SCHEME OF INSTRUCTION AND DETAILED SYLLABUS FOR MCA IN DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Effective from 2025 Batch Onwards

NATIONAL INSTITUTE OF TECHNOLOGY DELHI
(An autonomous Institute under the aegis of the Ministry of Education, Govt. of India.)

Phone: 011 3386 1005 Website: www.nitdelhi.ac.in

National Institute Of Technology Delhi

Department of Computer Science & Engineering

Vision and Mission Statements

Vision

To communicate quality Computer Science education for producing globally identifiable technocrats and entrepreneurs, upholding sound ethics, profound knowledge, and innovative ideas to meet industrial and societal expectations.

Mission

M1: To impart value-based technical knowledge and skill relevant to Computer Science and Engineering through effective pedagogies and hands-on experience on the latest tools and technologies to maximize employability.
M2: To strengthen multifaceted competence in allied areas of Computer Science in order to nurture creativity and innovations to adapt to the ever-changing technological scenario, requiring communally cognizant solutions.
M3: To create an appetite for research that leads to pursuing a research career or higher education in contemporary and emerging areas of computer science.
M4: To inculcate the moral, ethical, and social ideals essential for prosperous nation-building.

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Department of Computer Science & Engineering

Program Educational Objectives (PEOs)

PEO-1	Post Graduates will establish themselves as competent professionals in the computing industry or allied sectors by applying their knowledge in software engineering, application development, and secure system design to address societal and industrial challenges
PEO-2	Post Graduates will effectively utilize data analytics, machine learning, and artificial intelligence tools to interpret complex datasets and drive strategic decisions across diverse application domains.
PEO-3	Post Graduates will engage in advanced studies, cutting-edge research, or innovative entrepreneurial ventures in areas such as cloud computing, cybersecurity, blockchain, or emerging technologies, contributing to the growth of the IT ecosystem.
PEO-4	Post Graduates will demonstrate ethical integrity, effective communication, teamwork, and leadership skills while embracing lifelong learning to adapt to evolving technologies and global work environments.

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Department of Computer Science & Engineering

Program Outcomes (POs)

PO-1	**Computational Knowledge & Problem Solving:** Apply mathematical foundations, computing principles, and domain knowledge to model and solve real-world problems.
PO-2	**Software Design & Development:** Design, develop, test, and deploy robust software solutions that effectively address complex societal and business challenges while considering usability, performance, and sustainability..
PO-3	**Data Analytics & Insight Generation:** Critically analyse data to uncover patterns, generate actionable insights, and build predictive, evidence-based models.
PO-4	**Secure, Reliable & Sustainable Systems**: Engineer, deploy, and manage secure, reliable, and sustainable computing systems within realistic economic, environmental, and resource constraints.
PO-5	**Communication & Team Collaboration:** Communicate ideas and results clearly, and collaborate effectively in multidisciplinary teams, fostering a cooperative and high-performance work culture.
PO-6	**Ethics, Lifelong Learning & Leadership:** Uphold professional ethics, embrace lifelong learning, and provide leadership that drives continuous technological

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Program Specific Outcomes (PSOs)

PSO-1	Software Engineering and Application Development: Design, develop, test, deploy, and maintain efficient, scalable, and secure software solutions by applying modern programming paradigms, development methodologies, and quality-assurance practices for industrial and societal needs.
PSO-2	Data and Intelligence Systems: Analyse complex datasets and apply data- science, machine-learning, and artificial-intelligence techniques to uncover actionable insights and build intelligent systems that solve real-world problems.
PSO-3	Advanced Computing and Research Orientation: Demonstrate competence in advanced areas such as cloud computing, cybersecurity, blockchain, and pursue innovative research to contribute to the evolving IT ecosystem.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Semester I

S. No.	Course Code	Course Title	Teaching Load			Credits	Course Type
			L	T	P		
1.	CALM 101	Discrete Mathematics	3	1	0	4	DC
2.	CALM 102	Accounting and Financial Management	3	0	0	3	DC
3.	CABM 103	Problem Solving and Computer Programming	3	0	2	4	DC
4.	CABM 104	Web Technologies	3	0	2	4	DC
5.	CABM 105	Digital Logic and Computer Organization	3	0	2	4	DC
6.	CAPM 106	Seminar I	0	0	2	1	
		Total	**15**	**3**	**4**	**20**	

Semester II

S. No.	Course Code	Course Title	Teaching Load			Credits	Course Type
			L	T	P		
1.	CALM 151	Probability and Statistics	3	1	0	4	DC
2.	CABM 152	Software Engineering	3	0	2	4	DC
3.	CABM 153	Data Structures	3	0	2	4	DC
4.	CABM 154	Programming using Python	1	0	2	2	DC
5.	CALM 155	System Programming	3	1	0	4	DC
6.	CAPM 100	Mini Project	0	0	4	2	
	Total		**13**	**2**	**10**	**20**	

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Semester III

S. No.	Course Code	Course Title	Teaching Load			Credits	Course Type
			L	T	P		
1.	CABM 201	Operating Systems	3	0	2	4	DC
2.	CALM 202	Organizational Behaviour	3	0	0	3	DC
3.	CABM 203	Artificial Intelligence	3	0	2	4	DC
4.	CABM 204	Computer Networks	3	0	2	4	DC
5.	CABM XXX	Elective-I (Bouquet I)	3	0	2	4	DE
6.	CAPM 205	Term Paper	0	0	2	1	
	Total		**13**	**2**	**10**	**20**	

Semester IV

S. No.	Course Code	Course Title	Teaching Load			Credits	Course Type
			L	T	P		
1.	CABM 251	Database Management Systems	3	0	2	4	DC
2.	CABM 252	Design and Analysis of Algorithms	3	0	2	4	DC
3.	CABM 253	Machine Learning	3	0	2	4	DC
4.	CALM XXX	Elective-II (Bouquet II)	3	0	0	3	DE
5.	CALM XXX	Elective-III (Bouquet II)	3	0	0	3	DE
6.	CAPM 200	Project Work (Phase I)	0	0	4	2	
		Total	**15**	**1**	**8**	**20**	

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Semester V

S. No.	Course Code	Course Title	Teaching Load			Credits	Course Type
			L	T	P		
1.	CABM 301	Data Mining	3	0	2	4	DC
2.	CABM 302	Information Security	3	0	2	4	DC
3.	CALM 303	Theory of Computation	3	1	0	4	DC
4.	CALM XXX	Elective-IV (Bouquet III)	3	0	0	3	DE
5.	CALM XXX	Elective-V (Bouquet III)	3	0	0	3	DE
6.	CAPM 300	Project Work (Phase II)	0	0	4	2	
		Total	**15**	**3**	**4**	**20**	

Semester VI

S. No.	Course Code	Course Title	Teaching Load			Credits	Course Type
			L	T	P		
1.	CAPM 351	Industrial Training	0	0	38	19	
2.	CAPM 352	Seminar II	0	0	2	1	
		Total	**0**	**0**	**40**	**20**	

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Departmental Elective (Bouquet I)

S. No.	Course Code	Course Title	Teaching Load			Credits
			L	T	P	
1.	CABM 211	Internet of Things	3	0	2	4
2.	CABM 212	Big Data Management	3	0	2	4
3.	CABM 213	Biometrics Systems	3	0	2	4
4.	CABM 214	Computer Graphics	3	0	2	4
5.	CABM 215	FullStack Development	3	0	2	4
6.	CABM 216	E-Commerce Technologies and Management	3	0	2	4

Departmental Elective (Bouquet II)

S. No.	Course Code	Course Title	Teaching Load			Credits
			L	T	P	
1.	CALM 261	Nature-Inspired Algorithms	3	0	0	3
2.	CALM 262	Statistical Methods for Data Science	3	0	0	3
3.	CALM 263	Wireless Sensor Networks	3	0	0	3
4.	CALM 264	Natural Language Processing	3	0	0	3
5.	CALM 265	Information Storage and Retrieval	3	0	0	3
6.	CALM 266	Cloud Computing	3	0	0	3
7.	CALM 267	Modeling and Simulation	3	0	0	3

8.	CALM 268	Soft Computing	3	0	0	3
9.	CALM 269	Foundations of Cryptography	3	0	0	3
10.	CALM 270	Mobile Computing	3	0	0	3
11.	CALM 271	Multimedia Databases	3	0	0	3
12.	CALM 272	Game Theory	3	0	0	3
13.	CALM 273	Biometric Security	3	0	0	3
14.	CALM 274	Digital Image Processing	3	0	0	3
15.	CALM 275	Peer-to-Peer Networks	3	0	0	3
16.	CALM 276	Information Systems Management	3	0	0	3

Departmental Elective (Bouquet III)

S. No.	Course Code	Course Title	Teaching Load			Credits
			L	T	P	
1.	CALM XXX	Augmented and Virtual Reality	3	0	0	3
2.	CALM XXX	Sentiment Analysis	3	0	0	3
3.	CALM XXX	Motion Planning for Robotics	3	0	0	3
4.	CALM XXX	Compiler Design	3	0	0	3
5.	CALM XXX	Blockchain Technology	3	0	0	3
6.	CALM XXX	Computer Vision	3	0	0	3
7.	CALM XXX	Optimization Techniques	3	0	0	3
8.	CALM XXX	Quantum Computing	3	0	0	3
9.	CALM XXX	Digital Forensics	3	0	0	3
10.	CALM XXX	Evolutionary Computing	3	0	0	3

11.	CALM XXX	Multi-Agent Applications	3	0	0	3
12.	CALM XXX	Graph Mining	3	0	0	3
13.	CALM XXX	Social Network	3	0	0	3
14.	CALM XXX	Reinforcement Learning	3	0	0	3
15.	CALM XXX	Deep Learning	3	0	0	3

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Course Title:	**Discrete Mathematics**
Course Code:	**MAVL 101**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Illustrate the basics of discrete mathematics and predicate calculus	Remembering (Level-I)
CO-2	Explain set theory and relations	Remembering (Level-I)
CO-3	Demonstrate the concepts of graph theory and experiment with trees to solve problems like the minimum spanning tree and tree traversals	Applying (Level-III)
CO-4	Develop the concept of functions and recursive function theory	Creating (Level-VI)
CO-5	Illustrate different algebraic structures	Analyzing (Level-IV)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**1**	**1**			**1**			
CO-2	**3**	**1**	**1**						
CO-3	**2**	**3**	**1**				**2**		
CO-4	**3**	**2**				**1**	**1**		
CO-5	**3**		**2**	**1**					**2**

1 - Small extent **2 -** Significantly **3 -** Strongly

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Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Mathematical reasoning; propositions; negation, disjunction, and conjunction; implication and equivalence; truth tables; predicates; quantifiers; natural deduction; rules of Inference; methods of proofs; use in program proving; resolution principle.	**5**
Module-II	Set theory; Paradoxes in set theory; inductive definition of sets and proof by induction; Peano postulates; Fuzzy Sets; Relations; representation of relations by graphs; properties of relations; equivalence relations and partitions; Partial orderings; Posets; Linear and well-ordered sets.	**10**
Module-III	Functions; mappings; injections and surjections; composition of functions; inverse functions; special functions; Peano postulates; pigeonhole principle; recursive function theory, Representation of Integers, GCD, residue classes, linear congruence. Euclidean theorem, Chinese remainder theorem, and inclusion-exclusion principle. Binomial coefficients, permutation, and combination.	**7**
Module-IV	Graph Theory: elements of graph theory, Euler graph, Hamiltonian path, trees, tree traversals, spanning trees.	**7**
Module-V	Definition and elementary properties of groups, semigroups, monoids, rings, fields, vector spaces, field introduction to partially ordered sets, and lattices. Elementary combinatorics; counting techniques; recurrence relations; generating functions.	**7**

Learning Resources:

Textbooks:	1. Title- Discrete Mathematics and Applications, Author- .H.Rosen, Publisher- TataMcGraw Hill, Edition- Fifth edition 2003
Reference Books:	1. Title- Elements of Discrete Mathematics, Author- .C.L.Liu, Publisher- McGraw-Hill Book, Edition- Second edition 1985 2. Title- Discrete Mathematics for Computer Scientists and Mathematicians, Author- J .L.Mott, A.Kandel, T.P. Baker, Publisher- Prentice Hall of India, Edition- Second edition 2015 3. Title- Logic and Discrete Mathematics, Author- W.K.Grassmann and J.P.Tremblay, Publisher- Pearson, Edition- 1995
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**Accounting and Financial Management**
Course Code:	**CALM 102**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Prepare and analyse the final accounts of the firm	Applying, Analyzing (Level-III, IV)
CO-2	Prepare and analyse the funds & cash flow statements of the firm	Applying, Analyzing (Level-III, IV)
CO-3	Perform basic analysis of financial statements and write a report on the financial performance, conditions and effectiveness of the firm	Analyzing, Evaluating (Level-IV, V)
CO-4	Analyse and evaluate costing systems	Analyzing, Evaluating (Level-IV, V)
CO-5	Prepare different types of budgets and policies	Applying, Creating (Level-III, VI)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**		**2**		**2**	**1**	**1**		
CO-2	**3**		**3**		**2**	**1**	**2**		**1**
CO-3	**2**		**3**		**3**	**1**	**3**		**1**
CO-4	**3**		**2**		**2**	**1**	**2**		
CO-5	**2**		**2**		**2**	**2**	**1**		

1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Assets – Liabilities – Types - Trading account – Accounting records and Systems – Limitations - Income statement – Preparation and Interpretation.	**5**
Module-II	Depreciation – Methods - Inventory methods, Sources of working capital, Fund flows, Cash flows – Financial Statement analysis.	**8**
Module-III	Ratio analysis - Use of ratios in interpreting Trading Accounts and Financial Statements, Limitations – Management Accounting.	**7**
Module-IV	Variable costs – Fixed costs – Cost Volume Profit Analysis – Break even marginal and full costing contribution, Standard costing - Analysis of variance - Computer accounting and algorithms.	**8**
Module-V	Characteristics of Budgets - Forecasting – Long term, Short term – Methods of capital investment decision making, Sensitivity Analysis, Cost of capital.	**8**

Learning Resources:

Textbooks:	1. Title- An Introduction to Accountancy, Author- N. Maheswari and S.K. Maheswari, Publisher- Vikas Publishing, New Delhi, Edition- 11th edition, 2013
Reference Books:	1. Title- Principles of Management and Accounting, Author- Manmohan and Goyal, Publisher- SahityaBhawan, Edition- 5th Edition, 1994 2. Title- Management Accountancy, Author- J.Batty, Publisher- Macdonald & Evan Ltd., London, Edition- 3rd Edition, 1970
Other Suggested Readings:	

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Course Title:	**Problem Solving and Computer Programming**
Course Code:	**CABM 103**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Illustrate the steps involved in compiling, linking, and debugging any code written in a specific language	Remembering (Level-I)
CO-2	Explain the basic concepts such as keywords, identifiers, header files, and the methods of iteration or looping and branching, etc	Remembering (Level-I)
CO-3	Apply the concepts of functions to understand modular programming	Applying (Level-III)
CO-4	Utilise the concept of pointers and arrays to structure data in a computer program	Applying (Level-III)
CO-5	Develop the basic applications in C programming using structures, unions and file handling	Creating (Level-VI)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**2**			**2**	**1**	**1**	**1**		
CO-2	**3**	**2**		**2**		**2**	**1**		
CO-3	**2**	**3**		**1**		**1**	**2**		
CO-4	**2**	**3**		**1**		**1**	**2**		
CO-5	**3**	**3**		**1**	**1**	**1**	**3**		**1**

1 - Small extent **2 -** Significantly **3 -** Strongly

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Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Computers: Hardware and Software. Basic Model of Computation, Notion of Algorithms, Flowcharts, Top-down design, Bottom-up approaches of problem solving, Number system	**5**
Module-II	Introduction to programming language, Basics of C, Basic Data types – int, float, double, char, Bool, Void. Arithmetic and logical operators: precedence and associativity. Flow of Control- Conditional statements- If-else, Switch-case constructs, Loops- While, do-while, for.	**9**
Module-III	Function – User-defined functions, library functions, Parameter passing – call by value, call by reference, recursion.	**7**
Module-IV	Arrays- Advantages and drawbacks, One-dimensional, Multi-Dimensional Arrays and strings: Declaration, Initialization, Accessing, Passing arrays and strings as parameters to functions. Pointers, Dynamic memory allocation, Dynamic arrays – One-dimensional, Multidimensional dynamic arrays.	**7**
Module-V	Structure: Declaration, Initialisation, passing structure to function, Use of pointers in structure. Preprocessors, Macros, File management in C I/O – Opening, closing, and editing files. Correctness & Efficiency Issues in Programming, Time & Space measures.	**8**

Learning Resources:

Textbooks:	1. Title- Programming in ANSI C, Author- E. Balagurusamy, Publisher- TATA McGraw-Hill, Edition- 6th edition, 2012
Reference Books:	1. Title- Let Us C, Author- Yashavant Kanetkar, Publisher- Infinity Science Press, Edition- 13th edition, 2012 2. Title- The C Programming Language, Author- Brian Kernighan & Dennis Ritchie, Publisher- Prentice Hall, Edition- 2nd Edition, 1988 3. Title- Schaum's Outline of Programming with C, Author- Byron S Gottfried, Publisher- TATA McGraw-Hill, Edition- 2nd edition, 1996
Other Suggested Readings:	

List of Experiments:	
1.	Installation of C Development Environment.
2.	Introduction to Programming Logic Building.
3.	Basic Concepts of a Computer Programming Language.
4.	Implementation of sequential constructs.
5.	Implementation of selection constructs.
6.	Implementation of Iterative constructs and their nested variants.
7.	Implementation of arrays (One-dimensional and multidimensional along with operations performed on arrays).
8.	Implementation of functions (normal functions, recursive functions, and parameter passing methods).
9.	Implementation of Pointers with arrays, strings, and functions.
10.	Implementation of structures and Union.
11.	Implementation of file handling in C.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**Web Technologies**
Course Code:	**CABM 104**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the fundamental concepts of web design and development	Understand (Level-II)
CO-2	Develop interactive and dynamic web applications using JavaScript, handling events, and integrating with HTML elements	Creating (Level-VI)
CO-3	Develop server-side web applications using Perl	Creating (Level-VI)
CO-4	Utilize XML and related technologies to represent, process, and integrate data within web applications	Applying, Analyzing (Level-III, IV)
CO-5	Build dynamic web applications using PHP, AJAX, and integrate with databases	Creating (Level-VI)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**2**	**2**		**1**		**1**	**1**		
CO-2	**2**	**3**		**2**	**1**	**1**	**3**	**1**	
CO-3	**2**	**3**		**2**	**1**	**1**	**3**		**1**
CO-4	**2**	**2**	**1**	**1**		**1**	**2**	**1**	
CO-5	**1**	**3**	**1**	**2**	**1**	**1**	**3**	**2**	**1**

1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Web essentials, W3C , Client-Server Communication , Markup Languages , HTML5 – Semantic Elements – Forms – Graphics – Media – CSS, and Different Versions.	**5**
Module-II	Dynamic Web Applications– JavaScript: Basics, Statements, Hierarchy of Objects, Methods, Properties, Event Handling, Integrating JavaScript with various elements of HTML, Cookies, JSON, Applications.	**8**
Module-III	Data Handling, XML , DTD , XML Family of Technologies , Schema , Xquery , Xpath , JSON , AJAX , Database Connectivity	**7**
Module-IV	Single Page and Dynamic Page Applications, JS AJAX, XMLHttp , Applications, jQuery Basics , Effects, jQuery HTML and Traversing , Bootstrap, AngularJS	**8**
Module-V	Server-side programming, PHP, Forms, Sessions, MySQL, Node JS, Modules, NPM, Applications using Node JS with Databases, Overview of React JS, Comparison with Angular JS.	**8**

Learning Resources:

Textbooks:	1. Title- Web Programming- Building Internet Applications, Author- Chris Bates, Publisher- John Wiley & Sons, Edition- 3rd Edition, 2006
Reference Books:	1. Title- Javascript Bible, Author-D. Goodman, M. Morrison, P. Novitski, and C. G. Rayl Publisher- John Wiley & Sons, Edition- 7th Edition, 2010 2. Title- Web Technology: Theory and Practice, Author- Akshi Kumar, Publisher- Chapman and Hall/CRC, Edition- 1st Edition, 2018 3. Title- Web Technologies, Author- Jeffrey C.Jakson, Publisher- Pearson Education, Edition- 1st Edition, 2007
Other Suggested Readings:	

List of Experiments:	
1.	Designing static web pages using HTML
2.	Designing dynamic web pages using different cascading style sheets.
3.	Designing responsive web designs.
4.	Designing XML Schemas.
5.	Programs using JavaScript.
6.	Design event-driven programming, including event handling and form validation.
7.	Programs using Java servlets and JSP.
8.	Designing web applications using PHP.
9.	Designing web applications in the NetBeans environment.
10.	Database Connectivity with MySQL using Java Servlets, JSP, and PHP

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Course Title:	**Digital Logic And Computer Organization**
Course Code:	**CABM 105**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand and apply number systems, Boolean algebra, combinational and sequential circuit concepts, and analyze memory types and organization. (L2, L3)	Understand, Applying (Level-II,III)
CO-2	Interpret and utilize the architecture and operation of the ALU, instruction sets, addressing modes, control units, and processor organization. (L2, L3)	Understand, Applying (Level-II, III)
CO-3	Analyze pipelining techniques, identify instruction hazards, and evaluate pipeline design in modern CPUs. (L3, L4)	Applying, Analyzing (Level-III, IV)
CO-4	Evaluate memory organization strategies—including cache and virtual memory—and assess parallel, multi-core, embedded, GPU, and TPU processor architectures. (L4, L5)	Analyzing, Evaluating (Level-IV, V)
CO-5	Explain I/O techniques, including programmed I/O, interrupts, DMA, buses, and interface circuits, focusing on data transfer and device communication. (L1, L2)	Remembering, Understand(Level-I,II)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**1**		**1**		**1**	**1**		**1**
CO-2	**3**	**2**		**1**		**1**	**1**		**2**
CO-3	**3**	**2**		**2**		**1**	**1**		**2**
CO-4	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**1**	**3**
CO-5	**3**	**1**	**1**	**2**		**1**			**1**

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1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Number Systems, Binary Arithmetic, Boolean algebra, Map Simplifications, Gates Combinational Circuits, Sequential Circuits, Different Computer & Structure Functional Units, Basic Operational Concepts, Memory: Internal, External, Speed, Size, and Cost.	**9**
Module-II	CPU: Arithmetic and Logic Unit, Instruction Sets, RISC, CISC, Instruction pipeline, Addressing modes and formats, Register organization, Booth's Algorithm, Robertson Multiplication Algorithms. Control Unit Operation, Processor Organization.	**7**
Module-III	Pipelining: Basic Concepts, Instruction Hazards, Data Hazards, Influence on Instruction Sets, Data Path and Control Considerations, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline.	**5**
Module-IV	Memory Organization, Memory Management Requirements, Associative, Cache, Virtual Memory, Performance Considerations. Processors: Parallel, Multi-core, Mobile, Embedded, GPU, and TPU.	**8**
Module-V	External Devices: I/O modules, Programmed I/O, Interrupts, Interrupt Driven I/O, Direct Memory Access, Buses, Interface Circuits, I/O Channels, Asynchronous Data Transfer.	**7**

Learning Resources:

Textbooks:	1. Title-Digital Design, Author- M. Morris Mano, Michael D. Ciletti, Publisher- Pearson Education, Edition- 6th Edition, 2018 2.Title-Computer Organization and Architecture, Author- William Stallings, Publisher-PHI, Edition- 11th Edition, 2019
Reference Books:	1. Title- Computer Organization and Design - The Hardware/Software Interface, Author-D. A. Patterson and J. L. Hennessy, Publisher- Morgan Kaufmann, Edition- 2014 2. Title- Computer System Architecture, Author- M. Morris Mano, Publisher- Prentice Hall of India Pvt Ltd, Edition- Third edition, 2002 3. Title- Computer Organization, Author- C. Hamacher, Z. Vranesic, and S. Zaky, Publisher- McGrawHill, Edition- 2002
Other Suggested Readings:	

List of Experiments:	
1.	To study and verify the truth table of logic gates.
2.	To design code converters.
3.	To realize Half Adder and Full Adder and Half Subtractor and Full Subtractor by using Basic gates and NAND gates.
4.	To design and set up the following circuit using IC 7483. A 4-bit binary parallel adde and A 4-bit binary parallel subtractor.
5.	To design Multiplexers and De-multiplexers.
6.	To design Encoder and Decoder.
7.	To design and set up the following circuit 1) To design and set up a 4:1 Multiplexer (MUX) using only NAND gates. 2) To design and set up a 1:4 Demultiplexer(DE-MUX) using only NAND gates.
8.	Design and implementation of shift registers
9.	To realize a decoder circuit using basic gates and to verify IC 74LS139
10.	To set up and test a 7-segment static display system to display numbers 0 to 9.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**Probability and Statistics**
Course Code:	**CABM 151**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Describe fundamental statistical terms and explain concepts such as probability spaces, distributions, and descriptive statistics (L1,L2).	Remembering, Understand(Level-I,II)
CO-2	Analyze real-world data using statistical distributions and regression techniques to uncover patterns and interpret variability (L4).	Analysing (Level-IV)
CO-3	Evaluate estimation techniques and perform hypothesis testing using appropriate inferential methods (L5).	Evaluating (Level-V)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**		**2**		**1**	**1**		**1**	
CO-2	**2**		**3**			**1**		**2**	**1**
CO-3	**2**		**3**		**1**	**1**		**2**	**1**

1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Probability Spaces, Combinatorial methods (or) Counting techniques, Elementary Theorem,	**5**

	Conditional Probability, Bayes' theorem- Probability Distributions and Probability Densities.	
Module-II	Mathematical Expectation: Expected value, Moments, Chebyshev's theorem, Moment Generating functions, Product Moment, Conditional Expectation, Special Probability Distributions and Probability Densities, Functions of Random Variable. Multiple regression, Linear models, Logistic regression, Rates and Poisson regression, Nonlinear curve fitting, and correlation.	**8**
Module-III	Descriptive Statistics & Sampling Distributions: Population-Sampling-Measures of Central tendency, variations, and position, Sampling distributions: Standard Normal Distribution, Chi-Square Distribution, t-Distribution, F-Distribution, The Central Limit Theorem.	**7**
Module-IV	Estimation: Point Estimation: the method of moments and the method of maximum likelihood estimation, Interval estimation: estimation of mean, estimation of difference of means, estimation of variance, and estimation of ratio of variances.	**8**
Module-V	Test of Hypothesis, Testing for Attributes, Mean of Normal Population, One-tailed and two-tailed tests, F-test and Chi-Square test, Analysis of Variance, Nonparametric test.	**5**

Learning Resources:

Textbooks:	1. Title-Mathematical Statistics with Applications, Author-John.E.Freund, Irwin Miller, Marylees Miller, Publisher- Prentice Hall of India, Edition- 8th edition, 2014 2.Title-Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Author- Michael Mitzenmacher, Eli Upfal, Publisher-Cambridge University PressI, Edition- Second Edition, 2017
Reference Books:	1. Title-Introduction to Probability and Statistics for Engineers and Scientists, Author-Ross, Sheldon. M, Publisher- Academic Press, Edition- 5th Edition, 2014 2. Title- Introduction to Probability and Statistics for Engineers and Scientists, Author-Ross, Sheldon. M, Publisher- Academic Press, Edition- 2009
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**Software Engineering**
Course Code:	**CABM 152**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain and analyze the phases of the Software Development Life Cycle (SDLC) and their significance in structured software development. (L2, L4)	Understand,Analysing (Level-II,IV)
CO-2	Prepare a comprehensive Software Requirements Specification (SRS) document for a software project based on system requirements and modeling techniques. (L3, L6)	Applying, Creating (Level-III, VI)
CO-3	Apply suitable software design principles, modeling techniques, and development methodologies to create efficient software solutions. (L3, L6)	Applying, Creating (Level-III, VI)
CO-4	Identify and differentiate between various software verification and validation techniques, and assess their applicability in ensuring software quality. (L4, L5)	Analysing, Evaluating (Level-IV, V)
CO-5	Describe the principles of re-engineering and reverse engineering (L2)	Understand (Level-II)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**2**	**1**	**1**		**2**	**3**		**1**
CO-2	**3**	**3**	**2**		**2**	**1**	**3**		
CO-3	**3**	**3**	**3**	**1**		**1**	**3**	**1**	**2**

CO-4	**3**	**3**	**3**	**1**		**1**	**3**	**1**	**2**
CO-5	**3**	**3**	**1**			**1**	**3**	**1**	**2**

1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Software Engineering: Software Process, Software Process Models, Software Development Life Cycle (SDLC), Requirements, Specification, Design, Implementation, Maintenance, Use-case Modelling, Software Life Cycle, ethics for software engineers.	**8**
Module-II	Software Requirements & SRS Preparation: Techniques for Requirements Gathering, Functional vs Non-functional Requirements, Software Requirements Specification (SRS) Document: Structure and Standards, Data Flow Analysis, Transaction Analysis	**6**
Module-III	Software Design and Development: Design Concepts & Principles, Cohesion and Coupling, Data Encapsulation, Reusability, Module Reuse, Fourth Generation Languages (4GL), Coding Standards	**7**
Module-IV	Verification, Validation & CASE Tools: Module Testing, Software Testing Techniques, White box testing, Basis path testing, CASE Tools for Integration, Complete Software Process, Configuration Management	**7**
Module-V	Project Management and Maintenance: Project Planning and Scheduling, Software Metrics, Cost Estimation (COCOMO Model), Risk Management Activities, Maintenance Models, Software Reuse, Software Reengineering, Reverse Engineering	**8**

Learning Resources:

Textbooks:	1. Title-Software Engineering, Author-Ian Sommerville, Publisher- Pearson Education,Edition- 9th Edition (2010)
Reference Books:	1. Title-Object-Oriented and Classical Software Engineering, Author-Stephen R. Schach, Publisher-Tata McGraw-Hill (TMH), Edition-5th Edition (2010) 2. Title- Fundamentals of Software Engineering, Author- Rajib Mall, Publisher- PHI Learning, Edition- 4th Edition 3. Title- Software Engineering - A Practitioner's Approach, Author- Roger S. Pressman, Publisher-McGraw Hill, Edition- 7th Edition

Other Suggested Readings:	

List of Experiments:	
1.	Study and analyse the phases of the Software Development Life Cycle (SDLC).
2.	Gather requirements and differentiate between functional and non-functional requirements for a sample project.
3.	Prepare a Software Requirements Specification (SRS) document for a given software project
4.	Create use-case diagrams and perform data flow analysis for the sample project
5.	Apply software design principles such as cohesion, coupling, and data encapsulation to design modules.
6.	Develop module reuse and implement coding standards for small software components.
7.	Perform module testing using basic verification and validation techniques (white-box and black-box testing).
8.	Use CASE tools for software integration and configuration management.
9.	Plan and schedule a software project using project management techniques.
10.	Estimate software cost using the COCOMO model and analyze risk management strategies
11.	Study and simulate software maintenance models, reverse engineering, and re-engineering

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**Data Structures**
Course Code:	**CABM 153**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Write structured pseudocode to represent algorithmic solutions for given problems. (L1, L2).	Remembering, Understand(Level-I,II)
CO-2	Use linear and nonlinear data structures to model and solve real-time problems (L3, L5).	Applying,Evaluating(Level-III,V)
CO-3	Apply basic searching and sorting techniques in different application domains (L3)	Applying, (Level-III)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**2**			**1**	**1**	**1**		**1**
CO-2	**3**	**3**	**1**	**1**		**1**	**2**	**1**	**1**
CO-3	**3**	**3**	**1**	**1**		**1**	**2**	**1**	**1**

1 - Small extent **2 -** Significantly **3 -** Strongly

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Dynamic aspects of operations on data, Characteristics of data structures, Creation and manipulation of data structures, Operations on data structures, Types of data structures – linear and nonlinear. Introduction to algorithms: Asymptotic notations, Analysis of algorithms: Time and Space complexity.	**5**
Module-II	Arrays: Dynamic memory allocation, one-dimensional arrays, multidimensional arrays, operations on arrays, storage – Row major order, Column major order. Linked lists: types of linked lists – singly, doubly, and circularly linked lists, operations on linked lists.	**7**
Module-III	Stacks: Implementation of stacks– array and linked list, operations on stacks, Applications of Stacks, Notations – infix, prefix, and postfix, Conversion and evaluation of arithmetic expressions using Stacks. Queues: Implementation of queues– array and linked list, operations on queues, Types of queues – queue, double-ended queue, and priority queue.	**8**
Module-IV	Trees: Binary tree, Binary search tree, Threaded binary tree, Height-balanced trees, Tries, Heaps, Hash tables. Graph traversals: Breadth First Search, Depth First Search, Shortest path: Depth first search in directed and undirected graphs. Union-find data structure and applications. Directed acyclic graphs; topological sort.	**8**
Module-V	Searching: Linear search, Binary search, and Hashing. Algorithms and data structures for sorting: Insertion Sort, Bubble sort, Selection Sort, Merge sort, Quick Sort, Heap sort, Radix sort, Bucket sort. Algorithm design techniques: Divide and conquer, Greedy approach, and dynamic programming.	**8**

Learning Resources:

Textbooks:	1. Title-Introduction to Algorithms, Author- T.H. Cormen, C.E. Leiserson, R.L. Rivest and C.Stein, Publisher- MIT Press, Edition- 4th Edition, 2022
Reference Books:	1. Title- Data Structures, Author-S. Lipschutz and G.A.V. Pai, Publisher- Tata McGraw-Hill, Edition- 2010 2. Title- Data Structures and Problem Solving using Java, Author- M.A.Weiss, Publisher- Addison Wesley, Edition- 4th edition, 2009 3. Title- Classic Data Structures, Author- D. Samanta, Publisher- PHI, 2nd edition, 2009

Other Suggested Readings:	

List of Experiments:	
1.	Write a Program in C to Implement Stacks Using Arrays and Linked Lists
2.	Write a Program in C to Implement Queues Using Arrays and Linked Lists
3.	Write a program that uses functions to perform the following operations on a singly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal
4.	Write a program that uses functions to perform the following operations on a doubly linked list: i) Creation, ii) Insertion, iii) Deletion, iv) Traversal.
5.	Write a program that uses functions to perform the following operations on Circular Linked List i) Creation ii) Insertion iii) Deletion iv) Traversal
6.	Write a program that uses both recursive and non-recursive functions to perform The following searching operations for a Key value in a given list of integers: a) Linear search, b) Binary search
7.	Write a program that implements the following sorting i) Bubble sort, ii) Selection sort, iii)Quick sort.
8.	Write a program that implements the following: i) Insertion sort, ii) Merge sort iii)Heap sort.
9.	Write a program to perform the following operations: a) Insert an element into a binary search tree. b) Delete an element from a binary search tree. c) Search for a Key element in a binary search tree
10.	Write a program to implement the (a) Tree Traversal Methods (b) Graph Traversal Methods

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**Programming using Python**
Course Code:	**CABM 154**
L-T-P:	**1-0-2**
Credits:	**2**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain the fundamental concepts of Python programming	Remembering (Level-I)
CO-2	Explain the basic constructs used in Python programming	Remembering (Level-I)
CO-3	Apply control structures such as conditional and looping statements in Python to solve problems	Applying (Level-III)
CO-4	Develop file handling functionalities to manage persistent data and evaluate their effectiveness in Python applications	Creating (Level-VI)
CO-5	Use various utility-based Libraries for Python-based scientific computing	Evaluating (Level- V)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**1**			**1**	**1**	**1**		
CO-2	**2**	**3**		**1**	**1**	**1**	**2**		
CO-3	**2**	**1**	**2**			**1**	**1**	**2**	
CO-4	**1**	**2**	**2**	**1**		**1**	**2**	**3**	**1**
CO-5	**1**	**1**	**3**		**2**	**1**	**1**	**2**	

1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Python Programming Language, Features of Python Programming Language, Flavours of Python Programming Language, Installation of Python Programming Language, Execution of First Python Program.	**5**
Module-II	Data Types, Fundamental Data Types, Collection Data Types – Lists, Tuples, Sets, Frozen sets, Dictionaries, Variables, Operators.	**8**
Module-III	Control Statements, Conditional Statements, Looping Statements, Logical Programs, String Handling tendency, variations, and position, Sampling distributions: Standard Normal Distribution, Chi-Square Distribution, t-Distribution, F-Distribution, The Central Limit Theorem.	**7**
Module-IV	Functions, File handling, Object Oriented Programming in Python, Exception Handling in Python, Class and Objects.	**8**
Module-V	Different modules and packages for scientific computing in Python (Numpy, Pandas, Matplotlib, Scipy, Sympy, etc.), Database access, Regular Expressions.	**8**

Learning Resources:

Textbooks:	1. Title-Think Python: How to Think Like a Computer Scientist Author: Allen B. Downey, Publisher: Shroff/O,,Reilly Publishers 2nd edition, 2016
Reference Books:	1. Title-An Introduction to Python Author: Guido van Rossum and Fred L. Drake J, Publisher: Network Theory Ltd. Revised and updated for Python 3.2, 2011 2. Title- Introduction to Computation and Programming Using Python Author: John V Guttag, Publisher: MIT Press Revised and expanded Edition, 2013 3. Title- Exploring Python‖ Author: Timothy A. Budd, Publisher: Mc-Graw Hill Education (India) private Ltd. 2015
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Installing Python, Setting up Path and Environment Variables, Running Python, First Python Program.
2.	Keywords, Identifiers, Python Statement, Indentation, Documentation, Variables, Multiple Assignment.
3.	Understanding Data Type, Data Type Conversion, Python Input and Output Functions, and Import command.
4.	Operators in Python, Expressions, Precedence, Associativity of Operators, Non Associative Operators.
5.	Decision-making statements, Python loops, Python control statements.
6.	Numbers, Lists, Tuples, Sets, Dictionary, Functions & Methods of Dictionary, Strings.
7.	Built-in Functions, User-defined functions, Anonymous functions, Pass by value, Pass by Reference, Recursion
8.	Exceptions, Built-in exceptions, Exception handling, User-defined exceptions in Python.
9.	Python OOP Concepts, Object Class, Constructors, Inheritance
10.	Numpy data types, Operations on Numpy Array (indexing, slicing, shape/reshape, iteration, join, split, search, sort, filter)

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title:	**System Programming**
Course Code:	**CALM 155**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Apply the knowledge of assembly and macro processors to translate assembly language into machine code	Analysing (Level-IV)
CO-2	Analyse the working phases of the Compiler to undertake meaningful language translation	Analysing (Level-IV)
CO-3	Evaluate functionalities of Linkers, Loaders, interpreters, and debugging methods to manage system memory and provide a portable runtime environment	Evaluating (Level-V)
CO-4	Analyze the working of an operating system and its component	Analysing (Level-IV)

Course Articulation Matrix:

	PO- 1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**2**		**1**		**1**	**2**		**1**
CO-2	**2**	**3**		**1**		**1**	**2**		**1**
CO-3	**2**	**2**		**3**	**1**	**1**	**2**		**2**
CO-4	**2**	**1**		**3**		**1**	**1**		**3**

1 - Small extent **2 -** Significantly **3 -** Strongly

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**

Module-I	Introduction: Evolution of the Components of a Programming System, Evolution of Operating Systems. Machine Structure, Machine Language, and Assembly Language.	**5**
Module-II	Assemblers: Design of Assemblers. Table Processing: searching and sorting. Macro Language and the Macro Processor: Macro Instructions, Features of Macro facility, Implementation.	**7**
Module-III	Loaders: Loader Schemes, Design of an Absolute Loader, Design of a Direct-Linking Loader	**8**
Module-IV	Compilers: Statement of problem, Phases of the compiler, Data Structures, Recursion, Call and Return statements, Storage Classes – Use, Implementation, Block Structure, Nonlocal Go To's, Interrupts, Pointers.	**8**
Module-V	Operating Systems: I/O Programming, Memory Management, Processor Management, Device Management, Information Management.	**8**

Learning Resources:

Textbooks:	1. Title: Systems Programming Author: John J. Donovan, Publisher: Tata McGraw-Hill 2014
Reference Books:	1. Title-System Software- An Introduction to Systems Programming Author: L.L. Beck, Publisher: Addition Wesley 3rd Edition, 1996.
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Operating Systems

Course Code: CABM 201

L - T - P: 3 - 0 - 2

Credits: 4

Semester: III

Pre-requisites: Data Structures, Programming in C/C++

Course Outcomes:

CO-1	Demonstrate understanding of the fundamental concepts, structures, and services of operating systems, including process management, threads, and CPU scheduling techniques. [Bloom's L2, L3]
CO-2	Apply process synchronization mechanisms and deadlock handling techniques to analyze and solve concurrent processing problems. [Bloom's L3, L4]
CO-3	Analyze and evaluate memory management and file system mechanisms used in modern operating systems. [Bloom's L4, L5]
CO-4	Analyze and apply I/O management, protection and security mechanisms, and distributed operating system concepts in computing environments. [Bloom's L4, L5]

Course Articulation Matrix (CO-PO-PSO Mapping):

CO\PO-PSO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**			**1**		**1**	**2**		**1**
CO-2	**3**	**2**	**1**	**2**	**2**		**3**	**2**	**1**
CO-3	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**2**
CO-4	**2**		**1**	**3**		**2**	**2**	**1**	**2**

1 - Slightly **2 – Moderately** **3 - Substantially**

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Operating System Fundamentals: Definition, functions, and goals of an operating system. Types of operating systems — batch, interactive, time-sharing, real-time,

	distributed, and network OS. History and evolution of operating systems. Computer architecture support for OS — dual mode operation, privileged instructions, system calls, interrupts, and traps. Operating system structure — monolithic, layered, microkernel, and modular design. Process Management: Process states, Process Control Block (PCB), process creation and termination. Threads — user and kernel threads, multithreading models. CPU Scheduling: Scheduling criteria, algorithms — FCFS, SJF, Priority, Round Robin, Multilevel Queue and Feedback Queue scheduling. Multiprocessor and real-time scheduling.
Module-II	Process Synchronization: Critical section problem, Peterson's solution, Hardware support (test-and-set, compare-and-swap), Semaphores, Monitors. Classic IPC problems — Producer-Consumer, Readers-Writers, Dining Philosophers. Deadlock: Resource allocation graphs, conditions for deadlock. Deadlock prevention, deadlock avoidance — Banker's Algorithm. Deadlock detection and recovery strategies.
Module-III	Memory Management: Address binding, logical vs physical address space, base-limit registers. Swapping, Contiguous Allocation, fragmentation, compaction. Paging — page table structure, TLB, multi-level paging, inverted page tables. Segmentation with paging. Virtual Memory — demand paging, page fault handling, copy-on-write. Page Replacement Algorithms: FIFO, Optimal, LRU, Clock algorithm. Frame allocation policies. Thrashing and Working Set model. File Systems: File concept, attributes, operations, access methods, directory structure, mounting, file sharing and protection. File System Implementation — contiguous, linked, and indexed allocation. Free-space management. Directory implementation. Case study of Unix File System (inode structure). Network File System (NFS).
Module-IV	I/O System: I/O hardware, polling, interrupts, DMA. Kernel I/O subsystem — buffering, caching, spooling. Disk scheduling: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK. Device drivers — block and character devices, device switch tables. Protection & Security: Goals of protection, access matrix, ACLs and capability lists, revocation of access rights. RBAC. Security threats — Trojan horses, viruses, worms, denial-of-service. Authentication, encryption basics, OS hardening, firewalls. Distributed Operating Systems: Distributed system structure, network OS vs distributed OS. Remote Procedure Calls (RPC). Distributed file systems — design goals, naming, transparency. Client-server model. CAP theorem, distributed synchronization, Lamport clocks.

Learning Resources:

Textbooks:	1. Abraham Silberschatz, Peter B. Galvin, and Greg Gagne, Operating System Concepts, Addison-Wesley, 10th Edition, 2018. 2. Andrew S. Tanenbaum and Herbert Bos, Modern Operating Systems, Pearson, 4th Edition, 2014. 3. William Stallings, Operating Systems: Internals and Design Principles, Pearson, 9th Edition, 2018.
Reference Books:	1. Andrew S. Tanenbaum and Albert S. Woodhull, Operating Systems: Design and Implementation, Pearson, 3rd Edition, 2006. 2. D. M. Dhamdhere, Operating Systems: A Concept-Based Approach, McGraw Hill Education, 3rd Edition. 3. Douglas E. Comer, Operating System Design: The XINU Approach, CRC Press.
Other Suggested Readings:	1. Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, Arpaci-Dusseau Books, 2018. 2. Achyut S. Godbole, Operating Systems, McGraw Hill Education**.**

Lab Experiments:

Exp. No.	List of Experiments
1.	Introduction to Unix/Linux Environment — Basic shell commands: ls, cp, mv, grep, find, chmod, ps, top, kill, man.
2.	Shell Scripting — Writing shell scripts for file manipulation, conditional logic (if-else), loops, and functions.
3.	Implementation of Process-Related System Calls — Using fork(), exec(), wait(), exit() to create and manage processes.
4.	File I/O System Calls — Implementation using open(), read(), write(), close(), lseek() for file management operations.
5.	CPU Scheduling Algorithms — Implementation of First Come First Serve (FCFS) and Shortest Job First (SJF) scheduling.
6.	CPU Scheduling Algorithms — Implementation of Priority Scheduling and Round Robin (RR) scheduling with time quantum.
7.	Process Synchronization — Implementation of Producer-Consumer problem using semaphores (sem_wait , sem_post).
8.	Process Synchronization — Implementation of the Dining Philosophers problem and the Sleeping Barber problem.
9.	Deadlock Detection — Implementation of a resource-allocation graph based deadlock detection algorithm.

10.	Banker's Algorithm — Implementation of Banker's deadlock avoidance algorithm for resource allocation.
11.	Memory Management — Address translation simulation: logical to physical address mapping with paging.
12.	Page Replacement Algorithms — Implementation and comparison of FIFO, Optimal, and LRU page replacement policies.
13.	Disk Scheduling Algorithms — Implementation of FCFS, SSTF, SCAN, C-SCAN, and LOOK disk scheduling algorithms.
14.	Inter-Process Communication — Shared memory and message queue-based IPC using System V or POSIX APIs.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Organizational Behaviour

Course Code: CALM 202

L - T - P: 3 - 0 - 0

Credits: 3

Pre-requisites: NIL

Course Outcomes:

CO-1	To understand the basics of Organization Behaviour and its determinants.
CO-2	Application of motivation theories for employee motivation based on individual personality types.
CO-3	To Analyse the group dynamic in organization for the management of conflict between various groups.
CO-4	To evaluate the organization process and structure for effective management of employee stress and change in organization

Course Articulation Matrix (CO-PO-PSO Mapping):

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	-	-	-	2	3	1	-	2	-
CO-2	-	-	-	1	3	2	-	1	-
CO-3	-	-	-	1	3	3	1	2	1
CO-4	-	-	-	3	2	1	1	1	1

1 - Slightly **2 – Moderately** **3 - Substantially**

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Foundation of OB Organisational Behaviour: Concepts and Determinants; Emergence of organizational behaviour; Contributing disciplines of Organization Behaviour; Organization Behaviour models.
Module-II	Individual Behaviour Foundations of individual behaviour, Personality- Type A and B, Big five personality

	types, Perception - concept, perceptual process, factors influencing perception; learning Theories-cognitive and social learning; motivation theories-traditional and modern Theories
Module-III	Group Behaviour Group Behaviour - concept, types-of groups, group norms, group roles, group cohesiveness and group dynamics, Group and teams- teamwork, Interpersonal communication, Decision-making, Management of conflict and negotiation, Leadership theories and styles
Module-IV	Organizational Process and Structure Organizational processes – Elements of organization structure, organizational structure and design, organizational culture- concept and determinants; Organisational change- types of change, resistance to change, managing change; Stress- source, prevention and management of stress
Module-V	

Learning Resources:

Textbooks:	1. Robbins, S.P., Judge, T.A., Edwards, M., Sandiford, P., Fitzgerald, M., & Hunt, J. (2019) Organisational Behaviour, 9th Edition, Melbourne: Pearson 2. Wood, J., Zeffane, R.M., Fromholtz, F., Wiesner, R. Morrison, R., Factor, A. & McKeown, T. (2016), Organisational Behaviour Core Concepts and Applications, 4th Australia
Reference Books:	1. Newstrom, J.W. & Davis, K (2014), Organizational Behaviour at Work, Tata Mc GrawHill. 2. George, J. M., & Jones, G. R. (2012). Understanding and managing organizational behaviour (6th ed.). Pearson Education 3. Pareek, Udai, Understanding Organizational Behaviour, Oxford University Press, New Delhi
Other Suggested Readings:	

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Artificial Intelligence

Course Code: CABM 203

L-T-P: 3-0-2

Credits: 4

Pre-requisites: Data Structures, Probability and Statistics, and Programming Fundamentals.

Course Outcomes:

CO-1	Understand the basic concepts of AI.
CO-2	Apply search strategies to solve AI problems.
CO-3	Apply knowledge representation and reasoning to solve real world AI Problems.
CO-4	Analyze and apply intelligent systems and learning-based approaches for real-world applications.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**2**							
CO-2	**2**	**3**	**2**	**1**			**2**		
CO-3	**2**	**3**	**3**	**2**			**3**		
CO-4	**2**	**3**	**3**	**2**	**2**		**3**	**2**	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction: Overview of AI problems, examples of successful recent AI applications. The Turing test, Rational versus non-rational reasoning. Search Strategies: Problem spaces (states, goals and operators), problem solving by search. Uninformed search (breadth-first, depth-first, depth first with iterative deepening). Heuristics and informed search (hill climbing, generic best-first, A*). Minimax Search, Alpha-beta pruning . Space and time efficiency of search. Two-player games (introduction to minimax search). Constraint satisfaction (backtracking and local search methods).

Module-II	Knowledge representation and reasoning: Review of propositional and predicate logic, First order logic, Resolution and theorem proving, Forward chaining, Backward chaining ,Temporal and spatial reasoning. Review of probabilistic reasoning, Bayes theorem. Totally-ordered and partially-ordered Planning
Module-III	Quantifying Uncertainty, Basic of Probability, Probabilistic Reasoning, Bayes Net, Bayesian Network, Fuzzy Logic, Decisions Theory, Utility Function, Decision Network, Markov Decision Process, Probabilistic Reasoning over time, Hidden Markov Model, Kalman filter, Markov Chain Monte Carlo
Module-IV	Agents: Definition of agents, Agent architectures (e.g., reactive, layered, cognitive), Multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models. Expert Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.
Module-V	Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification, Information retrieval, Pagerank

Learning Resources:

Textbooks:	1. Artificial Intelligence: A Modern Approach, Author- S. Russell and P. Norvig, Publisher- Prentice Hall, Edition- 3rd Edition, 2009.
Reference Books:	1. Introduction to Artificial Intelligence and Expert Systems, Author- Dan W. Patterson, Publisher- Pearson Education, Edition- 1st Edition, 2015. 2. rtificial Intelligence, Author- Elaine Rich, Kevin Knight and Shivashankar B. Nair, Publisher- Tata McGraw Hill, Edition- 3rd Edition, 2009.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	WAP to the implementation of Breadth-First Search (BFS) and Depth-First Search (DFS) algorithms to find a path from the start node to the goal node in a graph.

2.	You are given a graph represented as an adjacency list, and you need to implement IDS,UCS and A* search algorithm to find a path from the start node to the goal node.
3.	WAP to the implementation of Breadth-First Search (BFS) and Depth-First Search (DFS) algorithms to find a path from the start node to the goal node in a graph.
4.	You are given a graph represented as an adjacency list, and you need to implement IDS,UCS and A* search algorithm to find a path from the start node to the goal node.
5.	You are given a scenario where a robot needs to navigate through a grid-based environment to reach a goal location. The robot can move in four directions: up, down, left, and right. The goal is to implement the Simple Hill Climbing algorithm to find the optimal path for the robot to reach the goal from a given starting position.
6.	Using a chessboard of dimensions 8x8 and eight identical queens, strategically place the queens to avoid any threats between them. The constraints are that no two queens can occupy the same row, column, or diagonal. Begin with a random placement of the queens and then iteratively select one queen at a time, determining the optimal placement to achieve a conflict-free configuration. Note: Use the random walk approach to select the next state.
7.	A). Using a chessboard of dimensions 8x8 and eight identical queens, strategically place the queens to avoid any threats between them. The constraints are that no two queens can occupy the same row, column, or diagonal. Begin with a random placement of the queens and then iteratively select one queen at a time, determining the optimal placement to achieve a conflict-free configuration. Note: Use the Simulated annealing approach to select the next state. B). Find out the path from vertex 'S' to vertex 'G' using the local beam search in a given graph.
8.	Using a chessboard of dimensions 8x8 and eight identical queens, strategically place the queens to avoid any threats between them. The constraints are that no two queens can occupy the same row, column, or diagonal. Begin with a random placement of the queens and then iteratively select one queen at a time, determining the optimal placement to achieve a conflict-free configuration. Note: Use the Genetic algorithms, initially generate k random state called population. The value of k may be (20 to 30). Do the following operation: Fitness function, Crossover, Mutation
9.	WAP to implement the Minimax algorithm for decision-making in two-player, zero-sum games using Tic-Tac-Toe as a model. It should includes: Board representation. Functions for player moves. Function to check for a win/draw. Generate all possible game states for a given state. Evaluate each state to determine if it leads to a win, loss, or draw.

	Assign a score to each state accordingly. Recursively apply the algorithm to generate a game tree until a terminal state is reached.
10.	By using "CONSTRAINT SATISFACTION PROBLEMS" design a Sudoku board consisting of 81 squares, some of which are initially filled with digits from 1 to 9. The objective is to fill in all the remaining squares such that no digit appears twice in any row, column, or 3×3 box.
11.	A map of Australia is given, showing each of its states and territories. The task is to colour each region either red, green, or blue in such a way that no neighbouring regions have the same colour using the constraints satisfaction problem. Use the following functions: Minimum-remaining-values (MRV) heuristic Least-constraining-value
12.	You have to schedule the tasks for a team of workers. Each task has certain constraints, such as which workers can do it and which tasks must be done before others. The details of the task are as follows: You have a scheduling problem involving three tasks (A, B, C) and two workers (X, Y). Constraints: Task A must be completed before task B. Task B must be completed by worker X. Task C can be completed by either worker X or Y. Represent each task and worker as a Boolean variable and Constraints are represented as clauses. Represent the problem as a set of Boolean variables and constraints and find the order of implementation of the tasks using the DPLL (Davis-Putnam-Logemann-Loveland) algorithm.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Computer Networks

Course Code: CABM 204

L-T-P: 3-0-2

Credits: 4

Pre-requisites:

Course Outcomes:

CO-1	To Understand the basic concepts of Computer Network.[K1]
CO-2	To Understand and remember layers of OSI Model, Multiplexing and Transmission Media [K1, K2]
CO-3	To Analyze the different Routing Techniques and IP Addressing Schemes. [K4]
CO-4	To Apply the concept of the Routing Techniques learned to Create (design and develop a new routing technique). [K3, K6]

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**3**	**3**	**3**	**1**	**-**	**1**	**2**	**3**
CO-2	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**2**	**3**
CO-3	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**2**	**3**
CO-4	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**2**	**3**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction: Internet History, Uses of computer networks, Network hardware, network software, Protocol layering, Reference models (OSI & TCP/IP Model). The Physical Layer: Theoretical basis for data communication, Transmission media: Guided and Unguided media, Switching (circuit, packet), Multiplexing (FDM, WDM, and TDM), Overview of PSTN, ISDN, and ATM. [10]
Module-II	The Data Link Layer: Data link layer design issues, Error detection and Correction

	Techniques, Elementary data link control protocols, Sliding window protocols, Example data link protocols (HDLC and PPP). The Medium Access Sublayer: The channel allocation problem, multiple access protocols, IEEE standard 802.3 & 802.11 for LANS and WLANs, Network devices-repeaters, hubs, Bridge, Switches and Routers. Transmission Networks: PDH Networks, SONET/SDH Networks, DWDM Networks, Introduction to Cell Switched Networks e.g Asynchronous Transfer Mode (ATM) and Packet Switched Networks. [10]
Module-III	Transport layer: Transport layer services, Elements of transport protocols, Overview of UDP and TCP. The Network Layer: Network layer design issues, routing algorithms, congestion control algorithms, Quality of Service, Introduction to IPv4 Addressing, Subnetworks and Subnetting, IPv4 protocol Packet Format, Forwarding of IP packets, IPv4 vs IPv6, Congestion control algorithms. [8]
Module-IV	Network security: Introduction to Network security, Model for Network security, Model for Network access security, Real-time Communication Security: Introduction to TCP/IP protocol stack, Implementation layers for security protocols and implications, IPsec: AH and ESP, IPsec: IKE IP Security: IP Security overview, IP Security architecture, Authentication Header, Encapsulating security payload, Combining security associations, Internet Key Exchange. [8]

Learning Resources:

Textbooks:	1. Behrouz A. Forouzan, McGraw-Hill Higher Education, Boston (2003), Softcover, pp. 973, plus XXXIV, ISBN: 0-07-251584-8. 2. Yu, S., Lin, X., Misic, J., & Shen, X. S. (Eds.). (2015). Networking for big data (Vol. 2). CRC Press. [T3] Dimitri, B., & Robert, G. (2000). Data networks.
Reference Books:	1. Black, U. (1993). Computer networks protocols, standards, and interfaces. Prentice-Hall, Inc.. [R2] A. Tanenbaum (2011) Computer Networks. 5th edition, Pearson**.**
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	1. Study of different types of Network cables and Practically implement the cross-wired cable and straight through cable using clamping tool.
2.	2. Study of Network Devices in Detail.
3.	3. Study of network IP, Connect the computers in Local Area Network.
4.	4. Study of basic network command and Network configuration commands.
5.	5. Performing an Initial Switch Configuration, performing an Initial Router Configuration, Configuring and Troubleshooting a Switched Network
6.	6. Connecting a Switch 10 Configuring WEP on a Wireless Router 11 Using the Cisco IOS Show Commands
7.	7. Examining WAN Connections, Interpreting Ping and Traceroute Output
8.	8. Demonstrating Distribution Layer Functions, Placing ACLs, Exploring Different LAN Switch Options, implementing an IP Addressing Scheme, Examining Network Address Translation (NAT)
9.	9. Observing Static and Dynamic Routing, Flow control protocol, Configuring Ethernet and Serial Interfaces, configuring a Default Route, Configuring Static and Default Routes
10.	10. Configuring RIP, Planning Network-based Firewalls, Configuring a Cisco Router as a DHCP Server

Networking Tools:

CISCO packet tracer tool, NS3, COOJA Simulator, OpenNMS, Wireshark Tool, pfSense, Port Forwarding, Network Virtualization, SDN ,and etc.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Database Management Systems

Course Code: CABM 251

L-T-P: 3-0-2

Credits: 4

Pre-requisites:

Course Outcomes:

CO-1	Learn the basic concepts of Database Systems
CO-2	Model the real-world systems using Entity Relationship Diagrams and Normalization
CO-3	Make use of SQL commands and relational algebraic expressions for query processing and apply ACID properties
CO-4	To gain hands-on experience with designing and implementing database management systems through programming projects and case studies

Course Matrix (CO-PO-PSO Mapping)

COs	PO1	PO 2	PO3	PO4	PO5	PO 6	PSO1	PSO2	PSO3
CO1	3						1		
CO2	2	1	1				2	2	1
CO3	3	2	2	2	2	1	2	2	
CO4	3	2	2	2	2	2	2		

1 - Slightly; **2 - Moderately;** **3 – Substantially**

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction - General introduction to database systems; Database - DBMS distinction approaches to building a database, data models, database management system, three schema architecture of a database, challenges in building a DBMS, various components of a DBMS.
Module-II	Database design and ER Model:- Overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML

	Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).
Module-III	Relational algebra: introduction, Selection and projection, set operations, renaming Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relation comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus v algebra, computational capabilities.
Module-IV	SQL - Introduction, data definition in SQL, table, and key and foreign key definitions update behaviours. Querying in SQL - basic select-from-where block and its semantic nested queries- correlated and uncorrelated, notion of aggregation, aggregation functions group by and having clauses, embedded SQL. Data Storage and Indexes - file organizations, primary, secondary index structures, various index structures – hash-based, dynamic hashing techniques, multi-level indexes, and B+ trees.
Module-V	Transaction management and Concurrency control: Transaction processing and Erro recovery - concepts of transaction processing, ACID properties, and serializability concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, and database recovery management. Error recovery and logging, undo, redo, undo-redo logging and recovery methods.

Learning Resources:

Textbooks:	1. Fundamentals of Database Systems Author-R. Elmasri and S.B. Navathe
Reference Books:	1. Database Systems Concepts, Author- H.f.Korth and Silberschatz 2. Data Base Design, Author- C.J. Date 3. DBM and Design, Author- Hansen and Hansen 4. Title- Database System, Author- Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments

1.	Library Management system (File Handling)
2.	Introduction to SQL , Installation of SQL-Server , SQL data definition, Constraints in SQL , Schema change Statement
3.	Basic SQL Queries
4.	Complex SQL Queries-1 , Nested Queries, Correlated Nested Queries, EXISTS Function in SQL, Aggregation Function
5.	Complex SQL Queries-2, Joined Tables, Aggregate Functions
6.	Complex SQL Queries-3 , Grouping , EXISTS and UNIQUE functions, Aggregate Functions
7.	Entity-Relationship Diagram from Case Study
8.	Normalization of the Case Study
9.	Webpage Connectivity with SQL Server Using XAMPP- 1
10.	Webpage Connectivity with SQL Server Using XAMPP- 2
11.	Mini DBMS Project
12.	Mini DBMS Project

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Design and Analysis of Algorithms

Course Code: CABM 252

L-T-P: 3-0-2

Credits: 4

Pre-requisites: Data Structures, Discrete Mathematics

Course Outcomes:

CO-1	Analyze the time and space complexity of algorithms using asymptotic notations and mathematical techniques.
CO-2	Design efficient algorithms using divide-and-conquer, greedy, dynamic programming, and graph-theoretic approaches.
CO-3	Apply advanced algorithmic techniques such as matching algorithms, randomized algorithms, and approximation algorithms to solve real-world computational problems.
CO-4	Analyze computational complexity, formulate reductions, and classify problems into P, NP, NP-hard, and NP-complete categories.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**2**	**3**			**1**	**2**	**2**	**2**
CO-2	**3**	**3**	**3**	**2**	**1**		**3**	**2**	**2**
CO-3	**3**	**3**	**3**	**2**	**2**		**3**	**3**	**3**
CO-4	**3**	**2**	**3**	**2**		**2**	**2**	**2**	**3**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction: Algorithms, Characteristics of Algorithms, Analysis of Algorithms, Design of Algorithms, Time and Space Complexity, Asymptotic Notations, Growth of Functions, Recurrence Relations and their Solution Methods, Master Theorem. Divide-and-Conquer Paradigm, Binary Search, Maximum Subarray Problem, Merge Sort, Quick Sort, Counting Inversions, Selection Problem, Medians and Order Statistics. Sorting in Linear Time: Counting Sort, Radix Sort, Bucket Sort.

Module-II	Advanced Data Structures: Red-Black Trees, Augmenting Data Structures, Binomial Heaps, B-Trees, Fibonacci Heaps, Data Structures for Disjoint Sets, Dictionaries, Priority Queues, Mergeable Heaps and Concatenable Queues. Greedy Method: Characteristics and Proof Techniques, Activity Selection Problem, Interval Scheduling, Huffman Coding, Job Sequencing, Minimum Spanning Trees, Kruskal's Algorithm and Prim's Algorithm.
Module-III	Dynamic Programming: Principles of Dynamic Programming, Matrix Chain Multiplication, Longest Common Subsequence, Edit Distance, Sequence Alignment, 0/1 Knapsack Problem, Subset Sum Problem. Graph Algorithms: Graph Representations, Breadth First Search, Depth First Search, Topological Sorting, Single Source Shortest Path, Dijkstra's Algorithm, Bellman-Ford Algorithm, All-Pairs Shortest Path, Floyd-Warshall Algorithm.
Module-IV	Computational Complexity and Advanced Algorithmic Techniques: Polynomial and Exponential Algorithms, Complexity Classes P and NP, Polynomial Time Reductions, NP-Hard and NP-Complete Problems, Satisfiability Problem, Vertex Cover Problem, Clique Problem, Subset Sum Problem and Traveling Salesperson Problem. Randomized and Probabilistic Algorithms, Randomized Quick Sort, Primality Testing, Integer Factorization, String Matching Algorithms, Rabin-Karp Algorithm, Knuth-Morris-Pratt Algorithm, Boyer-Moore Algorithm, Introduction to Approximation Algorithms.

Learning Resources:

Textbooks:	1. Introduction to Algorithms, Cormen, Leiserson, Rivest and Stein, 4th Edition, MIT Press.
Reference Books:	1. Fundamentals of Computer Algorithms, Ellis Horowitz and Sartaj Sahni. 2. Computer Algorithms: Introduction to Design and Analysis, Sara Baase and Allen Van Gelder. 3. Fundamentals of Algorithmics, Gilles Brassard and Paul Bratley. 4. Algorithm Design and Applications, Michael T. Goodrich, Roberto Tamassia and Michael H. Goldwasser. 5. The Design and Analysis of Computer Algorithms, Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman.
Other Suggested Readings:	1. Algorithms, Robert Sedgewick and Kevin Wayne. 2. Recent research articles and survey papers on algorithm design, randomized algorithms, approximation algorithms, and computational complexity.

Lab Experiments:

Exp. No.	List of Experiments
1.	Sort a given set of elements using the Quick Sort method and determine the time required to sort the elements. Repeat the experiment for different values of n and compare the performance with Merge Sort.
2.	Implement Merge Sort to sort a given set of elements and determine the time required to sort the elements for different input sizes. Compare the results with Quick Sort.
3.	Implement Counting Sort, Radix Sort and Bucket Sort for a given set of elements and compare their performance with comparison-based sorting algorithms.
4.	Implement Heap operations and Priority Queue using Heaps. Analyze the efficiency of insertion, deletion and heap construction operations.
5.	Solve the Activity Selection Problem and Job Sequencing Problem using Greedy Method and analyze the correctness and efficiency of the obtained solutions.
6.	Construct Huffman Codes for a given set of symbols and frequencies and determine the compression efficiency obtained.
7.	Implement the 0/1 Knapsack Problem using Dynamic Programming and determine the optimal profit for a given set of objects and knapsack capacity.
8.	Implement Longest Common Subsequence (LCS) and Edit Distance algorithms for two given strings and compare their applications in sequence matching.
9.	Implement Matrix Chain Multiplication using Dynamic Programming and determine the optimal parenthesization for minimizing the number of scalar multiplications.
10.	Print all vertices reachable from a given source vertex using Breadth First Search (BFS) and Depth First Search (DFS). Use DFS to determine whether a given graph is connected.
11.	Find the shortest paths from a given source vertex to all other vertices in a weighted graph using Dijkstra's Algorithm and Bellman-Ford Algorithm. Compare their performance on graphs containing negative edge weights.
12.	Find the Minimum Cost Spanning Tree of a given undirected graph using Kruskal's Algorithm and Prim's Algorithm. Also determine the All-Pairs Shortest Paths using Floyd-Warshall Algorithm and compare the obtained results.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Machine Learning

Course Code: CABM 253

L-T-P: 3-0-2

Credits: 4

Pre-requisites:

Course Objectives:

CObj-1	To introduce the foundations of Machine Learning, including data preparation and evaluation metrics.
CObj-2	To develop the ability to design and implement supervised and unsupervised learning algorithms.
CObj-3	To enable students to analyze and compare learning paradigms for different problem domains.
CObj-4	To explore neural networks, deep learning architectures, and optimization techniques.
CObj-5	To provide exposure to real-world applications of Machine Learning across domains such as computer vision, natural language processing, and data analytics.

Course Outcomes:

CO-1	Understanding the fundamentals of Machine Learning, types of learning, and describe data preparation techniques including preprocessing, feature scaling, and visualization (L2).
CO-2	Apply supervised learning algorithms to solve classification and regression problems (L3).
CO-3	Analyze unsupervised learning techniques and differentiate their applications in pattern discovery and dimensionality reduction (L4).
CO-4	Design and Implement neural network and deep learning architectures for tasks in different domains (L6).

Course Articulation Matrix:

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO1	2	1	1	1	1	1	1	2	1
CO2	2	2	2	1	2	1	2	3	2
CO3	2	2	3	1	2	1	2	3	2
CO4	2	3	3	3	3	1	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Introduction to Machine Learning** Introduction to Machine Learning (ML): definition, scope, applications. Types of learning: Supervised Learning, Unsupervised Learning, Reinforcement Learning. Mathematical foundations: probability, statistics, linear algebra, optimization. Bias–Variance tradeoff, underfitting vs. overfitting. Performance evaluation metrics: accuracy, precision, recall, F1-score, Receiver Operating Characteristic (ROC) curve. Data Preparation: Data Collection and Data Quality, Data Cleaning and Preprocessing, Handling Missing Values; Feature Scaling and Normalization; Exploratory Data Analysis (EDA); Data Visualization Techniques.	**10**
Module-II	**Supervised Learning** Training, Validation, and Testing. Linear regression, logistic regression. Decision trees, random forests. Support Vector Machines (SVM). k-Nearest Neighbors (k-NN). Ensemble methods: bagging, boosting, stacking.	**8**
Module-III	**Unsupervised Learning** Clustering: Fundamentals, K-Means Clustering, Hierarchical Clustering, Density-Based Spatial Clustering of Application with Noise (DBSCAN). Dimensionality Reduction: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA). Feature Selection Techniques. Association Rule: Apriori Algorithm.	**8**
Module-IV	**Neural Networks and Deep Learning** Basics of Artificial Neural Networks (ANN). Training with backpropagation. Convolutional Neural Networks (CNN) for image recognition. Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU). Optimization techniques: Gradient Descent, Stochastic Gradient Descent (SGD), Adam optimizer. Applications in computer vision, natural language processing	**10**

Learning Resources:

Textbooks:	1. T. M. Mitchell, “Machine Learning” McGraw Hill Education, First Edition, 2017. 2. A. Ethem, “Introduction to Machine Learning”, PHI Learning Pvt. Ltd., Third Edition, 2015. 3. C. M. Bishop, “Pattern recognition and machine learning”, Springer, First Edition, 2016. 4. I. Goodfellow, Y. Bengio and A. Courville, “Deep Learning”, MIT Press, 2016.

Reference Books:	1. T. Hastie, R. Tibshirani and J. Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2009. 2. K. P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012. 3. S. Shalev-Shwartz and S. Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, First Edition, 2014. 4. J. D. Kelleher, B. M. Namee and A. D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms: Algorithms, Worked Examples, and Case Studies", MIT Press, 2015.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Perform data preprocessing including handling missing values, feature scaling, normalization, and exploratory data analysis (EDA).
2.	Evaluate classification performance using metrics such as accuracy, precision, recall, F1-score, and Receiver Operating Characteristic (ROC) curve.
3.	Implement Linear Regression to predict continuous values and analyze model performance.
4.	Apply Logistic Regression for binary classification and validate results using confusion matrix
5.	Build and compare Decision Tree and Random Forest classifiers on a benchmark dataset.
6.	Perform K-Means Clustering and visualize cluster assignments on a dataset.
7.	Apply Principal Component Analysis (PCA) for dimensionality reduction and evaluate variance explained.
8.	Construct a simple Artificial Neural Network (ANN) for classification tasks using backpropagation.
9.	Implement a Convolutional Neural Network (CNN) for image recognition.
10.	Develop a Recurrent Neural Network (RNN) or Long Short-Term Memory (LSTM) model for sequence prediction (e.g., text or time series data).

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Department Elective (Bouquet I)

Course Title: Internet of Things

Course Code: CABM 211

L-T-P: 3-0-2

Credits: 4

Pre-requisites:

Course Outcomes:

CO-1	To demonstrate the basic concept of IoT, the architecture of IoT, and applications of IoT in the real life.[K1]
CO-2	To explain the mechanism of various protocols used in different layers of IoT. [K1, K2]
CO-3	To identify the challenges of Interoperability and techniques used for Interoperability in IoT. [K3]
CO-4	To interpret about various privacy and security issues in IoT communication. [K3, K4]

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**3**	**3**	**3**	**1**	**-**	**2**	**3**	**-**
CO-2	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**-**
CO-3	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**-**
CO-4	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**-**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Introduction: Internet of Things, Sensors, sensor classes, types of sensors, Actuator, Actuation, types of actuators, IoT Networking, IoT component, Functional components of IoT, IoT dependencies, IoT service-oriented architecture, IoT categories, IoT gateways, IoT and associated technologies, Architecture of IoT, Application of IoT.	**10**
Module-II	IoT Standards: Application Protocols- Constrained Application Protocol (CoAP), CoSIP, Message Queue Telemetry Transport (MQTT), Extensible Message and Presence protocol (XMPP), Advanced Message Queuing Protocol (AMQP), Data Distribution Service (DDS); Service Discovery	**10**

	Protocols: Multicast DNS (mDNS), DNS Service Discovery (DNS-SD); Infrastructure Protocols- Routing Protocol for Low Power and Lossy Networks (RPL), 6LoWPAN, IEEE 802.15.4 and ZigBee, Bluetooth Low Energy (BLE), Lowpower Wi-Fi, IEEE 802.15.6.	
Module-III	Interoperability in IoT: Machine to Machine communication, Architecture, and components for M2M, Standardization Effort for M2M. Interoperability in IoT, IoT Architecture for Interoperability, Open Industry Standards, SDN Origins and Evolution, Centralized and Distributed Control and Data Planes, API in SDN, Control mechanism, Switch Deployment, Controller configuration software, SDN for WSNs, Software-Defined WSN Prototype, Performance Analysis of Software Defined Networks. WSNs, Cluster formation of sensors in WSNs, Routing algorithms in WSNs, UAV Network, 5G based communication among IoT devices.	**8**
Module-IV	Security issues in the IoT: Traditional vs Lightweight security, Lightweight Cryptography, Key Agreement, Distribution and Security Bootstrapping, Processing data in the encrypted domain: Secure data aggregation, Authorization mechanisms for secure IoT services.	**8**

Learning Resources:

Textbooks:	1. Cirani S, Ferrari G, Picone M, Veltri L (2018). Internet of Things: Architectures, Protocols and Standards. John Wiley & Sons. 2. Buyya R, Dastjerdi AV(2016). Internet of Things: Principles and paradigms. Elsevier.
Reference Books:	1. Chou T (2017). Precision-Principles, Practices and Solutions for the Internet of Things. McGraw-Hill Education**.**
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Introduction to Arduino/ESP32 Development Environment for LED blinking, serial monitor usage and uploading code to microcontroller.

2.	Interface LEDs, push buttons, and buzzers for button-controlled LED and traffic light simulation
3.	Analog Sensor Interfacing to read analog sensor values such as Potentiometer, LDR (Light Dependent Resistor), data visualization on Serial Monitor.
4.	Develop automatic light control using LDR to ambient light sensing and automatic LED switching.
5.	Control actuator using sensor input for servo motor positioning, and automated gate simulation.
6.	Connect IoT device to Wi-Fi network for IP address acquisition, and Network configuration
7.	Create a local IoT web server on ESP 32 to display sensor values on browser and access through local network
8.	Implement publish-subscribe communication with MQTT broker setup, Sensor data publishing, and Client subscription.
9.	Exchange sensor data between two IoT nodes using Wireless communication and perform data synchronization.
10.	Send sensor data to cloud platform using ThingSpeak/Blynk integration and do the Real-time monitoring.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Big Data Management

Course Code: CABM 212

L-T-P: 3-0-2

Credits: 4

Pre-requisites: Database Management Systems

Course Outcomes:

CO-1	Understand the characteristics, lifecycle, and management challenges of Big Data systems.
CO-2	Apply distributed storage and resource management concepts using Hadoop and HDFS.
CO-3	Design and manage NoSQL databases for scalable Big Data applications.
CO-4	Utilize Big Data processing frameworks and implement data governance, security, and management practices.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**3**	**1**
CO-2	**3**	**3**	**2**	**3**	**1**	**1**	**3**	**3**	**2**
CO-3	**3**	**3**	**3**	**2**	**1**	**1**	**3**	**3**	**2**
CO-4	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction to Big Data and Data Management, Introduction to Big Data, Characteristics of Big Data (5Vs), Sources of Big Data, Challenges in Big Data Management, Big Data Lifecycle, Traditional Data Management versus Big Data Management, Data Warehousing Concepts, Data Lakes, Enterprise Data Architecture, Big Data Applications.
Module-II	Distributed Storage and Hadoop Framework, Distributed Computing Fundamentals, Cluster Computing, Distributed File Systems, Hadoop Ecosystem, Hadoop Architecture, Hadoop Distributed File System (HDFS), HDFS Components, Data

	Replication and Fault Tolerance, YARN Architecture, Hadoop Cluster Management.
Module-III	NoSQL Databases and Big Data Processing, Limitations of Relational Databases, NoSQL Concepts and Classification, Key-Value Stores, Document-Oriented Databases, Column-Family Databases, Graph Databases, MongoDB Architecture and Operations, Cassandra Architecture, Data Modeling in NoSQL Systems, CAP Theorem, Consistency Models.
Module-IV	Big Data Processing, Security and Management, MapReduce Programming Model, Hive, Pig, Apache Spark Fundamentals, Data Ingestion Concepts, Data Governance, Data Quality Management, Metadata Management, Big Data Security and Privacy Issues, Access Control, Data Backup and Recovery, Case Studies and Industrial Applications.

Learning Resources:

Textbooks:	1. Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers and Techniques, Pearson India Education Services Pvt. Ltd., 1st Edition, 2016. 2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media, 4th Edition, 2015.
Reference Books:	1. Bill Chambers and Matei Zaharia, Spark: The Definitive Guide, O'Reilly Media, 2018. 2. Alan Gates, Programming Pig: Dataflow Scripting with Hadoop, O'Reilly Media, 2011. 3. Jason Rutherglen, Dean Wampler, and Edward Capriolo, Programming Hive, O'Reilly Media, 2012.
Other Suggested Readings:	1. Pramod J. Sadalage and Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison-Wesley, 2012. 2. Judith Hurwitz, Alan Nugent, Fern Halper, and Marcia Kaufman, Big Data For Dummies, Wiley, 2013.

Lab Experiments:

Exp. No.	List of Experiments
1.	Install and configure Hadoop in standalone and pseudo-distributed modes. Verify HDFS and YARN services.
2.	Perform basic HDFS operations such as file creation, uploading, downloading, replication management, and directory manipulation.

3.	Analyze HDFS architecture and demonstrate fault tolerance through block replication and node failure simulation.
4.	Implement simple MapReduce programs (Word Count, Average Calculation, Maximum/Minimum Value Identification) and analyze their execution.
5.	Configure and execute Hive queries for data definition, data manipulation, aggregation, joins, and partitioning.
6.	Develop data processing applications using Apache Pig and compare Pig Latin scripts with equivalent SQL queries.
7.	Install and configure MongoDB. Perform CRUD (Create, Read, Update, Delete) operations on document-oriented datasets.
8.	Design and implement a NoSQL database schema using MongoDB for a real-world application and evaluate its scalability.
9.	Install and configure Apache Cassandra. Create keyspaces, tables, and perform data insertion, retrieval, and update operations.
10.	Compare relational database systems and NoSQL databases with respect to scalability, consistency, and performance.
11.	Implement data ingestion and storage workflows using Hadoop ecosystem tools and analyze data flow management.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Biometrics Systems

Course Code: CABM 213

L-T-P: 3-0-2

Credits: 4

Pre-requisites: Data structures, Algorithms

Course Outcomes:

CO-1	Demonstrate the basics of physical and biological science and engineering principles underlying biometric systems. [K1,K2]
CO-2	Understand and analyse biometric systems at the component level and be able to analyze and design basic biometric system applications [K2, K4]
CO-3	Analyze and evaluate various biometric security mechanisms. [K4, K5]
CO-4	Apply the concept of Biometric systems to develop applications. [K3, K6]

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**2**				**-**			
CO-2	**2**	**3**	**2**						
CO-3	**2**	**2**	**2**	**2**			**3**	**2**	
CO-4	**2**	**2**	**3**	**2**			**2**	**2**	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction of biometric traits and its aim: Why Biometrics? - Benefits of biometrics versus Traditional Authentication methods, Benefits of biometrics in identification Systems. Key Biometric Terms and Processes - Definitions, Verification and identification, Logical versus Physical Access, how biometric matching works, Image processing basic: what is image, acquisition, type, point operations, Geometric transformations, Linear interpolation, brightness correction, histogram. Basic image operations: Convolution, linear/non-linear filtering, Gaussian, Median, Min, Gray level reduction, Accuracy in biometric systems– False match rate, False non-match rate, Failure to enroll rate, Derived metrics.
Module-II	Filtering and enhancement: Special filters, enhancement filter, Edge detection, derivatives, Laplacian, unsharp masking, high boot filtering, sharpening special filtering, Edge detection. First and second derivative, thresholding, localization,

	Robert's method, Prewitt and Sobel, Laplacian of Gaussian, zero crossing. Canny edge detection, Fourier Series, DFT, inverse of DFT.
Module-III	Biometric system, identification and verification: Biometric system, authentication, physiological and behavioral properties, properties of biometric system, application areas. PCA, Eigen vectors and values, 2D-PCA, generalization to p-dim, covariance and correlation, algebra of PCA, projection of data. Finger scan – Components, how finger scan technology works, competing finger Scan technologies, Finger scan Deployments, Finger scan Strengths, Finger scan weaknesses. Facial Scan – Components, how facial scan technology works, competing facial Scan technologies, Facial scan Deployments, Facial scan Strengths, Facial scan weaknesses. Iris Scan - Components, how it works, Deployments, Iris scan Strengths, Iris scan weaknesses. Voice Scan - Components, how it works, Deployments, Voice scan Strengths, Voice scan weaknesses.
Module-IV	Other physiological biometrics – Hand Scan, Retina Scan, Automatic Fingerprint Identification Systems (AFIS). Other Leading Behavioural Biometrics – Signature scan, keystroke scan. Categorizing Biometrics Applications – Defining the Seven Biometric, Applications, Introduction to IBG's Biometric Solution Matrix, Assessing the Privacy Risks of Biometrics – Bio Privacy Technology Risk.
Module-V	Recommended Biometric for Network Security – Finger Biometrics, Face Biometrics, Voice Biometrics, Iris Biometrics, the Choice of a Biometric for Network Access, An Introduction to Statistical Measures of Biometrics – FAR, FRR, FTE, EER: Positive/negative identification, Biometric system security, Authentication protocols, Authentication methods. Matching, null and alternative hypothesis h0, h1, Error type I/II, Matching score distribution, FM/FNM, ROC curve, DET curve, FAR, FRR curves. Comparing two systems using ROC curve, Expected overall error, EER, available best error rates, cost function, biometric myths and misrepresentations, negative authentication, trade-offs b/w security and convenience**.**

Learning Resources:

Textbooks:	1. Anil K. Jain, Arun A. Ross and Karthik Nandakumar, "Introduction to Biometrics", Springer, 2011, ISBN 978-0-387-77326-1. 2. J. Ashbourn, "Biometrics: Advanced Identity Verification: The Complete Guide", Springer, 2000, ISBN-13: 978-1852332433. 3. J.L. Wayman, A.K. Jain, D. Maltoni and D. Maio, "Biometric Systems: Technology, Design and Performance Evaluation", Springer, 2005, ISBN 978-1-84624-064-1. 4. D. Maltoni, D. Maio, Anil K. Jain and Salil Prabhakar "Handbook of Fingerprint Recognition", Springer, 2009, ISBN 978-1848822535. 5. Stan Z. Li and Anil K. Jain "Handbook of Face Recognition", Springer; 2nd ed., 2011, ISBN 978-0856289314. 6. Rafael C. Gonzalez, Richard Eugene Woods, "Digital Image Processing using

	MATLAB", 2nd Edition, Tata McGraw-Hill Education 2010 7. Ruud M. Bolle, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, "Guide to Biometrics", Springer 2009 8. Richard O. Duda, David G.Stork, Peter E. Hart, "Pattern Classification", Wiley 2007.
Reference Books:	1."Biometrics- The Ultimate Reference", John D. Woodward, Jr. Wiley Dream tech 2." Implementing Biometric Security", John Chirillo, Scott Blaul, Wiley
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Image Acquisition and Preprocessing of Biometric Images – Capture biometric images and perform grayscale conversion, brightness adjustment, and histogram equalization.
2.	Geometric Transformations and Image Normalization – Apply translation, rotation, scaling, and interpolation techniques to biometric images.
3.	Image Filtering and Enhancement – Implement Gaussian, Median, Min/Max, and sharpening filters for biometric image enhancement.
4.	Edge Detection in Biometric Images – Perform Roberts, Prewitt, Sobel, Laplacian, LoG, and Canny edge detection techniques.
5.	Frequency Domain Analysis using DFT – Apply DFT, frequency filtering, and inverse DFT for biometric image processing.
6.	Face Recognition using PCA (Eigenfaces) – Extract facial features and perform recognition using Principal Component Analysis.
7.	Fingerprint Feature Extraction and Matching – Enhance fingerprint images, extract minutiae features, and perform fingerprint matching.
8.	Voice Biometric Authentication – Extract voice features (e.g., MFCC) and implement speaker verification and identification.
9.	Performance Evaluation of Biometric Systems – Compute FAR, FRR, FMR, FNMR, EER, and analyze system accuracy.
10.	ROC and DET Curve Analysis for Biometric Authentication – Generate ROC/DET curves and compare the performance of different biometric modalities.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Computer Graphics

Course Code: CABM 214

L-T-P: 3-0-2

Credits: 4

Pre-requisites:

Course Outcomes:

CO-1	Explain the fundamental concepts of computer graphics, display systems and graphics devices.
CO-2	Apply geometric transformations and viewing techniques to graphical objects.
CO-3	Analyze line, circle and polygon generation algorithms used in graphics systems.
CO-4	Develop two-dimensional and three-dimensional graphical applications using graphics programming tools.
CO-5	Evaluate modern graphics applications including animation, virtual reality and game graphics.

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	2	-	1
CO2	3	3	-	-	1	-	3	-	1
CO3	3	2	1	-	-	-	3	-	1
CO4	2	3	-	2	1	-	3	1	2
CO5	2	2	1	2	2	1	2	1	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	**Introduction to Computer Graphics** Introduction to computer graphics and its applications, graphics systems and architecture, raster scan and random scan displays, display processors, graphics input and output devices, coordinate systems, graphics software systems and standards.	**7**
Module-II	**Geometric Transformations and Viewing**	**8**

	Two-dimensional transformations including translation, rotation, scaling, reflection and shearing. Homogeneous coordinate representation, composite transformations, windowing and viewport transformations, two-dimensional viewing pipeline, introduction to three-dimensional transformations and viewing concepts.	
Module-III	**Graphics Primitives and Curves** Graphics primitives, DDA line drawing algorithm, Bresenham line drawing algorithm, midpoint circle generation algorithm, polygon representation, polygon filling techniques, line and polygon clipping algorithms, Bezier curves and B-Spline curves.	**7**
Module-IV	**Three-Dimensional Graphics and Rendering** Three-dimensional object representation, projections, hidden surface removal techniques, illumination models, shading techniques, color models, rendering pipeline and rendering techniques.	**7**
Module-V	**Advanced Graphics Applications** Computer animation principles, keyframe animation, multimedia graphics, virtual reality and augmented reality concepts, game graphics, OpenGL fundamentals, modern graphics applications and recent trends in computer graphics.	**7**

Learning Resources:

Textbooks:	1. Peter Bruce, Andrew Bruce and Peter Gedeck, "Practical Statistics for Data Scientists", O'Reilly Media, 2nd Edition, 2020. 2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press, 6th Edition, 2020.
Reference Books:	1. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning", Springer, 2nd Edition, 2021. 2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", O'Reilly Media, 2nd Edition, 2014. 3. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson, 6th Edition, 2007.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Introduction to graphics programming environment and drawing basic graphical objects.
2.	Implementation of DDA line drawing algorithm.
3.	Implementation of Bresenham line drawing algorithm.
4.	Implementation of midpoint circle drawing algorithm.
5.	Implementation of two-dimensional transformations.
6.	Implementation of composite transformations and window-to-viewport mapping.
7.	Implementation of line clipping algorithms.
8.	Implementation of polygon clipping algorithms.
9.	Implementation of polygon filling techniques.
10.	Implementation of Bezier and B-Spline curves.
11.	Implementation of three-dimensional transformations and projections.
12.	Development of a mini graphics application using OpenGL.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Full Stack Development

Course Code: CABM 215

L-T-P: 3-0-2

Credits: 4

Pre-requisites: NIL

Course Outcomes:

CO-1	Explain web technologies, HTML5, CSS, JavaScript, JSON, and client-server architecture.
CO-2	Apply JavaScript and DOM techniques to develop dynamic web pages.
CO-3	Develop React-based user interfaces with form validation and component-based design.
CO-4	Build server-side applications and APIs using Express.js and GraphQL.
CO-5	Develop full-stack MERN applications using MongoDB, Express.js, React, and Node.js.

Course Articulation Matrix:

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**2**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**
CO-2	**2**	**3**	**-**	**2**	**1**	**1**	**3**	**1**	**-**
CO-3	**2**	**3**	**-**	**2**	**1**	**1**	**3**	**-**	**1**
CO-4	**2**	**2**	**1**	**1**	**-**	**1**	**2**	**1**	**-**
CO-5	**1**	**3**	**1**	**2**	**1**	**1**	**3**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Web Essentials: Introduction to Web Technologies, Evolution of the World Wide Web (WWW), W3C Standards, Web Browsers and Web Servers, Client–Server Architecture, Internet Protocols, URL, HTTP and HTTPS, Domain Name System (DNS), Markup Languages. HTML5: Structure of Web Pages, Document Structure, Semantic Elements, Hyperlinks, Lists, Tables, Forms and Form Controls, Multimedia Elements (Audio and Video), Graphics using Canvas and SVG, HTML5 APIs, HTML Versions and Standards. CSS: Introduction to Cascading Style Sheets, Types of CSS (Inline,	**6**

	Internal and External), CSS Syntax and Selectors, Colors, Backgrounds, Borders, Margins, Padding, Box Model, Text and Font Styling, Positioning, Flexbox, Grid Layout, Responsive Web Design, Media Queries, CSS3 Features (Transforms, Transitions and Animations), Bootstrap Framework, CSS Versions and Standards.	
Module-II	Dynamic Web Applications: JavaScript: Basics, Statements, Hierarchy of Objects, Methods, Properties, Event Handling, Integrating JavaScript with Various Elements of HTML, Cookies, JSON, Applications. Document Object Model: DOM Manipulation, Selecting Elements, working with DOM Nodes, Updating Element Content & Attributes, Events, Different Types of Events, How to Bind an Event to an Element, Event Delegation, Event Listeners.	**7**
Module-III	Form enhancement and validation: Form Handling Techniques, Client-Side Validation, Error Handling, and User Input Validation. Introduction to MERN: MERN Components, Serverless Hello World. React Components: Issue Tracker, React Classes, Composing Components, Passing Data Using Properties, Passing Data Using Children, Dynamic Composition.	**7**
Module-IV	React State: Initial State, Async State Initialisation, Updating State, Lifting State Up, Event Handling, Stateless Components, Designing Components, State vs. Props, Component Hierarchy, Communication, Stateless Components. Express, REST API, GraphQL, Field Specification, Graph Based, Single Endpoint, Strongly Typed, Introspection, Libraries, The About API GraphQL Schema File, The List API, List API Integration, Custom Scalar types, The Create API, Create API Integration, Query Variables, Input Validations, Displaying Errors.	**8**
Module-V	MongoDB: Basics, Documents, Collections, Databases, Query Language, Installation, The Mongo Shell, MongoDB CRUD Operations, Create, Read, Projection, Update, Delete, Aggregate, MongoDB Node.js Driver, Schema Initialisation, reading from MongoDB, writing to MongoDB. Modularisation and Webpack: Back-End Modules, Front-End Modules and Webpack Transform and Bundle, Libraries Bundle, Hot Module Replacement, Debugging Define Plugin: Build Configuration, Production Optimisation.	**8**

Learning Resources:

Textbooks:	1. Chris Bates, "Web Programming- Building Internet Applications", John Wiley & Sons, Edition- 3rd Edition, 2006 2. Akshi Kumar, "Web Technology: Theory and Practice", Chapman and Hall/CRC, Edition- 1st Edition, 2018
Reference Books:	1. Ethan Brown, Web Development with Node and Express: Leveraging the JavaScript Stack, 3rd Edition, O'Reilly Media, 2024. 2. Jon Duckett, "JavaScript & jQuery: Interactive Front-End Web Development", Wiley, 2014. 3. Vasan Subramanian, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node". Apress, 2019. 4. Brad Dayley, Brendan Dayley, and Caleb Dayley, "Node.Js, Mongodb and Angular Web Development: The Definitive Guide to Using the Mean Stack to Build Web Applications", 2nd Edition, Pearson Education, 2018
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Programs using JavaScript basics including variables, operators, console output, and alert boxes.
2.	Programs using JavaScript arrays and array manipulation operations.
3.	Programs using JavaScript string handling and manipulation functions.
4.	Programs using JavaScript user-defined functions and palindrome verification
5.	Programs using JavaScript objects, properties, methods, and object traversal.
6.	Design event-driven web applications using DOM manipulation and event handling
7.	Development of React applications using functional components.
8.	Development of React applications using state management techniques
9.	Program using React Hooks and component lifecycle methods
10.	Development of RESTful web services using Express.js and Node.js. Development of Full-stack MERN application integrating React, Express.js, Node.js, and MongoDB

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: E-Commerce Technologies and Management

Course Code CABM 216

L-T-P: 3-0-2

Credits: 4

Pre-requisites: NIL

Course Outcomes:

CO-1	To Understand the E-Commerce Value Chain in Technology enabled environment
CO-2	To analysis the E-commerce Business Models and their performance Management
CO-3	To Evaluate the various electronic payment methods for secure online Transaction
CO-4	To analysis the Ethical, social, political and legal aspect of E-Commerce Technology.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**1**	**-**	**-**	**3**	**2**	**1**	**-**	**-**	**-**
CO-2	**-**	**-**	**-**	**3**	**2**	**1**	**-**	**1**	**-**
CO-3	**2**	**-**	**1**	**3**	**2**	**2**	**-**	**-**	**-**
CO-4	**-**	**-**	**-**	**3**	**1**	**3**	**-**	**-**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Overview of developments in Information Technology and Defining E-Commerce:, ecommerce vs e-business, value chain in ecommerce, Porter's value chain model, competitive advantage and competitive strategy, Technical and Economic Challeges for E-commerce
Module-II	E-Commerce framework and Architecture; E-commerce based Business models, Business to customer and business to business e-commerce, Impact of E-Commerce. E-Commerce performance Management.
Module-III	E-commerce management and security, Secure Electronic Payment-debit card, credit card, smart cards, E-Wallets; payment gateways; Electronic Fund Transfer; Emerging modes and systems of E-payment (M-Paisa, PayPal and other digital currency), UPI Apps, Aadhar-Enabled Payment Systems, BHIM App.
Module-IV	Understanding Ethical, Social and Political issues in E-Commerce: Basic Ethical

	Concepts, Analyzing Ethical Dilemmas, Legal Framework for E-Commerce: E-Commerce Legal Framework – Rights and Obligations in the World of E-commerce, Signing a contract Electronically – Domain name and Registration
Module-V	

Learning Resources:

Textbooks:	1. Elias M Award, "Electronic Commerce from Vision to Fulfilment", 3rd Edition, PHI, 2. Kutz, M, "Introduction to E-Commerce: Combining Business and Information Technology". Bookboon, Denmark, 2016. 3. Turban, E., King, D., Lee, J. K., Liang, T. P., & Turban, D. C. (2015). Electronic Commerce: A Managerial and Social Networks Perspective (8th ed.). Springer.
Reference Books:	1. Laudon, K. C., & Traver, C. G. (2021). E-commerce 2021–2022: Business. technology. society. (17th ed.). Pearson. 2. Andam, Z. R. B. (2003). E-commerce and e-business. Asia-Pacific Development Information Programme (UNDP-APDIP). 3. Pondicherry University, Directorate of Distance Education. (n.d.). E-Commerce (Paper Code: BCOM2005). [Bachelor of Commerce II Year Study Material]. Retrieved from https://dde.pondiuni.edu.in/files/StudyMaterials/UG/BCom/2year/BCOM2005ECommerceWM.pdf
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Departmental Elective (Bouquet II)

Course Title: Nature Inspired Algorithms

Course Code: CALM 261

L-T-P: 3-0-0

Credits: 3

Pre-requisites: NIL

Course Outcomes:

CO-1	Explain the fundamental concepts of Nature Computing, including self-organization, emergence, complexity, chaos, fractals, and nature-inspired computational paradigms.
CO-2	Apply evolutionary computing techniques such as hill climbing, simulated annealing, genetic algorithms, evolutionary programming, and genetic programming to solve optimization problems.
CO-3	Analyze swarm intelligence principles and implement optimization approaches based on Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO).
CO-4	Evaluate the performance and suitability of bio-inspired optimization algorithms, including Artificial Bee Colony (ABC) algorithms, hybrid optimization approaches, and memetic algorithms for complex computational problems.
CO-5	Design and develop solute.ons using advanced nature-inspired algorithms such as Cuckoo Search, Firefly, Bat, and Dolphin Echolocation algorithms for engineering, machine learning, robotics, and decision-support applications

Course Articulation Matrix:

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**2**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**
CO-2	**2**	**3**	**-**	**2**	**1**	**1**	**3**	**1**	**-**
CO-3	**2**	**3**	**-**	**2**	**1**	**1**	**3**	**-**	**1**
CO-4	**2**	**2**	**1**	**1**	**-**	**1**	**2**	**1**	**-**
CO-5	**1**	**3**	**1**	**2**	**1**	**1**	**3**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**

Module-I	**Introduction to Nature Computing** Introduction to Nature Computing and Nature Inspired Algorithms. Motivation, philosophy, and major branches of nature-inspired computing. Concepts of individuals, entities, and agents. Principles of parallelism, distributivity, interactivity, adaptation, feedback, self-organization, complexity, and emergence. Exploration and exploitation strategies in optimization. Comparison of bottom-up and top-down approaches. Fundamentals of chaos and fractals.	**6**
Module-II	**Computing Inspired by Nature** Introduction to meta-heuristic optimization and its characteristics. Evolutionary computing concepts. Hill climbing and simulated annealing. Darwin's theory of evolution and principles of genetics. Standard evolutionary algorithms, including genetic algorithms, reproduction, selection, crossover, and mutation. Evolutionary programming and genetic programming. Applications of evolutionary techniques in optimization and search problems.	**8**
Module-III	**Swarm Intelligence** Introduction to swarm intelligence and collective behaviour in nature. Ant colonies and ant foraging behaviour. Ant Colony Optimization (ACO), Simple Ant Colony Optimization (SACO), Ant Colony Algorithm (ACA), variants of ACO, and their applications in routing, scheduling, and optimization. Swarm robotics, social adaptation of knowledge, and cooperative problem-solving. Particle Swarm Optimization (PSO), algorithmic principles, variants, and applications.	**8**
Module-IV	**Bio-Inspired and Hybrid Optimization Algorithms** Artificial Bee Colony (ABC) algorithm. Bee foraging behaviour and communication mechanisms. Structure, working principles, and applications of ABC. Hybrid optimization approaches and their advantages. Memetic algorithms, concepts, implementation, and performance enhancement. Comparative analysis of bio-inspired optimization techniques and hybrid meta-heuristic frameworks.	**7**
Module-V	**Recent Trends and Applications Applications** Recent advances in nature-inspired computing. Cuckoo Search algorithm, Firefly algorithm, Bat algorithm, and Dolphin Echolocation algorithm, including biological inspiration, algorithmic design, and applications. Emerging trends in swarm and evolutionary computation. Engineering, industrial, and real-world applications of nature-inspired algorithms in optimization, machine learning, robotics, network design, scheduling, and decision support systems.	**7**

Learning Resources:

Textbooks:	1. Leandro Nunes de Castro, "Fundamentals of Natural Computing: Basic Concepts, Algorithms and Applications", Chapman & Hall/CRC, Taylor & Francis Group, Edition- 1st Edition, 2007. 2. Xin-She Yang, "Nature-Inspired Optimization Algorithms", Academic Press, Edition- 2nd Edition, 2020
Reference Books:	1. George Lindfield and John Penny, "Introduction to Nature-Inspired Optimization", Publisher- Academic Press, Edition- 1st Edition, 2017 2. Dario Floreano and Claudio Mattiussi, "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, Edition- 1st Edition, 2008. 3. Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, Edition- 1st Edition, 2006. 4. Marco Dorigo and Thomas Stützle, "Ant Colony Optimization", PHI (Prentice Hall of India), Edition- 1st Edition, 2005. 5. Raymond Chiong, "Nature-Inspired Algorithms for Optimisation", Springer, Edition- 1st Edition, 2009.
Other Suggested Readings:	

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Statistical Methods for Data Science

Course Code: CALM 262

L-T-P: 3-0-0

Credits: 3

Pre-requisites: NIL

Course Outcomes:

CO-1	Explain fundamental statistical concepts and their role in data science.
CO-2	Apply descriptive and inferential statistical techniques to analyze datasets.
CO-3	Analyze relationships among variables using correlation and regression techniques.
CO-4	Evaluate statistical models and hypothesis testing procedures for decision making.
CO-5	Apply statistical methods using software tools for solving real-world data science problems.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**1**	**2**	**-**	**-**	**-**	**1**	**2**	**-**
CO-2	**3**	**2**	**3**	**-**	**-**	**-**	**1**	**3**	**-**
CO-3	**2**	**2**	**3**	**1**	**-**	**-**	**1**	**3**	**1**
CO-4	**2**	**1**	**3**	**2**	**-**	**1**	**1**	**2**	**2**
CO-5	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	**Fundamentals of Statistics and Data Analysis** Introduction to data science and statistical thinking, types of data, data collection methods, data preprocessing, descriptive statistics, measures of central tendency, measures of dispersion, skewness, kurtosis, data visualization techniques, exploratory data analysis.	**8**
Module-II	**Probability and Statistical Distributions**	**8**

	Probability concepts, conditional probability, Bayes' theorem, random variables, probability distributions, Binomial distribution, Poisson distribution, Normal distribution, Exponential distribution, sampling distributions, Central Limit Theorem.	
Module-III	**Statistical Inference and Hypothesis Testing** Sampling techniques, parameter estimation, confidence intervals, hypothesis testing, one-sample and two-sample tests, Z-test, t-test, Chi-square test, F-test, Analysis of Variance (ANOVA), p-values and statistical significance.	**7**
Module-IV	**Correlation and Regression Analysis** Covariance and correlation analysis, simple linear regression, multiple regression, logistic regression, model fitting, residual analysis, goodness-of-fit measures, model evaluation and interpretation.	**7**
Module-V	**Statistical Methods for Data Science Applications** Feature selection techniques, dimensionality reduction concepts, statistical approaches for classification and prediction, outlier detection, A/B testing, time-series basics, statistical analysis using Python libraries such as NumPy, Pandas, SciPy and Statsmodels, case studies in data science.	**6**

Learning Resources:

Textbooks:	1. Peter Bruce, Andrew Bruce and Peter Gedeck, "Practical Statistics for Data Scientists", O'Reilly Media, 2nd Edition, 2020. 2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press, 6th Edition, 2020.
Reference Books:	1. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning", Springer, 2nd Edition, 2021. 2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", O'Reilly Media, 2nd Edition, 2014. 3. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson, 6th Edition, 2007.
Other Suggested Readings:	

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Wireless Sensor Networks

Course Code: CALM 263

L-T-P: 3-0-0

Credits: 3

Pre-requisites:

Course Outcomes:

CO-1	Explain the architecture, characteristics, and applications of Wireless Sensor Networks
CO-2	Analyze wireless communication technologies, MAC protocols, and energy-efficient networking mechanisms
CO-3	Design and evaluate routing protocols for efficient data transmission in WSNs
CO-4	Apply localization, synchronization, data aggregation, and security techniques in sensor networks
CO-5	Develop and assess WSN-based solutions for IoT and smart environment applications

Course Articulation Matrix:

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**2**
CO-2	**3**	**2**	**2**	**3**	**1**	**1**	**2**	**1**	**3**
CO-3	**3**	**3**	**2**	**3**	**1**	**1**	**3**	**1**	**3**
CO-4	**3**	**2**	**2**	**3**	**1**	**2**	**2**	**1**	**3**
CO-5	**2**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction to Wireless Sensor Networks - Introduction to WSNs, Evolution and Applications of WSNs, Characteristics and Challenges of Sensor Networks, Sensor Node Architecture, WSN Architecture and Design Issues, Hardware Components of Sensor Nodes, Comparison of Ad Hoc Networks and WSNs

Module-II	Wireless Communication and MAC Protocols - Wireless Communication Fundamentals, Radio Propagation Models, Energy Consumption in WSNs, Medium Access Control (MAC) Protocols, S-MAC, T-MAC, B-MAC, IEEE 802.15.4 Standard, ZigBee Architecture and Protocol Stack
Module-III	Routing Protocols in WSN - Routing Challenges in WSN, Data-Centric Routing Protocols, Hierarchical Routing Protocols, Location-Based Routing Protocols, LEACH, PEGASIS, TEEN, APTEEN, QoS-Aware Routing, Energy-Efficient Routing Techniques
Module-IV	Data Aggregation, Localization, and Security - Data Aggregation Techniques, Data Fusion and Compression, Localization and Positioning Methods, Time Synchronization in WSNs, Security Requirements in WSN, Key Management and Secure Routing, Attacks and Countermeasures in WSN
Module-V	IoT Integration and Advanced Topics - WSN and Internet of Things (IoT), Cloud-Assisted Sensor Networks, Mobile Sensor Networks, Underwater and Multimedia Sensor Networks, Machine Learning in WSN, Smart Cities and Industrial IoT Applications, Recent Trends and Research Challenges

Learning Resources:

Textbooks:	1. Simon Haykin, Neural Networks: A Comprehensive Foundation, Pearson, Second Edition, 2001. 2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, Third Edition, 2009. 3. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, Wiley India, Second Edition, 2007.
Reference Books:	1. Melanie Mitchell, An Introduction to Genetic Algorithms, Prentice Hall, 1998. 2. D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989. 3. S. V. Kartalopoulos, Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications, IEEE Press/PHI, 2014. 4. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications, PHI, 2003.
Other Suggested Readings:	1. Xin-She Yang, Nature-Inspired Optimization Algorithms, Elsevier, 2014. 2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Natural Language Processing

Course Code: CALM 264

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Data Structures, Probability and Statistics, Linear Algebra, Python Programming, Machine Learning Fundamentals

Course Outcomes:

CO-1	Understand the fundamental concepts, linguistic structures, and preprocessing techniques used in Natural Language Processing.
CO-2	Apply statistical and probabilistic models for language modeling, sequence labeling, and text analysis.
CO-3	Design and implement machine learning and deep learning models for solving NLP tasks.
CO-4	Develop NLP-based solutions for real-world applications such as sentiment analysis, machine translation, information retrieval, and conversational systems.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	**3**	**2**	**2**		**1**	**1**	**2**	**3**	**2**
CO-2	**3**	**2**	**3**	**2**		**1**	**2**	**3**	**2**
CO-3	**3**	**3**	**3**	**2**	**2**		**3**	**3**	**3**
CO-4	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-II	Statistical Natural Language Processing: Probabilistic Language Models, N-Gram Language Models, Maximum Likelihood Estimation (MLE), Smoothing Techniques, Hidden Markov Models (HMMs), Viterbi Algorithm, Part-of-Speech Tagging using HMMs.

Module-III	Syntax and Semantics: Context-Free Grammars, Dependency Parsing, Semantic Parsing, Semantic Role Labeling, Word Sense Disambiguation, Distributional Semantics.
Module-IV	Machine Learning and Applications of NLP: Supervised and Unsupervised Learning in NLP, Naïve Bayes, Decision Trees, Maximum Entropy Models, Support Vector Machines, Neural Networks, Information Retrieval, Text Classification, Sentiment Analysis, Machine Translation and Speech Recognition.

Learning Resources:

Textbooks:	1. Speech and Language Processing, Daniel Jurafsky and James H. Martin, 3rd Edition, Pearson.
Reference Books:	1. Natural Language Processing with Transformers, Lewis Tunstall, Leandro Von Werra and Thomas Wolf, O'Reilly Media, 2023. 2. Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta and Harshit Surana, O'Reilly Media, 2021. 3. Natural Language Understanding, James Allen, 2nd Edition, Pearson Education, 2007. 4. Natural Language Processing: A Paninian Perspective, Akshar Bharati, Vineet Chaitanya and Rajeev Sangal, PHI Learning, 2023. 5. Natural Language Processing and Information Retrieval, Tanveer Siddiqui and U. S. Tiwary, Oxford University Press, 2008.
Other Suggested Readings:	Recent literature on Transformer Models, Large Language Models and Generative AI.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Information Storage and Retrieval

Course Code: CALM 265

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Data Mining and Warehousing and Relational Database Management Systems

Course Outcomes:

CO-1	Describe the components, architecture, and operations of an Information Retrieval (IR) system, including text processing, indexing, and retrieval of textual data.
CO-2	Implement indexing techniques such as inverted index, suffix trees, and signature files for efficient information storage and retrieval.
CO-3	Apply Boolean, vector space, and probabilistic retrieval models to perform queries and interpret retrieval results.
CO-4	Design, develop, test, and evaluate Information Retrieval systems using performance measures such as precision, recall, F-score, and related metrics.
CO-5	Apply web scraping, distributed information retrieval, multimedia retrieval, Semantic Web concepts, and recommendation techniques to real-world IR applications.

Course Articulation Matrix:

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**2**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**
CO-2	**2**	**3**	**2**	**2**	**1**	**1**	**3**	**1**	**-**
CO-3	**2**	**3**	**2**	**2**	**1**	**1**	**3**	**1**	**1**
CO-4	**2**	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**1**
CO-5	**2**	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Introduction to Information Retrieval: Basic Concepts of Information Retrieval, Data Retrieval vs. Information Retrieval, Relationship between Text Mining and Retrieval, System Block Diagram, Automatic	**6**

	Text Analysis: Luhn's Ideas, Conflation Algorithm, Indexing and Index Term Weighting, Probabilistic Indexing, Automatic Classification, Measures of Association, Different Matching Coefficients, Cluster Hypothesis, Clustering Techniques: Rocchio's Algorithm, Single Pass Algorithm, Single Link Algorithm.	
Module-II	Indexing and Searching Techniques: Indexing: Inverted File, Suffix Trees and Suffix Arrays, Signature Files, Scatter Storage or Hash Addressing, Searching Techniques: Boolean Search, Sequential Search, Serial Search, Cluster-Based Retrieval, Query Languages, Types of Queries, Pattern Matching, Structural Queries, Retrieval Models: Basic Concepts, Boolean Model, Vector Model, Probabilistic Model.	**7**
Module-III	Evaluation and Visualization: Performance Evaluation: Precision and Recall, Mean Reciprocal Rank (MRR), F-Score, NDCG, User-Oriented Measures, Visualization in Information Systems: Starting Points, Query Specification, Document Context, User Relevance Judgment, Interface Support for Search Process.	**7**
Module-IV	Distributed and Multimedia Retrieval:Distributed Retrieval: Introduction, Collection Partitioning, Source Selection, Query Processing, Multimedia Retrieval: Introduction, Data Modeling, Query Language, Background-Spatial Access Method, A Generic Multimedia Indexing Approach, One-Dimensional Time Series, Two-Dimensional Color Images, Automatic Feature Extraction, Trends and Research Issues.	**8**
Module-V	Web Searching: Introduction, Challenges, Web Characteristics, Search Engines: Centralized Architecture, Distributed Architecture, User Interfaces, Ranking, Crawling the Web, Indices, Browsing, Meta-Searchers, Searching Using Hyperlinks, Trends and Research Issues, Introduction to Web Scraping: Python for Web Scraping, Request, HTML Parsing, Beautiful Soup.	**8**

Learning Resources:

Textbooks:	1. Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, Introduction to Information Retrieval, 1st Edition, Cambridge University Press, 2008. 2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval: The Concepts and Technology Behind Search, 2nd Edition, Addison-Wesley/Pearson, 2011.

Reference Books:	1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, 2nd Edition, Addison-Wesley, 2011. 2. David A. Grossman and Ophir Frieder, Information Retrieval: Algorithms and Heuristics, 2nd Edition, Springer, 2004. 3. W. Bruce Croft, Donald Metzler, and Trevor Strohman, Search Engines: Information Retrieval in Practice, Addison-Wesley, 2009.
Other Suggested Readings:	

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Cloud Computing

Course Code: CALM 266

L-T-P: 3-0-2

Credits: 4

Pre-requisites:

Course Objectives:

CObj-1	To introduce the fundamental concepts, service models, and deployment models of Cloud Computing.
CObj-2	To develop the ability to design and implement cloud applications using modern platforms and tools.
CObj-3	To enable students to analyze cloud architectures, resource provisioning, and virtualization techniques.
CObj-4	To explore cloud security, governance, and compliance frameworks.
CObj-5	To provide exposure to emerging paradigms such as edge computing, IoT integration, and quantum cloud computing.

Course Outcomes:

CO-1	Understanding the fundamentals of Cloud Computing, including service models and deployment models (L2).
CO-2	Apply cloud programming frameworks and tools to develop scalable applications (L3).
CO-3	Analyze cloud architectures, resource provisioning strategies, and differentiate between compute, storage, and networking services across platforms (L4).
CO-4	Design cloud-based solutions integrating big data, IoT, and edge computing, and implement case studies in different domains (L6).

Course Articulation Matrix:

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO1	2	1	1	1	1	1	1	2	1
CO2	2	2	2	1	2	1	2	3	2
CO3	2	2	3	1	2	1	2	3	2
CO4	2	3	3	3	3	1	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**

Module-I	**Foundation of Cloud Computing (8 Hours)** Introduction to Cloud Computing: definition, scope, and characteristics. Service models: IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service). Deployment models: Public cloud, Private cloud, Hybrid cloud, Community cloud. Virtualization concepts: hypervisors, virtual machines, containers. Benefits, challenges, and economics of cloud adoption.	**8**
Module-II	**Cloud Architecture and Services (8 Hours)** Cloud reference architecture. Resource provisioning and elasticity. Compute services: Amazon EC2, Google Compute Engine, Microsoft Azure Virtual Machines. Storage services: Amazon S3, Google Cloud Storage, Azure Blob Storage. Networking in cloud: Virtual Private Cloud (VPC), load balancing, content delivery networks (CDN). Identity and access management.	**8**
Module-III	**Cloud Programming and Tools (8 Hours)** Cloud application development models. APIs and Web services in cloud. Programming frameworks: Hadoop, MapReduce, Apache Spark. Containerization and orchestration: Docker, Kubernetes. Serverless computing: AWS Lambda, Google Cloud Functions, Azure Functions. Case studies in cloud application development.	**8**
Module-IV	**Security, Governance, and Compliance (8 Hours)** Cloud security fundamentals: authentication, authorization, encryption. Data privacy and protection in cloud. Security challenges: multi-tenancy, insider threats, data breaches. Governance frameworks and compliance standards: GDPR (General Data Protection Regulation), HIPAA (Health Insurance Portability and Accountability Act), ISO/IEC 27001. Risk management and disaster recovery in cloud environments.	**8**
Module-V	**Emerging Trends and Applications (8 Hours)** Cloud for big data analytics and machine learning. Edge computing and fog computing. Cloud in Internet of Things (IoT). Multi-cloud and hybrid cloud strategies. Case studies: cloud in healthcare, agriculture, finance, and smart cities.	**8**

Learning Resources:

Textbooks:	1. R. Buyya, C. Vecchiola and S. T. Selvi "*Mastering Cloud Computing: Foundations and Applications Programming*" Morgan Kaufmann Pub, 2013. 2. T. Erl, Z. Mahmood, and R. Puttini, "*Cloud Computing Concepts, Technology & Architecture*", Pearson, 2013. 3. T. Velte, A. Velte and R. Elsenpeter, "*Cloud Computing, A Practical Approach*", McGraw Hill Education, 2017.

Reference Books:	1. G. Reese, "*Cloud Application Architectures: Building Applications and Infrastructure in the Cloud*", O'Reilly, First Edition, 2011. 2. M. Miller, "*Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online*", Que Pub, 2008. 3. K. Hwang, J. Dongarra and G. C. Fox, "*Distributed and Cloud Computing: From Parallel Processing to the Internet of Things*", Morgan Kaufmanns, First Edition, 2013.
Other Suggested Readings:	

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Modeling and Simulation

Course Code: CALM 267

L-T-P: 3-0-0

Credits: 3

Pre-requisites:

Course Outcomes:

CO-1	To provide strong foundation on concept [K1]
CO-2	To understand of simulation and modelling and practice to design simulation models. [K1, K2]
CO-3	To Analyse the different System Dynamics & Probability Concepts in Simulation. [K4]
CO-4	To Apply the concept of the Simulation of Queuing Systems and Discrete System. [K3, K6]

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**2**	**2**	**2**	**2**	**1**	**-**	**1**	**2**	**2**
CO-2	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**2**
CO-3	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**
CO-4	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Modeling and Simulation: Nature of Simulation systems, Models and Simulation, Continuous and Discrete Systems, System Modeling, Concept of Simulation, Components of Simulation study, Principles used in modeling, Static and Dynamic physical models, Static and Dynamic Mathematical models. Introduction to Static and Dynamic System Simulation, Advantages, Disadvantages and pitfalls of Simulation.	**10**
Module-II	System Simulation and Continuous System: Simulation Types of System Simulation, Monte Carlo Method, Comparison of analytical and	**10**

	Simulation methods, Numerical Computation techniques for Continuous and Discrete Models, Distributed Lag Models, Cobweb Model, Continuous System Models, Analog and Hybrid computers, Digital Analog Simulators, Continuous system simulation languages, Hybrid simulation, Real Time Simulations.	
Module-III	System Dynamics & Probability Concepts in Simulation: Exponential growth and decay models, logistic curves, Generalization of growth models, System dynamics diagrams, Multi segment models, Representation of Time Delays, Discrete and Continuous Probability functions, Continuous Uniformly Distributed Random Numbers, Generation of Random Numbers, Generating Discrete Distributions, Non Uniform Continuously Distributed Random Numbers, Rejection Method.	**8**
Module-IV	Simulation of Queuing Systems and Discrete System: Simulation Poisson arrival patterns, Exponential Distribution, Service Times, Normal Distribution Queuing Disciplines, Simulation of Single and Two Server Queue. Application of queuing theory in computer system, Discrete Events. Generation of arrival patterns, Simulation Programming tasks, Gathering Statistics, Measuring Occupancy and Utilization, Recording Distribution and Transmit Times.	**8**

Learning Resources:

Textbooks:	[T1] Dr Shailendra Jain, "Modeling & Simulaion Using Matlab and Simulink", Wiley. [T2] James Harrington, KerimTumay, "Simulation Modeling Methods", TMGH.
Reference Books:	[R1] Jerry Banks, John S Carson, "Discrete event System Simulation", Pearson Education [R2] Gordon G., "System Simulation", PHI Learning India [R3] Frank L Severence, "System Modelling and Simulation an Introduction", Wiley
Other Suggested Readings:	

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Soft Computing

Course Code: CALM 268

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Fundamentals of Artificial Intelligence, Probability and Statistics

Course Outcomes:

CO-1	Explain the fundamental concepts, components, and applications of Soft Computing
CO-2	Apply fuzzy logic principles and fuzzy inference systems to solve problems involving uncertainty
CO-3	Design and implement Artificial Neural Network models for classification, prediction, and pattern recognition tasks
CO-4	Utilize evolutionary and swarm intelligence algorithms to solve optimization problems
CO-5	Develop hybrid soft computing solutions for complex real-world applications and emerging intelligent systems.

Course Articulation Matrix:

COs /POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**
CO-2	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**3**	**1**
CO-3	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**3**	**1**
CO-4	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**3**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction to Soft Computing - Fundamentals of Soft Computing, Hard Computing vs. Soft Computing, Components of Soft Computing, Applications of Soft Computing, Basics of Artificial Intelligence and Computational Intelligence, Introduction to Uncertainty and Approximate Reasoning

Module-II	Fuzzy Logic Systems - Classical Sets and Fuzzy Sets, Membership Functions, Fuzzy Set Operations, Fuzzy Relations and Composition, Fuzzy Inference Systems, Fuzzification and Defuzzification Methods, Mamdani and Sugeno Fuzzy Models, Applications of Fuzzy Logic
Module-III	Artificial Neural Networks (ANN) - Biological Neuron and Artificial Neuron Models, Architecture of Neural Networks, Learning Methods, Perceptron and Multi-Layer Perceptron (MLP), Backpropagation Algorithm, Radial Basis Function Networks, Associative Memory Networks, Applications of Neural Networks
Module-IV	Evolutionary Computing - Genetic Algorithms (GA), Representation and Encoding, Selection, Crossover, and Mutation Operators, Fitness Functions, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Applications in Optimization Problems.
Module-V	Hybrid Soft Computing Systems and Applications - Neuro-Fuzzy Systems, Genetic-Fuzzy Systems, Hybrid Intelligent Systems, Soft Computing in Data Mining, Pattern Recognition and Classification, Image Processing Applications, Recent Trends: Deep Learning, Swarm Intelligence, Explainable AI

Learning Resources:

Textbooks:	1. Simon Haykin, Neural Networks: A Comprehensive Foundation, Pearson, 2nd Edition, 2001. 2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 3rd Edition, 2009. 3. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, Wiley India, 2nd Edition, 2007.
Reference Books:	1. Melanie Mithell, An Introduction to Genetic Algorithms, Prentice Hall, 1998. 2. D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989. 3. S. V. Kartalopoulos, Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications, IEEE Press/PHI, 2014. 4. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications, PHI, 2003.
Other Suggested Readings:	1. Xin-She Yang, Nature-Inspired Optimization Algorithms, Elsevier, 2014. 2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.

National Institute Of Technology Delhi

Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Foundations of Cryptography

Course Code: CALM 269

L-T-P: 3-0-0

Credits: 3

Pre-requisites: NIL

Course Outcomes:

CO-1	Explain the fundamental concepts of cryptography and security mechanisms for secure communication.
CO-2	Apply classical cryptographic techniques for encryption and decryption of information
CO-3	Analyze symmetric-key cryptographic algorithms and their modes of operation.
CO-4	Apply public-key cryptographic techniques for secure communication and key exchange.
CO-5	Analyze authentication mechanisms and modern cryptographic applications.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**1**		**2**			**1**		**2**
CO-2	**3**	**2**		**1**			**2**		**1**
CO-3	**3**	**2**		**3**			**2**		**3**
CO-4	**3**	**2**		**3**			**2**		**3**
CO-5	**2**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**3**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Information Security Concepts, CIA Triad, Authentication and Authorization, Threats, Vulnerabilities and Attacks, Security Services and Mechanisms (Encryption, Digital Signatures, Authentication and Access Control Mechanisms)
Module-II	Classical Cryptography: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Vigenère Cipher, Rail Fence Cipher, Cryptanalysis Techniques.
Module-III	Symmetric-Key Cryptography: Block and Stream Ciphers, Feistel Network, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Modes of

	Operation (ECB, CBC, CFB, OFB, CTR).
Module-IV	Public-Key Cryptography: Principles of Public-Key Cryptography, RSA Algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptosystem introduction to Elliptic Curve Cryptography (ECC).
Module-V	Authentication and Modern Applications: Cryptographic Hash Functions Message Authentication Codes (MAC), Digital Signatures, Public Key Infrastructure (PKI), SSL/TLS Overview, Cryptography in Blockchain and Cryptocurrency, introduction to Quantum Cryptography

Learning Resources:

Textbooks:	1. Cryptography and Network Security: Principles and Practice, William Stallings, 8th Edition, Pearson
Reference Books:	1. Cryptography and Network Security, Behrouz A. Forouzan, Debdeep Mukhopadhyay, McGraw Hill. 2. Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell, CRC Press. 3. Cryptography: Theory and Practice, Douglas R. Stinson and Maura Paterson, CRC Press. 4. Cryptography and Network Security, Atul Kahate, McGraw Hill Education.
Other Suggested Readings:	1. Publications on Cryptographic Standards (AES, SHA, Digital Signatures). 2. Applied Cryptography, Bruce Schneier, Wiley.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Mobile Computing

Course Code: CALM 270

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Nil

Course Outcomes:

CO-1	To understand the fundamental principles of wireless transmission, signal propagation, multiplexing techniques, and the core mechanics of frequency management and hand-off characteristics in cellular networks [L1]
CO-2	To analyze the structural subsystems, multiple-access techniques (SDMA/FDMA/TDMA/CDMA), and the core operational of GSM and evolutionary telecommunication standards [L4].
CO-3	To analyze the operational topologies, protocol stacks, and service capabilities of standard infrastructure/ad-hoc Wireless LANs (IEEE 802.11) against Wireless Personal Area Networks (Bluetooth) [L4].
CO-4	To analyze the systemic limitations of standard internet protocols (IP/TCP) when deployed over wireless links, and mathematically/conceptually appraise the theoretical efficiency of specialized mobile transport variations [L4].
CO-5	To understand the architectural frameworks, gateway translation models, and caching mechanisms of the Wireless Application Protocol (WAP) stack and location-based service environments [L2].

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**2**
CO-2	**3**	**-**	**-**	**3**	**-**	**1**	**-**	**-**	**3**
CO-3	**3**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**3**
CO-4	**3**	**-**	**-**	**3**	**-**	**1**	**-**	**-**	**3**
CO-5	**2**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Introduction to Wireless Networks - Applications - History - Simplified Reference Model - Wireless transmission - Frequencies - Signals - Antennas - Signal propagation - Multiplexing - Modulation - Spread spectrum - Cellular Systems: Frequency Management and Channel	**7**

	Assignment - types of hand-off and their characteristics.	
Module-II	MAC - Motivation - SDMA - FDMA - TDMA - CDMA - Telecommunication Systems – GSM: Architecture Location tracking and call setup - Mobility management - Handover - Security - GSM - SMS - International roaming for GSM - call recording functions - subscriber and service data management - DECT - TETRA - UMTS - IMT-2000.	**7**
Module-III	Wireless LAN - Infrared vs. Radio transmission - Infrastructure - Adhoc Network - IEEE 802.11WLAN Standards - Architecture - Services - HIPERLAN - Bluetooth Architecture & protocols.	**8**
Module-IV	Mobile Network Layer - Mobile IP - Dynamic Host Configuration Protocol - Mobile Transport Layer - Traditional TCP - Indirect TCP - Snooping TCP - Mobile TCP - Fast retransmit/Fast recovery - Transmission/Time-out freezing - Selective retransmission - Transaction Oriented TCP.	**7**
Module-V	WAP Model - Mobile Location based services - WAP Gateway - WAP protocols - WAP user agent profile caching model - wireless bearers for WAP - WML - WML Scripts – WTA – iMode – SyncML.	**7**

Learning Resources:

Textbooks:	[T1] Jochen Schiller, "Mobile Communication", Second Edition, Pearson Education, 2008. [T2] Raj Kamal, Mobile Computing, Oxford University Press, 2019
Reference Books:	[R1] Rappaport Theodore S., Wireless Communications: Principal and Practice, Pearson Education, 2010. [R2] C. Siva Ram Murthy, B. S. Manoj, "Adhoc Wireless Networks: Architectures and Protocols", Second Edition, Pearson Education, 2008. [R3] Vijay. K. Garg, "Wireless Communication and Networking", First Edition, Morgan Kaufmann Publishers, 2008.
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Game Theory

Course Code: CALM 272

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Discrete Mathematics, Probability and Statistics, and Programming Fundamentals**.**

Course Outcomes:

CO-1	Understand the fundamental concepts and principles of Game Theory
CO-2	Analyze Nash Equilibrium and strategic behavior in competitive games.
CO-3	Apply game-theoretic models to analyze Prisoner's Dilemma, repeated games, and extensive-form games.
CO-4	Analyze and apply game-theoretic approaches for bargaining, pricing, and resource allocation problems.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**2**					**2**		
CO-2	**2**	**3**	**2**	**1**			**2**		
CO-3	**2**	**3**	**3**	**2**			**3**		
CO-4	**2**	**3**	**3**	**2**	**1**		**3**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction: What is game theory , The theory of rational choice, interacting decision makersNash Equilibrium: Theory Strategic games; the Prisoner's Dilemma, Bach or Stravinsky?, Brass Paradox, Matching Pennies, The stag Hunt, Nash Equilibrium, Best response functions, Dominated actions, Equilibrium in single population.
Module-II	Mixed Strategy Equilibrium Introduction, Mixed strategy Nash equilibrium, The formation of players' beliefs, finding all mixed strategy Nash equilibria, games in which each player has a continuum of actions
Module-III	Extensive Games with Perfect Information Introduction, Strategies and outcomes, Nash equilibrium, Subgame perfect equilibrium, Finding subgame perfect equilibria of finite horizon games, Stackelberg's model of duopoly Repeated Games:The Prisoner’s Dilemma, General Result

Module-IV	Bargaining Bargaining as an extensive game, Illustration: trade in a market, Nash's axiomatic model, Relation between strategic and axiomatic models.
Module-V	Incentives and Pricing in Communications Networks: Large Networks, Pricing and Resource Allocation, Alternative Pricing and Incentive Approaches

Learning Resources:

Textbooks:	1. Title- Algorithmic Game Theory, Author- Noam Nisan, Tim Roughgarden, Eva Tardos, and Vijay V. Vazirani, Publisher- Cambridge University Press, Edition- 2007. 2. Title: An Introduction to Game Theory, Author- Martin J. Osborne, Publisher- Oxford University Press, Edition- 1st Edition, 2003.
Reference Books:	1. Title- Game Theory for Applied Economists, Author- Robert Gibbons, Publisher- Princeton University Press, Edition- 1992.
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Information Systems Management

Course Code: CALM 273

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Nil

Course Outcomes:

CO-1	Understand the fundamental concepts, modalities, and applications of biometric security systems.
CO-2	Apply biometric feature extraction and matching techniques for person identification and verification.
CO-3	Analyse the performance, reliability, and security requirements of biometric
CO-4	Apply multimodal biometric techniques and biometric security mechanisms for authentication
CO-5	Analyse emerging trends, privacy issues, and applications of biometric security in modern systems.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**1**		**2**			**1**		**2**
CO-2	**3**	**2**	**1**	**2**			**2**	**2**	**2**
CO-3	**3**	**2**	**1**	**2**			**2**	**1**	**3**
CO-4	**3**	**2**		**2**			**2**	**1**	**3**
CO-5	**2**	**1**	**1**	**3**			**1**	**1**	**3**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction to Biometrics: Fundamentals of Biometrics, Biometric System Components, Verification and Identification, Biometric Characteristics, Performance Measures (FAR, FRR, EER), Applications of Biometric Security
Module-II	Physiological Biometrics: Fingerprint Recognition, Face Recognition, Iris Recognition, Retina Recognition, Palmprint Recognition, Feature Extraction and Matching Techniques

Module-III	Behavioral Biometrics: Signature Verification, Keystroke Dynamics, Voice Recognition, Gait Recognition, Behavioral Feature Extraction and Classification Techniques
Module-IV	Biometric System Security: Biometric Template Protection, Spoofing Attacks, Presentation Attacks, Liveness Detection, Biometric Cryptosystems, Multimodal Biometrics, Fusion Techniques.
Module-V	Applications: Privacy and Ethical Issues in Biometrics, Biometric Standards, Aadhaar and e-Governance Applications, Mobile Biometrics, Deep Learning for Biometrics, Emerging Trends in Biometric Security

Learning Resources:

Textbooks:	1. Introduction to Biometrics, Anil K. Jain, Arun A. Ross, Karthik Nandakumar, Springer. 2. Guide to Biometrics, Ruud M. Bolle et al., Springer.
Reference Books:	1. Handbook of Biometrics, Springer. 2. Biometrics: Identity Assurance in the Information Age, McGraw Hill. 3. Automatic Fingerprint Recognition Systems, Springer. 4. Automated Biometrics: Technologies and Systems, Springer.
Other Suggested Readings:	1. ISO/IEC 19794 Standards for Biometric Data Interchange Formats. 2. NIST Biometric Evaluation Reports and Guidelines. 3. IEEE papers on Biometrics and Security.

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Digital Image Processing

Course Code: CALM 274

L-T-P: 3-0-0

Credits: 3

Pre-requisites:

Course Outcomes:

CO-1	To provide the overview and fundamental concepts of digital image processing field. [K1]
CO-2	To learn and understand various image transform used in digital image processing. [K2]
CO-3	To analyse the various image processing algorithms to real problems. [K4]
CO-4	To apply the concept Image processing algorithms for develop applications. [K3, K6]

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**2**	**2**	**3**	**2**	**1**	**-**	**2**	**2**	**1**
CO-2	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**1**
CO-3	**2**	**2**	**2**	**3**	**1**	**2**	**2**	**3**	**2**
CO-4	**2**	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:	
Module	**Detailed Syllabus**
Module-I	Introduction: Digital image, steps of digital image processing systems, elements of visual perception, connectivity, and relations between pixels. Simple operations - arithmetic, logical, geometric operations. Mathematical preliminaries- 2D LTI systems, 2D convolution, correlation, 2D random sequence, 2D spectrum**.**
Module-II	Image Transforms: 2D orthogonal and unitary transforms- properties and examples. 2D DFT, FFT, DCT, Hadamard transform, Haar Transform, Slant transform, KL Transform- properties and examples. Image Enhancement: point processing, spatial filtering in space and frequency, Nonlinear filtering, Color image processing fundamentals.

Module-III	Image Restoration: Image observation and degradation model, circulant and block circulant matrices and their application in degradation model, Algebraic approach to restoration, Inverse by Wiener filtering, Generalized inverse- SVD and iterative methods, blind deconvolution, image reconstruction from projections.
Module-IV	Image Compression: Image compression: redundancy and compression models; lossless and lossy. Lossless- variable-length, Huffman, Arithmetic coding, bit-plane coding, Lossless predictive coding, lossy Transform (DCT) based coding, JPEG standard, sub-band coding.
Module-V	Image Segmentation & Applications: Edge detection, line detection, curve detection, Edge linking and boundary extraction, boundary representation, region representation and segmentation, morphology-dilation, erosion, opening, and closing. Image understanding and recognition: Matching by templates, classifiers, models, statistical, neural network-based, matching shapes by contour and texture. Applications: Automatic visual system in part inspection, forensic and security system, entertainment- multimedia, scientific and medical investigation.

Learning Resources:

Textbooks:	[T1] Gonzalez, Rafael C. Digital image processing. Pearson education india, 2009. Reference Books:
Reference Books:	[R1] Annadurai, S. Fundamentals of digital image processing. Pearson Education India, 2007. [R2] Pratt, William K. Digital image processing: PIKS Scientific inside. Vol. 4. Hoboken, New Jersey: Wiley-interscience, 2007..
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Peer-to-Peer Networking

Course Code: CALM 275

L-T-P: 3-0-0

Credits: 3

Pre-requisites:

Course Outcomes:

CO-1	Explain the fundamental concepts, architectures, protocols, and applications of Peer-to-Peer (P2P) networks, and distinguish them from traditional client-server systems.[K1]
CO-2	Analyze and design structured and unstructured P2P overlay networks using Distributed Hash Tables (DHTs) such as Chord, Kademlia, Pastry, and CAN for efficient resource discovery and routing. [K1, K2]
CO-3	Evaluate P2P communication, storage, and content distribution mechanisms, and assess their performance in terms of scalability, reliability, load balancing, and fault tolerance. [K3]
CO-4	Investigate security, trust, privacy, and incentive mechanisms in P2P systems, and apply these concepts to emerging decentralized applications such as blockchain, IoT, and edge computing [K3, K4]

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**3**	**3**	**3**	**3**	**1**	**-**	**2**	**3**	**1**
CO-2	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**1**
CO-3	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**2**
CO-4	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Introduction: Introduction to P2P Systems, Evolution of distributed computing, Client-server versus Peer-to-Peer paradigm, Characteristics of P2P systems, Advantages and limitations of P2P networks, Overlay networks and virtual topologies, P2P Architectures - Centralized P2P architecture, Decentralized architecture, Hybrid architecture, Structured and unstructured P2P systems, Super-peer architectures, P2P Applications.	**10**

Module-II	Distributed Hash Tables and Resource Discovery: Hashing Mechanisms, Distributed Hash Tables (DHTs)- Concepts and design principles, Key-space partitioning, Resource indexing and lookup, Structured P2P Protocols - Chord architecture, Finger tables, Distance metrics, Node join and leave operations, Routing complexity analysis, Advanced DHT Systems – Kademlia, Pastry, Tapestry, CAN (Content Addressable Network).	**10**
Module-III	P2P Services, Topology Control and Distributed Storage: P2P Communication Services- P2P VoIP systems, SIP-based communication, UDP and TCP transport mechanisms, HTTP tunnelling, Topology Control- Distributed topology control frameworks, Structured topology control, Unstructured topology control, Network coding-based topology optimization, Distributed File Systems - Distributed File System (DFS), P2P backup systems, Universal File Systems, Overlay Multicasting- Multicast over overlays, Resilience in multicast systems, QoS-aware P2P architectures.	**8**
Module-IV	Trust, and Security: Incentive Mechanisms- Free-riding problem, Reputation-based incentives, Economic incentive models, Game-theoretic approaches, Trust Management- Trust establishment and propagation, EigenTrust, PeerTrust, PowerTrust, GossipTrust, FuzzyTrust, Security Issues in P2P Networks- Content pollution attacks, Sybil attacks, DDoS attacks, Privacy and Anonymity - Anonymous communication, TOR routing, Privacy-preserving P2P systems.	**8**

Learning Resources:

Textbooks:	[T1] Yu-Kwong Ricky Kwok (2011). Peer-to-Peer Computing Applications, Architecture, Protocols, and Challenges, Chapman & Hall/CRC Computational Science. [T2] Quang Hieu Vu , Mihai Lupu , Beng Chin Ooi (2010). Peer-to-Peer Computing Principles and Applications, Springer-Verlag Berlin Heidelberg
Reference Books:	[R1] Andrew S. Tanenbaum, Maarten van Steen (2002) Distributed Systems: Principles and Paradigms, Prentice Hall
Other Suggested Readings:	

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Scheme of Master of Computer Application to be applicable from 2025-2026 onwards

Course Title: Information Systems Management

Course Code: CALM 276

L-T-P: 3-0-0

Credits: 3

Pre-requisites: Nil

Course Outcomes:

CO-1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business [L1].
CO-2	Design, develop and implement Information Technology solutions for business problems [L3].
CO-3	Analysis of computing systems and telecommunication networks for business information systems [L4].
CO-4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions [L4].
CO-5	Plan projects, work in team settings and deliver project outcomes in time [L3].

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**-**
CO-2	**2**	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**1**
CO-3	**2**	**1**	**-**	**1**	**1**	**2**	**2**	**1**	**2**
CO-4	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**
CO-5	**1**	**2**	**1**	**2**	**1**	**3**	**2**	**1**	**1**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Meaning, Nature and Scope of Information Systems, Evolution of Information Systems Management, Contemporary approaches to Information Systems – Technical Approach, Behavioral Approach, Socio-Technical Approach, Global Information Systems – Introduction, Growth and Management. Strategic uses of ISM for Competitive Advantage.	**8**
Module-II	Major types of Systems in the organization from a functional	**7**

	perspective; Understanding Decision Support System - ISM and DSS - Decision making with data - types of decisions, Business Intelligence, Business Process Reengineering and Information Technology, Managing Social Media: Social Dynamics of the Internet, Social Networks in the Enterprise.	
Module-III	Application of Operational Information System to Business; Application of Tactical and Strategic Information Systems to Business. Enterprise application – Enterprise systems, Systems for supply chain management, Customer relationship management and Knowledge management.	**8**
Module-IV	System development process; Systems analysis; Structured systems analysis and design; Alternative application development and evaluation.	**7**
Module-V	Pitfalls, Ethical, Societal Challenges, Computer crime, privacy issues, Ethical Hacking, Security Management of Information Technology, Significance of IT Act 2000. Emerging Trends in MIS.	**7**

Learning Resources:

Textbooks:	[T1] Kenneth C Laudon and Jane P Laudon, "Management Information Systems: Managing the Digital Firm" 16th Edition, Pearson Education Asia, 2015. [T2] W. S. Jawadekar, Management Information Systems, TMH, 2004
Reference Books:	[R1] 1.O, Brien, James George M. Marakas , Ramesh Behl "Management Information Systems", 10 edition, McGraw Hill Education; 2017
Other Suggested Readings:	