handling: Reading from and writing to files - Opening files: open(), Reading files: read(), readline(), readlines(),Writing files: write(), writelines(), Closing files: close(). seek() for navigation in files. File object method tell(). Exception Handling - Handling errors: try, except, Finalizing code execution: finally, Raising exceptions: raise. Use of a context manager with the *with* statement for file handling.

Unit V

Implementation of Python programs

References

1. M. C. Brown, The Complete Reference, McGraw-Hill Education, 2018.

2. A. B. Downey, Think Python: How to Think Like a Computer Scientist, O'Reilly, 2021.

3. R. Thareja, Python Programming Using Problems Solving Approach, Oxford University Press, 2017.

4. M. Lutz, Learning Python: Powerful Object-Oriented Programming, O'Reilly, 2017.

5. L. Ramalho, Fluent Python: Clear, Concise, and Effective Programming, O'Reilly, 2022.

6. A. Kanetkar and Y. Kanetkar, Let Us Python, BPB Publications, 2023.

Elective - 1

CSC7E501: Theory of Computation

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand basic concepts in the theoretical foundations of Computer Science.
CO2: Interpret types of formal languages and its machine equivalence
CO3: Construct automation and grammar for all formal languages
CO4: Model the concept of Turing Machines and Develop mathematical views towards general computation.
CO5: Understand machines hierarchy with respect to the capabilities using the Chomsky hierarchy.
CO6: Show a competent understanding of complexity theory

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1				✓		✓		
CO2			✓			✓	✓	✓
CO3		✓			✓	✓		
CO4	✓	✓		✓			✓	
CO5			✓			✓		
CO6	✓			✓	✓	✓	✓	✓

Unit I

The central concepts of Automata Theory - Alphabets, Strings, Languages, Grammars, Productions and Derivation - Introduction to automata-Regular languages, Regular expressions, Chomsky Hierarchy, Deterministic Finite Automata, Non-deterministic Finite Automata - Equivalence of Deterministic and Nondeterministic Finite Automata-Closure properties regular languages-DFA state minimization-Pumping lemma and proof for existence of non-regular languages.

Unit II

Context-Free Grammars (CFG)- Derivations- sentential forms- Parse tree- Ambiguity in grammars and Languages- Applications of CFG- Simplification of Context free Grammars- Normal forms: Chomsky Normal form (CNF) and Greibach Normal form (GNF).

Unit III

Pushdown Automata (PDA)- Formal Definition-Graphical notations - Language accepted by PDA- Deterministic and Non-Deterministic PDA - Equivalence of PDAs and CFGs-Pumping lemma for CFLs, Closure properties of CFLs.

Unit IV

Turing Machines - Notation- Instantaneous Description- Transition Diagram The language of a Turing Machine- Variants of TMs-Multitape TMs, Nondeterministic TMs, multitask machines - Universal Turing Machines- Equivalence of the various variants with the basic model - Church-Turing Thesis.

Unit V

Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG, Closure properties of recursive and recursively enumerable language, Un-decidability - Halting problem reductions- Complexity: Complexity Classes - Class P - Class NP- NP-complete and NP-Hard problems.

References:

1. Peter Linz.An Introduction to Formal Languages and Automata, Jones and Bartlett,6th Ed., 2016
2. John E.Hopcroft,Rajeev Motwani and Jeffrey D.Ullman, Introduction to Automata Theory,Languages and Computation,Pearson Education,3rd Ed., 2008
3. H.R.Lewis and C.H.Papadimitriou, Elements of the Theory of Computation, Prentice Hall of India,2nd Ed., 1997
4. Martin J.C., Introduction to Languages and the Theory of Computation, Tata McGraw Hill, 3rd Ed.,2002
5. J.E.Sagage, Models of Computation, exploring the power of Computing, Addison Wesley, 1998.
6. Michael Sipser: Introduction to Theory of Computation, Cengage Learning, Indian Edition, 2012
7. D. S. Garey and G. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, New York, 1979.

CSC7E502: Operating System Concepts

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the basic concepts underlying operating systems and how a typical operating system works
CO2: Understand the Process, CPU Scheduling algorithms, and the concept of Concurrency control.
CO3: Analyze the performance of memory allocation and replacement techniques.
CO4: Understand the concepts of protection and security in an OS
CO5: Understand Sufficient knowledge about file access and the basics of Virtualization.
CO6: Understanding lowest-level Operating system code and its interactions with hardware.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1			✓	✓		✓		✓
CO2	✓	✓				✓		
CO3	✓			✓				
CO4					✓	✓	✓	
CO5				✓		✓	✓	
CO6	✓		✓	✓		✓	✓	✓

Unit I

System software Overview: Operating system, Assembler, Macro Processor, Compiler and Interpreters, Linker, Loader. Fundamentals of OS: OS services and components, Different types of operating systems, multitasking, multiprogramming, time-sharing, buffering, and spooling.

Unit II

Process & thread management: Concept of process and threads, process states, process management, context switching, interaction between processes and OS, multithreading. CPU Scheduling algorithms, Concurrency control: Concurrency and race conditions, mutual exclusion, semaphores, classical IPC problem and solutions, Dead locks - characterization, detection, recovery, avoidance, and prevention.

Unit III

Memory management: Issues-Memory Allocation, Dynamic Relocation, various management strategies. Virtual memory, Paging, Segmentation: Typical implementations of paging and segmentation systems, Disk Scheduling. File Systems: File concept, File support, Access methods, Allocation methods.

Unit IV

Protection & security-Protection: Goals of protection, Domain of protection, Access matrix. Security: the security problem, authentication, one-time passwords, program threats, System threats, Threat monitoring, Encryption. Virtualization Concepts: Virtual machines; support multiple operating systems simultaneously on a single hardware platform.

Unit V

Implementation -Commands and Shell programs, Operating System Concepts.

References:

1. D. M. Dhamdhere, Operating Systems, Tata Mc Graw Hill, 2nd Ed., 2008
2. Abraham Silberschatz,Peter B. Galvin & Greg Gagne, Operating System Concepts, Wiley, 10th Ed., 2021
3. Gary J Nutt, Operating systems-A Modern Perspective, Addison Wesley,2000.
4. Flynn & Meteos, Understanding Operating System, Thomsan, 4th Ed., 2005
5. Andrew Tanenbam, Albert S. Woodhull, Operating Systems Design & Implementation, Pearson,3rd Ed., 2006
6. William Stallings,Operating Systems: Internals Design Principles, 9 th Edition, Pearson Education India., 2018
7. Andrew S. Tanenbaum & Herbert Bos,Modern Operating Systems, Global Edition 5th Edition, Kindle Edition, 2022

CSC7E503: Computer Organization and Architecture

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Model number system concepts.
CO2: Design sequential circuit and combinational circuit.
CO3: Demonstrate the functional architecture of a computer system.
CO4: Illustrate principles of the memory system in detail.
CO5: Understand basic Input / Output Organization, interrupt processing and I/O interfaces.
CO6: Understand 8085 and 8086 microprocessor architecture.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓					✓		✓
CO2		✓			✓	✓		
CO3	✓	✓		✓		✓		✓
CO4		✓				✓		
CO5	✓	✓	✓	✓		✓	✓	
CO6		✓				✓		

Unit I

Digital Computers and Digital Systems, Number systems and Conversions, Digital Logic Circuits- Boolean Algebra & Map simplification, combinational circuits, flip flops, design of sequential circuits, Digital Components-Integrated Circuits, Decoders, Multiplexers, Registers, Shift Registers, Binary Counters, data representation - data types, complements, fixed-point representation, floating-point representation, other binary codes, error detection codes.

Unit II

Computer Arithmetic: Design of adders, signed addition and subtraction, Arithmetic and Branching Conditions, Multiplication of positive numbers, signed number multiplication- Booth Algorithm, fast multiplication, division- restoring and non-restoring algorithm, floating point numbers and operations- single & double precision.

Unit III

Basic computer organization-machine instructions- classification, function, addresses, size, addressing modes- instruction cycle - instruction sequencing. fundamental concepts- registers, register transfers, performing arithmetic or logic operations, memory read and write, execution of a complete instruction, branch instruction, Single bus, two bus, three bus organization, a complete processor- Control unit: - hardwired control, microprogrammed control, micro instructions-types.

Unit IV

The Memory System: Some Basic Concepts, Semiconductor RAM Memories, Read-Only Memories, Speed, Size and Cost, Cache Memories, Virtual Memories, Memory Management Requirements, Secondary Storage, memory interleaving. Input / Output Organization -Accessing I/O devices- programmed I/O, interrupt I/O - interrupts - interrupt processing- hardware interrupts-programmable interrupt controller-vectored interrupts - interrupt nesting - daisy chaining- direct memory access (DMA)- DMA operations & DMA Controller, Introduction to I/O interfaces, I/O channels, IO Processors.

Unit V

8085 microprocessor - Architecture: Block diagram-addressing modes instruction set, Instruction cycle-timing diagrams - different machine cycles - fetch and execute operation. 8086 microprocessor - Architecture: Block diagram-Intel 8051 Microcontroller-Architecture - basic instructions-basic assembly language programs peripherals: interrupts, timers, parallel port, serial port.

References:

1. V C Hamacher, Computer Organization, Mc-Graw Hill International Edition, Fifth Edition, 2002
2. Morris Mano, Digital logic and Computer design, Prentice Hall of India, 2004.
3. M Morris Mano, Computer System Architecture, Prentice Hall, Third Edition., 2017
4. William Stallings, Computer Organization and Architecture, Fifth Edition., 2015
5. Andrew S Tanenbaum, Structured Computer Education, Prentice Hall, Fourth Edition, 1998
6. Floyd and Jain, Digital Fundamentals, Pearson Education, Eighth Edition, 2006
7. Ramesh. S. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Wiley Eastern Ltd, New Delhi, 6th Edition, 2013

CSC7E504: Computer Graphics

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Explain the organization of an interactive computer graphics system.
CO2: Understand the important transformations on graphical objects.
CO3: Learn different clipping algorithms on an image
CO4: Describe the different types of curves and generate curves.
CO5: Design graphical objects, interactive graphics systems and animation systems.
CO6: Apply the operations like projections and rendering for 3D picture generation.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓		✓		✓		✓
CO2	✓		✓	✓	✓		✓	✓
CO3	✓	✓	✓			✓		✓
CO4	✓	✓	✓	✓			✓	
CO5	✓		✓		✓	✓		
CO6				✓		✓		✓

Module I

Graphics hardware: Raster scan and random scan displays, color CRTs, Hard copy output devices, interactive input devices, Output primitives –points and lines. Line drawing algorithms – DDA, Bresenham, parametric and nonparametric forms of circle and ellipse, midpoint algorithms for circle and ellipse, polygon filling algorithms – boundary fill, flood fill and scan line fill, Filling arcs – pattern filling. Attributes of output primitives - Antialiasing. Graphical user interface - Logical classification of input devices.

Module II

Two-dimensional transformations: Representation of points -Transformations and matrices -transformation of points- Transformations of lines – Rotation - Reflection- Scaling - Combined transformations - Homogeneous coordinates. Viewing transformations: Viewing pipeline, window to viewport transformation. Clipping: Interior and exterior clipping-Point clipping- Line clipping – Cohen Sutherland - Liang Barsky- Sutherland Hodgeman Polygon clipping- Curve clipping - Text clipping.

Module III

Polygon meshes, Quadric surfaces, sweep representations, Bezier surfaces, B-spline surfaces. Three Dimensional Transformations: Three-dimensional scaling, shearing, rotation, reflection, translations - Rotation about arbitrary axis Parallel to coordinate axis- Rotation about arbitrary axis in space. Projections: Orthographic projections – Oblique projections-perspective projections and Vanishing points.

Module IV

Color models: Color- Chromaticity - Tristimulus theory of color – RGB color system - CMY color system -HSV color system. Modeling techniques and fractals: Surfaces and hierarchical modeling- Hierarchical modeling with structures – Fractals. Animation: Computer assisted animation – Real-Time animation techniques.

Module V

Implementation of Graphics techniques.

References:

1. Donald Hearn, Pauline Baker, M., Computer Graphics with OpenGL, 3 rd Edition, Pearson Education,2004, ISBN:978-0-13-015390-6.
2. David F. Rogers, Procedural Elements for Computer Graphics, 2nd Edition, Tata McGraw Hill, 2001, ISBN-13:978-0-07-047371-3, ISBN-10:0-07-047371-4.
3. James D. Foley et.al., Introduction to Computer Graphics, Addison Wesley Publishing Company, 1994, ISBN: 0-201-60921-5.
4. David F. Rogers, Mathematical Elements for Computer Graphics, 2nd Edition, Tata McGraw Hill, 2001, ISBN- 13:978-0-07-048677-5, ISBN-10:0-07-048677-8.
5. James D. Foley, Andries Van Dam, Steven K. Feiner, John F. Hughes, Computer Graphics Principles and Practice (3rd Edition), Addison–Wesley, 2013
6. Amarendra N Sinha and Arun D Udai, Computer Graphics, McGraw Hill, 2008 Publications, 2007.

CSC7E505: Bioinformatics

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4
Course Outcomes:

CO1: Understand the basic concepts of Bioinformatics and its significance in biological data analysis.
CO2: Understand the popular genomic and proteomic databases and to impart knowledge in processing and analyzing genomic data.
CO3: Identify steps in sequence alignment.
CO4: Conceptualize the advanced topics in Bioinformatics.
CO5: Understand Basic concepts of phylogeny.
CO6: Develop Visualization of protein structures using Rasmol or Rastop.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓			✓		✓		✓
CO2	✓		✓	✓		✓		
CO3	✓	✓			✓	✓		
CO4	✓			✓		✓	✓	✓
CO5				✓		✓		
CO6	✓	✓	✓		✓	✓		✓

Unit I

Cells-Prokaryotes and Eukaryotes-DNA double helix- central dogma - RNA, Amino acids, Proteins -string representations- different levels of protein structures-DNA cloning- A brief introduction to different map pings techniques of genomes- genome sequencing methods-DNA microarrays - Human Genome Project-A glossary of biological terms.

Unit II

Scope of bioinformatics-Genomics and Proteomics- Problems in bioinformatics - sequence alignment, phylogeny, gene finding, microarray analysis, Homology and evolutionary relationships; Homology analysis and function of an entire gene or of segments within it, secondary structure prediction, protein structure prediction, comparative genomics and drug design.

Unit III

Data management, Data life cycle, An introduction to the major resources at NCBI, EBI and ExPASy - Nucleic acid sequence databases: GenBank, EMBL, DDBJ - Protein sequence databases: SWISS-PROT, TrEMBL, PIR-PSD - Genome Databases at NCBI, EBI, TIGR, SANGER - How to access these databases and to make use of the tools available. Various file formats for bio-molecular sequences like genbank and fasta, the concept of profiles- The derived databases- Prosite, Pfam, PRINTS, CATH, SCOP.

Unit IV

Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, and paralogues. Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM matrices, differences between distance and similarity matrix, pairwise sequence alignments: basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, BLAST and FASTA and their versions, Multiple sequence alignments (MSA): the need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.), Algorithm of CLUSTALW.

Unit V

Phylogeny: Basic concepts of phylogeny; molecular evolution; Definition and description of phylogenetic trees, Phylogenetic analysis algorithms - Maximum Parsimony, UPGMA and Neighbour-Joining, Gene Finding: The six reading frames- Computational gene finding in prokaryotes and eukaryotes Basic signals - start and stop codons, promoters etc.- important coding measures- Introduction to genomic signal processing Molecular visualization: Visualization of protein structures using Rasmol or Rastop.

References:

1. Hooman H. Rashidi and Lukas K.Buehler, Bioinformatics Basics: Applications in Biological Science and Medicine, CAC Press 2000.
2. Dan Gusfiled, Algorithms on Strings Trees and Sequences, Cambridge University Press 1997.
3. P. Baldi. S. Brunak, Bioinformatics: A Machine Learning Approach, MIT Press, 1988.
4. Harshawardhan P.Bal, Bioinformatics - Principles and Applications - Tata McGraw Hill, 2008
5. Mount D, Bioinformatics; Sequence & Genome Analysis, Cold spring,Harbor Press, 2nd Edition, 2004
6. Andrzej K. Konopka and M. James C. Crabbe, Compact Handbook of Computational Biology, CRC Press, 1st Edition, 2004

Elective 2 (Open Elective)
CSC7E506: Introduction to Data Science

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial

Number of Credits: 4

Course Outcomes:

CO1: To establish a robust foundation in data science and its application areas.
CO2: Understand the overview of data analytics in the context of machine learning and artificial intelligence
CO3: Apply data preparations and analysis to solve real word problems
CO4: Demonstrate an understanding of statistics and machine learning concepts
CO5: Explore the importance of data visualization.
CO6: Familiarize Python Packages for Basic Data Analytics- numpy, pandas, matplotlib.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓		✓		✓	
CO2		✓		✓		✓		✓
CO3	✓		✓		✓	✓		
CO4	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓
CO6		✓		✓		✓		✓

Module I

Introduction to Data Science: Definition - Evolution of Data Science - Data Science Process - Data Collection Strategies – Exploring Your Data -Types of Data -Getting Data-Data Preprocessing – Data Cleaning – Data Integration and Transformation – Dimensionality Reduction – Data Ethics-Applications of Data Science in various fields.

Module II

Statistics and Probability for Data Science: Linear Algebra: Vector-Matrices, Statistics: Central Tendencies-Correlation, Statistical Inference: Populations and samples - Statistical modeling - Probability: Conditional probability-Bayes's Theorem-Continuous Distribution -Normal Distribution, Hypothesis and Inferences: - fitting a model - Hypothesis Testing: p-Value-p-Hacking-Bayesian Inference.

Module III

Machine Learning: Introduction - Supervised Learning - Unsupervised Learning, Reinforcement Learning Basic Machine Learning Algorithms: Linear Regression-Logistic Regression-Naive Bayes--Decision Tree-K-Nearest Neighbours-Clustering-Neural Networks-Deep Learning. Confusion matrix - Evaluation Metrics - Overfitting - Underfitting.

Module IV

Python - Basic syntax and data types - operators - String - Data Structures in Python - List - Tuple - Set - Dictionary - Conditional Statements - Python Loops - Functions - Modules - Packages - Numpy - Pandas - Matplotlib.

Module V

Demonstration of Data Analytics implementations using matplotlib-BarChart-LineChart-ScatterPlot.

References

1. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from The Frontline", O'Reilly, 2014.
2. G James, D Witten, T Hastie and R Tibshirani," An Introduction to Statistical Learning with Applications in R", Springer Texts in Statistics, Springer, 2013.
3. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.
4. Robert J Woz, Data Analytics for Beginners, 2017.
5. Mohammed J. Zaki and Wagner Miera Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.
6. Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, O'Reilly, 2016.
7. V.K. Jain, Data Science and Analytics, Khanna Publishing, 2019.
8. Anil Maheshwari, Data Analytics, McGraw Hill Education, 2018

CSC7E507: Introduction to Web Technology

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Practice the various HTML tags and use them to develop the user-friendly web pages.
CO2: Understand the difference between the HTML, PHP and XML documents
CO3: Develop the modern web pages using the HTML and CSS features with different layouts as per need of applications.
CO4: Develop applications with advanced features of PHP by establishing connection with MySQL databases.
CO5: Use server-side scripting with PHP to generate the web pages dynamically using the database connectivity.
CO6: Develop the modern Web applications using the client and server-side technologies and the web design fundamentals.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓		✓	✓	✓	
CO2	✓			✓	✓	✓	✓	✓
CO3		✓	✓	✓		✓		
CO4		✓		✓		✓		✓
CO5	✓		✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓			✓	✓	

Module I

Introduction to Web programming - Introduction to SGML features - HTML, XHTML, DHTML, XML - HTML Vs XML - Overview of HTML- basic formatting tags - Attributes - Navigation links using anchor tag - Lists - table tag, HTML form controls - Creating XML documents - Parsing an XML document - Writing well-formed documents - Organizing elements with namespaces - Defining elements in a DTD - Declaring elements and attributes in a DTD.

Module II

CSS-Need for CSS-Introduction to CSS - basic syntax and structure - using CSS - background images - colors and properties - manipulating texts - using fonts. Client side scripting - What is Javascript - How to develop Javascript - simple Javascript - variables functions - conditions - loops and repetition.Javascript and objects - Javascript own objects - the DOM and web browser environments - forms and validations.

Module III

Server-side programming – server-side scripts – PHP – designing dynamic web pages using PHP - defining PHP variables – variable types – operators – control flow constructs in PHP – passing form data between pages - establishing connection with MySQL database – managing database.

Module IV

Overview of content management system - coding for reusability– user management - article publishing - additional CMS features – Web site development using Joomla.

Module V

Implementing web applications using various tools and techniques.

References

1. Thomas A. Powell, The Complete Reference HTML, 3rd Edition, McGraw-Hill/Osborne Media, ISBN: 0072129514, 2001
2. Robert W. Sebesta, Programming with World Wide Web, 7th Edition, Addison-Wesley, ISBN: 9780132665810, 2012
3. XueBal et. al, The Web Warrior Guide to Web programming, Thomson Learning,
4. H.M. Deitel, P.J. Deitel and A.B. Goldberg, Internet and World Wide Web: How to Program, 5th edition, Pearson Education, 2013
5. Steven Holzner, PHP The complete Reference,1st Edition, McGraw Hill, 2007.
6. Web Technologies, Black Book, Dreamtech Press.
7. Internet and World Wide Web How to program, P.J. Deitel & H.M. Deitel Pearson 5th edition, Pearson Education, 2018
8. V.K. Jain, Advanced Programming in Web Design, Cyber Tech Publications,2018
9. Julie C.Meloni, PHP, MySQL and Apache, Pearson Education,2012

Semester - 2

CSC8C504: Design and Analysis of Algorithms

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Become familiar with diverse algorithmic techniques and their practical applications.
CO2: To introduce basic principles that drive various algorithm analysis and design strategies.
CO3: Discuss the complexity analysis techniques and overview of P, NP problems
CO4: Discuss about the concept of design and analysis of parallel algorithms.
CO5: Develop critical thinking skills to evaluate algorithmic solutions based on problem constraints and performance requirements.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓		✓	✓	✓		
CO4	✓	✓				✓	✓	✓
CO5		✓	✓	✓	✓	✓	✓	✓

Unit I

Algorithm Analysis: Steps in developing algorithms, Methods of specifying an algorithm. Important Problem Types. Importance of algorithm analysis, Time and Space Complexity. Growth of Functions: Asymptotic notations. Solving recurrences: Substitution method, Recursion Tree method, Master's Theorem, problem solving using Master's theorem.

Unit II

Basic Designing Techniques: Brute Force Approaches: Brute Force String Matching. Divide-and-Conquer: Merge sort, Quick sort, Binary Search, Stressen's Matrix Multiplication. Greedy Method: The General Method, Huffman coding, Knapsack Problem, Job Sequencing with Deadlines, Minimum-Cost Spanning Trees: Prim's Algorithm, Kruskal's Algorithm; Single Source Shortest Path algorithm.

Unit III

Dynamic Programming: The General Method, Warshall's Algorithm, Floyd's Algorithm for the All-Pairs Shortest Paths Problem, 0/1 Knapsack, The Traveling Salesperson problem. Backtracking: n-Queens problem, Hamiltonian Circuit Problem, Sum of subset Problem. Branch and Bound: Assignment Problem, Knapsack Problem, Traveling Salesperson Problem.

Unit IV

Complexity: Complexity classes – P, NP, NP-Hard and NP-complete Problems, NP-completeness reductions for Hamiltonian cycle and Traveling Salesman Problem. P versus NP problem.

Unit V

Design and Analysis of Parallel Algorithms: PRAM models – EREW, ERCW, CREW and CRCW, Relation between various models, Analyzing Parallel Algorithms-Amdahl's Law. Parallel merging and sorting.

References:

1. Anany Levitin: Introduction to the Design & Analysis of Algorithms, 2nd Edition, Pearson Education, 2007.
2. Thomas H Cormen, Charles E Leiserson, & Ronald L Rivest, Introduction to Algorithms, 2nd Ed. Prentice Hall of India Private Limited, New Delhi, 2001.
3. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran: Fundamentals of Computer Algorithms, 2nd Edition, Universities Press, 2007.
4. S. Basse, Computer Algorithms: Introduction to Design and Anal ysis, Addison Wesley, 1998.
5. U.Manber, Introduction to Algorithms: A creative approach, Ad dison Wesley, 1989
6. V.Aho, J.E. Hoperaft, J.D.Ullman, The design and Analysis or Computer Algorithms, Addison Wesley, 1974
7. Gilles Brassard & Paul Bratley, Fundamentals of Algorithmics, Prentice Hall of India, 2007.
8. Goodman S E & Hedetniemi, Introduction to the Design & Analysis of Algorithms, Mc- Graw Hill, 2002.

CSC8C505: Data Communication and Networking

Contact Hours per Week: 3 Lecture + 2 Lab +1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Illustrate the basics of data and signal.
CO2: Understanding Network Models and Architectures.
CO3: Detailed knowledge of networking protocols.
CO4: Develop skills in configuring and managing network devices.
CO5: Explore and implement network security principles and practices.
CO6: Hands-on experience in configuring and managing these devices to ensure efficient network operations.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1			✓	✓	✓		✓	
CO2	✓	✓				✓		✓
CO3	✓	✓		✓	✓		✓	
CO4			✓			✓		✓
CO5	✓	✓	✓		✓			
CO6	✓	✓	✓	✓	✓			

Unit I

Data and signals -Analog and Digital signals, Line configuration, Topology, Transmission mode, Guided and Unguided media, Parallel and Serial data transmission, Layered approaches-OSI and TCP/IP. Multiplexing. Transmission impairments- Distortion, Attenuation, Noise. Analog modulation- AM, PM, FM. Sampling theorem, Analog pulse modulation, Digital pulse modulation. ASK, FSK, PSK and PSK. Digital data transmission and Interface standards. DTE and DCE. Modems.

Unit II

Data Link Layers – Error Detection and Correction. Data Link Control – line Discipline, flow control, error control. Data link Protocol synchronous and asynchronous protocol, character-oriented and Bit-Oriented protocol. Multi Access Protocols- ALOHA and CSMA. Switching. Networking and Internetworking devices- Repeaters, Bridges, Routers and Gateways. LANs: Ethernet, token bus, token ring. Bluetooth architecture.

Unit III

Network Layer: address and protocol- ARP, IP, ICMP, IGMP.IPv4 and IPv6.Subnetting, Routing Algorithms – Shortest path, Flooding, Distance Vector Routing, Link state Routing, Congestion Control Algorithms. Internetworking: Tunneling, Internetwork Routing, Fragmentation, IPv4 Vs IPv6Protocol, IP Addresses, Internet Control Protocols–ICMP, ARP, RARP, DHCP.

Unit IV

Transport Layer- Design Issues, Connection Management, Transmission Control Protocol (TCP), User Datagram Protocol (UDP). Application layer: Protocols, DNS, Telnet, www and HTTP. Computer Network Security- Introduction, Need for security, Principles of Security, Types of Attacks. Symmetric and Public key algorithms. Authentication. Integrity,Key Distribution, and Certification.

Unit V

Implementation of Networking Concepts and Techniques.

References:

1. Behrouz A.Forouzan,Data Communications And Networking, Fourth Edition, McGrawHill, 2001
2. AS Tanenbaum, DJ Wetherall, Computer Networks, 5th Ed., Prentice-Hall, 2010.
3. WilliamStallings,DataandComputer Communication, Eighth Edition, Prentice Hall,2007
4. J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring Internet, Pearson Education, 8th Edition, 2020.
5. Kurose and Ross, Computer Networks A systems approach, Pearson Education, 8th Edition, 2022.
6. G. R. Wright.TCP/IP Illustrated, Volume 2: The Implementation, Addison Wesley, 1995.
7. Tomsho, Greg. *Guide to networking essentials*. Course Technology Press, 2011.

CSC8C506: Advanced Database Management System

Contact Hours per Week: 3 Lecture + 2 Lab +1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Illustrate the basics of database system concepts, concepts of relational data model, entity-relationship model.
CO2: Understand the concepts of relational database design, relational algebra and calculus.
CO3: Apply the normalization techniques to improve the database design.
CO4: Describe various database manipulation commands in SQL.
CO5: Understand Transaction Processing Locking using the concept of Concurrency control.
CO6: Engaging in lab assignments that involve advanced database design, query optimization, and transaction management to apply theoretical knowledge practically.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓	
CO3	✓	✓	✓			✓	✓	
CO4	✓		✓	✓	✓		✓	✓
CO5	✓		✓		✓	✓	✓	
CO6	✓	✓	✓	✓	✓	✓	✓	✓

Unit I

Database System Concepts, Purpose of Database Systems, Views of Data - Data Abstraction, Instances and Schemes, Data Independence, Data Models. Relational Data Model - Relational Model concepts, keys, Integrity constraints - Domain Constraints, Key Constraints, Entity Integrity Constraints, Referential Integrity Constraints. ER Data Model Design Issues, Entity Relationship Diagram, Weak Entity Sets, Extended ER Features, Design of an ER Database Schema, Reduction of an ER Schema to Tables. Relational Algebra-Selection and Projection, Set operations, Renaming, Joins, Division. Relational Calculus.

Unit II

Relational database design - Design Principles, Normalization, Normal Forms - 1NF, 2NF, 3NF, BCNF, 4NF & PJNF, Domain Key Normal Form. Transactions -concepts, states of Transactions, ACID properties. Schedules - serial schedules, concurrent schedules, Serializability, Concurrency control protocols - Two-phase locking, Deadlock, Granularity, Timestamp Ordering Protocol. Distributed Database Concepts.

Unit III

Relational Database Query Languages - Basics of QBE, SQL –Data Definition Language (DDL), Data Manipulation Language (DML), Data Control Language (DCL) Commands, Basics of Query Processing. Data Definition in SQL - Data types, Creation, Insertion, Viewing, Updation, Deletion of tables, Renaming, Dropping of tables. Data Constraints - I/O constraints, Primary key, foreign key, unique key constraints, Database Manipulation in SQL - Select command, Logical operators, Range searching, Pattern matching, grouping data from tables in SQL, GROUP BY, HAVING clauses, Joins. Views - Creation, Renaming the column of a view, DROP view.

Unit IV

MySQL Data types: Using set and select commands, Flow control constructs - if, if /else, while, goto. Global variables, Data types, Operators and Functions, Data Definition and Manipulation Statements, Code Blocks, Stored Procedures- create, alter, and drop, passing and returning data to stored procedures, using stored procedures within queries. Cursors - Working with cursors, Error Handling. User-defined functions, implementing triggers.

Unit V

Implementation of Database Programming using MySQL.

References:

1. Abraham Silbersehatz, Henry F. Korth and S.Sudarshan, Database system concepts, 6th Edition, Tata McGraw-Hill 2010, India, 2008.
2. Fundamentals of Database Systems, Ramez Elmasri, Shamkant B.Navathe, Pearson Education, (7th Edition), 2017.
3. CJ Date, Introduction to Database Systems, Addison Wesley.
4. Vikram Vaswani, MySQL The complete Reference,1st Edition, Tata McGraw-Hill, 2004.
5. Paul DuBois, MySQL Cookbook, 2nd Edition, O'Reilly Media, 2006.
6. Garcia-Molina, Hector. Database systems: the complete book. Pearson Education India, 2008.

Elective - 3

CSC8E508: Artificial Intelligence

Contact Hours per Week: 3 Lecture + 2 Lab +1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the concepts of Artificial Intelligence and its applications.
CO2: To introduce basic principles that drive complex real-world intelligence applications.
CO3: Understand basic issues of knowledge representation techniques.
CO4: Learn fundamental concepts and algorithms related to machine learning and deep learning.
CO5: Apply AI techniques to various domains.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓			✓	✓		✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓
CO3		✓	✓			✓	✓	✓
CO4	✓		✓	✓	✓		✓	
CO5	✓	✓	✓		✓	✓		✓
CO6	✓	✓	✓	✓	✓	✓	✓	

Unit I

Introduction: Artificial Intelligence- problems, scope and applications, Problem spaces and search- Production system- problem characteristics- Heuristics Search Techniques: Control and implementation of state space search, Generate and test, Hill climbing, Depth-first search, Breadth-first search, Best-first search – OR Graphs, A* Algorithm, Problem Reduction – AND-OR Graph, AO* Algorithm, Constraint Satisfaction, Means-ends analysis.

Unit II

Knowledge representation - representation and mappings, Approaches to knowledge representation, issues in knowledge representation, Using predicate logic- representing simple facts in logic, Representing instances and ISA relationships, Computable functions and Predicates, Resolution, conversion to clausal form, Unification algorithm, Natural deduction, Knowledge representation using rules, forward versus backward reasoning, Symbolic reasoning under uncertainty- Nonmonotonic reasoning, Slot and filler structures - Semantic nets, frames, conceptual dependency, scripts.

Unit III

Game Playing - Minimax search procedure, adding Alpha-beta cut-offs, Additional refinements, Iterative deepening, Planning system and its components, Understanding, Understanding as constraint satisfaction.

Unit IV

Learning - Forms of learning - Supervised learning, Learning Decision Trees, Theory of Learning, Linear Regression and Classification, Perceptron, Feed Forward Networks, Gradients and Learning, Back-Propagation, Unsupervised learning, Reinforcement learning, Deep learning - Computation graph for Deep Learning, basic concepts of Convolutional Networks, Recurrent Neural Networks and Transfer learning, Applications.

Unit V

Implementation of real-world problems using AI techniques and models specified in Unit IV.

References:

1. E. Rich, K. Knight and S.B.Nair, Artificial Intelligence, 3rd Edn. TMGH, New Delhi, 2009.
2. G.F. Luger and W.A Stubblefield, Artificial Intelligence - Structures and Strategies for complex problem solving, Addison-Wesley-1998.
3. P.H Winston - Artificial Intelligence, Addison-Wesley-1992.
4. Nils J.Nilsson, Artificial Intelligence, A New Synthesis, Morgan Kauf 2000.
5. W.F. Clocksin and C.S. Mellish, Springer Verlag, Programming in Prolog 2003
6. Dan W.Patterson , Introduction to Artificial Intelligence and Expert Systems, Prentice Hall, 1990
7. Jurafsky D., Martin J.H., Speech and natural language processing, Second Edition, Prentic Hall, 2008, ISBN 10: 0131873210.
8. Padhy, N.P., Artificial intelligence and Intelligent systems, Oxford University Press, 2005

CSC8E509: Big Data Technologies

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the fundamental concepts and architecture of big data technologies.
CO2: Learn about various NoSQL databases and their applications.
CO3: Develop skills in using big data frameworks and tools like Hadoop.
CO4: Understanding the concept of MapReduce.
CO5: Gain expertise in data streaming and real-time data processing.
CO6: Implement big data solutions to solve real-world problems.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓			✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	v	✓	✓	✓
CO4	✓	✓	✓		✓	✓		
CO5				✓		✓		✓
CO6	✓	✓	✓	✓		✓	✓	

Unit I

Introduction to Big Data - definition and importance of Big Data - four dimensions of Big Data - structured data, unstructured data - Integrating data types into a big data environment- Distributed computing and Big Data. Big Data stack - layer 0,1 and 2- Big Data management - Operational databases - Relational databases - Non relational databases - NoSQL - key-value pair databases - document databases - columnar databases - graph databases -spatial databases.

Unit II

Big Data analysis - basic analytics - operationalized analytics - modifying business intelligence products to handle Big Data - Big Data analytics examples - Analytics solutions - text analytics - exploring unstructured data - understanding text analytics - analysis and extraction techniques- the extracted information - text analytics tools forBig Data.

Unit III

NoSQL databases - types - Advantages over Relational Databases - Mon- goDB - introduction - MongoDB -the data model - designing the database - collections - documents - data types -id Field - indexes - viewing available databases and collections - opening a database- inserting data - querying for data - retrieving documents - aggregation commands - grouping results - conditional operators - specifying an array of matches - applying criteria for search - $slice - $size - $exists - $type- $elemMatch -$not (meta-operator) - update() - save() - $inc - $set- $unset - $push - $pushAll -$addToSet - removing elements from an array - atomic operations - modifying and returning a document atomically - renaming a collection - removing data - referencing a database - implementing index-related functions - min() and max().

Unit IV

Introduction to Hadoop Distributed File System, Hadoop ecosystem, MapReduce Implementation with Hadoop, Big Data Management Tools: PIG: Pig's Data Model, HIVE: Hive Architecture, HIVEQL, HBASE: MapReduce Integration, Zookeeper- Understanding MapReduce - key/value pairs - the Hadoop Java API for MapReduce - the Mapper class - the Reducer class - the Driver class.

Unit V

Implementation of Big Data Analysis techniques.

References:

1. Eelco Plugge, Peter Membrey and Tim Hawkins, The Definitive Guide to MongoDB: The NOSQL Database for Cloud and Desktop Computing, Apress Berkeley, CA, 2010
2. Chris Elaton, Dirk Deroos, Tom Deutsch, George Lapis and Pual Zikopoulos, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, 1st Edition, Tata McGraw Hill Education, 2012
3. Garry Turkington, Hadoop Beginner's Guide, Packt Publishing Ltd., 2013
4. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
5. Tom White, Hadoop: The Definitive Guide, 3rdEdn, O'reilly Media, 2012
6. Big Data Fundamentals: Erl/Khattak/Buhler, Pearson Education India, 2016
7. Pete Warden, "Big Data Glossary", O'Reily, 2011

CSC8E510: Principles of Compiler Design

Contact Hours per Week: 3 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Model the process of translating a high-level language to an executable code.
CO2: Describe how different phases of a compiler work.
CO3: Experiment top down and bottom-up parsing algorithms.
CO4: Apply flow graph for the intermediate codes.
CO5: Apply optimization techniques to have a better code for code generation.
CO6: Understand the basics of Storage organization and Storage allocation strategies.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1			✓	✓		✓	✓	
CO2		✓		✓		✓		✓
CO3	✓			✓	✓		✓	
CO4		✓	✓			✓		
CO5		✓		✓				✓
CO6	✓				✓	✓	✓	

Unit I

Introduction to compiling: Compilers - Analysis of the source program - Phases of a compiler - Cousins of the Compiler - Grouping of Phases - Compiler construction tools - Lexical Analysis - Role of Lexical Analyzer - Input Buffering - Specification of Tokens.

Unit II

Syntax analysis: Role of the parser - Writing Grammars - Context-Free Grammars - Top-Down parsing - Recursive Descent Parsing - Predictive Parsing - Bottom-up parsing - Shift Reduce Parsing - Operator Precedence Parsing - LR Parsers - SLR Parser - Canonical LR Parser - LALR Parser.

Unit III

Intermediate code generation: Intermediate languages - Declarations - Assignment Statements - Boolean Expressions - Case Statements - Back patching - Procedure calls.

Unit IV

Code generation: Issues in the design of code generator - The target machine - Runtime Storage management - Basic Blocks and Flow Graphs - Next-use Information - A simple Code generator - DAG representation of Basic Blocks - Peephole Optimization.

Unit V

Code optimization and run time environments: Introduction - Principal Sources of Optimization - Optimization of basic Blocks - Introduction to Global Data Flow Analysis - Runtime Environments - Source Language issues - Storage Organization - Storage Allocation strategies.

References:

1. V Aho A, Ravi Sethi, D Ullman J, Compilers Principles, Techniques and Tools, 3rd Edition, Pearson Education Singapore P Ltd., 2007
2. K. V. N. Sunitha, Compiler Construction, Pearson, 2013
3. W Appel and Andrew, Modern Compiler Implementation in C, 1st Edition, Cambridge University Press, 1997
4. Allen I Holub, Compiler Design in C, 1st Edition, PHI Learning Pvt Ltd., 2015
5. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, 1st Edition, BSP Books Pvt Ltd., 2005
6. Torben Egidius Mogensen, Basics of Compiler Design, Department of Computer Science, University of Copenhagen, 2010

CSC8E511: Quantum Computing

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Demonstrate proficiency with the mathematics behind quantum algorithms, such as unitary operators and quantum gates.
CO2: Understand the major quantum computing algorithms, such as Grover and Shor.
CO3: Understand Quantum computational complexity and error correction mechanisms.
CO4: Learn the framework of quantum computation, and how that may be useful for future quantum technologies.
CO5: Acquire knowledge of describing the evolution of quantum systems
CO6: Model basic Quantum Circuits.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓		✓				✓
CO2	✓	✓		✓		✓	✓	
CO3			✓	✓	✓			✓
CO4	✓	✓		✓		✓		✓
CO5			✓			✓		
CO6	✓			✓	✓		✓	✓

Unit I

Introduction: Overview of traditional computing – Church-Turing thesis – circuit model of computation– reversible computation – quantum physics– quantum physics and computation – Dirac notation and Hilbert Spaces– dual vectors operators – the spectral theorem –functions of operators– tensor products – Schmidt decomposition theorem.

Unit II

QUBITS and Quantum Model of Computation: State of a quantum system – time evolution of a closed system – composite systems –measurement – mixed states and general quantum operations – quantum circuit model –quantum gates – universal sets of quantum gates – unitary transformations – quantum circuits.

Unit III

Quantum Algorithms: Superdense coding – quantum teleportation – applications of teleportation – probabilistic versus quantum algorithms – phase kick-back – the Deutsch algorithm – the Deutsch-Jozsa algorithms– Simon's algorithm – Quantum phase estimation and quantum Fourier Transform – eigenvalue estimation.

Unit IV

Order-finding problem – eigenvalue estimation approach to order finding – Shor's algorithm for order finding – finding discrete logarithms – hidden subgroups – Grover's quantum search algorithm – amplitude amplification – quantum amplitude estimation –quantum counting – searching without knowing the success probability.

Unit V

Quantum Computational Complexity and Err Correction: Computational complexity – black-box model – lower bounds for searching – general black-box lower bounds – polynomial method – block sensitivity – adversary methods –classical error correction – classical three-bit code – fault tolerance – quantum error correction – three- and nine-qubit quantum codes – fault-tolerant quantum computation.

References:

1. P. Kaye, R. Laflamme, and M. Mosca, "An introduction to Quantum Computing", Oxford University Press, 1999.
2. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing Company, 2007.
3. Michael A. Nielsen, Issac L. Chuang, "Quantum Computation and Quantum Information", Tenth Edition, Cambridge University Press, 2010.
4. Scott Aaronson, "Quantum Computing Since Democritus", Cam- bridge University Press, 2013.
5. N. David Mermin, "Quantum Computer Science: An Introduction", Cambridge University Press, 2007.

CSC8E512: Mobile Communication

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Understand the fundamental concepts of wireless and mobile networks.
CO2: Illustrate the wireless application protocols for mobile content development.
CO3: Understand TCP/IP extensions for wireless mobile networking.
CO4: Understand WAP Design and principles of operations.
CO5: Analyze various wireless mobile programming methodologies.
CO6: Understand the concept of GSM in real time applications.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓				✓		✓
CO2				✓			✓	
CO3	✓	✓	✓			✓		
CO4						✓		✓
CO5	✓		✓	✓			✓	
CO6		✓			✓	✓		

Unit I

Introduction, wireless transmission - frequencies for radio transmission- signal propagation - multiplexing - modulation - spread spectrum - cellular systems - medium access control - specialized MAC - SDMA - FDMA - TDMA - classical and slotted aloha - CSMA - collision avoid- ance - polling - CDMA - comparison of S/T/F/CDMA.

Unit II

Telecommunication systems - GSM-mobile services - system architecture-radio interface - protocols - localization and calling - handover - security-new data services - satellite systems- routing- localization - handover- broadcast systems - digital audio and video broadcasting.

Unit III

Wireless LAN-Infrared Vs radio transmission -infrastructure and adhoc networks-IEEE 802.11, hiperlan- Bluetooth -IEEE 802.15

Unit IV

Mobile network layer - mobile IP - IP packet delivery - registration - tunneling and encapsulation - optimizations - reverse tunneling - dynamic host configuration protocol-Mobile ad-hoc networks, Transport Layer-TCP-Indirect TCP-Snooping TCP-Mobile TCP- retransmission- recovery-transaction oriented TACP.

Unit V

WAP-Design and principles of operations, WAP architecture, Overview- WAP model, components-WAE, overview-WWW model-WAE model- WTA architecture, Wireless session protocol specifications-Wireless transaction protocol specification-security specification- Wireless datagram protocol-wireless control message protocol specification.

References:

1. Schiller J., Mobile Communications, Addison Wesley, 2/e, Pearson Education, 2009.
2. Gray.S.Rogers,John Edwards, An Introduction to Wireless Technology, Pearson Education, 2012
3. Singhal et.al S., The Wireless Application Protocol, Addison Wesley, 2001
4. C. Siva Ram Murthy, WDM Optical Networks: Concepts, Design, and Algorithms, Pearson Education, 2015
5. Yi-Bang Lin and Imrich Chlamtac, Wireless and Mobile Architectures, Wiley Student Edition, 2008.
6. William Stallings, Wireless Communications and Networks, Pren- tice Hall, 2004.
7. Vijay K.Garg, Wireless Communications and Networking, Morgan Kaufmann Publishers / Elsevier, 2009.

Semester – 3

CSC9C601: Data Analytics Using Python

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the overview of data analytics in the context of Machine Learning and Artificial Intelligence.
CO2: Experiments and explorations through Python by familiarizing packages necessary to perform various data analytics tasks.
CO3: Develop Python programs by applying various Machine Learning algorithms.
CO4: Perform data preparations and analytics to solve real-world problems and to gain insight.
CO5: Detailed study of Python Packages for Basic Data Analytics and advanced data analytics - numpy, pandas, matplotlib, seaborn, scikit-learn.
CO6: Design Exploratory and Explanatory Data Analysis using Python packages

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓		✓		✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓	
CO3		✓	✓		✓			✓
CO4	✓		✓		✓	✓		
CO5		✓		✓		✓		✓
CO6		✓		✓	✓		✓	

Unit I

Introduction to Data science, Nneed for data science, Role and skills required for a Data scientist. Introduction to Data Analysis, Understanding the nature of data. Relevance of Data Analysis process. Problem Definition, Data Collection, Data Extraction, Data Preparation, Data Exploration, Data Visualization, Predictive Modelling, Model Validation, Deployment and Communication stages in Data Analysis. Quantitative and Qualitative Data Analysis. Introduction to Data Analytics. Data Analytics for insight. Technologies and Tools, Scope, Trends and Range of Applications of Data Analytics. Data as foundation for Artificial Intelligence. AI enhancing Data Analytics. Machine learning as a subset of AI. Role of Machine learning in automating the Data Analytics process.

Unit II

Features of Python and its suitability in Data Analytics - Data Manipulation and Analysis, Statistical Analysis and Machine Learning, Data plotting and Visualization, Big Data Processing, Automation and Scripting. Reading.Python Libraries and their inter operability. Pandas for data storage and manipulation - Series, DataFrames, DataFrame operations, I/O, Data cleaning and Preprocessing, Data manipulations, Statistical and Mathematical operations, Plotting, Working with Date and Time. Numpy for Numerical computations- Arrays, Array operations, Array manipulations, Handling missing data, Matrix operations, File I/O and processing.

Unit III

Data visualisation using Matplotlib - Basic plotting, Titles and Labels, Legends and annotations, multiple plots, Types of plots, saving plots. Advanced Data Visualization using Seaborn - Basic and Customised Plotting, Built in Datasets, Types of Plots, Saving and Exporting plots.

Scikit-learn for machine learning –methods for Classification: Logistic Regression, Decision Trees, Random Forests, Support Vector Machines, K-Nearest Neighbours. Methods for Regression: Linear Regression, Ridge and Lasso Regression, Decision Trees, Random Forests, Support Vector Regression.

Unit IV

Scikit-learn Methods for Model Evaluation: Performance metrics for Classification, Regression, Cross-validation . Methods for Feature Selection and Engineering, Methods for Clustering, Methods for Dimensionality Reduction, Methods for Model Validation. Introduction to functionalities of SciPy, Statsmodels, Keras, TensorFlow, PyTorch.

Unit V

Implementation of Data Analytics Operations in Python.

References:

1. F. Neili, Python Data Analytics with Pandas, Numpy, and Matplotlib. 2nd ed., Apress, 2018.
2. J. Rogel-Salazar, Data Science and Analytics with Python, 1st ed., CRC Press, 2017.
3. W. McKinney, Python for Data Analysis, 2nd ed., O'Reilly, 2017.
4. A.C. Müller and S. Guido, Introduction to Machine Learning with Python, 1st ed., O'Reilly, 2016.
5. J. VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, 1st ed., O'Reilly, 2016.
6. J. Grus, Data Science from Scratch: First Principles with Python, 1st ed., O'Reilly, 2015.

CSC9C602: Advanced Machine Learning

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand elementary mathematical concepts necessary for advanced machine learning algorithms.
CO2: Develop and model various supervised machine learning algorithms.
CO3: Understand the architecture of the Convolutional Neural Networks.
CO4: Implement recent and popular unsupervised machine learning approaches.
CO5: Understand the setting up of machine learning projects and overview of reinforcement learning strategies.
CO6: Design and implement artificial neural network and deep learning architectures.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓		✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓		✓	✓	✓	
CO5	✓	✓	✓	✓	✓		✓	✓
CO6	✓	✓		✓	✓	✓	✓	✓

Unit I

Introduction to Linear Algebra: Matrices, Vector spaces, Orthogonality, Determinants, Overview of Eigenvalues and Eigenvectors. Fundamentals of Probability: - Axioms of probability, Conditional probability, Random variables, Probability distributions and Density functions. Expectation and Variance. Distributions: Bernoulli, Binomial, Multinomial, Uniform, Normal, Chi-Square, t and F.

Unit II

Introduction to Machine Learning: -Definition of learning systems, Goals and applications of machine learning, Types of learning, Components of a machine learning pipeline-supervised, unsupervised, and reinforcement, machine learning. Testing, Training and Validation, Errors and loss, Bias and Variance Trade off, Overfitting and

underfitting, Supervised Learning: Classification and Regression-Decision trees, Support Vector Machines, Naïve Bayes Classifiers, K Nearest Neighbors; Ensemble Learning: Bagging, boosting, stacking, Random Forest algorithm. Regression-Linear Regression, Logistic Regression.

Unit III

Unsupervised Learning - Data Clustering: Partitioning Methods, Hierarchical methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data - Constraint-Based Cluster Analysis- expectation maximization algorithm, Dimensionality reduction; principal component allocation, linear discriminant analysis, Reinforcement Learning - Design and Analysis of ML Experiments, Elements of reinforcement learning, model-based learning, temporal difference learning, Cross-validation and resampling methods, Performance Analysis and accuracy measures.

Unit IV

Introduction to Artificial Neural Networks and Deep Learning Concepts Neural networks, Perceptron, Multi-Layer Perceptron, Back propagation algorithm, Fundamentals of deep learning- Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Introduction to Convolutional Networks, Sequence Modeling using Recurrent Nets, overview of LSTM and GRU-Generative Networks: Auto encoders, Generative Models, GANs framework, GANs application.

Unit V

Implementation of Machine Learning and Deep Learning Algorithms.

References:

1. Ethem Alpaydin, Introduction to Machine Learning- 3rd Edition, PHI, 2014.
2. Tom M. Mitchell, Machine Learning, McGraw-Hill, 1st Ed., 2017
3. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning (Adaptive Computation and Machine Learning), MIT Press, 2016.
4. Kuntal Ganguly, Learning Generative Adversarial Networks, Packt Publishing, 2017
5. Gilbert Strang, Linear algebra and its applications, Fourth Edition, Cengage Learning, 2006.
6. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition., John Wiley & Sons, 2014
7. P. Harrington, Machine learning in action, Manning Publications Co, 2012

CSC9C603: Digital Image Processing

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understanding of image histograms, image smoothing and sharpening techniques, and various filtering methods.
CO2: Develop the ability to critically analyze and evaluate different image processing methods and their effectiveness.
CO3: Foster creativity and innovation in developing new approaches and solutions in the field of image processing.
CO4: Learn to work effectively in teams to tackle complex image processing challenges.
CO5: Develop proficiency in using image processing tools and software.
CO6: Capability to complete a real-world image processing project, demonstrating the ability to solve practical problems in various scenarios.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓		✓	✓	
CO3	✓	✓		✓	✓	✓		✓
CO4	✓	✓	✓			✓	✓	
CO5	✓	✓		✓	✓	✓		
CO6		✓	✓		✓	✓	✓	✓

Unit I

Introduction - digital image representation - fundamental steps in image processing - elements of digital image processing systems - digital image fundamentals - elements of visual perception - a simple image model - sampling and quantization - basic relationship between pixels - image geometry.

Unit II

Image transforms - introduction to Fourier transform - discrete Fourier transform (DFT) - properties DFT- other separable image transforms - Walsh, Hadamard and Discrete Cosine transform. Hotelling transform.

Unit III

Image enhancement - basic grey level transformation - histogram equalization - image subtraction - Image averaging - spatial filtering - smoothing, sharpening filters - Laplacian filters. Enhancement in the frequency domain - frequency domain filters - smoothing, sharpening filters - homomorphic filtering.

Unit IV

Image restoration - model of Image degradation/restoration process - noise models - inverse filtering - least mean square filtering - constrained least mean square filtering. Edge detection - thresholding - region-based segmentation - Boundary representation Image compression -Types and techniques.

Unit V

Implementations of Image Processing Techniques.

References:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing - 3rd ed., Prentice Hall of India, New Delhi, 2008
2. B. Chanda and D.D. Majumder, Digital Image Processing and Analysis, PHI,2nd Edition., 2011
3. A.K. Jain, Fundamentals of Digital Image Processing, PHI 4. W.K. Pratt, Digital Image Processing, John Wiley, 2006
4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing Analysis and Machine Vision, Cengage Learning India Pvt Ltd, 4th Edition, 2017
5. W.K. Pratt, Digital Image Processing: PIKS Scientific Inside,John Wiley,4th Edition,ISBN: 0471767778., 2007
6. A. Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
7. S Jayaraman, S Esakkirajan, T Veerakumar,"Digital Image Processing" Tata McGraw Hill Education, 2020

Elective 4

CSC9E601: Stream Processing

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Understand the applicability and utility of different streaming algorithms.
CO2: Describe and apply current research trends in data-stream processing
CO3: Analyze the suitability of stream mining algorithms for data stream systems
CO4: Program and build basic stream processing systems, services and applications.
CO5: Solve problems in real-world applications that process data streams.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓		✓		✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓
CO3				✓		✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓
CO5		✓	✓			✓		✓

Unit I

Foundations of Data Systems: Introduction to Data Processing, Stages of Data processing, Data Analytics, Batch Processing, Stream processing, Data Migration, Transactional Data processing, Data Mining, Data Management Strategy, Storage, Processing, Integration, Analytics, Benefits of Data as a Service, Challenges.

Unit II

Real-time data processing: Introduction to Big data, Big data infrastructure, Real-time Analytics, Near real-time solution, Lambda architecture, Kappa Architecture, Stream Processing, Understanding Data Streams, Message Broker, Stream Processor, Batch & Real-time ETL tools, Streaming Data Storage.

Unit III

Data models and query languages: Relational Model, Document Model, Key-Value Pairs, NoSQL, Object-Relational Mismatch, Many-to-One and Many-to-Many Relationships, Network data models, Schema Flexibility, Structured Query Language, Data Locality for Queries, Declarative Queries, Graph Data models, Cypher Query Language, Graph Queries in SQL, The Semantic Web, CODASYL, SPARQL.

Unit IV

Event processing with Apache Kafk: Kafka as Event Streaming platform, Events, Producers, Consumers, Topics, Partitions, Brokers, Kafka APIs, Admin API, Producer API, Consumer API, Kafka Streams API, Kafka Connect API.

Unit V

Real-time processing using Spark streaming: Structured Streaming, Basic Concepts, Handling Event-time and Late Data, Fault-tolerant Semantics, Exactly-once Semantics, Creating Streaming Datasets, Operations on Streaming Data, Selection.

Practical Exercises: Install MongoDB, Design and Implement Simple application using MongoDB, Query the designed system using MongoDB, Create an Event Stream with Apache Kafka, Create a Real-time Stream processing application using Spark Streaming

References:

1. Streaming Systems: The What, Where, When and How of Large-Scale Data Processing, Tyler Akidau, Slava Chemyak, Reuven Lax, O'Reilly, 2018
2. Designing Data-Intensive Applications, Martin Kleppmann, O'Reilly Media, 2017
3. Practical Real-time Data Processing and Analytics: Distributed Computing and Event Processing using Apache Spark, Flink, Storm and Kafka, Packt Publishing, 2017
4. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2014.
5. Kafka: The Definitive Guide - Real-Time Data and Stream Processing at Scale, Gwen Shapira, Todd Palino, Rajini Sivaram, O'Reilly publication, 2021

CSC9E602: Android Application Development

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1.Show the installation and configuration of Android application development tools.
CO2.Design good user interfaces for the mobile application.
CO3.Apply Java programming concepts to Android application development.
CO4.Discuss the different mobile data management in Android.
CO5.Evaluate the core building blocks of Android and android lifecycle architecture.
CO6.Design and create an Android project based on UI components.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1			✓			✓		
CO2			✓			✓		
CO3	✓		✓		✓			
CO4		✓	✓		✓			
CO5				✓	✓			
CO6	✓				✓		✓	

UNIT I:

Introduction to Android Architecture: Introduction, History, Features, Application Environment and Tools, Introduction to Software's and Tools: Android Studio. Introduction to Building Tools: Java, JDK, JRE, Android SDK, Android Developer Tools. Setting up Android Environment, Introduction to Android OS: Android Architecture.: Overview of the Stack, Linux Kernel, Native Libraries, Dalvik Virtual Machine, Android Virtual Machine (ADT). Application Components- Activity, Content providers, Broadcast receivers, Services. Intents- Explicit and Implicit Intents, Intent Filter, Manifest File. Debugging android application.

UNIT II

User Interface Design: Views &View Groups, Views: Button, Text Field, Radio Button, Toggle Button, Checkbox, Spinner, Image View, Image switcher, Event Handling, Listeners, Layouts: Linear, Relative, ListView, Grid View, Table View, Web View, Adapters. Creating the user interface programmatically, managing changes to screen orientation, displaying notifications- Setting up notifications, Notification manager

UNIT III:

Mobile Data Management Shared Preferences – Saving and Loading User Preferences, Persisting Data to Files, Creating and using Databases, SQLite Databases. Content Providers - Using a Content Provider, Built-in Content Provider - Browser, Call log, Contacts, Media Store and Settings.

UNIT IV:

Native Capabilities, Location-based services Camera, Audio, Sensors and Bluetooth, Maps & Location: Maps: Map-Based Activities, how to load maps, to finding map API key, GPS, Working with Location Manager, working with Google Maps extensions, Location Updates, location-based services (LBS), Location Providers, selecting a Location Provider, Finding Your Location

UNIT V:

Android Application development using Android studio.

References:

1. Android App Development for Dummies, 3ed, Michael Burton, Wiley.2010
2. Head First Android Development 2e: A Brain-Friendly Guide, Dawn Griffiths & David Griffiths, 2017 – O'Reilly
3. Android Programming for Beginners - Second Edition, John Horton,2018
4. Java Programming for Android Developers for Dummies, Second Edition, Barry Burd, 2016
5. Conder, Shane. Android Wireless Application Development, 2/e. Pearson Education India, 2010.
6. Burd, Barry. Android application development all-in-one for dummies. John Wiley & Sons, 2015.

CSC9E603: Cyber-Physical Systems

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:
CO1: Understand the basic concepts and principles of CPS.
CO2: Acquire expertise in integrating physical and computational components within Cyber-Physical Systems.
CO3: Develop skills to effectively design and analyze Cyber-Physical Systems applications.
CO4: Address security and privacy challenges in CPS to ensure data and system integrity.
CO5: Analyze and verify the correctness of CPS implementations against system requirements and timing constraints.
CO6: Ability to develop concepts, and logics towards solving an unknown problem in research and industry.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓		✓	✓			✓	
CO2	✓	✓	✓		✓	✓		✓
CO3			✓		✓	✓		
CO4	✓	✓		✓	✓		✓	✓
CO5			✓		✓		✓	
CO6	✓	✓		✓		✓		✓

Unit I

Introduction: Cyber-Physical System, Key Features of CPS, Application Domains of CPS, Basic principles of design and validation of CPS, Challenges in CPS. CPS Platform components: CPS HW platforms, Processors, Sensors and Actuators, CPS Network - Wireless, CAN, Automotive Ethernet, Scheduling Real-Time CPS tasks.

Unit II

Synchronous and Asynchronous Model: Reactive Components, Components Properties, Components Composing, Synchronous Designs and Circuits, Asynchronous Processes and operations, Design Primitives in Asynchronous Process, Coordination Protocols in Asynchronous Pro- cess, Leader Election, Reliable Transmission.

Unit III

Security of Cyber-Physical Systems: Introduction to CPS Securities, Basic Techniques in CPS Securities, Cyber Security Requirements, Attack Model and Countermeasures, Advanced Techniques in CPS Securities.

Unit IV

Advanced Automata-based modeling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, zenoness, Formal Analysis: Flow pipe construction, reachability analysis, Analysis of CPS Software, Weakest Preconditions, Bounded Model checking.

Unit V

CPS Application: Health care and Medical Cyber-Physical Systems, Smart grid and Energy cyber-physical systems, WSN based Cyber-Physical Systems, Smart Cities. Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid.

References:

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
2. R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
3. T. D. Lewis "Network Science: Theory and Applications", Wiley, 2009.
4. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag 2009.
5. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
6. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996.
7. Raj Rajkumar, Dionisio de Niz and Mark Klein, "Cyber-Physical Systems", Addison-Wesley, 2017.

CSC9E604: Blockchain Technology

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: To acquire knowledge about blockchain and its diverse technological components.
CO2: To gain knowledge about various operations associated with the life cycle of Blockchain and Crypto currency.
CO3: To educate on the principles, practices, and policies related to the Bitcoin business.
CO4: To acquire knowledge about cryptography and consensus algorithms.
CO5: Design Blockchain based application with Swarm and IPFS.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓		✓	✓			✓
CO2	✓	✓				✓		✓
CO3			✓	✓			✓	
CO4	✓	✓		✓		✓		
CO5		✓	✓		✓			✓

Unit I

Introduction to Blockchain: Distributed DBMS – Limitations of Distributed DBMS, Introduction to Block chain – History, Definition, Distributed Ledger, Blockchain Categories – Public, Private, Consortium, Blockchain Network and Nodes, Peer-to-Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.

Unit II

Blockchain Architecture: Operation of Bitcoin Blockchain, Blockchain Architecture – Block, Hash, Distributer P2P, Structure of Blockchain- Consensus mechanism: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET).

Unit III

Blockchain-based Future System: Project presentation- Futures smart contract: Blockchain oracles- Web3j: Setting up the Web3J- Installing web3j- Wallet creation, Java client: The wrapper generator- Initializing web3j- Setting up Ethereum accounts- Deploying the contract.

Unit IV

Blockchains in Business and Creating ICO: Public versus private and per-missioned versus permissionless blockchains- Privacy and anonymity in Ethereum- Why are privacy and anonymity important? - The Ethereum Enterprise Alliance- Blockchain As-a-Service- Initial Coin Offering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts- Contract security and testing the code.

Unit V

Distributed Storage IPFS and SWARM: Ethereum Virtual Machine- Swarm and IPFS: Installing IPFS, Hosting frontend: Serving frontend using IPFS, serving frontend using Swarm, IPFS file up- loader project: Project setup the web page.

References:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
2. Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, "Blockchain by Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, and Hyperledger", Packt Publishing Limited, 2018.
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
4. Franco, P. (2014). Understanding Bitcoin: Cryptography, engineer- ing and economics. John Wiley and Sons.
5. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder,S. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press.
6. William Stallings, Cryptography and Network Security, Pearson 2004.

CSC9E605: Cryptography and Network Security

Contact Hours per Week:4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the fundamentals of cryptography.
CO2: Interpret data integrity, authentication, digital signatures.
CO3: Analyze different network security applications
CO4: Familiarize standard algorithms that provide confidentiality, integrity and authenticity.
CO5: Develop knowledge about network security technologies.
CO6: To understand various protocols for network security to protect against the threats in the networks.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓			✓	✓	✓	✓	
CO2			✓	✓	✓	✓		
CO3	✓	✓	✓				✓	✓
CO4	✓	✓	✓	✓	✓		✓	✓
CO5		✓	✓	✓		✓		
CO6			✓			✓		

Unit I

Computer security concepts - challenges - security attacks - security services - security mechanisms - a model for network security. Cryptography - symmetric encryption principles - cryptography - cryptanalysis - Feistel Cipher structure. Symmetric block encryption algorithms - DES - Triple DES - AES - random and pseudorandom numbers - stream cipher and RC4 - cipher block modes of operation.

Unit II

Message authentication - approaches - MAC - one way Hash function - secure Hash functions - Message Authentication Codes. Public key cryptography principles - algorithms - digital Signatures.

Unit III

Network security applications - symmetric key distributions using symmetric encryption - Kerberos version 4 - key distributions using asymmetric encryption - X.509 certificates -public key infrastructure - federated identity management.

Unit IV

Transport level security - web security considerations - secure socket layer and transport layer security - SSL architecture - SSL record protocol - change cipher spec protocol - handshake protocol. Transport layer security - HTTPS - SSH. IP Security - overview - policy - encapsulating security payload - combining security associations - internet key exchange.

Unit V

Intruders - intruders, intrusion detection, password management. Malicious software - types, viruses, countermeasures, worms, DDoS. Firewalls - need - characteristics, types, firewall basing, location and configuration - DMZ networks, VPN - distributed firewalls.

References:

1. William Stallings, Network Security Essentials Applications and Standards, 4th Edition, Pearson India, ISBN: 8131761754, 2011
2. William Stallings, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson India, ISBN: 9332518777, 2012
3. Atul Kahate, Cryptography and Network Security, 3rd Edition, Tata McGraw-Hill Publishing, ISBN: 9789332900929, 2017
4. Eric Maiwald, Fundamental of Network Security, 1st Edition, Tata McGraw - Hill Education, 0071070931, 2010
5. Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: Private Communication in Public World, 2nd Edition, PHI Learning Pvt Ltd, ISBN: 8120322134, 2017

Elective - 5

CSC9E606: Data Mining

Contact Hours per Week: 3 Lecture + 2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Recognize the significance and broad application of data mining and warehousing in societal contexts.

CO2: Gain insights into data quality assessment and methods for preprocessing data.

CO3: Acquire knowledge of popular data mining algorithms such as classification, clustering, association rule mining, and anomaly detection.

CO4: Apply data mining techniques to real-world datasets to solve practical problems in various domains.

CO5: Develop critical thinking skills to formulate appropriate data mining strategies and interpret results.

CO6: Develop a research-oriented mindset to explore advanced topics and emerging trends in data mining.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓		✓		✓		
CO2	✓		✓	✓	✓		✓	
CO3	✓	✓				✓		✓
CO4	✓	✓	✓	✓			✓	
CO5	✓		✓		✓	✓		
CO6				✓				✓

Unit I

Data warehouse - definition - operational database systems Vs data warehouse - multidimensional model - schemas for multidimensional databases - OLAP operations in the multidimensional data model - data warehouse architecture.

Unit II

Data mining - definition - functionalities - major issues in data mining - data preprocessing methods - data discretization and concept hierarchy generation. Association rule mining - mining various kinds of association rules - association mining to correlation analysis - constraint based association mining.

Unit III

Classification and prediction - issues regarding classification and prediction - classification by decision tree induction - Bayesian classification - support vector machines - associative classification - other classification methods - prediction - accuracy and error measures - evaluating the accuracy of a classifier or predictor - ensemble methods - model section.

Unit IV

Cluster Analysis- K-Means Algorithm-Example and suggestions for improvements- A Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods (DBSCAN), outlier analysis-Graph mining-spatial data mining - multimedia data mining - text mining.

Unit V

Implementation of Data mining techniques.

References:

1. Jain Pei, Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, 3rd Edition, Elsevier, 2011
2. Alex Berson and Stephen J. Smith, Data Warehousing, Data Mining and OLAP, Computing Mcgraw-Hill, 2004
3. K.P. Soman, Shyam Diwakar and V. Ajay, Insight into Data mining Theory and Practice, 1st Edition, Prentice Hall of India, 2008
4. Da Ruan, Guoquing Chen, Etienne E.Kere, Geert Wets, Intelligent Data Mining, Springer, 2007.
5. Jiawei Han and MichellineKamber, Data Mining: Tools and Techniques, Morgan Kaufmann, 3rd Edition, 2011
6. Ian Good fellow et.al, Deep learning, First edition, MIT Press, 2016
7. Richard Royger, Data mining – 1st Edition, CRC Press, 2nd Edition, 2017.

CSC9E607: Pattern Recognition

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the fundamental concepts of pattern recognition and machine learning.
CO2: Illustrate various algorithms for classification and clustering.
CO3: Apply pattern recognition methods for pre-processing, feature extraction, and feature Selection to multivariate data.
CO4: Understand the concepts of soft computing techniques for Pattern Recognition
CO5: Describe the concepts of Syntactic methods - stochastic search- Boltzmann learning – Nonmetric methods- decision trees-CART

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓	✓		✓	✓	✓
CO2					✓	✓		
CO3	✓	✓		✓		✓		✓
CO4			✓	✓	✓	✓	✓	
CO5		✓		✓		✓		✓
CO6	✓	✓	✓		✓	✓		✓

Unit I

Introduction - introduction to statistical - syntactic and descriptive approaches - features and feature extraction - learning - Bayes Decision theory - introduction - continuous case - 2- category classification - minimum error rate classification - classifiers - discriminant functions - and decision surfaces - error probabilities and integrals - normal density - discriminant functions for normal density.

Unit II

Parameter estimation and supervised learning - maximum likelihood estimation - the Bayes classifier - learning the mean of a normal density - general Bayesian learning - nonparametric technic - density estimation -parzen windows - k-nearest neighbor estimation - estimation of posterior probabilities - nearest-neighbor rule - k-nearest neighbor rule.

Unit III

Linear discriminant functions - linear discriminant functions and decision surfaces - generalized linear discriminant functions - 2-category linearly separable case - non-separable behavior -linear programming algorithms, support vector machines- multilayer neural networks - feed-forward operation and classification, backpropagation algorithm, error surface, backpropagation as feature mapping.

Unit IV

Syntactic methods - stochastic search- Boltzmann learning - NonMetric methods- decision trees-CART - other tree methods, grammatical methods, grammatical inference.

Unit V

Unsupervised learning and clustering - mixture densities and identifiability, maximum likelihood estimates, applications to normal mixtures, unsupervised Bayesian learning, data description, and clustering.

References:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, Second edition, 2006
2. Gonzalez R.C. and Thomson M.G., Syntactic Pattern Recognition - An Introduction, Addison Wesley, 2008
3. Fu K.S., Syntactic Pattern Recognition and Applications, Prentice Hall, Englewood cliffs, 1982
4. Rajan Shinghal, Pattern Recognition: Techniques and Applications, Oxford University Press, 2008.
5. Earl Gose , Steve Jost, “Pattern Recognition and Image Analysis”, PEARSON,2015.
6. V. S. Devi, M. N. Murty, “Pattern Recognition: An Introduction”, Universities Press, Hyderabad, 2011.

CSC9E608: Internet of Things

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the fundamental concepts and principles of the Internet of Things and its applications.
CO2: Understand roles of sensors in IoT.
CO3: Describe different protocols used for IoT design.
CO4: Familiar with data handling and analytics tools in IoT.
CO5: Recognize the challenges and security considerations associated with IoT deployments and learn strategies to mitigate them.
CO6: Understand the role of IoT in various domains of Industry.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓			✓	✓	✓	
CO2					✓	✓		
CO3				✓		✓		✓
CO4	✓		✓			✓	✓	
CO5	✓		✓				✓	
CO6		✓			✓	✓	✓	✓

Unit I

IOT Definitions and Functional Requirements – Motivation – Architecture - Web 3.0 View of IoT– Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT - The Toolkit Approach for End-user Participation in the Internet of Things. Middleware for IoT: Overview – Communication middleware for IoT –IoT Information Security.

Unit II

Protocols – IEEE 802.15.4 – BACnet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP–Security. Building IoT with RASPBERRY PI vs ARDUINO: Building IOT with RASPBERRY PI- IoT Systems.

Unit III

Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi- Raspberry Pi Interfaces. Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

Unit IV

Integrating IOT: Integrated Billing Solutions in the IoT, Business Mod- els for the IoT - Network Dynamics: Population Models – Information Cascades – Network Effects - Network Dynamics: Structural Models - Cascading Behavior in Networks - The Small World Phenomenon.

Unit V

Case Studies and Real-world Applications.

References:

1. Honbo Zhou, ―The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
2. ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands- on approach, Universities Press, 2015.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.
4. Jan Holler, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle,"From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols , Wiley, 2012.
6. David Easley and Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press - 2010.
7. Olivier Hersent, Omar Elloumi and David Boswarthick , The Internet of Things: Applications to the Smart Grid and Building Automation, Wiley, 2011

CSC9E609: Natural Language Processing

Contact Hours per Week: 3 Lecture + 2 Lab+1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand the fundamental concepts of Natural Language Processing.
CO2: Design algorithms for solving NLP-based problems.
CO3: Develop useful systems for language processing and related tasks involving text Processing.
CO4: Understand how to employ literary-historical NLP-based analytic techniques like stylometry, topic modeling, and named entity recognition in personal research.
CO5: Describe the methods used for part of speech tagging and named entity recognition.
CO6: Design solutions for solving text or information extraction, summarization and classification problems.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		✓		✓	✓	✓	✓	
CO2	✓	✓		✓		✓		✓
CO3			✓		✓	✓		
CO4	✓			✓		✓	✓	
CO5		✓				✓		
CO6	✓	✓		✓		✓		✓

Unit I

Introduction - Models -and Algorithms - The Turing Test -Regular Ex- pressions Basic Regular Expression Patterns -Finite State Automata - Regular Languages and FSAs - Morphology - Inflectional Morphology - Derivational Morphology -Finite-State Morphological Parsing - Combining an FST Lexicon and Rules -Porter Stemmer.

Unit II

N-grams Models of Syntax - Counting Words - Unsmoothed N-grams-Smoothing-Backoff -Deleted Interpolation - Entropy - English Word Classes - Tagsets for English - Part of Speech Tagging -Rule-Based Part of Speech Tagging - Stochastic Part of Speech Tagging - Transformation- Based Tagging.

Unit III

Context Free Grammars for English Syntax- Context-Free Rules and Trees - Sentence-Level Constructions - Agreement - Sub Categorization- Parsing - Top-down - Earley Parsing - Feature Structures - Probabilistic Context-Free Grammars.

Unit IV

Representing Meaning - Meaning Structure of Language - First Or- der Predicate Calculus-Representing Linguistically Relevant Concepts-Syntax-Driven Semantic Analysis - Semantic Attachments - Syntax- Driven Analyzer - Robust Analysis - Lexemes and Their Senses - Internal Structure - Word Sense Disambiguation - Information Retrieval.

Unit V

Implementation of Natural Language Processing Techniques

References:

1. D.Jurafsky and J. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition,2nd Edition, Prentice Hall, 2008.
2. C. Manning and H. Schutze, Foundations of Statistical Natural Language Processing", MIT Press, 1999.
3. James Allen. Natural Language Understanding, Addison Wesley, 1994.
4. Hobson Lane, Cole Howard, HannesHapke. Natural Language Processing in Action, 2019
5. Victoria fromkin, Robert Rodman and Nina Hyams, An Introduction to language, Tenth Edition, 2013
6. Alexander Clark and Chris Fox, The Handbook of Computational linguistics and natural language processing, Wiley-Blackwell, 2012.
7. Grant S Ingersoll, Thomas Morton, Andrew L Farris, Taming Text, Manning Publications,2013 Christopher D. Manning and Hin Rich Schutze, Foundations of statistical natural language processing, 1st Edition, MIT press, 1999.

CSC9E610: Digital Signal Processing

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Develop a foundational understanding of digital signal processing principles.
CO2: Acquire knowledge about different types or categories of digital signals.
CO3: Illustrate the time domain representations of signals and systems.
CO4: Explain the frequency analysis of signals.
CO5: Implementation of various algorithms in digital signal processing.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓		✓		✓		
CO2	✓	✓				✓		
CO3			✓	✓			✓	✓
CO4			✓				✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓

Unit I

Signals and Signal Processing - Characterization and classification of Signals, Typical signal processing operations, Typical Signal Processing Applications, Advantage of Digital Signal Processing.

Unit II

Classification of signals –Introduction to vector space - The concept of frequency in continuous and discrete time signals -Sampling of analog signals – Sampling theorem – Quantization and Coding – Digital to analog conversion.

Unit III

Time Domain Representation of signals and systems - Discrete time signals, Operations on sequences, Discrete time Systems, Linear Time invariant Discrete Time Systems-convolution sum – correlation of discrete time signals. Z- transforms.

Unit IV

Frequency Analysis of Signals - Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Fourier Transform of discrete time signals –Discrete Fourier Transform (DFT). FFT-Wavelet Transform - FIR and IIR Filters.

Unit V

Implementation of various Signal Processing Algorithms.

References:

1. Proakis, John G. and Dimitris G. Manolakis. Digital signal processing: principles, algorithms and applications. Pearson Education India, 2001.
2. Roberts, Michael J. Signals and systems: analysis using transform methods and MATLAB. McGraw-Hill Higher Education, 2011.
3. Oppenheim, Alan V., and Ronald W. Schafer. Digital Signal Processing [by] Alan V. Oppenheim [and] Ronald W. Schafer, Prentice Hall, 1975.
4. Antoniou, Andreas. Digital signal processing, McGraw-Hill, 2016.
5. Rabiner, Lawrence R., Bernard Gold, and C. K. Yuen. Theory and application of digital signal processing. Prentice-Hall, 2007.

Semester – 4

CSC10C604: Software Engineering

Contact Hours per Week: 4 Lecture + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Understand software process models and web engineering concepts.
CO2: Understand software requirements and structured analysis of systems.
CO3: Illustrate the process of software design and user interface design.
CO4: Understand the basic concepts of software quality and scheduling of software projects.
CO5: Illustrate various software testing processes.
CO6: Apply project management and report preparation skills.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓			✓		✓	✓
CO2		✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓		✓	✓
CO4	✓	✓	✓	✓		✓		
CO5		✓		✓		✓		✓
CO6	✓	✓		✓	✓		✓	

Unit I

Software Process Models- Generic Process Model: Framework Activities, Task Sets, Process Patterns, Process Lifecycle. Formal Methods in Software Development. Traditional Software Process Models - Different types and characteristics. Prescriptive Process Models. Component-Based Development. Aspect-Oriented Software Development. Agile Software Development - Characteristics, Agile software Process Models.

Unit II

Software Requirements: Functional and Non-Functional Requirements, Eliciting Requirements, Developing Use Cases, Requirement Analysis and Modelling, Software Requirement and Specification (SRS) Document.

Unit III

Software Design: Abstraction, Architecture, Patterns, Separation of Concerns, Modularity. Information Hiding, Functional Independence, Cohesion and Coupling, Object-Oriented Design, Data Design, Architectural Design, User Interface Design, Component Level Design.

Unit IV

Software Quality: McCall's Quality Factors, ISO 9126 Quality Factors, ISO/IEC 25010 and latest software quality models and frameworks. Overview of Quality Control-Quality Assurance, Risk Management, Risk Mitigation, Monitoring and Management (RMMM). Estimation and Scheduling of Software Projects: Software Sizing, LOC and FP based Estimations. Constructive Cost Model (COCOMO).

Unit V

Software Testing: Verification and Validation, Error, Fault, Bug and Failure, Unit and Integration Testing, White-box and Black-box Testing, Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta Testing. Regression Testing, Performance Testing, Stress Testing, Re-engineering, Reverse Engineering.

References:

1. Pressman R.S, Software Engineering, a practitioner's approach to seventh edition, McGraw Hill, 2010
2. Ian Somerville, Software Engineering, Pearson Education Asia, 2021
3. Jalote P, An Integrated Approach to Software Engineering, Narosa, 2005
4. Mall R, Fundamentals of Software Engineering, Prentice Hall India., 2018
5. Rajib Mall, Fundamentals of Software Engineering,PHI Learning Pvt Ltd, 3rd Edition, 2009
6. Rohit Khurana, Software Engineering: Principles and Practices, Vikas Publishing House Pvt Ltd, 2nd Edition, 2019
7. Keyes, Jessica. *Software engineering handbook*. Auerbach Publications, 2003.
8. Jain, Deepak. *Software Engineering: Principles and Practices*. Oxford University Press, 2009.

CSC10C605: Web Technology

Contact Hours per Week: 3 Lecture +2 Lab + 1 Tutorial
Number of Credits: 4

Course Outcomes:

CO1: Practice the concepts of Web programming including HTML5 futures and tag sets.
CO2: Practice server side and client-side scripting.
CO3: Develop applications using JSP scripting elements by Linking to external files and Accessing databases from JSP.
CO4: Develop applications with advanced features of PHP by establishing connection with MySQL databases.
CO5: Implement client-side Scripting with CGI/Perl.
CO6: Understand the difference between the HTML, PHP and XML documents.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓		✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓	✓
CO3		✓	✓		✓	✓	✓	
CO4	✓		✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓			✓	✓	
CO6	✓			✓	✓	✓	✓	✓

Unit I

Introduction to Web programming - Introduction to SGML features - HTML, XHTML, DHTML, XML - HTML Vs XML - Creating XML documents - Parsing an XML document - Writing well-formed documents - Organizing elements with namespaces - Defining elements in a DTD - Declaring elements and attributes in a DTD. Familiarization of HTML5 futures and tag sets.

Unit II

Introduction to scripting - server-side and client-side scripting. CGI/Perl: Creating a link to a CGI Script - Using a link to send data to a CGI Script - parsing data sent to a Perl CGI script - Using CGI script to process form data - Using scalar variables in Perl - Using variables in Perl - Using arithmetic operators in Perl - arrays, list, hashes, strings, pattern and regular expressions, text processing, subroutines - Associating a form with a script

Unit III

Java Server Pages - JSP scripting elements - Linking to external files - JSP declarations - JSP Expressions - JSP Scriplets - Processing client requests- Accessing a database from JSP. Advantages of JSP compared with other languages.

Unit IV

PHP: Advanced features of PHP, Defining PHP variables - variable types - operators - control flow constructs in PHP- Function, creating a Function, Function Libraries, Arrays, strings and Regular Expressions, GET and POST methods - Establishing connection with MySQL database - management system data - parsing data between pages

Unit V

Implementation of web technologies.

References:

1. Robert W. Sebesta, Programming with the World Wide Web, 4th edition, Pearson Education, 2009.
2. XueBal et. al, The Web Warrior Guide to Web programming, Thomson Learning, 2003
3. H.M. Deitel, P.J. Deitel and A.B. Goldberg, Internet and World Wide Web: How to Program, Pearson Education, 2013
4. Steven Holzner, PHP The complete Reference,1st Edition, McGraw Hill, 2007.
5. Philip Hanna, JSP The complete Reference, 2nd Edition, McGraw Hill, 2002.
6. Paul Barry, Head First Python, 1st Edition, O'Reilly Media, 2010
7. Scott Guelicb, ShishirGundavaram and Gunther Birznieks, CGI Programming with Perl, 2ndEdition, O'Reilly Media, 2000.

CSC10C606: Project Work & Dissertation

Number of Credits: 12

Course Outcomes:

CO1: Demonstrate the ability to conduct independent research, including the identification of relevant research questions, literature review, and synthesis of existing knowledge.
CO2: Understand the project requirements, reflect on their learning and take appropriate actions to implement it.
CO3: Communicate effectively and to present ideas clearly and coherently to specific audiences in both written and oral forms.
CO4: Apply advanced technical skills and knowledge in computer science to solve complex problems.
CO5: Plan, organize, and execute a substantial computer science project within given constraints.
CO6: Innovate, experiment, and analyze research findings and practice the process of scientific publishing.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓	✓		✓			✓
CO2	✓	✓	✓		✓		✓	
CO3		✓		✓		✓		
CO4	✓	✓	✓		✓	✓	✓	✓
CO5		✓	✓	✓	✓		✓	
CO6	✓	✓		✓		✓		✓

Course Outline:

Major project work is to be done individually by each student, under the guidance of a faculty member of the Department. The Project Supervisor has to constantly monitor the works done by the student, imparting him/her the necessary inputs for the successful completion of the project work. Students can either take up real-life application-oriented project work or research and development projects. The student can formulate a project problem with the help of her/his guide and submit the project proposal of the same. Approval of the project proposal is mandatory. If approved, the student can commence working on it, complete it and submit the report.

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