Course Curriculum for B Tech in Computer Science and Engineering

Computer Science and Engineering Department

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India.)

Department of Computer Science and Engineering
National Institute of Technology Delhi

About the Department

The Computer Science and Engineering Department was started in 2010 along with the foundation of NIT Delhi. Initially, only the Bachelor of Technology Programme was offered with the intake 30 which presently has been increased to 60. Now, apart from B. Tech., the department also offers Master of Technology (CSE & Analytics), and Ph.D programs which cover a number of important areas of Computer Science and Engineering. The department provides the students with a broad undergraduate and graduate curriculum, based on the application and theoretical foundations of computer science. The departmental faculties and students participate in interdisciplinary research. The department envisions producing quality graduates, capable of leading the world in the technical realm. The department is equipped with the latest configuration and high computing system with hi-speed Internet facilities. The Computer Science Program at this institute is dedicated to educate students and to advance research in computer and information technology. The department has all the facilities to carry out the related teaching and research work.

VISION

To communicate quality Computer Science Education for producing globally identifiable skilled 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**, nurture **creativity, and innovation,** and create an entrepreneurial **environment** for an ever-changing technological scenario requiring communally cognizant solutions.

M3 To create an appetite for **research, and higher education** in contemporary, and emerging areas of Computer Science.

M4 To inculcate the **moral, ethical, and social ideals** essential for prosperous nation-building.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1 Graduates are prepared to be employed in IT industries and be engaged in continuous learning, understanding, and applying innovative ideas while maintaining strong ethical standards.

PEO2 Graduates are prepared to pursue higher studies and continue to develop their professional knowledge.

PEO3 Graduates are equipped to do research in areas of specialization and the allied fields.

PEO4 Graduates are prepared to meet the changing needs of society through knowledge-based service, exhibit leadership qualities with demonstrable attributes in lifelong learning and become successful entrepreneurs.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1 Ability to analyze, develop and design new tools and approaches to create cutting-edge solutions for Industry.

PSO2 Ability to carry out research and education in trans-disciplinary fields to solve the problems of national as well as international significance.

B. Tech. (Computer Science and Engineering)

Programme Framework

- Minimum Credits requirements for completion of BTech program is 160
- The Curriculum is based on the guidelines of National Education Policy (NEP)–2020
- The curriculum has embedded the Multi Exit/ Multi Entry in the BTech program
- There is provision of Major degree and Minor Degree for students
- The curriculum is designed to meet the prevailing and ongoing industrial requirements
- The curriculum includes Project based Education with Projects every year
- The curriculum is flexible and offers Choice Based Credit System (CBCS)
- The curriculum inherits the Value based Education and offers Interdisciplinary/Multidisciplinary Courses
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Startups
- The curriculum aims at the Holistic Development of the students
- In the proposed UG scheme, the department of CSE is proposing following specializations:
    1. *Artificial Intelligence and Machine Learning (Bucket 1)*
    2. *Data Science (Bucket 2)*
    3. *Information Security (Bucket 3)*
    4. *Computer Systems (Bucket 4)*
    5. *Networks and Distributed Systems (Bucket 5)*

- Total **7 electives** are proposed in the complete UG program, among them **at least 5**

electives are required from a bucket to get the specialization (with the respective bucket) with B.Tech in Computer Science and Engineering

- Students can attend 2 MOOC/NPTEL/any online courses (as per department list) among the proposed **7 electives** and the evaluation will be done by the Department as per Academic Calendar and prevailing norms.
- Students can do any number of courses from the other IITs/NITs/or any other CFTI institutes. There will be the provision of credit transfer as per NIT Delhi norms.
- If any student from the other branch will do **4 courses (16 credits) and one project (2 credits)**, then the student will be awarded the **minor degree in Computer Science and Engineering with the respective bucket specialization.** The project should be approved by the department of CSE Hence, in a minor degree a student should complete **18 credits other than the desired credits** of his/her major degree.

Cardinal Mentions

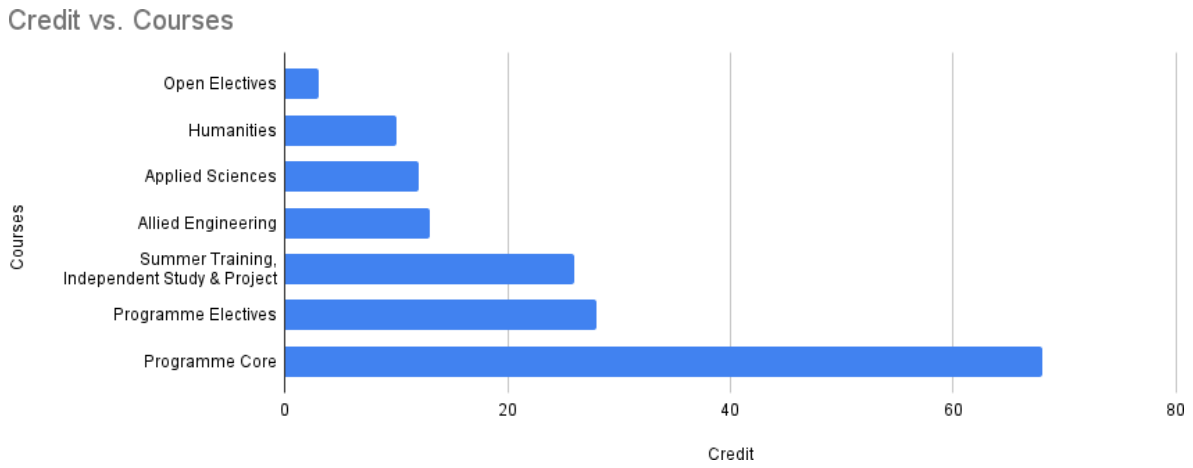
✔ The students can exit after completing 1st Year, 2nd Year and 3rd Year from the program and will be awarded Certificate, Diploma and Advanced Diploma in Computer Science and Engineering respectively. A minimum Credit requirement for Certificate is 40 Credits, Diploma is 80 Credits and Advanced Diploma is 120 Credits respectively.

✔ The other branches students can opt for Minor Degree in Computer Science and Engineering across any specialization offered by the department from 5th Semester onwards by obtaining 18 credits from Computer Science and Engineering (16 credits in course work and 02 credits in projects) from the respective specializations.

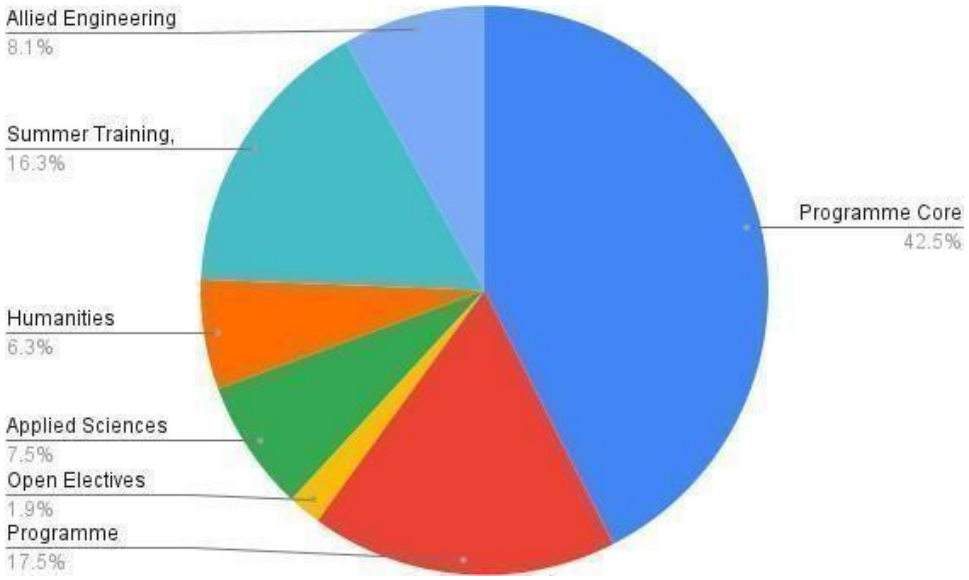
Semester wise Credit Structure

Sl. No.	Courses	Credits								Total
		1st Year		2nd Year		3rd Year		4th Year		
		1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	7th Sem	8th Sem	
1	Programme Core	8	13	12	12	16	7	0	0	68
2	Programme Electives	0	0	0	0	4	8	16	0	28
3	Open Electives	0	0	0	0	0	3	0	0	3
4	Applied Sciences	4	4	4	0	0	0	0	0	12
5	Humanities	4	0	0	3	0	0	3	0	10
6	Summer Training, Independent Study & Project	0	2	0	1	0	2	1	20	26
7	Allied Engineering	4	1	4	4	0	0	0	0	13
Total		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

Credits Distribution



Credits Distribution (%)



Course Scheme

Year	First Semester						Second Semester					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
Ist	CSBB 103	Problem Solving & Computer Programming	2	0	2	3	CSBB 151	Data Structures	3	0	2	4
	CSBB 102	Introduction to Computer Systems	3	0	2	4	CSLB 152	Discrete Structures	3	1	0	4
	MALB 101	Advanced Calculus	3	1	0	4	CSLB 154	System Programming	3	0	0	3
	HMBB 101	Theory and Practices of Human Ethics	2	0	2	3	MALB 152	Applied Linear Algebra	3	1	0	4
	MEBB 162	Engineering Visualization	3	0	2	4	CSPB 154	Introduction to Hardware	0	0	2	1
	HMPB 102	Communication Skills	0	0	2	1	CELB 101	Environmental Sciences	2	0	0	2
	HSPB 150	Holistic Health & Sports	0	0	2	1	CSPB 100	Project I	0	0	4	2
	Total					**20**	**Total**					**20**
IInd	**Third Semester**						**Fourth Semester**					
	CSBB 202	Design and Analysis of Algorithms	3	0	2	4	CSBB 251	Computer Architecture and Organization	3	0	2	4
	CSBB 203	Operating System	3	0	2	4	CSBB 252	Artificial Intelligence	3	0	2	4
	CSBB 204	Database Management Systems	3	0	2	4	CSBB 254	Software Engineering	3	0	2	4
	MALB 202	Probability and Statistics	3	1	0	4	HMBB 251	Professional Communication	2	0	2	3
	ECBB 206	Digital Electronics and Logic Design	3	0	2	4	ECBB 254	Communication Systems	3	0	2	4
							CSPB 200	Project II	0	0	2	1
	Total					**20**	**Total**					**20**

	Fifth Semester						Sixth Semester					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
IIIrd	CSBB 301	Computer Networks	3	0	2	4	CSBB 351	Compiler Design	3	0	2	4
	CSLB 302	Theory of Computation	3	1	0	4	CSBB 352	Theory of App Development	2	0	2	3
	CSBB 303	Data Mining	3	0	2	4	XXXB XXX	Open Elective	3	0	0	3
	CSBB 304	Quantum Computing	3	0	2	4	CSXB XXX	Elective 2 [Select in Set 2 from the respective specialization]	3	0/1	2/0	4
	CSXB XXX	Elective 1 [Select in Set 1 from the respective specialization]	3	0/1	2/0	4	CSXB XXX	Elective 3 [Select in Set 2 from the respective specialization]	3	0/1	2/0	4
							CSPB 300	Project III	0	0	4	2
							CSPB 301	Internship (during summer break)	Credit will be given in next Semester			
	Total					**20**	**Total**					**20**
	Seventh Semester						**Eighth Semester**					
IVth	CSXB XXX	Elective 4 [Select in Set 3 from the respective specialization]	3	0/1	2/0	4	CSPB 400	B. Tech Project (Internship inside NIT Delhi / Outside NIT Delhi)	-	-	-	16
	CSXB XXX	Elective 5 [Select in Set 3 from the respective specialization]	3	0/1	2/0	4	CSLB XXX	MOOC Course	3	0	0	3
	CSXB XXX	Elective 6 [Select in Set 3 from the respective specialization]	3	0/1	2/0	4	CSPB 402	Seminar	0	0	2	1
	CSXB XXX	Elective 7 [Select in Set 3 from the respective specialization]	3	0/1	2/0	4						
	HMLB 401	Management Principles and Practices	3	0	0	3						
	CSPB 301	Internship (completed in last summer break)	-	-	-	1						
	Total					**20**	**Total**					**20**

Bucket 1 of Elective Courses [Specialization in Artificial Intelligence and Machine Learning]												
Set-1												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 311	Machine Learning	3	0	2	4	CSBB 312	Pattern Recognition	3	0	2	4
	CSBB 313	Digital Image Processing	3	0	2	4	CSBB 314	Computer Vision	3	0	2	4
	CSLB 315	Optimization Techniques	3	1	0	4	CSBB 405	Fuzzy Logic and Applications	3	0	2	4
	CSBB 406	Cloud Computing	3	0	2	4	CSLB 359	Chemistry for Computer Science Engineers	3	1	0	4
Set-2												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 314	Computer Vision	3	0	2	4	CSLB 315	Optimization Techniques	3	1	0	4
	CSBB 316	Information Storage & Retrieval	3	0	2	4	CSBB 317	Soft Computing	3	0	2	4
	CSBB 405	Fuzzy Logic and Applications	3	0	2	4	CSBB 407	Natural Language Processing	3	0	2	4
	CSBB 408	Reinforcement Learning and Applications	3	0	2	4	CSBB 409	Social Network Analysis	3	0	2	4
	CSBB 412	Motion Analytics	3	0	2	4	CSBB 415	Motion Planning for Robotics	3	0	2	4
	CSBB 424	Deep Learning and Applications	3	0	2	4						
Set-3												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 405	Fuzzy Logic and Applications	3	0	2	4	CSBB 406	Cloud Computing	3	0	2	4
	CSBB 407	Natural Language Processing	3	0	2	4	CSBB 408	Reinforcement Learning and Applications	3	0	2	4
	CSBB 409	Social Network Analysis	3	0	2	4	CSBB 412	Motion Analytics	3	0	2	4
	CSBB 413	Introduction to Cognitive Computing	3	0	2	4	CSLB 414	Game Theory	3	1	0	4
	CSBB 415	Motion Planning for Robotics	3	0	2	4	CSBB 424	Deep Learning and Applications	3	0	2	4

Bucket-2 [Specialization in Data Science]												
Set-1												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 311	Machine Learning	3	0	2	4	CSLB 315	Optimization Techniques	3	1	0	4
	CSLB 321	Mathematical Foundation of Data Science	3	1	0	4						
Set-2												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 314	Computer Vision	3	0	2	4	CSLB 315	Optimization Techniques	3	1	0	4
	CSBB 323	Data Handling & Visualization	3	0	2	4	CSBB 325	Time Series Analysis	3	0	2	4
	CSBB 326	Distributed System	3	0	2	4	CSBB 406	Cloud Computing	3	0	2	4
	CSBB 409	Social Network Analysis	3	0	2	4	CSBB 421	Internet of Things	3	0	2	4
	CSBB 422	Big Data Analytics	3	0	2	4	CSBB 424	Deep Learning and Applications	3	0	2	4
Set-3												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 314	Computer Vision	3	0	2	4	CSBB 406	Cloud Computing	3	0	2	4
	CSBB 409	Social Network Analysis	3	0	2	4	CSLB 414	Game Theory	3	1	0	4
	CSBB 421	Internet of Things	3	0	2	4	CSBB 422	Big Data Analytics	3	0	2	4
	CSBB 424	Deep Learning and Applications	3	0	2	4	CSBB 425	Information Security and Privacy	3	0	2	4
	CSBB 426	Business Intelligence and Analytics	3	0	2	4	CSBB 427	Advanced Databases	3	0	2	4

Bucket 3 [Specialization in Information Security]												
Set-1												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 331	Network and Data Security	3	0	2	4	CSBB 333	Cryptography and Computer Security	3	0	2	4
	CSBB 335	Information Security	3	0	2	4	CSBB 436	Block chain Technology	3	0	2	4
Set-2												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 333	Cryptography and Computer Security	3	0	2	4	CSBB 335	Information Security	3	0	2	4
	CSBB 439	Database and Online Social Media Security	3	0	2	4						
Set-3												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 436	Block chain Technology	3	0	2	4	CSBB 439	Database and Online Social Media Security	3	0	2	4
S	CSBB 440	Introduction to Cyber Security	3	0	2	4	CSBB 444	Software Security	3	0	2	4

Bucket 4 of Elective Courses [Specialization in Computer Systems]												
Set-1												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 341	Advanced Computer Networks	3	0	2	4	CSBB 343	Computer Graphics	3	0	2	4
	CSBB 344	Object Oriented Programming	3	0	2	4	CSBB 427	Advanced Databases	3	0	2	4
Set-2												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSLB 315	Optimization Techniques	3	1	0	4	CSBB 326	Distributed Systems	3	0	2	4
	CSBB 346	Parallel Algorithms	3	0	2	4	CSLB 348	Randomized Algorithms	3	1	0	4
	CSBB 406	Cloud Computing	3	0	2	4						
Set-3												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSLB 315	Optimization Techniques	3	1	0	4	CSBB 406	Cloud Computing	3	0	2	4
	CSBB 452	Advanced Operating Systems	3	0	2	4	CSLB 454	Computational Complexity	3	1	0	4
	CSBB 456	Real Time Systems	3	0	2	4						

Bucket 5 of Elective Courses [Specialization in Networks and Distributed Systems]												
Set-1												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 406	Cloud Computing	3	0	2	4	CSBB 410	Wireless Sensor Networks	3	0	2	4
Set-2												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSLB 315	Optimization Techniques	3	1	0	4	CSLB 353	Queuing Theory	3	1	0	4
	CSBB 354	Mobile Computing	3	0	2	4	CSBB 326	Distributed Systems	3	0	2	4
	CSBB 356	Network and Wireless Security	3	0	2	4	CSBB 357	High Performance Computing	3	0	2	4
	CSBB 358	Information Theory and Coding	3	0	2	4						
Set-3												
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
	CSBB 341	Advanced Computer Networks	3	0	2	4	CSBB 35X	Optical Networks	3	0	2	4
	CSBB 411	Distributed Databases	3	0	2	4	CSLB 414	Game Theory	3	1	0	4
	CSBB 472	Next Generation Networks	3	0	2	4						

List of new courses introduced in the scheme

Sub Code	Subject Name	L	T	P	C
CSBB 415	Motion Planning for Robotics	3	0	2	4
CSBB 411	Distributed Databases	3	0	2	4
CSLB 359	Chemistry for Computer Science Engineers	3	1	0	4

List of Open Elective courses introduced in the scheme

Sub Code	Subject Name	L	T	P	C
CSLB 361	Tiny Machine Learning	3	1	0	4
CSLB 362	Network Security and Cryptographic Protocols	3	1	0	4

DETAILED SYLLABI

B.Tech.

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

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Understand the basics of computer and various Problem solving approaches.	L1, L2
CO2	Understand the fundamentals of C programming.	L1, L2
CO3	Apply functions, arrays, and structures for solving problem.	L2, L3, L4
CO4	Understand the use of pointers and file management in C.	L2, L3

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 – Substantially

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.	04
Module-II	Introduction to programming language, Basics of C, Basic Data types - int, floa double, char, Bool, Void. Arithmetic and logical operators: precedence and association. Flow of Control Conditional statements- If-else, Switch-case constructs Loops- While, do-while, for.	06
Module-III	Function - User defined functions, library functions, Parameter passing call by value, call by reference, recursion.	04

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 array.	06
Module-V	Structure: Declaration, Initialization, passing structure to function, Use of pointers in structures. Preprocessors, Macros, File management in C 1/0 - Opening closing and| editing files. Correctness & Efficiency Issues in Programming, Time & Space measures.	04

Learning Resources:

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Text Books:	1. Programming in ANSI C E. Balagurusamy TATA McGraw Hil1 6 edition, 2012
Reference Books:	1. Let Us C By Yashwant Kanetkar, Infinity Science Press, 13th edition, 2. Schaum's Outline of Programming with C by Byron S Gottfried, TATA McGraw Hill, 2nd edition, 1996 3. The C Programming Language by Brian Kernighan & Dennis Ritchie, Prentice Hal, 2nd edition, 1988
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	Familiarization of Linux environment - How to do Programming in C with Linux.
	Familiarization of console VO and operators in C. a. Display "Hello World" b. Read two numbers, add them and display their sum c. Read the radius of a circle, calculate its area and display it d. Evaluate the arithmetic expression ((a -b/c *d+ e) * (f +g)) and display solution. Read the values of the variables from the user through console.
3	Write a program to a. Calculate simple and compound interest. b. Find the roots of quadratic equation.
4	Write a program to swap values of two variables with and without using third variable.
5	Write a program to find the largest of three numbers with and without ternary Operators.
6	Write a program to input name, marks of 5 subjects of a student and display the name of the student, the total marks scored, percentage scored and the class of result.
7	Read a Natural Number and check whether the number is a. prime or not b. Armstrong or not C. even or odd.
8	Write a program to compute grade of students using if else adder. The grades are assigned as followed: Marks Grade marks<50 F 50 marks< 60 C 60 marks<70 B 70 marks<80 B+ 80 marks<90 A 90 marks<100 A+
9	Write a program to check whether the entered year is leap year or not (a year is leap if it is divisible by 4 and divisible by 100 or 400).
10	Write a program to find whether a character is consonant or vowel using switch statement.
11	Find the factorial of a given Natural Number n using recursive and non-recursive functions.
12	Compute sum of the elements stored in an array using pointers and user defined function.

Course Title:	**Introduction To Computer Systems**
Course Code:	**CSBB 102**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Understand the basic data types of High-Level Languages that are stored and processed by Computer Systems.	L1, L2
CO2	Understand the dynamic behavior of memory organization, operating systems and the system software used in software development.	L2, L3, L4
CO3	Apply the concept of number systems, Logic gates and Boolean Algebra through programming experiments.	L3, L4, L5
CO4	Explain the basic mechanisms involved in data communication, and computer networking.	L1, L2

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	

1 – Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Computers: Digital and Analog Computers; Characteristics of Computer; Evolution of Computers; Generations of Computer; Classification of Computer, Input and Output devices.	06
Module-II	Computer Memory: Introduction, Memory Representation, Memory Hierarchy, CPU Registers, Impact of Cache Memory on System Performance, Programming Language and Program Development.	06
Module-III	Computer Software: Introduction, Types of Software, System Software, Application Software, Operating System (Introduction, Objectives of Operating System, Types of OS, Functions of OS, Protection and Security, User Interface, Examples of Operating Systems).	08
Module-IV	Data Representation: Introduction, Number System, Conversion from Decimal to Binary, Octal, Hexadecimal, Conversion of Binary, Octal,	08

	Hexadecimal to Decimal, Conversion of Binary to Octal, Hexadecimal, Conversion of Octal, Hexadecimal to Binary, Boolean Logic, Logic Gates.	
Module-V	Data Communication and Computer Network: Introduction, Importance of Networking, Data Transmission Media, Data Transmission across Media, Data Transmission and Data Networking, Computer Network, Network Types, Network Topology, Communication Protocol, Network Devices, Wireless Networking.	08

Learning Resources:

Text Books:	1. Computer Systems: A Programmer's Perspective by Randal Bryant, David O'Halloran, Pearson, 3rd edition, 2015
Reference Books:	1. Computer Fundamentals by Anita Goel , Pearson, 1st edition, 2010 2. Computer Fundamentals And Programming In C by Reema Thareja , Oxford University Press, Second edition, 2016. 3. Fundamentals of Computers by E Balagurusamy, McGraw Hill Education
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	To identify front panel, indicator, and switches along with rear side connection in a computer system.
2	To familiarize with a computer system layout and mark the position of motherboard, HDD, CD/DVD drives, and add on cards.
3	To create a document about describing about yourself using MS-WORD.
4	To create, open, rename, copy and delete the files in command prompt.
5	To execute external commands in MS-DOS.
6	To write a C program for converting a binary number to its decimal equivalent.
7	To write a C program for converting a decimal number to its binary equivalent.
8	To implement basic logic gates using C programming.
9	To implement universal gates using C programming.
10	To implement special gates XOR, XNOR using C programming.

Course Title:	**Advanced Calculus**
Course Code:	**MALB 101**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Understand the theory and methods of Differential, Integral and Vector Calculus	L2
CO2	Apply different methods for solving problems in Differential, Integral and Vector Calculus	L3
CO3	Analyze sequence and series for its convergence. Analyse function for continuity and differentiability. Analyse curves and surfaces for concavity, inflection points, maxima and minima.	L4
CO4	Evaluate extreme points for the function of several variables. Evaluate limits. Evaluate limit of sequences and sum of some convergent series. Evaluate multiple integrals in rectangular, polar, cylindrical, and spherical coordinates.	L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	3	-	-	-	-	-	-	-	-	-	-	-	–	-
CO-4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Differential Calculus [Functions of Single Variable]: Limit and Continuity of functions; differentiability; Jacobian, Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's theorems with remainders, Expansions; Convergence of sequences and series of real numbers; Power series.	10
Module-II	Differential Calculus [Functions of Several Variables]: Functions of several variables, limit and continuity, Partial Derivatives and Differentiability, Maxima & Minima of two variables, Lagrange method of multiplier.	08

Module-III	Integral Calculus: Fundamentals theorem of integral calculus, Riemann Integration, Improper Integrals, Double and Triple integrals-computation of surface area and volumes-change of variables in double and triple integrals.	10
Module-IV	Vector Calculus: Scalar and vector field; Vector differentiation; Level surfaces, Directional Derivatives, Gradient of Scalar field; Divergence and Curl of a vector field; Laplacian, Line and Surface integrals; Green's theorem in plane Gauss Divergence's theorem and Stoke's theorem.	08

Learning Resources:

Text Books:	1. Thomas Calculus by G. Thomas, M. Weir, J.Hass (Pearson Publication, 2010). 2. Introduction to Real Analysis by R.G. Bartle, D.R. Sherbert (John Wiley and Sons, 2011). 3. Advanced Engineering Mathematics by E. Kreyszig (John Wiley and Sons).
Reference Books:	
Other Suggested Readings:	

Course Title:	**Theory And Practices of Human Ethics**
Course Code:	**HMBB 101**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Develop and understand the basic elements of human values and business ethics at the organizational level and get acquainted with the business world.	L5
CO2	Understand the possible engagement between Industry 5.0 and the human ethics and exploring the extent up to which the AI technology may replace or complement the core human values.	L2
CO3	Build better technology by taking into consideration all the possible rules, regulations and governance regimes of Artificial Intelligence (AI) based technology.	L4, L5
CO4	Develop the balance between the internal values as engineers with respect to engineering technology keeping in line with moral sense of external values and wellbeing.	L3, L5, L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	2	2	1	1	3	2	3	3	3	3	3	3	3
CO-2	2	1	3	3	1	3	3	3	3	3	3	2	2	1
CO-3	1	1	3	3	1	3	3	3	3	3	3	1	3	2
CO-4	1	1	1	1	1	3	2	3	3	3	2	3	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Organizational Systems and Resources Personality, Types of Personality, Determinants of Personality. Biographical and Personal factors. Environmental Factors. Psychological Factors. Big Five Personality traits	06
Module-II	Feelings, Classification of Feelings. Dimensions of Emotions. Emotions and External Constraints. Emotional Intelligence. Artificial Intelligence. Authority,	06

	Responsibility and Accountability: Meaning and Balance, Case Study: Surveillance technologies and Privacy at Work.	
Module-III	Human Resource Policies& Procedures, Big Data and Privacy Policies, e-Governance Regimes, Algorithm based Decision-making versus non-epistemic human values & Ethics	06
Module-IV	Concept of moral Relativism and Moral Imperialism, Cognitive Moral Development, Approaches to Fostering Ethical Behavior, Artificial intelligence and Value alignment, Digital wellbeing.	06

Learning Resources:

Text Books:	1. Organizational Behaviour: Text and Cases by Chitale, et.al. PHI Learning Private Limited. 2. Ethics of Artificial Intelligence by Matthew S. Liao (ed.), 2020, Oxford University Press
Reference Books:	1. Ethics in Engineering by Mike W. Martin & Roland Schinzinger McGrow Hills 2. What kind is intelligence? Philosophical Psychology 31 (2), 232-252 Davide Serpico (2018) Research Paper 3. Insightful artificial intelligence. Mind & Language 36 (2), 315-329 Marta Halina (2021). Research Paper 4. Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor Virginia Eubanks (2018) St Martin's Press
Other Suggested Readings:	

Course Title:	**Engineering Visualization**
Course Code:	**MEBB 162**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Remember the use of different instruments used in Engineering Drawing and Importance of BIS and ISO codes.	L1
CO2	Illustrate various types of mathematical curves and scale.	L2
CO3	Construct orthographic projection of Point, Line, and Plane	L3
CO4	Construct orthographic and sectioning views of regular solids.	L3
CO5	Create Orthographic view to Isometric projection/view and vice-versa.	L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1		1								2	1
CO-2	3	2	2		2								2	2
CO-3	3	3	3	2	2								3	2
CO-4	3	3	3	2	2								3	2
CO-5	3	2	3	2	3								3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons. Scales: Plain scales, Diagonal scales, Scale of chords.	06
Module-II	Curves used in Engineering Practice: Ellipse, Parabola, Hyperbola, normal and tangents to these curves, Involute, Cycloid, Epi-cycloid, Hypo- cycloid, Spiral, Helix on cone and cylinder.	06
Module-III	Orthographic projection of points: Principles of Orthographic projection, Projections of points. Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference	10

	planes, Traces, Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.	
Module-IV	Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes. Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.	08
Module-V	Isometric views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects. Assembly drawings of the machine parts. NOTE: Interpretation of drawings: Introduction of CAD package to construct a simple solid model, using a CAD package to construct solid models and generating orthographic, isometric, sectional views with dimensioning, Assembly of components and generation of corresponding drawings. Animation of machines in CAD.	06

Learning Resources:

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Text Books:	1. Engineering Graphics, N.D. Bhatt and V.M. Panchal, Charotar Publishers. 2. Jolhe, D. A., Engineering drawing, Tata McGraw Hill
Reference Books:	1. Engineering Drawing, Agarwal, B, McGraw Hill Education, 2015, Second edition. 2. Shah, M. B. and Rana, B. C., Engineering Drawing, Pearson Education, 2009 3. K.V. Natarajan, A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006. 4. AutoCAD 2007 Bible E. Finkelstein, Wiley Publishing Inc.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	Experiments
1	Lettering, Dimensioning,
2	Plan Scale, Diagonal Scale, Scale of Chords
3	Geometrical construction of Engineering Curves
4	Introduction of Projection of Points and Lines
5	Traces of lines
6	Projection of Planes
7	Projections of Regular Solids
8	Sectional Views of Solids
9	Isometric views
10	Orthographic to isometric

Course Title:	**Communication Skills**
Course Code:	**HMPB 102**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Apply principles of career-oriented writing to create effective resumes, cover letters, and job applications tailored to specific roles.	L3
CO2	Demonstrate understanding of workplace and academic communication by composing formal emails, business letters, and structured research abstracts.	L2
CO3	Apply effective strategies to organise and deliver oral presentations using verbal and non-verbal communication.	L3
CO4	Apply appropriate interpersonal communication skills during group discussions and interviews for professional readiness.	L3

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1										3		1		1
CO-2				1						3		1		2
CO-3									1	3	1	1		2
CO-4									2	3	1	1		2

1 - Slightly; 2 - Moderately; 3 – Substantially

List of Activities:

Sl. No.	**Activities**
1	Introduction to Communication: verbal & non-verbal, types (oral, written), formal vs informal, barriers, importance in workplace
2	Writing a Resume / CV / Bio-data: structure, action verbs, layout, tailored content, do's & don'ts
3	Writing a Cover Letter and SOP: personalized letters, career goals, matching with job/course, tone & structure
4	Job Application and Email Etiquette: subject line, salutation, clarity, professionalism, signature format

5	Technical Correspondence: process description, short reports, memo writing, proposal basics
6	Research Communication: process description, short reports, memo writing, proposal basics
7	Email Writing and Business Letter Formats: inquiry letters, complaint, adjustment, order placing, follow-up formats
8	Oral Presentation Skills: voice modulation, pauses, body language, eye contact, confidence
9	Student Presentations (Part 1): peer assessment, time management, self-reflection, feedback
10	Student Presentations (Part 2): clarity, audience engagement, delivery improvement, critique
11	Group Discussion Techniques: initiating, topic analysis, turn-taking, leadership, conflict resolution
12	Group Discussion Practice: simulated rounds, feedback, team coordination, summarizing
13	Interview Skills: types of questions, STAR method, grooming, attitude, body language
14	Mock Interviews & Feedback: performance review, articulation, first impressions, refinement tips

Learning Resources:

Text Books:	1. Raman, M., & Sharma, S. Technical Communication. Oxford University Press. 2. Kumar, K. Effective Communication Skills. Khanna Publishing House, Delhi. 3. Pushplata, & Kumar, S. Communication Skills. Oxford University Press.
Reference Books:	1. Rizvi, M. A. Effective Technical Communication. New Delhi: McGraw Hills Education 2. Jones, L &R. Alexander. New International Business English. UK: CUP
Other Suggested Readings:	1. Hewings, M. English Pronunciation in Use. Advanced. Cambridge: CUP

Course Title:	**Holistic Health & Sports**
Course Code:	**HSPB 150**
L-T-P:	**0-0-2**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Demonstrate an understanding of the interrelationship between physical fitness, mental well-being, and lifestyle choices for overall health improvement.	L2, L3
CO2	Utilize knowledge of biomechanics, exercise physiology, and injury prevention to enhance athletic performance and promote safe training methods.	L3, L4
CO3	Create tailored fitness, nutrition, and recovery strategies that align with individual goals and health needs.	L5, L6
CO4	Implement stress management, mindfulness, and psychological techniques to support mental health and optimize sports performance.	L3, L4

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
CO-3	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1
Avg	0.25	0	0	0	0	1	0	0	0.75	0	0	0.25	0	0	0.25

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Fundamentals of Holistic Health & Wellness: Introduction to holistic health: Physical, mental, and emotional well-being; Principles of health and fitness: Importance of exercise, nutrition, and rest	06

	Role of lifestyle choices in overall well-being; Stress management techniques: Meditation, yoga, and breathing exercises; Impact of sleep, hydration, and recovery on performance	
Module-II	Sports Science & Performance Enhancement: Basics of exercise physiology: Muscle function, energy systems, and endurance; Biomechanics in sports: Movement analysis and injury prevention; Strength and conditioning principles for athletes and general fitness; Role of flexibility, mobility, and posture in injury prevention; Sports-specific training methods and techniques	06
Module-III	Nutrition & Recovery Strategies: Fundamentals of sports nutrition: Macronutrients and micronutrients; Hydration and electrolyte balance for optimal performance; Meal planning for athletes and active individuals; Recovery strategies: Active recovery, massage, and cold/hot therapy; Supplementation in sports: Benefits and risks	06
Module-IV	Mental Resilience & Social Aspects of Sports: Psychological aspects of sports performance and motivation; Mindfulness, visualization, and goal-setting techniques; Coping with competition stress and mental fatigue; Team dynamics and leadership in sports; Role of sports in community building and personal development	06

Learning Resources:

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Text Books:	1. Foundations of Sport and Exercise Psychology by Robert S. Weinberg & Daniel Gould. 2. Sports Nutrition: A Handbook for Professionals by Christine Karpinski & Melissa W. Kaye.
Reference Books:	
Other Suggested Readings:	

Course Title:	**Data Structures**
Course Code:	**CSBB 151**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Explain the fundamentals of data structures and algorithms	L1
CO2	Build data structures for a given problem	L2
CO3	Illustrate applications and use of tree data structures	L3
CO4	Compare algorithms for graph data structures	L4
CO5	Compare the basic algorithmic techniques and choose a suitable one for a given problem	L5
CO6	Develop algorithms using various searching and sorting techniques	L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	3	2		2		3	1	1	2	2	3
CO-2	3	2	2	3	3		2	2		1	1	2	2	3
CO-3				3	3				2				2	3
CO-4	3				2							1	2	3
CO-5		2	2	3	3		2	3		1	1	2	2	3
CO-6	3			3	3		2	2	3	1	1	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

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 algorithm: Asymptotic notations, Analysis of algorithms: Time and Space complexity.	07

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.	07
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.	07
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	07
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, dynamic programming.	08

Learning Resources:

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Text Books:	1. Fundamentals of Data Structures E. Horowitz, S. Sahni Computer Science Press 2nd Edition, 2008.
Reference Books:	1. Data Structures Using C by A. M. Tanenbaum, Y. Langsam, M. J. Augenstein Pearson Education 1990. 2. Data Structures Using C by E. Balagurusamy TATA McGraw Hill 2013 3. Data Structure and Program Design by R.L. Kruse Prentice Hall 2nd Edition, 1996
Other Suggested Readings:	

Lab Experiments:

Exp. No.	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 singly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal
4.	Write a program that uses functions to perform the following operations on 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 tree traversal methods

Course Title:	**Discrete Mathematics**
Course Code:	**CSLB 152**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Illustrate the basics of discrete mathematics and predicate calculus	L2
CO2	Explain set theory and relations.	L2
CO3	Demonstrate the concepts of graph theory and experiment with trees to solve problems like minimum spanning tree and tree traversals.	L3, L4
CO4	Develop the concept of functions and recursive function theory	L3, L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2										3	
CO-2	3	3	3								2	3	3	2
CO-3	3	3	3		3		3		3			3	3	3
CO-4	3	2	3		2		2					3	3	

1 - Slightly; 2 - Moderately; 3 – Substantially

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.	05
Module-II	Set theory; Paradoxes in set theory; inductive definition of sets and proof by induction; Peono postulates; Relations; representation of relations by graphs; properties of relations; equivalence relations and partitions; Partial orderings; Posets; Linear and well-ordered sets	10
Module-III	Graph Theory; elements of graph theory, Euler graph, Hamiltonian path, trees, tree traversals, spanning trees.	07

Module-IV	Functions; mappings; injection and surjections; composition of functions; inverse functions; special functions; Peono postulates; pigeonhole principle; recursive function theory.	07
Module-V	Definition and elementary properties of groups, semigroups, monoids, rings, fields, vector spaces and lattices. Elementary combinatorics; counting techniques; recurrence relation; generating functions.	07

Learning Resources:

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Text Books:	1. K.H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, 5th Edition, 2003.
Reference Books:	1. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book Company, 2nd Edition, 1985. 2. J.L. Mott, A. Kandel, T.P. Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 2nd Edition, 1986. 3. W.K. Grassmann and J.P. Tremblay, Logic and Discrete Mathematics, Pearson, 1995.
Other Suggested Readings:	

Course Title:	**System Programming**
Course Code:	**CSLB 154**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Apply the knowledge of assembler and macro processors to convert assembly language into machine code.	L4, L2
CO2	Analyse working phases of Compiler to undertake meaningful language translation.	L6, L3
CO3	Evaluate Linkers, Loaders, Interpreters and debugging methods to manage system memory and provide a portable runtime environment.	L5
CO4	Analyse the working of an operating system and its components.	L6, L2

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-2	3	3	2	3	-	-	-	-	-	-	-	-	3	-
CO-3	3	3	-	3	-	-	-	-	-	-	-	-	3	3
CO-4	2	2	3	3	-	-	-	-	-	-	-	-	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

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.	07
Module-II	Assemblers: Design of Assembler, Table Processing: searching and sorting, Macro Language and the Macro Processor: Macro Instructions, Features of Macro facility, Implementation.	07
Module-III	Linkers and Loaders: Concept of linking, Case study of Linker in x86 machines, various loading schemes, Design of an absolute loader, Design of a direct-linking loader.	07

Module-IV	Compilers: Statement of problem, Phases of the complier, Data structures, Recursion, Call and Return statements, Storage Classes-Use implementation, Block structure, Nonlocal GoTo's, Interrupts, Pointers. Debuggers: Introduction to various debugging techniques, Case Study: - Debugging in Turbo C++ IDE.	08
Module-V	Operating System: I/O programming, Memory management, Processor management, Device management, Information management.	07

Learning Resources:

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Text Books:	1. Systems Programming, Donovan John J.,New York, Tata Mc-Graw Hill 2014 2. Introduction to Systems Software, Dhamdhere, D.M., Tata Mc-Graw Hill 1996
Reference Books:	1. Principles of compiler Design Aho A.V. and J.D. Ullman Addison Wesley/ Narosa 2. System Software- An Introduction to System Programming L.L. Beck Addition Wesley 3rd edition, 1996
Other Suggested Readings:	

Course Title:	**Applied Linear Algebra**
Course Code:	**MALB 152**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To understand matrix concept and solve systems of linear equations.	L3
CO2	To introduce vector space and linear transformations.	L2, L3
CO3	To study the concept of eigen value, vector and eigen space.	L4
CO4	To analyze the inner product spaces and orthogonality.	L4, L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	1									3	2
CO-2	3	2	2	2									3	2
CO-3	3	2	3	2									3	3
CO-4	2	3	3	2									3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Elementary row and column operations on a matrix; Row reduction and echelon forms of matrix; Rank of a matrix; Normal form; Inverse of matrix.	06
Module-II	Homogeneous and non-homogeneous system of linear equation and their solutions; Determinant properties; Linear model in business, science and engineering; Application to computer graphic.	07
Module-III	Vector space and its subspace; Spanning sets and linear independence; Basis of vector space.	05
Module-IV	Linear Transformations; Matrix of a linear transformation; Range space and Rank; Null Space and nullity; Row Space; Eigen values and eigen vectors; Eigen space;	08

	Diagonalization of matrices; Similarity of matrix; Application to differential equations.	
Module-V	Inner Product; Inner product space; Application to inner product space; Diagonalization of symmetric matrices; Orthogonal sets; Orthogonal projections; Gram Schmidt process, least square approximations; Quadratic forms; Constrained optimization; The singular wave	08

Learning Resources:

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Text Books:	1. David C Lay, Linear Algebra and its Applications, 2011, Pearson Publications
Reference Books:	1. Gilbert S., Introduction to Linear Algebra, 2009, Cambridge Press. 2. Kreyszig E., Advanced Engineering Mathematics, 2008, John Wiley and Sons.
Other Suggested Readings:	

Course Title:	**Introduction To Hardware**
Course Code:	**CSPB 154**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Identify various hardware components of a system.	L1
CO2	To assemble the computer.	L2
CO3	To test various electronic components using Digital Multi-meter.	L1

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1		1		2	1							1	1
CO-2	1		1		2	1			1				1	1
CO-3	2		1		2	1							1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Lab Experiments:

Exp. No.	**List of Experiments**
1	To study the history of a Computer System.
2	Study of CPU
3	Study of RAM
4	Study of Processor
5	History of HDD and CDROM
6	Testing of Electronics components using a Digital Multimeter
7	Study of Motherboard
8	Simulation of electric circuit using any electric circuit simulator.
9	Study of peripheral devices I (Input- Keyboard, Mouse)
10	Study of peripheral devices II (Output- Printer, Monitor, Scanner)

Course Title:	**Environmental Sciences**
Course Code:	**CELB 101**
L-T-P:	**2-0-0**
Credits:	**2**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To gain knowledge about environment and ecosystem.	L2
CO2	To gain knowledge about the conservation of biodiversity and its importance.	L-3
CO3	To aware students about problems of environmental pollution, its impact on human, ecosystem and control measures and understand the issues related to Solid waste.	L4
CO4	To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.	L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	2	3	2					2	1	1	1
CO-2	2	2	2	2	1	3	3					2	1	1	1
CO-3	3	2	2	2	2	3	3					2	3	2	2
CO-4	3	2	1	1		2	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.	04
Module-II	Ecosystem: Ecosystems - Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Biogeochemical cycles.	08

Module-III	Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. Inida as a mega- diversity nation, Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	08
Module-IV	Environmental Pollution: Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Noise pollution Solid waste, Green House Effect, Global Warming, Climate Change, Ozone Layer Depletion and Photochemical Smog	12

Learning Resources:

Text Books:	1. Anubha Kaushik and C. P. Kaushik‘s ―Perspectives in Environmental Studies, 6th Age International Publishers, 2018. 2. Benny Joseph, Environmental Science and Engineering ‘,McGraw Hill Education, 2017. 3. Gilbert M. Masters, Introduction to Environmental Engineering and Science ‘, 2nd edition, Pearson Education, 2004. 4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall, 2011. 5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering; International edition, 2015.
Reference Books:	1. Environment Impact Assessment Guidelines, Notification of Government of India, 2006. 2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
Other Suggested Readings:	

Course Title	DESIGN AND ANALYSISOFALGORITHMS
Course Code	CSBB 202
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Analyze the asymptotic time and space complexity of algorithms, and understand the trade-off between these complexities	L4, L2
CO-2	Design and implement algorithms for solving various computational problems, using techniques such as divide-and-conquer, greedy algorithms, dynamic programming, and graph algorithms	L6, L3
CO-3	Use randomized algorithms, approximation algorithms, and NP-completeness to solve real-world problems and to evaluate the practical efficiency of algorithms	L5
CO-4	Develop strong problem-solving skills and a deep understanding of the principles of algorithm design and analysis	L6, L2

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3			2								2	3	
CO-2	3	3	3	2	3	2	2	3	2		2	3	3	2
CO-3	3	3	3		3		3		3			3	3	3
CO-4	3	2	3		2		3					3	3	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Introduction: Algorithms, Analysis of Algorithms, Design of Algorithms, Complexity of Algorithms, Asymptotic Notations, Growth of function, Recurrences and their solution methods. Sorting in polynomial Time: Insertion sort, Merge sort, Heap sort, and Quick sort Sorting in Linear Time: Counting sort, Radix Sort, Bucket Sort, Medians and order statistics.	08
Module-II	Advanced Data Structure: Red Black Trees, Augmenting Data Structure, Binomial Heap, B-Tree, Fibonacci Heap, and Data Structure for Disjoint Sets, All kinds of Algorithms on these data structures, Dictionaries and priority Queues, mergeable heaps, concatenable queues.	08
Module-III	Advanced Design and Analysis Techniques: Dynamic programming, Greedy Algorithm, Backtracking, Branch-and-Bound, Amortized Analysis. Graph Algorithms: Elementary Graph Algorithms, Breadth First Search, Depth First Search, Minimum Spanning Tree, Kruskal's Algorithms, Prim's Algorithms, Single Source Shortest Path, All pair Shortest Path, Maximum flow and Traveling Salesman Problem	08
Module-IV	Dynamic Programming: Chained matrix multiplication, longest common subsequence. Divide and Conquer: Order Statistics – finding the median, exponentiation, matrix multiplication, LCS. Computational Geometry: Line segments, Optimal polygon triangulation. Approximate Algorithm: Travelling Salesman Problem, vertex-cover problem.	06

Module-IV	Primality testing, Integer factorization, Randomized algorithms, Probabilistic algorithms. String Matching algorithms: Rabin Karp, KMP, Boyer Moore. Introduction to problem classes – NP, NPC, NP-Hard	05

Learning Resources

Text Books:	1. Introduction to Algorithm, Cormen, Leiserson, Rivest, Prentice Hall of India, 3rd Edition 2010
Reference Books:	1. Fundamental of Computer algorithms, Horowitz and Sahani, Universities Press, Edition Second edition 2008. 2. Computer Algorithms Introduction to Design and Analysis, Sara Baase and Allen Van Gelder, Pearson Education, Edition 3rd Edition 1999. 3. Fundamental of Algorithms, Brassard Bratley, PHI, Edition 1st Edition 1996. 4. Algorithms Design, M T Goodrich et. al., John Wiley, Edition. 5. The Design and analysis of Algorithms, A V Aho et al, Pearson Education, Edition 1st Edition 2002. 6. Algorithm Design, Jon. Kleinberg and E Tardos, Pearson Education, Edition 1st Edition 2013.
Other Suggested Readings:	7.

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, the number of elements in the list to be sorted. The elements can be read from a file or can be generated using the random number generator
2	Implement a Merge Sort algorithm to sort a given set of elements and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted. The elements can be read from a file or can be generated using the random number generator.
3	A) Obtain the Topological ordering of vertices in a given digraph. B) Compute the transitive closure of a given directed graph using Warsh all's algorithm
4	Implement 0/1 Knapsack problem using Dynamic Programming
5	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm
6	Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm
7	A) Print all the nodes reachable from a given starting node in a digraph using BFS method. B) Check whether a given graph is connected or not using DFS method.
8	Find a subset of a given set S = {s1, s2,….., sN} of n positive integers whose sum is equal to a given positive integer d. For example, if S= {1, 2, 5, 6, 8} and d = 9 there are two solutions {1,2,6} and {1,8}. A suitable message is to be displayed if the given problem instance doesn't have a solution
9	Implement any scheme to find the optimal solution for the Traveling Salesperson problem and then solve the same problem instance using any approximation algorithm and determine the error in the approximation
10	Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.
11	Implement All-Pairs Shortest Paths Problem using Floyd's algorithm.
12	Implement N Queen's problem using Back Tracking

Course Title	OPERATING SYSTEM
Course Code	CSBB 203
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Understanding of the fundamental concepts, design principles, and implementation techniques of modern operating systems.	L2, L3
CO-2	Ability to design, implement, and evaluate process management, memory management, file system management, and input/output management algorithms.	L5, L6
CO-3	Ability to understand and implement distributed systems, such as client-server systems, distributed file systems, and distributed operating systems.	L2, L3, L4
CO-4	Hands-on experience with the design and implementation of operating systems through programming projects and case studies.	L5, L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	Detailed Syllabus	Contact Hours
Module-I	Basics: Operating System Functionalities, Types of Operating Systems, Computer Architecture support to Operating Systems.	05
Module-II	Process Management: Threads, Process Scheduling - Uniprocessor scheduling algorithms, Multiprocessor and Real-time scheduling algorithms, Process Synchronization - Peterson's Solution, Bakery. Algorithm, Hardware Support to Process Synchronization, Semaphores, Critical Regions, Monitors - Deadlock prevention, deadlock avoidance, and Detection and Recovery - Bankers Algorithm.	10
Module-III	Memory Management: Segmentation and space allocation, Basics of linking and loading, Demand Paging, Page replacement algorithms, Analysis of page allocation policies, Thrashing- Working Set.	07
Module-IV	File Systems: Contiguous, Sequential, and Indexed Allocation, File system interface, File System implementation; Case study of Unix File system, Mounting and Unmounting files systems; Network File systems.	07
Module-V	I/O System: Disk Scheduling, Device drivers - block and character devices, streams, Character and Block device switch tables. Protection and Security - Accessibility and Capability Lists.	07

Learning Resources:

Text Books:	1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne Operating System concepts Addison-Wesley Sixth edition, 2003.
Reference Books:	1. Andrew Tanenbaum, Modern Operating Systems Prentice Hall. 2. William Stallings Operating Systems Prentice Hall. 3. Harvey M. Deitel An introduction to operating systems Addison-Wesley 4. Andrew Tanenbaum & Albert Woodhull Operating Systems: Design and Implementation Prentice-Hall 5. Douglas Comer Operating System Design - The XINU Approacht Prentice-Hallt 6. A.M. Listert Fundamentals of Operating Systemst Macmillant 1979
Other Suggested Readings:	7.

Lab Experiments:

Exp. No.	List of Experiments
1	Basics of Unix Commands
2	Implementation of Process Related System Calls (Fork).
3	Implementation of System Calls (Open, Read, Write, and Close) for File Management
4	Implementation of Process Synchronization
5	Implementation of Memory Management Using Address Translation
6	Implementation of FIFO Page Replacement Algorithms
7	Implementation of LRU Page Replacement Algorithms
8	Implementation of First Come First Serve and Shortest Job First Scheduling Algorithm
9	Implementation of Priority and Round Robin CPU Scheduling Algorithm
10	Implementation of Banker's Algorithm.
11	Implementation of Sleeping Barbar Problem in Process Synchronization
12	Implementation of Algorithm for Deadlock Detection

Course Title	DATABASE MANAGEMENT SYSTEM
Course Code	CSBB 204
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Learn the basic concepts of Database Systems	L2
CO-2	Model the real-world systems using Entity Relationship Diagrams and convert the ER model into a relational logical schema using various mapping algorithms.	L3
CO-3	Make use of SQL commands and relational algebraic expressions for query processing.	L4
CO-4	Simplify databases using normalization process based on identified keys and functional dependencies and solve the atomicity, consistency, isolation, durability, transaction, and concurrency-related issues of databases	L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												1		
CO-2	2	1	1										2	2	1
CO-3	3	2	2	2	2	1							2	2	
CO-4	3	2	2	2	2	2							2		

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
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	06
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).	08
Module-III	Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	06
Module-IV	SQL - Introduction, data definition in SQL, table, key and foreign key definitions, update behaviours. Querying in SQL - basic select-from-where block and its semantics, 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.	08
Module-V	Transaction management and Concurrency control: Transaction processing and Error recovery - concepts of transaction processing, ACID properties, and	08

	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:

Text Books:	1. R. Elastic and S.B. Navathe Fundamentals of Database Systems Pearson 2016
Reference Books:	1. H.f.Korth and Silberschatz Database Systems Concepts McGraw Hill 2. C.J. Date Data Base Design Addison Wesley 3. Hansen and Hansen DBM and Design PHI 4. Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom Database System Pearson 2nd Edition
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	Library Management system (File Handling)
2	Introduction to SQL a) Installation of SQL-Server b) SQL data definition c) Constraints in SQL d) Schema change Statement
3	Basic SQL Queries
4	Complex SQL Queries-1 a) Correlated Nested Queries b) Nested Queries c) EXISTS Function in SQL d) Aggregation Function
5	Complex SQL Queries-2 a) Joined Tables b) Aggregate Functions
6	Complex SQL Queries-3 a) Grouping b) EXISTS and UNIQUE functions c) 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

Course Title	Computer architecture and organization
Course Code	CSBB 251
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Identify functional units and illustrate register transfer operations	L1
CO-2	Explain the internal organization of the computer and its instructions	L2
CO-3	Understand fixed- and floating-point algorithms and apply micro program instructions.	L3
CO-4	Summarize the memory organization and pipelining concepts	L2

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	1		1			1						3	
CO-2	2	1		1	2		1						3	3
CO-3	3	2		1	2		2				2		3	3
CO-4	3	2		1	3		2				1		3	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	Detailed Syllabus	Contact Hours
Module-I	Introduction: Function and structure of a computer Functional components of a: Function and structure of a computer, Functional components of a computer, Interconnection of components, Performance of a computer.	05
Module-II	Representation of Instructions Representation of Instructions: Machine instructions, Operands, addressing: Machine instructions, Operands, addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures.	06
Module-III	Processing Unit: Organization of a processor - Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Microprogrammed control unit.	06
Module-IV	Memory Subsystem: Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Error correction memories, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Hardware support for memory management.	10
Module-V	Input/Output Subsystem: Access of I/O devices, I/O ports, I/O control mechanisms - Program controlled I/O Interrupt controlled I/O and DMA controlled I/O I/O interfaces Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O interfaces - Serial port, Parallel port, PCI bus,	09

	SCSI bus, USB bus, I/O peripherals - Input devices, Output devices, Secondary storage devices.	

Learning Resources:

Text Books:	1. D. A. Patterson, J. L. Hennessy, Computer Organization and Design – The Hardware/Software Interface, Morgan Kaufmann, 2014.
Reference Books:	1. M. Morris Mano, Computer System Architecture, Prentice Hall of India Pvt Ltd, Third edition, 2002. 2. W. Stallings, Computer Organization and Architecture – Designing for Performance, Prentice Hall of India, 2002. 3. C. Hamacher, Z. Vranesic, S. Zaky, Computer Organization, McGraw-Hill, 2002. 4. J. P. Hayes, Computer Architecture and Organization, McGraw-Hill, 1998.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	To study and verify the truth table of logic gates.
2	Implement Half Adder and Full Adder using basic logic gates.
3	To simplify the given expression and to realize it using Basic gates and Universal gates
4	Implement Gray-to-Binary and Binary-to-Gray code conversion.
5	To implement 4 x 1 and 8 x 1 multiplexers
6	Verify the excitation table of various Flip Flops
7	To Design an 8-bit Arithmetic Logical Unit.
8	Design the control unit of a computer using either handwriting or microprogramming based on its register transfer language description.
9	To implement a simple instruction set computer with a control unit and a data path.
10	To design the data path of a computer from its register transfer language description.

Course Title	Artificial intelligence
Course Code	CSBB 252
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Understand the basic concepts of AI.	L1, L2
CO-2	Apply search strategies to solve AI problems.	L3
CO-3	Apply knowledge representation and reasoning to solve real-world AI Problems.	L3
CO-4	Explore machine learning concepts and algorithms for real-world applications.	L4

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												2	2
CO-2	2	3	3	3	3								3	3
CO-3	2	2	3	3	3								3	3
CO-4	2	2	3	3	3								3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction, History, Possible Approaches in AI, Automated Problem-Solving Agent: Intelligent Agent & Environment, Complex Problems and AI, Shannon number, Problem Representation in AI	06
Module-II	Search Strategies: Search introduction, Uninformed Search, Informed/Heuristic Search, Beyond Classical Search, Local Search, Problem Reduction, Adversarial Search, Constraint Satisfaction Problems	06
Module-III	Logic and Deduction: Logical Agents, Propositional logic and Predicate Logic, First Order Logic, inference in First order Logic, Inferencing by Resolution Refutation, Classical Planning	07
Module-IV	Quantifying Uncertainty, Introduction 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	08
Module-V	Learning Agent, Introduction to Machine Learning, Types of Machine Learning, learning from experience: Reinforcement Learning, Background, Model based and Model free learning, TD and Q Learning, RL Applications, Learning from Example, Supervised learning: Introduction, Naive Bayes, Decision Tree, Perceptrons, Neural Network, Introduction to Deep Learning. AI Applications and Ethics, Ethics of AI.	09

Learning Resources:

Text Books:	1. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Halls, Fourth Edition, 2020
Reference Books:	1. Nils J. Nilsson Artificial Intelligence: A New Synthesis Morgan-Kaufmann, 1998. 2. Judea Pearl Heuristics: Intelligent Search Strategies for Computer Problem Solving Addison-Wesley Publishing Company 1984.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	Introduction to Prolog programming
2	Python Frameworks Tutorial (with Jupyter and Colab) and it's Data Structures
3	Searching in graph-based problem space, exploring Uninformed search Techniques
4	Exploring Informed search Techniques (Vacuum world and Maze Problem)
5	Exploring Uninformed and Informed search Techniques (PACMAN Search Space)
6	Multi-agent in a search space
7	Introduction Logical Agent and Knowledge representation using Prolog
8	Reasoning Under Uncertainty using Bayesian Learning
9	Reinforcement Learning using Q-Learning
10	Introduction to Machine Learning and Python libraries for Data Analysis (Pandas, NumPy, Matplotlib)

Course Title	Software engineering
Course Code	CSBB 254
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Analyze the basic knowledge in software engineering to learn the various software development process models.	L4, L2
CO-2	Develop the standard models about the software product that is to be engineered and the processes that provides a framework for the software engineering methodologies.	L6, L3
CO-3	Apply the knowledge of software engineering to analyse the progress of the projects with the issues raised and develop the process for software projects using real life experiments.	L5
CO-4	Evaluate the software project processes and components of the projects to identify the risks, manage the change to assure quality in software projects and also able to see the risks with the help of real time projects.	L6, L2

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3											3	
CO-2	3	3	2	3									3	
CO-3	3	3		3									3	3
CO-4	2	2	3	3									2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Definition of software and Software engineering, Need of Software engineering, Difference between Program and Product, Software development life cycle, Different life cycle models (waterfall, Iterative waterfall, Prototype, Evolutionary, Incremental and Spiral model), Agile software development and their characteristics, V-Model. Critical Comparisons of SDLC models.	06
Module-II	Software Requirements: Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management. System models: Context models, behavioral models, data models, object models, structured methods.	08
Module-III	Software Design: Goals of good software design, Design strategies and methodologies, Data oriented software design, Structured Design: Structure chart, Coupling, Cohesion, Modular structure, Packaging, Object oriented design, Topdown and bottom-up approach, Design patterns, Structured Analysis: DFD, Data Dictionary, Software Measurement and Metrics: Various Size Oriented Measures:	08

	Halstead's software science, Function Point (FP) based measures, Cyclomatic Complexity Measures: Control flow graphs. Development: Selecting a language, Coding guidelines, Writing code, Code documentation.	
Module-IV	Software Testing: Testing process, Design of test cases, Functional Testing: Boundary value analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Structural testing, Path testing, Data flow and mutation testing, Unit testing, Integration and system testing, Debugging, Alpha & beta testing, testing tools & standards	06
Module-V	Software Maintenance: Management of maintenance, Maintenance process, Maintenance models, Regression testing, Reverse engineering, Software reengineering, Configuration management, documentation. Quality Management: Quality concepts, software quality assurance, software reviews, formal technical reviews, statistical software quality assurance, software reliability, the ISO 9000 quality standards. Current trends in Software Engineering: Software Engineering for projects and products. Introduction to Web Engineering and Agile process.	08

Learning Resources:

Text Books:	1. Roger S. Pressman Software Engineering, A practitioner's Approach Mc Graw Hill International Edition 6th edition. 2. Sommerville Software Engineering Pearson Education 7th edition.
Reference Books:	1. James F. Peters, Witold Pedrycz Software Engineering, an Engineering approach John Wiley. 2. Waman S Jawadekar Software Engineering principles and practice, the Mc Graw-Hill Companies 2000
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	INTRODUCTION TO RAPTOR 1) Find the roots of a quadratic equation. 2) Print all the numbers until the given number 3) Find the largest among the given three numbers.
2	1) Find whether a number is prime. 2) Find the factorial of a given number. 3) Generate pyramid pattern. 4) Find the minimum and maximum element in an array.
3	To draw different levels of DFD.
4	To draw an ER diagram on UPS system
5	To draw a (a) Use case diagramof ATM system. (b) Use case diagram of online shopping system (c) UML diagram of credit card processing
6	Create a project of parking pass for students using ASANA software.
7	Create a project of purchasing MATLAB software using ASANA software.
8	To draw a Gantt chart and network diagram
9	To draw a structured chart.
10	Development of design Document.
11	Development of SRS document.
12	To draw different levels of DFD.
13	To draw a sequence diagram and collaboration diagrams.

Course Title	Computer networks
Course Code	CSBB 301
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Understand the most appropriate networking architecture and technologies for a given organizational structure	L2
CO-2	Identify the lacunae in the existing protocols of various layers of the protocol stack and propose	L4, L5
CO-3	Design, analyse, and evaluate networks and services for homes, data centres, IoT/IoE, LANs and WANs	L3, L4, L5
CO-4	Program/Implement network communication services for client/server and other application layouts.	L3, L6
CO-5	Design and implement various Protocols on Transport layer and Application layers of the network	L3, L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	
CO-5	3	2	3	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: history and development of computer networks, Basic Network Architectures: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit switched, packet switched, message switched, extranet, intranet, Internet, wired, wireless).	06
Module-II	Physical layer: line encoding, block encoding, scrambling, modulation demodulation (both analog and digital), errors in transmission, multiplexing (FDM, TDM, WDM, OFDM, DSSS), Different types of transmission media. Data Link Layer services: framing, error control, flow control, medium access control. Error & Flow control mechanisms: stop and wait, Go back N and selective repeat. MAC protocols: Aloha, slotted aloha, CSMA, CSMA/CD, CSMA/CA, polling, token passing, scheduling.	08
Module-III	Local Area Network Technology: Token Ring. Error detection (Parity, CRC), Ethernet, Fast Ethernet, Gigabit Ethernet, Personal Area Network: Bluetooth and Wireless Communications Standard: Wi-Fi (802.11) and WiMAX.	07

Module-IV	Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Supernetting, Classless addressing, Network Address Translation.	07
Module-V	Transport layer: UDP, TCP. Connection establishment and termination, sliding window, flow and congestion control, timers, retransmission, TCP extensions, Queuing theory, Single and multiple server queuing models, Little's formula. Application Layer. Network Application services and protocols including e-mail, www, DNS, SMTP, IMAP, FTP, TFTP, Telnet, BOOTP, HTTP, IPSec, Firewalls.	08

Learning Resources:

Text Books:	1. AS Tanenbaum, DJ Wetherall Computer Networks Prentice-Hall 5TH Edition, 2010
Reference Books:	1. LL Peterson, BS Davie, Computer Networks: A Systems Approach Morgan-Kauffman 5th Edition, 2011 2. JF Kurose, KW Ross Computer Networking: A Top-Down Approach Addison-Wesley 5th Edition, 2009 3. Behrouz A. Forouzan Data Communication and Network McGraw Hill 5th Edition, 2012 4. William Stallings Data and Computer Communications Pearson 8th Edition, 2007
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	Implement the data link layer framing methods such as character, character stuffing and bit stuffing.
2	Implement on a data set of characters the three CRC polynomials – CRC 12, CRC 16 and CRC CCIP.
3	Implement Dijkstra‘s algorithm to compute the shortest path thru a graph.
4	Take an example subnet graph with weights indicating delay between nodes. Now obtain Routing table art each node using distance vector routing algorithm
5	Take an example subnet of hosts. Obtain broadcast tree for it.
6	Take a 64-bit playing text and encrypt the same using DES algorithm.
7	Write a program to break the above DES coding.
8	Using RSA algorithm encrypt a text data and decrypt the same.

Course Title	Data mining
Course Code	CSBB 303
L-T-P	3-0-2
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Understand the advantages and disadvantages of multiple data mining methods.	L2
CO-2	Learn the concepts behind feature engineering and be able to place them into practice through different types of data.	L2, L3
CO-3	Be able to choose an appropriate model/s for a dataset and evaluate the performance and reliability of such model/s.	L3, L4, L5
CO-4	Apply different data mining algorithms/methods to real-world data	L3, L4

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1			1				2	2
CO-4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Data Mining: Statistical Limits on Data Mining, MapReduce and the New Software Stack Finding Similar Items: Applications of Near-Neighbor Search, Shingling of Documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, The Theory of Locality-Sensitive Functions, LSH Families for Other Distance Measures, Applications of Locality-Sensitive Hashing, Methods for High Degrees of Similarity.	07
Module-II	Clustering: Introduction to Clustering Techniques, Hierarchical Clustering, K-means Algorithms, The CURE Algorithm, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism.	06
Module-III	Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices, Principal-Component Analysis, Singular-Value Decomposition, CUR Decomposition, Recommendation Systems: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction.	07
Module-IV	Link Analysis: PageRank, Efficient Computation of PageRank, Topic Sensitive PageRank, Link Spam, Hubs, and Authorities. Mining Social-Network Graphs: Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, Partitioning of Graphs, Finding Overlapping Communities, Simrank, Counting Triangles, Neighborhood Properties of Graphs.	08

Module-V	Mining Data Streams: The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in a Window, Decaying Windows Advertising on the Web: Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The Adwords Problem/Implementations.	08

Learning Resources:

Text Books:	Tille: The Mining of Massive Datasets Author: Jure Leskovec, Anand Rajaraman Milliway, D. Ullman Publisher: Cambridge University Press Edition: Third Edition
Reference Books:	1. Data mining and analysis: fundamental concepts and algorithms by Zaki, Mohammed J., and Wagner Meira Jr. Publisher Cambridge University Press Edition 2014. 2. Data mining: concepts and techniques: concepts and techniques by Han, Jiawei, MichelineKamber, and Jian Pei. Publisher Elsevier Edition 2011.
Other Suggested Readings:	

Lab Experiments

Exp. No.	List of Experiments
1	Basics of WEKA tool a) Investigate the Application interfaces. b) Explore the default datasets
2	Pre-process a given dataset based on the following: a) Attribute Selection b) Handling Missing Values Pre-process a given dataset based on the following: a) Discretization b) Eliminating Outliers
3	Create a dataset in ARFF (Attribute-Relation File Format) for any given dataset and perform Market-Basket Analysis
4	Generate Association Rules using a) Apriori algorithm. b) FP-Growth algorithm
5	Demonstrate classification process on a given dataset using a) Naïve Bayesian Classifier. b) Nearest Neighbor Classifier
6	Build a Decision Tree using ID3 algorithm
7	Build a distance matrix of the given data using various distance measures.
8	Cluster the given dataset by using the k-Means algorithm and visualize the cluster mean values and standard deviation of dataset attributes.
9	Cluster the given dataset using a a) Hierarchical clustering algorithm. b) DBSCAN algorithm
10	a) Detect anomalies using any clustering algorithm. b) Implement density-based outlier detection

Course Title	Theory of computation
Course Code	CSLB 302
L-T-P	3-1-0
Credits	04
Pre-requisites	None

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Understand formal machines, languages and computations.	L2
CO-2	Design finite state machines for acceptance of strings.	L3, L6
CO-3	Design context free grammars for formal languages.	L3, L6
CO-4	Utilise the concept of formal languages and develop pushdown automata accepting strings.	L3, L4
CO-5	Design Turing machine and distinguish between decidability and undecidability.	L3, L4, L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	2
CO-5	2	2	3	2	2	2	1	1					2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Regular languages Introduction: Scope of study as limits to compubality and tractability. Why it suffices to consider only decision problems, equivalently, set membership problems. Notion of a formal language. DFAs and notion for their acceptance, informal and then formal definitions. Class of regular languages. Closure of the class under complementation, union and intersection. Strategy for designing DFAs. Pumping lemma for regular languages. Its use as an adversarial game. Generalized version. Converses of lemmas do not hold. 6 NFAs. Notion of computation trees. Definition of languages accepted. Construction of equivalent DFAs of NFAs. NFAs with epsilon transitions. Guess and check paradigm for design of NFAs. Regular expressions. Proof that they capture precisely class of regular languages. Closure properties of and decision problems for regular languages. Myhill-Nerode theorem as characterization of regular languages. States minimization of DFAs.	10

Module-II	Context free languages Notion of grammars and languages generated by grammars. Equivalence of regular grammars and finite automata. Context free grammars and their parse trees. Context free languages. Ambiguity. Pushdown automata (PDAs): deterministic and nondeterministic. Instantaneous descriptions of PDAs.Language acceptance by final states and by empty stack. Equivalence of these two. PDAs and CFGs capture precisely the same language class. Elimination of useless symbols, epsilon productions, unit productions from CFGs. Chomsky normal form. Pumping lemma for CFLs and its use. Closure properties of CFLs. Decision problems for CFLs.	08
Module-III	Turing machines, r.e. languages Informal proofs that some computational problems cannot be solved. Turing machines (TMs), their instantaneous descriptions. Language acceptance by TMs. Hennie convention for TM transition diagrams. Robustness of the model-- equivalence of natural generalizations as well as restrictions equivalent to basic model. Church-Turing hypothesis and its foundational implications. Codes for TMs. Recursively enumerable (r.e.) and recursive languages. Existence of non-r.e. languages.	07
Module-IV	Undecidability Notion of undecidable problems. Universal language and universal TM. Separation of recursive and r.e. classes. Notion of reduction. Some undecidable problems of TMs. Rice's theorem. Undecidability of Post's correspondence problem (PCP), some simple applications of undecidability of PCP.	05
Module-V	Intractability Notion of tractability/feasibility. The classes NP and co-NP, their importance. Polynomial time many-one reduction. Completeness under this reduction. Cook-Levin theorem: NP-completeness of propositional satisfiability, other variants of satisfiability. NP-complete problems from other domains: graphs (clique, vertex cover, independent sets, Hamiltonian cycle), number problem (partition), set cover.	06

Learning Resources:

Text Books:	1. J. E. Hopcroft R. Motwani and J. D. Ullman Introduction to Automata Theory, Languages and Computation Addison Wesley 3rd Edition, 2006
Reference Books:	1. M. Sipser Introduction to the Theory of Computation Thomson 2001 2. C. H. Papadimitriou. Computational Complexity Addison Wesley 1994 3. Jerome Keisler H. Joel Robbin Mathematical Logic and Computability McGraw-Hill Internationals 2000 4. C. H. Papadimitriou, H. Lewis Elements of Theory of Computation Prentice Hall 1981 5. J. C. Martin Introduction to Languages and the Theory of Computation Mc Graw Hill 2002 6. M. R. Garey and D. S. Johnson Computers & Intractability W. H. Freeman & Co., San Francisco 1979 7. S. M. Srivastava A Course on Mathematical Logic Springer 2008
Other Suggested Readings:	

Course Title	QUANTUM COMPUTING
Course Code	CSBB 304
L-T-P	3-0-2
Credits	04
Pre-requisites	MAL 241 & MAL151

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Analyze the behavior of basic quantum algorithms.	L2
CO-2	Implement simple quantum algorithms and information channels in the quantum circuit model.	L3
CO-3	Simulate a simple quantum error-correcting code.	L4
CO-4	Prove basic facts about quantum information channels.	L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Quantum: States, Wave function, Probability Density and probability, Steady State and Time-dependent, Superposition, Orthogonality and commutation	07
Module-II	Quantum Physics & Mechanics: Mixed states, Density matrix, composite systems and entanglement, Measurement and Uncertainty relations, tunnelling and non-cloning	07
Module-III	Quantum Circuits: single-qubit gates, multiple qubit gates, design of quantum circuits. Quantum Information: Comparison between classical and quantum information theory. Bell states. Quantum teleportation.	08
Module-IV	Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search	08
Module-V	Noise and error correction: Graph states and codes, Quantum error correction, fault-tolerant computation	06

Learning Resources:

Text Books:	1. M. A. Nielsen and I. Chuang Quantum Computation and Quantum Information Cambridge University Press 2000 2. Pittenger A. O. An Introduction to Quantum Computing Algorithms Birkhauser 1999
Reference Books:	1. C. Bernhardt Quantum Computing for Everyone MIT Press 2019 2. D. McMahon Quantum Computing Explained John Wiley & Sons 2008

Other Suggested Readings:	

Course Title:	**Compiler Design**
Course Code:	**CSBB 351**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Identify the phases of compilers for a programming language.	L1, L2
CO-2	Learn context-free grammars, compiler parsing techniques, construction of abstract syntax trees.	L3
CO-3	Generate syntax-directed translation rules for a given context-free grammar by examining S-attributed and L- attributed grammars and practice of compiler implementation and generate intermediate code by applying various code optimization strategies.	L4
CO-4	Build a domain-specific mini compiler.	L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1										2	1
CO-2	3	3	2	2	1								3	2
CO-3	3	3	3	2	2								3	3
CO-4	3	3	3	3	3								3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Compilers Analysis of the source program, Phases of a compiler, Cousins of the Compiler, Grouping of Phases, Boot- strapping and Compiler construction tools, Symbol Table. Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, From Regular expression to Automata and Design of Lexical Analysis generator.	10
Module-II	Syntax Analysis: Role of the parse, Writing Grammars, Context-Free Grammars, Ambiguous Grammars, Top-Down parsing, Recursive Descent Parsing, Predictive Parsing, Bottom-up parsing, Shift Reduce Parsing, Operator Precedence Parsing, LR Parsers, SLR Parser, Canonical LR Parser, LALR Parser.	08
Module-III	Syntax Directed Translation: Syntax Directed Definitions, Application of SDT and SDT schemes.	05

Module-IV	Intermediate Code Generation: Directed acyclic graphs, three-address code Intermediate languages -Declarations, Assignment Statements, Boolean Expressions, Array references, Back patching.	06
Module-V	Code Generation and Optimization: Issues, Basic Blocks, and Flow Graphs, DAG representation of Basic Blocks, Optimization of basic Blocks, Peephole Optimization, Principal Sources of Optimization, Loop Optimization, Global Data Flow Analysis.	07

Learning Resources:

Text Books	1. Compilers Principles, Techniques, and Tools, Alfred Aho, Ravi Sethi, Jeffrey D Ullman, Pearson Publications, 2014
Reference Books	1. The Theory and Practice of Compiler Writing, Tremblay, Sorenson, Addison-Wesley, 1992 2. Compiler Design in C, Holub, PHI Publication
Other Suggested Readings	

Lab Experiments:

Exp No.	Lab Experiments
1	Identify the files created during the compilation and execution of a C program.
2	Create a program to generate a Lexical Analyzer to identify the following tokens: Keywords, Identifier, Operators, Digits, Literals, and Separators.
3	Read about the FLEX tool and its installation, and then create a program using FLEX to generate a Lexical Analyzer and identify the following tokens: Keywords, Identifier, Operators, Literals, and Separators.
4	Write a program using FLEX to count the number of Lines, Words, Capital Letters, Small Letters, Numbers, Digits, Special Character, Delimiter, Operator, Relational Operator, Total Characters.
5	Write a program using FLEX to read and validate a mathematical expression and display the result. The result should follow the BODMAS Rule. If the expression is invalid, then display it as invalid.
6	Mini Project: Domain/Application Specific Project: Create a lexical analyzer for the Mini Project
7	Perform the following: a. Write a C program to find First and Follow for all non-terminals. b. Explore YACC Tool. c. Download and Install the YACC Tool on your system and prepare an installation lab manual.
8	Perform the following: a. Write a YACC program to check if the entered statement is a valid arithmetic expression. b. Design a grammar for a declarative statement for the C program. Further, write a YACC program to check if the entered statement is a valid declarative statement according to the grammar generated. Design a grammar for a relational expression of C language. Further, write a YACC program to check if the entered statement is a valid relational expression according to the grammar generated.
9	Perform the following: a. Consider the example of a simple desk calculator. You are required to write YACC specifications for this grammar. Show your parsing sequence for the sample input string. b. Write a YACC program to recognize a series of expressions, each on a new line. Also, give a parse sequence for each of the expressions. For the grammar below, write a YACC program to compute the decimal value of an input string in binary.
10	Mini Project: Domain/Application Specific Project: Create syntax analyzer for the Mini Project
11	Perform the following: a. Using YACC, write semantic actions to check if the parenthesis is balanced and count the number of matching parentheses. $P -> (P) \mid a$ Using YACC, write semantic actions translating arithmetic expressions from infix into postfix notation.
12	Perform the following: a. Append semantic actions to the grammar of a simple desk calculator. b. Write a YACC program to evaluate sum, product, min, and max expressions.

Course Title:	**Theory of App Development**
Course Code:	**CSBB 352**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Demonstrate understanding of the fundamentals of android environment.	L2
CO-2	Develop user interface and database for better user experience and efficient data access.	L3
CO-3	Applying development techniques for best user interface and experience in the android application.	L4
CO-4	Applying suitable connectivity controls to the android ap- plication.	L4

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	1		2								2	1
CO-2	2	2	3	2	3								3	2
CO-3	2	2	3	2	3								3	3
CO-4	2	2	3	2	3								3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Fundamentals of Java for Android Application Develop- ment, Overview of Android, Developing Spectacular An- droid Applications, Fragments and Intents in Android, User Interface, Application Programming, Android Resources, App Widget.	06
Module-II	User Interface and Application Components: Front-End De- signing, User Input Handling, Data Storage, Status Bar, Pictures and Menus, Emailing and Networking in Android, Working with Location Services and Maps, Working with Graphics and Animation, Audio, Video and Camera.	06
Module-III	Extended Development, Publication and Connectivity : De- velopment for Tablets, Supporting Older Versions of An- droid, Application publication on Google Play Store, Mone- tizing and Distributing Android Applications. Working with Bluetooth, NFC, and Wi-Fi, Telephony and SMS and Hard- ware Sensors.	06
Module-IV	User Experience Enhancement: Memory management, Working with the Source Editor, Adding Outlets and Ac- tions, and Adding Animation and Sound, to the application. The Trip Model: Implementing the Master View Con- troller, Working with Split View Controllers and the Master View, Finishing the Basic App Structure, Working with Web Views, Displaying Events Using a Page View Controller, Geocoding, and Location Selection.	06

Learning Resources:

Text Books	1. Android App Development for Dummies, Michael Burton, Wiley, Third edition 2. IOS App Development for Dummies, Jesse Feiler, Wiley, First edition 3. Android Application Development - Black Book, Pradeep Kothari, Dreamtech Press, First edition
Reference Books	1. Android Programming: The Big Nerd Ranch Guide, Bill Phillips and Brian Hardy, Big Nerd Ranch Guides, Second edition 2. iOS Programming: The Big Nerd Ranch Guide, Christian Keur and Aaron Hillegass, Big Nerd Ranch Guides, Fifth edition
Other Suggested Readings	

Lab Experiments

Exp. No.	Lab Experiments
1	Installation of Android studio.
2	Development Of Hello World Application
3	Create an application that takes the name from a text box and shows hello message along with the name entered in text box, when the user clicks the OK button
4	Create a screen that has input boxes for User Name, Password, Address, Gender (radio buttons for male and female), Age (numeric), Date of Birth (Date Picket), State (Spinner) and a Submit button. On clicking the submit button, print all the data below the Submit Button (use any layout)
5	Design an android application to create page using Intent and one Button and pass the Values from one Activity to second Activity
6	Design an android application Send SMS using Intent
7	Create an android application using Fragments
8	Design an android application Using Radio button
9	Design an android application for menu.
10	Create a user registration application that stores the user details in a database table.

Course Title:	**Machine Learning**
Course Code:	**CSBB 311**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Gain knowledge about basic concepts of Learning system, Learning Problems, Learning Task and mathematics behind machine learning	L1, L2
CO-2	Understand the machine learning models and basic concepts of artificial neural network.	L2
CO-3	Solve the classification problem using Bayesian Learning Model.	L3
CO-4	Apply the hypothesis concepts on various Learning Models	L3, L4
CO-5	Understand the concepts of Genetic algorithm and Reinforcement Learning.	L2, L4

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	3	2	-	2	-	3	1	1	2	2	3
CO-2	3	2	2	3	3	-	2	2	-	1	1	2	2	3
CO-3	-	-	-	3	3	-	-	-	2	-	-	-	2	3
CO-4	3	-	-	-	2	-	-	-	-	-	-	1	2	3
CO-5	-	2	2	3	3	-	2	3	-	1	1	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Machine Learning: Introduction to Machine Learning, Types: Supervised, Unsupervised, Reinforcement learning. Applications in industry: NLP, vision, healthcare, recommendation and security. Basic ML workflow: Data preprocessing, training, evaluation. Introduction to tools: Python, Scikit-learn, Pandas.	06
Module-II	Supervised Learning Algorithms: Regression: Linear Regression, Ridge, Lasso, gradient descent. Evaluation metrics: MSE, MAE. Classification: Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, SVM, Naïve Bayes. Model evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-score, ROC/AUC. Handling overfitting, underfitting, and imbalanced data.	10

Module-III	Unsupervised Learning Algorithms: Clustering techniques: K-Means, Hierarchical clustering. Elbow method. Association analysis with the Apriori algorithm. Ensemble methods: Bagging, Boosting. Basic overview of Dimensionality reduction: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA).	06
Module-IV	Introduction to Neural Networks: Perceptron, Feed forward neural network, Backpropagation, Deep Learning: Deep Neural Network, Convolutional Neural Network, Recurrent Neural Network and LSTM (Introductory), Overfitting, Underfitting, Bias-variance tradeoff, Cross-validation and mode selection.	08
Module-V	Advanced Topics and Capstone Project: Introduction to Reinforcement Learning, Explainable AI, bias and fairness in ML, Introduction to Federated Learning and privacy-preserving ML, ML in real-life scenarios, Mini project/case study using real-world datasets.	06

Learning Resources:

Text Books	1. Introduction to Machine Learning, E. Alpaydin, MIT Press, 2nd Edition, 2009
Reference Books	1. Machine Learning, T. M. Mitchell, McGraw-Hill, 1997 2. Machine learning in action, P. Harrington, Manning Publications Co, 2012 3. Pattern recognition and Machine Learning, C. M. Bishop, Springer, 2007 4. Machine Learning for Big Data, J. Bell, Wiley, 2014
Other Suggested Readings	

List of Experiments

Sr. No.	Lab Experiments
1.	Perform data loading, cleaning, preprocessing, and visualization using Pandas, NumPy, and Matplotlib on a student performance and weather dataset.
2.	Develop and compare linear, multiple linear, and logistic regression models using housing, academic performance, and breast cancer datasets to predict outcomes and classify data.
3.	Investigate the bias-variance tradeoff by fitting linear and polynomial regression models of varying degrees to the UCI Energy Efficiency dataset.
4.	Implement KNN and Decision Tree classifiers on the Iris dataset and evaluate their accuracy using a confusion matrix.
5.	Analyze the impact of Bagging, Boosting, and Stacking on decision tree performance using the Pima Diabetes dataset.
6.	Compare the performance of PCA and LDA for dimensionality reduction on the UCI Wine dataset.
7.	Develop a sentiment analysis model using a Naive Bayes classifier to categorize tweets from the Sentiment140 dataset as positive, negative, or neutral.
8.	Use K-Means and hierarchical clustering to segment customers based on behavioral data from the Mall Customers dataset.
9.	Create and train a deep neural network using Keras to classify images from the MNIST dataset.
10.	Develop a movie recommendation system using collaborative filtering on the MovieLens dataset and evaluate it using RMSE.
11.	Forecast stock prices using advanced Learning models and evaluate their accuracy using a confusion matrix.

Course Title:	**Pattern Recognition**
Course Code:	**CSBB 312**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain and compare various pattern classification approaches, structural pattern recognition methods, and classifier combination techniques.	L2, L4
CO-2	Summarize and analyze research trends in pattern recognition, including parameter optimization strategies, and relate them to practical applications	L2, L4
CO-3	Apply performance evaluation metrics to pattern recognition systems and critically compare results presented in re- search literature.	L3, L5
CO-4	Implement basic pattern classifiers, classifier combinations, and structural pattern recognizers for real-world applications such as document analysis and recognition	L3, L6

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	1	-	-	-	2	-	2	3	2
CO-2	2	3	2	3	2	1	-	-	-	2	-	3	3	3
CO-3	2	3	3	3	2	-	-	-	-	2	-	3	3	3
CO-4	3	3	3	3	3	1	-	-	-	3	-	3	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Pattern recognition and learning (supervised, unsupervised), training and test sets, feature selection, Clustering vs. Classification; Applications; Linear Algebra, vector spaces, probability theory, estimation techniques	08
Module-II	Classification: Univariate and multivariate density, discriminant functions for the normal Density different cases, Bayes decision theory – discrete features, compound Bayesian decision theory and context, Minimum-error rate classification, Classifiers, Discriminant functions, Decision surfaces, Nor- mal density and discriminant functions, discrete features Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case	08
Module-III	Clustering: Different distance functions and similarity measures, Criterion for clustering, Methods of clustering - partitional, hierarchical, graph theoretic, density based., Cluster validity	06

Module-IV	Un-supervised learning and clustering: Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering. Date description and clustering – similarity measures, criteria function for clustering	07
Module-V	Pattern recognition using discrete hidden Markov models: Discrete-time Markov process, Extensions to hidden Markov models, three basic problems of HMMs, types of HMM, continuous observation densities, multiple mixtures per state, speech recognition applications.	07

Learning Resources

Text Books	1. Pattern Recognition: An Algorithmic Approach, By M. Narasimha Murty and V. Susheela Devi, Springer; 2011 edition 2. Fundamentals of Pattern Recognition and Machine Learning, By Braga-Neto, Springer International Publishing, 2020 3. Pattern Recognition, By S. Theodoridis and K. Koutroumbas, 4th Ed., Academic Press, 2009
Reference Books	1. Pattern Recognition and Machine Learning, By Christopher Bishop, Springer-Verlag New York, 2006 2. Combining Pattern Classifiers: Methods and Algorithms, By Ludmila I. Kuncheva, 2nd Edition, John Wiley, 2014 3. Pattern Classification, by R.O Duda, P.E. Hart and D.G. Stork, John Wiley, 2001
Other Suggested Readings	

Lab Experiments

Exp. No.	Lab Experiments
1	Implement and evaluate linear regression for fitting a curve to given data.
2	Use Bayesian Decision theory of statistical pattern recognition to classify the object.
3	Perform Gaussian model fitting and analyze its accuracy for given datasets.
4	Apply Bayesian inference techniques for curve fitting and compare results with classical methods.
5	Implement and test a Bayes classifier for univariate and multivariate Gaussian distributions under different covariance conditions. Compare decision boundaries for each case using synthetic datasets.
6	Apply K-Means, hierarchical clustering, and density-based clustering to a given dataset. Compare cluster quality using silhouette score and other validity measures.
7	Implement Gaussian Mixture Models (GMM) using Expectation-Maximization (EM) algorithm for clustering. Evaluate performance and compare with K-Means results.
8	Fit a nonlinear curve using a mixture of Gaussian models.
9	Train a discrete HMM for a sequential dataset (e.g., speech or gesture data). Solve the three basics HMM problems: evaluation, decoding, and learning.

Course Title:	**Digital Image Processing**
Course Code:	**CSBB 313**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Learn the basics and mathematical background of Machine learning	L1, L3
CO-2	Data exploratory analysis before applying machine learning	L2
CO-3	Utility of image compression techniques for storage and transmission purpose.	L3, L5
CO-4	To learn about color imaging, color models, and color image processing.	L4

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-2	2	1	1	-	-	-	-	-	-	-	-	-	2	2
CO-3	3	2	2	2	2	1	-	-	-	-	-	-	2	2
CO-4	1	1	1	1									1	1

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Digital image representation, Fundamental steps in image processing, Components of Digital Image processing systems, Elements of visual perception, Image Formation model, Image Sampling and quantization, Relation- ship between pixels – neighborhood, adjacency connectivity, regions, boundaries and distance measures.	07
Module-II	Image Enhancement: Enhancement by point processing, Sample intensity transformation, Histogram processing, Image subtraction, Image averaging Spatial filtering- Smoothing Spatial filters, Sharpening Spatial filters, Frequency domain- Fourier Transform, Low-Pass, High-Pass, Laplacian Homomorphic filtering.	08
Module-III	Image Segmentation: Detection of discontinuities – point, line and edge detection, Edge linking and boundary detection, Thresholding, Region-based segmentation – region growing, region splitting and merging Use of motion in segmentation- Spatial techniques and Frequency domain techniques.	08

Module-IV	Image Compression: Coding redundancy, Interpixel redundancy, fidelit criteria, Image compression models, Error-free compression, Variable length coding, Bit-plane coding, Loss- less predictive coding, Loss compression, Image compression standards, Real-Time image transmission JPEG and MPEG.	07
Module-V	Color Image Processing: Color Models, Pseudo color Image Processing, Color Transformations, Smoothing and sharpening, Image Segmentation based on color.	06

Learning Resources:

Text Books	1. Digital Image Processing, R.C. Gonzalez, R.E Woods, Pear- son Education, 3rd Edition, 2008
Reference Books	1. Digital Image Processing Using MATLAB, R.C. Gonzalez, R.E Woods, S. L. Eddins, PHI Publication, 2003 2. Image Processing, Analysis, and Machine Vision, M. Sonka, V. Hlavac, R. Boyle, Brooks/Cole, 3rd edition, 2007 3. Digital Image Processing, W.K. Pratt, Wiley-Inter-science, 4th Edition, 2007
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1	Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale)
2	Implementation of transformations namely, translation, rotation, scale and shear
3	Implementation of Histogram, and Histogram Equalization
4	Implementation of FFT (1-D & 2-D) of an image
5	Implementation of Image Compression by DCT
6	Implementation of Image Smoothening Filters (Mean and Median filtering of an Image)
7	Implementation of image sharpening filters and Edge Detection using Gradient Filters
8	Implementation of image restoring techniques
9	Implementation of image segmentation techniques
10	Program for morphological operation: erosion and dilation

Course Title:	**Computer Vision**
Course Code:	**CSBB 314**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Machine Learning Course**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understand foundational concepts of deep learning, including neural networks, training methods, and optimization techniques.	L1, L2, L3
CO-2	Develop and evaluate convolutional neural networks (CNNs) for image classification and object detection.	L4, L5, L6
CO-3	Design recurrent neural networks (RNNs) and Transformer models for NLP and time-series analysis.	L4, L5, L6
CO-4	Implement advanced deep learning techniques for generative modeling, speech recognition, and gesture recognition.	L4, L5

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	3	1							3	2
CO-2	3	2	3	3	3	1							3	2
CO-3	3	3	3	3	3	1							3	2
CO-4	2	3	3	3	3	1							3	2

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to computer vision: Overview of Computer Vision, Applications of Computer Vision in Robotics, Health- care, and Autonomous Vehicles, Basic Image Formation and Representation, Image Filtering: Smoothing, Sharpening, and Histogram Equalization.	06
Module-II	Image Processing and Feature Detection Fundamentals: Grayscale and Color Image Processing, Image Transformations: Fourier Transform, Discrete Cosine Transform (DCT), Edge Detection: Sobel, Canny, and Laplacian, Corner and Blob Detection (Harris Corner Detector, FAST, SIFT, and SURF), Image Matching and Transformation: Homographic and RANSAC, Key point Descriptors	08
Module-III	Machine Learning for Computer Vision Tasks: Classification: SVMs, KNN, Decision Trees, Introduction to Neural Networks and Convolutional Neural Networks (CNNs), Deep Learning Architectures for Vision (Alex Net, ResNet, VGG), Anomaly Detection in Images (e.g., Autoencoders), Applications: Face Recognition, Gesture Recognition, and Scene Understanding	07

Module-IV	Convention computer vision and algorithms: Object detection and segmentation e.g. Edge, texture, region, detection of sliding windows: Feature extraction, e.g. linear binary pattern, principal component analysis, Gabor filters, bags of features, Matching and recognition e.g. Bayesian classifier, support vector machine, fusion, Image alignment and stitching. Principal Component Analysis (PCA)	08
Module-V	Deep learning and Neural Networks for computer vision: Key components and basic architecture of deep neural net- work, Convolution neural network, Object detection using R-CNN, Segmentation using image-to image neural network, Temporal processing and recurrent neural network.	07

Learning Resources:

Text Books	1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer, 2016
Reference Books	1. Computer Vision: a Modern Approach, David Forsyth and Jean Ponce, Pearson, 2015 2. Multiple View Geometry in Computer Vision, Richard Hart- ley and Andrew Zisserman, Cambridge University Press, 2014
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1	To implement data visualization techniques such as box plot, scatter plot, and Q plot for comprehensive analysis of a given dataset.
2	To apply Gaussian, Median, and Bilateral filters to reduce noise in images while preserving important structural details.
3	To enhance and detect edges in images by applying Sobel, Prewitt, and Laplacian filters, emphasizing significant transitions in pixel intensity.
4	To classify images using a Support Vector Machine (SVM) model and assess performance through cross-validation and key metrics such as accuracy and confusion matrix.
5	To apply Convolutional Neural Networks (CNNs) for image classification and evaluate the model's performance using standard metrics such as accuracy and confusion matrix.
6	To implement K-Nearest Neighbors (KNN) for image classification and evaluate its effectiveness through cross-validation and performance metrics such as accuracy.
7	To apply the Fast Fourier Transform (FFT) to convert images into the frequency domain and filter out high-frequency noise, enhancing image quality.
8	To apply Principal Component Analysis (PCA) for reducing the dimensionality of image datasets while retaining the most significant features.
9	To extract texture features from images using Gabor filters, enhancing the under- standing of surface patterns and texture-related information.
10	To perform object detection by leveraging Region-based Convolutional Neural Net- works (R-CNN) for detecting and classifying objects in images.
11	To implement Long Short-Term Memory (LSTM) networks for sequential image classifications and evaluate the model's performance using cross-validation and accuracy metrics.
12	To classify images using a Decision Tree model and evaluate its performance using cross-validation and metrics such as accuracy, precision, and recall.

Course Title:	**Optimization Techniques**
Course Code:	**CSBB 315**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	To understand the fundamentals of Linear Programming and Dynamic Programming.	L1, L3
CO-2	Enumerate the fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.	L1, L2
CO-3	Identify appropriate optimization methods to solve complex problems involved in various industries.	L1, L2, L4
CO-4	To understand the graphical, simplex, and analytical methods for making effective decisions.	L2, L5

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-2	1	1	2	-	-	-	-	-	-	-	-	-	1	2
CO-3	1	2	1	2	2	1	-	-	-	-	-	-	2	2
CO-4	2	2	2	2	1	2	-	-	-	-	-	-	2	-

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Preliminaries: Proofs, Vector Spaces and Matrices, Linear Transformations, Eigenvalues and Eigenvectors, Orthogonal Projections, Quadratic Forms, Matrix Norms, Concepts from Geometry, Elements of Calculus	06
Module-II	Unconstrained Optimization: Basics of Set Constrained and Unconstrained Optimization, One Dimensional Search Methods, Golden Section Search, Fibonacci Search, New- ton's Method, Secant Method, Solving Ax = b	08
Module-III	Linear Programming: Introduction to Linear Programming, Simplex Method, Duality	07
Module-IV	Nonlinear Constrained Optimization: Problems with Equality Constraints, Problems with Inequality Constraints, Karush Kuhn Tucker Condition, Convex Optimization Problems	08

Module-V	Algorithms for Constrained Optimization: Projections, Project gradient methods, Penalty methods.	07

Learning Resources:

Text Books	1. An Introduction to Optimization, Edwin K.P. Chong, Stanislaw H. Zak, Wiley, 4th
Reference Books	1. Convex Optimization, Stephen Boyd, Lieven Vandenberghe, 3rd 2. Modern Optimization with R (Use R), Paulo Cortez, Springer, 2014
Other Suggested Readings	

Course Title:	**Information Storage and Retrieval**
Course Code:	**CSBB 316**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain the fundamental concepts of information retrieval, including system components, indexing techniques, term weighting, clustering methods, and retrieval models.	L1, L2, L3
CO-2	Apply indexing, searching, and retrieval techniques (Boolean, Vector Space, Probabilistic) to represent and query information effectively.	L3, L4
CO-3	Evaluate the performance of IR systems using standard measures (Precision, Recall, F-score, NDCG, MRR) and apply visualization techniques for user-oriented retrieval.	L4, L5
CO-4	Design and analyze retrieval strategies for distributed, multimedia, and web-scale information systems, including web scraping and modern search engines.	L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	1	1							1	2	2
CO-2	2	3	2	2	2					1		1	2	3
CO-3	2	2	3	3	2					1		1	3	3
CO-4	2	3	3	3	2							1	3	3

Scale: 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 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.	07
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.	07
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.	08

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.	07
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.	07

Learning Resources:

Text Books	1. Introduction to Information Retrieval, by Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press, 2008
Reference Books	1. Modern Information Retrieval, Ricardo Baeza-Yates, Berthier Ribeiro-Neto, Addison-Wesley, 2nd Edition, 2011 2. Information Representation and retrieval in the digital age, Medford, Information Today Press, 2003 3. Information Storage and Retrieval, R. R. Korfhage, R. R. Korfhage, 1997Text Information Retrieval Systems, Charles T. Meadow, Academic Press, 2007 4. Visualization for Information Retrieval, Zhang, Springer, 2008
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1	Implementation of a simple Boolean search system using a small document collection.
2	Implement a tokenization and stemming technique on a given text dataset.
3	Build an inverted index for a set of documents.
4	Implement a simple indexing system using suffix arrays and suffix trees.
5	Implement a basic document clustering algorithm (e.g., k-means clustering).
6	Implement a probabilistic indexing and retrieval model. Evaluate an IR system using precision, recall, and F-score metrics.
7	Visualization of the search results with relevant feedback.
8	Implementing a keyword-based search and query expansion.
9	Implement a basic web crawler and indexer for small websites.
10	Implement an image retrieval system based on color and texture features.
11	Implement a basic recommendation system based on collaborative filtering.
12	Implement a simple text categorization system using Naive Bayes or SVM.
13	Develop a small-scale web scraper using Python's BeautifulSoup and Requests.
14	Implement a distributed IR system with collection partitioning and query processing.

Course Title:	**Soft Computing**
Course Code:	**CSBB 317**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understand the fundamental principles of soft computing, including fuzzy logic, artificial neural networks	L2, L3
CO-2	Explain applications and operations of Fuzzy Logic in real life Problems	L4, L5
CO-3	Analyze and evaluate the performance of different soft computing models for specific applications.	L2, L3, L4
CO-4	Design and implement soft computing solutions using appropriate tools and techniques for practical and innovative problem-solving	L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	1	3				1				3	2
CO-2	3	2	2	2	3				1				3	3
CO-3	3	3	2	3	3				1				3	3
CO-4	2	3	3	3	2				1				3	3

Scale: 1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Soft computing vs Hard computing, Applications of Soft computing, Basic mathematics of soft computing, Learning and statistical approach to regression and classification.	06
Module-II	Neural Networks: Single layer perceptron, learning rules, ADALINE Network, LMS algorithm, multi-layer perceptron, Radial basis function, Associative Memory Networks, Kohnen's self-organizing networks, Hopfield Network, Principal component analysis, Introduction to SVM, Binary classification, Regression by SVM: linear & nonlinear, Decom- posing multiclass classification into binary classification.	08
Module-III	Fuzzy Logic: Introduction to Fuzzy logic, Probability vs Possibility Theory, Classical set and fuzzy set, fuzzy set operations, Criteria for Selecting appropriate aggregation Operators. Fuzzy relation, Fuzzy composition, Fuzzy Inference system, Fuzzification, Fuzzy rule-based system, Defuzzification, Fuzzy Arithmetic, Fuzzy logic application, Predicate logic, Fuzzy Rule based Approximate Reasoning, Models of Neuro-fuzzy system (NFS), Interpretation of NFS layers, Adaptive N-F Inference system (ANFIS) Architecture	08

Module-IV	Metaheuristic Approaches: Concept of" Genetics" and" Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, Ant Colony Optimization, Particle Swarm Optimization	08
Module-V	Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs.	06

Learning Resources:

Text Books	1. A comprehensive foundation. Neural Networks, Simon Haykin, Pearson, Second Edition, 2001
Reference Books	1. Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley & Sons, Third Edition, 2009 2. An Introduction to Genetic Algorithms, Melanie Mitchell, Prentice-Hall, 1998 3. Genetic Algorithms in Search, Optimization, and Machine Learning, D. E. Goldberg, Addison-Wesley, 1989 4. Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications, S. V. Kartalopoulos, IEEE Press, PHI, 2014 5. Neural Networks, Fuzzy Logic and Genetic Algorithms: Syn- thesis & Applications, S. Rajasekaran & G. A. Vijayalakshmi Pai, PHI, 2003 6. Principles of Soft Computing, S. N. Sivanandam & S. N. Deepa, Wiley - India, Second Edition, 2007
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1	Form a perceptron net for basic logic gates with binary input and output.
2	Using Adaline network, generate XOR function with bipolar inputs and targets.
3	Design a feed forward neural network with back propagation from scratch to classify numbers using MNIST dataset.
4	Using Kohonen's Self-Organizing Map (SOM) cluster the MNIST dataset and visualizing the resulted clusters on a 2D map.
5	Design a SVM based classifier to classify two selected classes from Iris dataset. Also evaluate the decision boundary.
6	Use PCA as a dimensionality reduction technique on the Iris dataset to reduce dimensions from 4 to 2 and visualize class separation in 2D space.
7	Design fuzzy inference systems for an Automatic Washing Machine with 5 modes of operation.
8	Design and simulate a fuzzy inference system for temperature control of an Air Conditioner.
9	Using an Adaptive Neuro-Fuzzy Inference System (ANFIS) model, predict daily energy consumption based on historical time-series data of temperature and humidity over the Energy Consumption Dataset.
10	Solve the traveling salesman problem using a genetic algorithm to find the shortest possible route that visits all cities exactly once and returns to the starting city.

Course Title:	**Mathematical Foundation of Data Science**
Course Code:	**CSLB 321**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Define and recall fundamental mathematical concepts in data science (linear algebra, probability, calculus) and ex- plain their relevance in data-driven contexts	L1, L2, L3
CO-2	Apply appropriate mathematical methods to solve problems and employ them in a variety of data science applications.	L3, L4, L5
CO-3	Analyze and solve optimization problems using suitable mathematical and computational techniques.	L4, L5
CO-4	Design and implement solutions for data science problems by applying different algorithms effectively.	L3, L4, L5

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	-	-	-	-	-	-	-	-	-	1	1
CO-2	3	2	2	2	-	-	-	-	-	-	-	-	1	1
CO-3	2	2	2	2	-	-	-	-	-	-	-	-	2	2
CO-4	2	2	2	2	-	-	-	-	-	-	-	-	2	2

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Basics of Data Science: Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems.	05
Module-II	Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes.	07
Module-III	Probability, Statistics and Random Processes: Probability theory and axioms; Random variables; Probability distributions and density functions (univariate and multivariate); Expectations and moments. Covariance and correlation; Statistics and sampling distributions; Hypothesis testing of means, proportions, variances and correlations;	08

	Confidence (statistical) intervals; Correlation functions; White- noise process.	
Module-IV	Optimization: Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization; Optimization view of machine learning.	08
Module-V	Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem; Linear classification problems and clustering problems, kernel methods problems, regression trees and ensemble methods problems, dimension reduction.	08

Learning Resources

Text Books	1. G. Strang. Introduction to Linear Algebra, Wellesley- Cambridge Press, Fifth edition, USA, 2016. 2. Bendat, J. S. and A. G. Piersol. Random Data: Analysis and Measurement Procedures. 4th Edition. John Wiley & Sons, Inc., NY, USA, 2010 3. Montgomery, D. C. and G. C. Runger. Applied Statistics and Probability for Engineers. 5th Edition. John Wiley & Sons, Inc., NY, USA, 2011.
Reference Books	1. David G. Luenberger, Optimization by Vector Space Methods, John Wiley & Sons (NY), 1969. 2. Cathy O'Neil and Rachel Schutt. Doing Data Science, O'Reilly Media, 2013.
Other Suggested Readings	

Course Title:	**Data Handling and Visualization**
Course Code:	**CSBB 323**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Visualize the objects in different dimensions.	L2
CO-2	Design and process the data for Virtualization.	L3
CO-3	Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical science.	L4
CO-4	Apply the virtualization techniques for research projects.	L5

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1	3	1							3	2
CO-2	3	2	2	2	3	2							3	3
CO-3	3	3	3	3	3	2							3	3
CO-4	2	3	3	3	2	3					1	1	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction and Data Foundation: Basics - Relationship between Visualization and Other Fields - The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets.	10
Module-II	Foundations for Visualization: Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables - Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson‘s Affordance theory – A Model of Perceptual Processing.	08
Module-III	Visualization Techniques: Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three-Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data: Visualizing Spatial Data- Visualization of Point Data -Visualization of Line Data - Visualization of Area Data - Other Issues in Geospatial Data Visualization Multivariate Data: Point-Based Techniques - Line- Based Techniques - Region-Based	08

	Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.	
Module-IV	Interaction Concepts and Techniques: Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations - Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces - A Unified Framework. Interaction Techniques: Screen Space - Object-Space -Data Space -Attribute Space- Data Structure Space - Visualization Structure - Animating Transformations -Interaction Control	08
Module – V	Research Directions in Virtualizations: Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation, Hardware and Applications.	06

Learning Resources:

Text Books:	1. Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques, Applications", 2010. 2. Colin Ware, "Information Visualization Perception for Design", 2nd edition, Margon Kaufmann Publishers, 2004.
Reference Books:	1. Robert Spence "Information visualization – Design for interaction", Pearson Education, 2nd Edition, 2007. 2. Alexandru C. Telea, "Data Visualization: Principles and Practice," A. K. Peters Ltd, 2008.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1	Acquiring and plotting data.
2	Statistical Analysis – such as Multivariate Analysis, PCA, LDA, Correlation regression and analysis of variance.
3	Financial analysis using Clustering, Histogram and HeatMap.
4	Time-series analysis – stock market.
5	Visualization of various massive dataset - Finance - Healthcare - Census – Geospatial.
6	Visualization on Streaming dataset (Stock market dataset, weather forecasting).
7	Market-Basket Data analysis-visualization.
8	Text visualization using web analytics.

Course Title:	**Time Series Analysis**
Course Code:	**CSBB 325**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Probability and Statistics; Programming in Python**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain time series fundamentals, components, stationarity, and autocorrelation concepts.	L1, L2
CO-2	Apply decomposition methods, smoothing techniques, and evaluate forecasting performance.	L3
CO-3	Construct ARIMA/ SARIMA models using Box-Jenkins methodology with proper diagnostics.	L4
CO-4	Utilize modern tools (Prophet, ML methods) and handle multivariate time series analysis.	L5
CO-5	Develop comprehensive time series projects with deployment considerations and anomaly detection.	L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	2	1	-	-	-	-	1	3	-
CO-2	3	3	2	3	2	3	2	-	1	-	1	2	3	2
CO-3	3	3	3	3	2	2	2	-	2	1	2	2	3	2
CO-4	3	3	3	2	3	2	2	1	2	2	2	2	3	3
CO-5	3	3	3	3	3	2	3	2	3	3	3	3	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Foundations and Visualization:** Introduction to time series: definition, characteristics, examples from engineering, finance, healthcare. Types of time series data: univariate vs. multivariate, discrete vs. continuous. Components of time series: trend, seasonality, cyclicity, irregularity. Data pre- processing: handling missing values, outliers, date-time indexing. Visualization techniques: line plots, seasonal plots, lag plots, autocorrelation plots.	08
Module-II	**Stationarity and Autocorrelation:** Concept of station- arity: weak vs. strong stationarity. Visual identification of non-stationarity. Statistical tests: Augmented Dickey-Fuller (ADF), KPSS tests. Transformations for achieving station- arity: differencing, logarithmic, Box-Cox transformations. Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). White noise and random walk processes.	07

Module-III	**Classical Forecasting Methods:** Smoothing techniques: Simple Moving Average (SMA), Simple Exponential Smoothing (SES). Holt's linear trend method. Holt-Winters seasonal method (additive and multiplicative). Classical de- composition methods. STL decomposition. Error metrics: MAE, MSE, RMSE, MAPE. Forecast evaluation and model comparison.	07
Module-IV	**ARIMA Models and Box-Jenkins Methodology:** Autoregressive (AR) models: properties, estimation, forecasting. Moving Average (MA) models: properties, invertibility. ARIMA models: integration and differencing. Sea- sonal ARIMA (SARIMA) models. Box-Jenkins methodology: identification, estimation, diagnostic checking. Model selection criteria: AIC, BIC. Residual analysis and forecasting with prediction intervals.	08
Module-V	**Modern Methods and Applications:** Prophet frame- work: handling trend, seasonality, holidays. Vector Autoregression (VAR) for multivariate series. Introduction to ma- chine learning for time series: feature engineering, regression with lags. Anomaly detection in time series: statistical methods, control charts. Applications in engineering: predictive maintenance, quality control, demand forecasting.	06

Learning Resources

Text Books	1. Hyndman, R.J. and Athanasopoulos, G., Forecasting: Principles and Practice, 3rd Edition, OTexts, 2021 (Available free online). 2. Nielsen, A., Practical Time Series Analysis: Prediction with Statistics and Machine Learning, O'Reilly Media, 2019.
Reference Books	1. Montgomery, D.C., Jennings, C.L. and Kulahci, M., Intro- duction to Time Series Analysis and Forecasting, 2nd Edition, Wiley, 2015. 2. Box, G.E.P., Jenkins, G.M., Reinsel, G.C. and Ljung, G.M., Time Series Analysis: Forecasting and Control, 5th Edition, Wiley, 2015. 3. Tsay, R.S., Analysis of Financial Time Series, 3rd Edition, Wiley, 2010.
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Time Series Data Exploration and Visualization: Load and parse time series data; create comprehensive visualizations; identify time series components visually.
2	Stationarity Testing and Transformations: Implement stationarity tests (ADF, KPSS); apply transformations; compute and interpret ACF and PACF.
3	Decomposition and Smoothing Methods: Implement classical decomposition and STL; apply smoothing techniques (SMA, SES, Holt, Holt-Winters); compare methods using error metrics.
4	ARIMA Model Building and Diagnosis: Identify ARIMA model orders using ACF/PACF plots; fit AR, MA, ARMA, and ARIMA models; perform residual analysis.
5	Seasonal ARIMA and Prophet Models: Build SARIMA models; implement model selection using information criteria; use Prophet for forecasting with seasonality.
6	Multivariate Analysis and ML Methods: Implement Vector Autoregression (VAR) models; apply machine learning methods with feature engineering for time series.
7	Anomaly Detection and Applications: Implement statistical anomaly detection methods; create control charts; develop real-time monitoring systems.
8	Comprehensive Project: End-to-End Time Series Analysis: Choose domain-specific dataset; perform complete analysis including EDA, modeling, validation, and fore- casting with presentation.

Course Title:	**Distributed System**
Course Code:	**CSBB 326**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Analyze distributed systems architectures, models, and core challenges.	L4
CO-2	Evaluate communication and coordination mechanisms for correctness, scalability, and performance trade-offs.	L5
CO-3	Design distributed algorithms and middleware solutions for coordination, mutual-exclusion, leader election, and fault- tolerance in realistic network models.	L6
CO-4	Critically assess replication, consistency models, and recovery protocols for distributed data and propose appropriate consistency/replication strategies.	L5
CO-5	Develop and test distributed applications and prototypes using contemporary tools and middleware, and evaluate their QoS properties.	L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	2	2	-	-	-	-	-	-	-	2	3
CO-2	2	3	2	3	2	-	-	-	-	-	-	-	1	2
CO-3	2	3	2	2	2	-	-	-	-	-	-	-	2	3
CO-4	3	2	2	2	2	-	-	-	-	-	-	-	1	3
CO-5	2	2	3	3	3	-	-	-	2	2	2	3	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Definition, examples and goals of distributed systems: taxonomy and design goals (scalability, transparency, avail- ability). System models: architectural (client-server, peer-to-peer, layered, object-based), fundamental models (message-passing vs shared memory), synchronous vs asynchronous systems.	06
Module-II	Communication & Coordination: Networking and IPC primitives; external data representation and marshalling; sockets overview. RPC, RMI, message-oriented middleware, publish/subscribe. Logical clocks, Lamport & vector clocks, global state and dis- tributed snapshots. Coordination: mutual exclusion (centralized, Ricart-Agrawala), multicast, leader election.	09
Module-III	Consistency, Replication & Fault Tolerance: Data-centric & client- centric consistency models. Replica management and consistency protocols; quorum and voting. Fault models, checkpointing & recovery, commit protocols, consensus overview	07
Module-IV	DFS concepts and architectures; NFS, AFS, HDFS case stud- ies. Distributed databases: fragmentation, replication, distributed query processing. Name services, DNS, directory services, peer-to- peer systems (Napster style), overview of Google GFS / Bigtable/	08

	Dynamo concepts.	
Module-V	Distributed Applications & Emerging Topics: Middleware design & service-oriented architectures; microservices and web services. Distributed transactions (flat & nested), concurrency control, atomic commit protocols. Emerging: cloud/edge/fog, blockchain fundamentals.	06

Learning Resources

Text Books	1. George F. Coulouris, Jean Dollimore, and Tim Kindberg, Distributed Systems: Concepts and Design, 5th Edition, Pearson, 2011.
Reference Books	1. Andrew S. Tanenbaum and Maarten van Steen, Distributed Systems: Principles & Paradigms, 2nd Edition, Pearson Prentice Hall, 2006. 2. Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms and Systems, 1st Edition, Cambridge University Press, 2008 (paperback reprint correcting 2008 errata, published March 2011). 3. Nancy A. Lynch, Distributed Algorithms, 1st Edition, Morgan Kaufmann, 1996.
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	To implement a simple chat application using TCP sockets.
2	To develop a program for message exchange using UDP sockets.
3	To simulate a basic Remote Procedure Call mechanism over sockets.
4	Lamport Logical Clock To simulate event ordering using Lamport's logical clock.
5	To simulate causality detection using vector clocks.
6	Centralized Mutual Exclusion: To implement centralized control for accessing a critical section.
7	To simulate leader election using the Bully algorithm.
8	To demonstrate file replication and update propagation between nodes.
9	To implement file transfer between client and server with an integrity check.
10	To implement a basic producer-consumer system using message queues.

Course Title:	**Fuzzy Logic and Applications**
Course Code:	**CSBB 405**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain the fundamental concepts of fuzzy set theory, membership functions, and fuzzy logic principles.	L2
CO-2	Apply fuzzy set operations, fuzzy relations, and fuzzy inference mechanisms to model real-world problems.	L3
CO-3	Analyze fuzzy decision-making, fuzzy classification, and optimization problems in engineering contexts.	L4
CO-4	Evaluate the effectiveness of fuzzy logic applications in various domains such automotive, computer networks and medical.	L5

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-2	3	2	-	1	-	-	-	-	-	-	-	-	2	2
CO-3	3	3	2	2	2	-	-	-	-	-	-	-	2	2
CO-4	3	2	2	-	2	-	-	-	-	-	-	-	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Fuzzy Logic- Crisp vs. fuzzy logic, limitations of Boolean logic, Fuzzy applications, Uncertainty and Information, Fuzzy Sets and Membership, Chance versus Fuzziness, Fuzzy Sets- Operations, Properties, Noninteractive Fuzzy Sets, Alternative Fuzzy Set Operations, Classical Relations and Fuzzy Relations- Cartesian Product, Crisp Relations, Fuzzy Relations, Tolerance and Equivalence Relations, Fuzzy Tolerance and Equivalence Relations, Value Assignments.	09
Module-II	Features of the Membership Function, Fuzzification, Defuzzification to Crisp Sets, -cuts for Fuzzy Relations, Defuzzification to Scalars, Fuzzy Logic, Approximate Reasoning, Fuzzy Systems- Natural Language, Linguistic Hedges, Fuzzy (Rule-Based) Systems, Membership Value Assignments- Intuition, Inference, Rank Ordering, Neural Networks, Genetic Algorithms, Inductive Reasoning	09
Module-III	Automated Methods for Fuzzy Systems- Batch Least Squares Algorithm, Recursive Least Squares Algorithm, Gradient Method, Clustering Method, Learning from Example, Modified Learning from Example, Fuzzy Systems Simulation- Fuzzy Relational Equations, Nonlinear Simulation Using Fuzzy Systems, Fuzzy Associative Memories (FAMs), Rule-base Reduction Methods	09

Module-IV	Decision Making with Fuzzy Information- Fuzzy Synthetic Evaluation, Fuzzy Ordering, Nontransitive Ranking, Preference and Consensus, Multi objective Decision Making, Fuzzy Bayesian Decision Method, Decision Making under Fuzzy States and Fuzzy Actions, Fuzzy Classification - Classification by Equivalence Relations, Cluster Analysis, Cluster Validity, c-Means Clustering, Hard c-Means (HCM), Fuzzy c-Means (FCM), Automotive Applications, Computer Network Applications, Medical Applications.	09

Learning Resources:

Text Books	1. Timothy Ross, "Fuzzy Logic with Engineering Applications", 2nd Edition, John Wiley & Sons, Ltd.
Reference Books	1. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Pearson Education. 2. John Yen, Reza Langari, "Fuzzy Logic: Intelligence, Control, and Information", Pearson Education.
Other Suggested Readings	

Lab Experiments

Sl. No.	List of Experiments
1	Create and visualize various membership functions (triangular, trapezoidal, Gaussian, sigmoidal).
2	Implement union, intersection, and complement using min–max and algebraic methods.
3	Define fuzzy relations, implement max–min and max–product composition.
4	Create linguistic terms (e.g., “Low,” “Medium,” “High”) for a given domain and map them to membership functions.
5	Design of a Mamdani Fuzzy Inference System for temperature control problem. Define rules, fuzzify inputs, apply inference, defuzzify outputs.
6	Build a system with multiple conflicting rules and observe effects of different aggregation operators.
7	Solve a multi-criteria decision-making problem (e.g., project selection) using fuzzy scoring.
8	Implement fuzzy c-means clustering for a given dataset and compare with k-means.
9	Design a driver drowsiness detection and scoring system.
10	Create a fuzzy “link quality” score from latency, loss, and residual bandwidth for Fuzzy QoS Routing Metric.
11	Design a Fuzzy Risk Scoring for Type-2 Diabetes.
12	Develop a system with Fuzzy C-Means (FCM) for MRI Brain Segmentation.

Course Title:	**Cloud Computing**
Course Code:	**CSBB 406**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understand the fundamental concepts, service models, and deployment strategies of cloud computing and evaluate its benefits and challenges in real-world applications.	L2
CO-2	Analyze the architecture of cloud systems and apply knowledge of virtualization and data center technologies to design scalable and efficient cloud solutions.	L4
CO-3	Implement and evaluate basic cloud-based programs using distributed programming frameworks.	L5
CO-4	Develop and demonstrate the ability to use modern cloud platforms and services for application development and deployment.	L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	-	-	-	-	-	-	-	-	-	-	2	3
CO-2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO-3	2	2	3	-	2	-	-	-	-	-	-	-	3	2
CO-4	2	2	3	1	3	-	-	-	-	-	-	-	3	1

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Fundamentals of Cloud Computing: Definition, Evolution, and History. Characteristics and Benefits of Cloud Computing. Cloud Service Models: IaaS, PaaS, SaaS. Deployment Models: Public, Private, Hybrid, Community. Challenges and Risks in Cloud Migration	06
Module-II	Cloud Architecture and Technologies: Cloud Reference Architecture and Components, Cloud Layers: Infrastructure, Platform, and Application, Data Center Design and Inter- connection Networks, Cloud Infrastructure: Compute, Storage, and Networking, Networking Support and Role of the Internet in Cloud	07
Module-III	Virtualization in Cloud: Concept and Types of Virtualizations, Virtualization Tools and Technologies: Hypervisors (VMware, KVM, Xen). Virtualization of CPU, Memory, I/O Devices. Virtual Machines vs Containers, Resource Management in Virtual Environments, Data Center Virtualization and Orchestration	07
Module-IV	Cloud Programming and Distributed Frameworks: Features of Cloud Programming, Parallel and Distributed Programming Paradigms, Introduction to MapReduce Programming Model, Google File System (GFS), Hadoop Distributed File System (HDFS), Hadoop Ecosystem: Architecture and Applications, Overview of Cloud Development Platforms (e.g., AWS Lambda, Azure Functions)	08

Module-V	Cloud Platforms and Services: Overview of Popular Cloud Providers: AWS, Microsoft Azure, Google Cloud, Cloud Storage Services: Amazon S3, Google Cloud Storage. SaaS, PaaS, and IaaS in Practice, Case Studies on Cloud-Based Solutions. Cloud Security Basics: IAM, Data Protection, Compliance.	08

Learning Resources:

Text Books	1. Cloud Computing, Principal and Paradigms, Edited By Raj Ku- mar Buyya, James Broberg, A.Goscinski, Wiley, 2011 2. Cloud Computing: A Practical Approach, Anthony Velte and Robert C. Elsenpete, McGraw Hill, 2018 3. Cloud Computing: Bible, Barrie Sosinsky, Wiley Publication, 2018
Reference Books	1. Cloud Computing: Web Based Applications That Change the Way You Work and Collaborate Online, Robert Gibbons, Que Publishing, August 2008 2. Cloud Computing – Insights into New Era Infrastructure, Kumar Saurabh, Wiley Indian, 2011 3. Cloud Computing Best Practices for Managing and Measuring Processes for on demand Computing, Haley Beard, Emereo Pty Limited, July 2008 4. Cloud Computing: A Practical Approach, Anthony T. Velte, Robert, Elsen Peter, TMH, 2018
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Install hypervisor with linux or windows OS on top of host OS.
2	Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
3	Install Google App Engine (GAE). Create hello world app and other simple web applications using python/java.
4	Use Google App Engine (GAE) launcher to launch the web applications.
5	Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
6	Implement a procedure to transfer the files from one virtual machine to another virtual machine.
7	Install Hadoop node cluster and run basic applications.

Course Title:	**Natural Language Processing**
Course Code:	**CSBB 407**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Theory of Automata**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand NLP basics and language analysis. (L2)	L2
CO-2	Describe parsing techniques and feature-based parsing. (L2)	L2
CO-3	Resolve ambiguity using statistical methods and probabilistic processing. (L4)	L4
CO-4	Apply advanced parsing techniques like feature unification and probabilistic parsing (L3)	L3
CO-5	Implement NLP applications including machine translation and speech recognition (L5)	L5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2			1							1	3	2
CO-2	3	2			1							1	3	2
CO-3	3	3		2	2							1	3	3
CO-4	3	2	2	2	2							1	3	3
CO-5	3	3	3	2	3				2	2	2	2	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: The study of Language, Introduction to NLP, Regular Expression, Finite State Automata, Evaluating Language Understanding Systems, Different levels of Language Analysis, Representations and Understanding, Linguistic Background.	06
Module-II	Grammars and Parsing: Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top-Down Chart Parsing, Feature Systems and Augmented Grammars, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks.Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case	08

Module-III	Grammars for Natural Language: Auxiliary Verbs and Verb Phrases, Movement Phenomenon in Language, Handling questions in Context- Free Grammars, hold mechanisms in ATNs, Human preferences in Parsing, Encoding uncertainty, Deterministic Parser.	06
Module-IV	Ambiguity Resolution: Statistical Methods, Probabilistic Language Processing, Estimating Probabilities, Part-of-Speech tagging, Obtaining Lexical Probabilities, Probabilistic Context-Free Grammars, Dependency Parsing, Best First Parsing, Semantics and Logical Form, Word senses and Ambiguity, Encoding Ambiguity in Logical Form	08
Module-V	Advanced Features and Syntax, Features and Unification: Feature structures – Unification of feature structures – Features structures in the grammar – Implementing unification – Parsing with unification constraints – Types and Inheritance. Lexicalized and Probabilistic Parsing: Probabilistic context-free grammar – problems with PCFGs – Probabilistic lexicalized CFGs –Dependency Grammars – Human parsing.	08

Learning Resources

Text Books:	1. James Allen, Natural Language Understanding, Pearson Education, 2003 2. Foundation of Statistical Natural Language Processing, Manning and Schutze, 1998
Reference Books:	1. D. Jurafsky, J. H. Martin, Speech and Language Processing, Pearson, 2008 2. Bharati, Chaitanya and Sangal: Natural Language Processing- a Paninian, 1995
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	a. Write a python program to perform tokenization by word and sentence using nltk. b. Write a python program to eliminate stopwords using nltk.
2.	a. Write a python program to perform Parts of Speech tagging using nltk. b. Write a python program to perform lemmatization using nltk.,
3.	a. Write a python program for chunking using nltk. b. Write a python program to perform Named Entity Recognition using nltk.
4.	Write a python program to find Term Frequency and Inverse Document Frequency (TF-IDF).
5.	Write a python program to find all unigrams, bigrams and trigrams present in the given corpus
6.	Write a python program to find the probability of the given statement “This is my cat” by taking an example corpus into consideration.
7.	Write the python code to perform sentiment analysis using NLP
8.	Write the python code to develop Spam Filter using NLP
9.	Write the python code to detect Fake News using NLP.

Course Title:	**Reinforcement Learning and Applications**
Course Code:	**CSBB 408**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Machine Learning Course**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain the core principles, historical evolution, and inter- disciplinary connections of Reinforcement Learning, emphasizing the Bellman equation's role in decision-making processes.	L1, L2, L3
CO-2	Analyze and mathematically formulate problems as Markov Decision Processes (MDPs) and apply dynamic programming techniques (e.g., policy iteration, value iteration) to derive and evaluate optimal policies.	L4, L5, L6
CO-3	Design and implement model-free prediction and control methods in Reinforcement Learning using Monte Carlo methods and Temporal-Difference (TD) learning techniques, including SARSA.	L4, L5, L6
CO-4	Evaluate and apply advanced concepts such as the multi- armed bandit problem, policy gradient methods, and function approximation techniques to optimize decision-making in Reinforcement Learning tasks.	L4, L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	2	1					1			1	2
CO-2	3	3	3	2	2					1			2	3
CO-3	2	3	3	3	2					1			2	3
CO-4	2	3	3	3	3					1			2	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Reinforcement Learning: Reinforcement Learning, Supervised Learning vs. RL, Unsupervised Learning vs. RL, Markov Decision Process (MDP), States, Actions, Rewards, Transition Probabilities, Discount Factor, Policy, Value Functions, Bellman Equations, Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration.	07
Module-II	Multi-Armed Bandit Problem: n-Armed Bandit Problem, Exploration vs. Exploitation, Action-Value Methods, Incremental Implementation, Optimistic Initial Values, Upper Confidence Bound (UCB), Gradient Bandits, Contextual Bandits, Non-Stationary Bandit Problems.	07
Module-III	Markov Decision Processes and Solution Methods: Markov Decision Process (MDP), Agent-Environment Interface, Goals, Rewards, Returns, Markov Property, Value Functions, Dynamic Programming, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Monte Carlo Methods, First-Visit Monte Carlo, Every-Visit	08

	Monte Carlo, Temporal Difference (TD) Learning, SARSA, Q-Learning, N-Step Bootstrapping, Combining TD and Monte Carlo Methods.	
Module-IV	Deep Reinforcement Learning: Deep Reinforcement Learning (Deep RL), Deep SARSA, Deep Q-Learning, Deep Q-Networks (DQN), Neural Networks in Q-Learning, Training Stability in Deep RL, Experience Replay, Target Networks, Applications of Deep RL, Game Playing, Robotics, Autonomous Systems.	07
Module-V	Advanced Policy-Based Methods: Policy Gradient Methods, Baseline Subtraction, Variance Reduction Techniques, Actor-Critic Methods, Advantage Actor-Critic (A2C), Combining Value Function Approximation with Policy Gradients, Exploration-Exploitation Strategies, A2C Algorithm, Advanced RL Algorithms.	07

Learning Resources:

Text Books	1. Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto, MIT Press, 2nd Edition, 2018
Reference Books	2. Deep Reinforcement Learning Hands-On, Maxim Lapan, Packt Publishing, 2nd Edition (2020)
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Implement basic Markov Decision Process (MDP) with policy evaluation and improvement.
2	Implement policy iteration and value iteration algorithms for a grid world.
3	Implement first-visit and every-visit Monte Carlo for value estimation.
4	Implement SARSA and Q-Learning algorithms and compare performance.
5	Implement N-step TD methods and compare with Monte Carlo and TD methods.
6	Implement the Deep SARSA algorithm with neural networks for function approximation.
7	Implement Deep Q-Learning (DQN) with experience replay and target networks, and Tune hyperparameters in a DQN model to improve training and performance.
8	Implement A2C (Advantage Actor-Critic) method for a control problem like Cart- Pole.
9	Implement and compare exploration-exploitation strategies like epsilon-greedy and softmax, and apply algorithms to train an agent for a simple game or a robotics task.

Course Title:	**Social Network Analysis**
Course Code:	**CSBB 409**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Describe the fundamental concepts, properties, and models of social and complex networks.	L2
CO-2	Apply centrality measures, network models, and community detection techniques to analyze real-world networks	L3
CO-3	Analyze diffusion processes, epidemic models, and link analysis methods in social networks.	L4
CO-4	Use network visualization and analysis tools (Gephi, NetworkX, Pajek, UCINET) to model, visualize, and interpret network data.	L4, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1		1						1		2	1
CO-2	3	3	2	2	2						1		3	2
CO-3	2	3	3	3	2						2		3	3
CO-4	2	2	3	3	3						2		3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Basic Network Properties: Empirical Study of Networks: Technological networks, Information networks, Social networks, Biological networks, Economic networks. Fundamentals of Network Theory: Mathematics of net- works, Measures and metrics, Structural properties of net- works: Diameter, Clustering Coefficient, Degree distribution.	08
Module-II	Network Models: Random graphs, Random graphs with general degree distributions, small world, Power-law, De- centralized centrality in small world. Temporal Networks, Multilayer Networks. Node Centralities: Degree centrality, Closeness centrality, Betweenness centrality, Centralization, eigenvector centrality.	08
Module-III	Network communities and Link analysis: Graph Partitioning, Edge betweenness, Modularity optimization and Spectral Clustering, Community Detection Algorithms, Overlap- ping communities in networks. Link Analysis: HITS and Page Rank.	07
Module-IV	Diffusion and Epidemics on Networks: Physical diffusion, Diffusion equation, Random walks on graph. Epidemics models SI, SIS, SIR. Modeling of infection propagation.	07
Module-V	Network Visualization: Network X, UCINET, Gephi, Pajek, Graphviz.	06

Learning Resources:

Text Books	1. Networks: An Introduction, Mark Newman, Oxford University Press, 20-May-10 2. Network Science, Albert Laszlo Barabasi, Cambridge University Press, 2016 3. Networks, Crowds, and Markets: Reasoning About a Highly Connected World, David Easley and Jon Kleinberg, Cambridge University Press, Sep-10
Reference Books	1. The Structure of Complex Networks Theory and Applications, Ernesto Estrada, Oxford University Press, 17-Dec-11 2. Dynamical Processes on Complex Networks, Alain Barrat, Marc Barthelemy, and Alessandro Vespignani, Cambridge University Press, 24-Nov-08 3. The Structure and Dynamics of Networks, Mark Newman, Albert- Laszlo Barabasi, & Duncan J. Watts, Princeton University Press, April 17, 2006 4. Exploratory Social Network Analysis with Pajek, Nooy, Wouter de, Andrej Mrvar, and Vladimir Batagelj, Cambridge University Press, 10-Jan-05
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1.	Study of basic network properties using NetworkX (degree, clustering coefficient, diameter).
2.	Simulation of Random Graphs and Small-world networks.
3.	Calculation of centrality measures (degree, closeness, betweenness, eigenvector centrality) on a real dataset
4.	Detection of communities in networks using modularity and spectral clustering
5.	Implementation of PageRank and HITS algorithms using Python/NetworkX.
6.	Modeling SI, SIS, and SIR epidemic propagation on networks.
7.	Simulation of diffusion processes and random walks on graphs.
8.	Visualization of real-world social network data using Gephi
9.	Comparative analysis of multilayer networks with Pajek/UCINET.

Course Title:	**Motion Analytics and Planning of Robotics**
Course Code:	**CSBB 412**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain the foundational concepts of robotics such as robot definitions, classifications, degrees of freedom, workspace, and their applications in various fields.	L2
CO-2	Illustrate the principles of robot kinematics including for- ward and inverse kinematics, trajectory planning, and trans- formations using D-H parameters.	L2, L3
CO-3	Apply the concepts of robot dynamics to analyze configuration space, inertia tensors, and motion behavior in robotic systems.	L3, L4
CO-4	Utilize control schemes and sensor integration to enable robot vision, and image processing algorithms.	L3, L4
CO-5	Develop solutions for advanced robotic applications by implementing motion planning for multi-robot systems in 3D environments and exploring machine learning and deep learning models.	L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1									1	3	2
CO-2	2	3	3	2								1	3	2
CO-3	2	3	3	2								1	3	3
CO-4	2	2	3	2								1	3	3
CO-5	2	2	3	3								1	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Motion analytics and Mathematics: Introduction to Motion analytics, Trigonometry and Vector, Mechanics, and Signal Processing	06
Module-II	Introduction to Bio-Motion and Human Gait: Anatomy of Human body, motion physiology, bio-mechanics and human gait, Anthropometry in Bio-Motion, Walking and Gait Terminologies, Movement Analysis Methods Vision Based, Marker Based Motion Capture, Marker Less Motion Capture, Sensor Based, and Other Techniques	07
Module-III	Kinematic and inverse kinematics Robot Kinematics: Kinematic conventions, Mapping, free body diagram, Homogeneous transformations, Rotation matrix, Forward Kinematics Denavit Hardenberg (DH) representation, inverse kinematics: solution of inverse problems, imaging measurement techniques, biomechanical	07

	models, force transducers and force plates, bone on bone force.	
Module-IV	Model of Human Pose and Motion: Object detection, computer vision-classification, semantic segmentation, object detection, instance segmentation, traditional object detectors- SIFT, HOG, BOW, deep learning based object detectors: Landmark detection, sliding windows detection, bounding box prediction (YOLO algorithm), anchor boxes, evaluating object localization, human body representation, traditional method- latent variables, models-PCA, FA etc., discriminative model-regression, generative model- Kalman filter, partial filter.	08
Module-V	Machine Learning for Motion Modelling: ML Approaches: Type of Machine Learning, Understanding Data and Feature Engineering in ML, Reasoning Under Uncertainty, Fuzzy Logic, Probabilistic Reasoning, Neural Network: Motion Graph, Inverse Kinematics, Latent Variable Model, Super- vised Techniques, Unsupervised Techniques, Reinforcement Techniques.	08

Learning Resources:

Text Books	1. Principles of Robot Motion: Theory, Algorithms, and Implementations, H. Choset, K. M. Lynch, S. Hutchinson, G. A. Kantor, W. Burgard, L. E. Kavraki, S. Thrun, MIT Press, Cambridge, MA, 2005
Reference Books	1. Planning Algorithms, S. M. LaValle, Cambridge University Press, NY, 2006 2. Robot Analysis- The mechanics of Serial and Parallel Manipulators, L. Tsai, John Wiley & Sons, 1999
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Study the components of a robotic system, identify degrees of freedom (DOF), and classify robots based on structure and applications.
2	Measure and analyze the workspace, resolution, accuracy, and repeatability of a robotic manipulator.
3	Implement forward kinematics for a 2-DOF or 3-DOF robotic arm using D-H parameters.
4	Solve inverse kinematics for a simple robotic arm and validate the results using simulation.
5	Perform trajectory planning for a robotic arm to move between two predefined points in its workspace.
6	Simulate the configuration space of a robotic arm in a 2D environment.
7	Implement a basic PID control scheme for controlling the position of a robotic joint.
8	Interface a proximity or IR sensor with a robotic system to detect obstacles and trigger actions.
9	Develop a simple vision-based system to detect and track an object using a camera.
10	Pose Estimation models- decision tree for body segment classification.

Course Title:	**Introduction to Cognitive Computing**
Course Code:	**CSBB 413**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understanding the fundamentals and concepts of cognitive computing	L2
CO-2	Understand Natural language processor role in Cognitive computing	L2
CO-3	Implementing various tools associated with cognitive computing.	L3
CO-4	Study various case studies related to cognitive computing.	L4

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	2	-	-	-	-	-	-	-	-	1	2
CO-2	1	2	2	-	1	-	-	-	-	-	-	-	2	1
CO-3	3	1	3	-	1	-	-	-	-	-	-	-	3	2
CO-4	2	2	2	-	2	-	-	-	-	-	-	-	2	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, under- standing cognition Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation and visualization services	08
Module-II	Natural Language Processing-Support of Cognitive System The role of NLP in a cognitive system, understanding linguistics, Phonology, morphology, lexical analysis, syntax and syntactic analysis, importance of Hidden Markov models, Semantic Web, applying natural language technologies to business problems, enhancing shopping experience, fraud detection	08
Module-III	Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data	06
Module-IV	The Business Implications of Cognitive Computing: Preparing for change, advantages of new disruptive models, knowledge meaning to business, difference with a cognitive systems approach, meshing data together differently, using business knowledge to plan for the future	08

Module-V	CASE STUDIES: Cognitive Systems in health care, Cognitive Assistant for visually impaired – AI for cancer detection, Predictive Analytics, Text Analytics, Image Analytics, Speech Analytics – IBM Watson - Introduction to IBM's Power AI Platform - Introduction to Google's TensorFlow Development Environment, Components of Deep QA	06

Learning Resources:

Text Books	1. Hurwitz, Kaufman, and Bowles, "Cognitive Computing and Big Data Analytics", Wiley, Indianapolis. 2. Judith Hurwitz, Marcia Kaufman, and Adrian Bowles, Cognitive Computing and Big Data Analytics", Wiley, 2015.
Reference Books	1. Dagmar Monett Diaz and Mario Arias Oliva, "Cognitive Computing: Theory and Applications", Elsevier, 2016. 2. Douglas R. Stinson, Cryptography: Theory and Practice, Chapman and Hall/CRC Press, 3rd Edition, 2006 3. Vijay V Raghavan, Venkat N. Gudivada, Venu Govindaraju, Cognitive Computing: Theory and Applications: Volume 35 (Hand-book of Statistics), North Holland.
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Create a single LIF neuron model and simulate its response to input currents.
2	Build a simple feedforward neural network using NengoDL and train it on a balanced dataset.
3	Build an SNN for handwritten digit recognition on MNIST Dataset Using NengoDL.
4	Build an attention model to modulate input processing.
5	Simulate a decision-making neural model using attractor networks in NengoDL.
6	Create a simple visual cortex model that processes basic image inputs.
7	Convert a traditional ANN to an SNN and analyze differences in output and efficiency.
8	Convert a TensorFlow MLP model to an equivalent spiking model.
9	Optimizing a cognitive model with temporal dynamics in NengoDL.
10	Implement multi-layer perceptron (MLP) and train using backpropagation on any dataset.
11	Combine NengoDL spiking models with TensorFlow deep learning layers.
12	Analyze and compare energy consumption of SNNs versus traditional ANNs simulated in NengoDL.

Course Title:	**Game Theory**
Course Code:	**CSBB 414**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understand the game theory tools, equilibrium concepts.	L2
CO-2	Identify and understand pure strategy equilibrium in game theory contexts along with the decision-making procedures.	L2
CO-3	Implement different types of conceptual games logic.	L3
CO-4	Analyze the requirements of network-based games including strategic network formation and network admission control.	L4

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	1	-	-	-	-	-	-	-	-	-	3	1
CO-2	2	1	2	-	1	-	-	-	-	-	-	-	2	3
CO-3	2	3	3	-	2	-	-	-	-	-	-	-	3	2
CO-4	2	2	2	-	2	-	-	-	-	-	-	-	2	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Game Theory, History, Terminologies, Two- person zero-sum game-Assumptions, pure and mixed strategy, payoffs, Minimax, Rules for dominance, Algebraic and Graphical methods	06
Module-II	Solution Concepts for Static Games: Complete information: rationalizability, Nash equilibrium: concept and examples, epistemic foundations, Incomplete information: Bayesian Nash equilibrium, interim correlated rationalizability, Symmetric games and symmetric equilibria.	07
Module-III	Combinatorial games, Winning and losing positions, Sub- traction Game, 3-Pile and K-Pile Games, Proof of Correct- ness, Variations of K-Pile Games, Graph Games, Construction, Proof of finiteness, SG theorem for sum of games. Solution Concepts for Extensive-form Games: Backwards induction, subgame perfection, iterated conditional dominance, Bargaining with complete information	08
Module-IV	Cournot's Oligopoly, Bertrand's Oligopoly, Electoral Com- petition, Median Voter Theorem, Auctions, role of knowledge, Decision making and Utility Theory, Mixed Strategy Equilibrium, Extensive Games with Perfect Information, Stackelberg's model of Duopoly, Buying Votes, Committee Decision making, Repeated Games, Prisoner's Dilemma	09
Module-V	Super modular Game and Potential games, Wireless net- works – Resource allocations, Admission control, Routing in sensor and Ad Hoc networks, Modeling network traffic and strategic network formation – CDMA power control, Network admission control.	06

Learning Resources:

Text Books	1. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003 2. Fudenberg, Drew, and Jean Tirole. Game Theory. MIT Press, 1991.
Reference Books	1. Martin Osborne and Ariel Rubinstein, "A course in Game Theory", PHI, 2016. 2. Allan Mackenzie, "Game Theory for Wireless Engineers", Synthesis lectures on Communications, 2006. 3. Thomas Ferguson, Game Theory, World Scientific, 2018.
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Introduction to Gambit's graphical user interface.
2	Construct the Game tree for the Prisoner's Dilemma in Gambit.
3	Evaluate Nash equilibrium for Prisoner's Dilemma using nashpy and without using nashpy.
4	Construct the Game tree for the Battle of Sexes in Gambit.
5	Construct the Game tree for the Hunting Game in Gambit.
6	Construct the tic tac toe game.
7	Implement Matching Pennies (Two players, each having a penny, are asked to choose from among two strategies – heads (H) and tails (T). The row player wins if the two pennies match, while the column player wins if they do not). Find Nash Equilibrium nashpy and without using nashpy.
8	Implement Routing congestion game (player 1 is interested in getting good service, hence would like the others to choose different routes, while player 2 is interested only in disrupting player 1's service by trying to choose the same route). Find Nash Equilibrium nashpy and without using nashpy.
9	Implement (SENATE RACE: An incumbent senator (from a rightist party) runs against a challenger (from a leftist party). They first choose a political platform, leftist or rightist, where the senator has to move first. If both choose the same platform, the incumbent wins, otherwise the challenger wins. Assume that the value of winning is 10, the value of compromising their political views (by choosing a platform not consistent with them) is 5, and the payoff is the sum of these values) Use Gambit to illustrate a Game tree.
10	Implement the SENATE RACE and find out Nash equilibrium with and without using nashpy.
11	Implement CENTIPEDE GAME (two players alternately face two stacks of money. To make a move, a player has the choice either to pass, in which case both stacks grow slightly and the other player now must make a move facing slightly larger stacks, or to take the larger stack, in which case the other player gets the smaller one and the game ends. If it didn't end before, the game ends after a fixed number of rounds, in which case both players share the accumulated money evenly) Use Gambit to illustrate a Game tree.
12	Implement the CENTIPEDE GAME and find out Nash equilibrium with and without using nashpy.

Course Title:	**Motion Planning for Robotics**
Course Code:	**CSBB 415**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Explain the foundational concepts of robotics such as robot definitions, classifications, degrees of freedom, workspace, and their applications in various fields.	L2
CO-2	Illustrate the principles of robot kinematics including for- ward and inverse kinematics, trajectory planning, and trans- formations using D-H parameters.	L2, L3
CO-3	Apply the concepts of robot dynamics to analyze configuration space, inertia tensors, and motion behavior in robotic systems.	L3, L4
CO-4	Utilize control schemes and sensor integration to enable robot vision, motion planning, and intelligent functionalities like biped walking.	L3, L4
CO-5	Develop solutions for advanced robotic applications by implementing motion planning for multi-robot systems in 3D environments and exploring areas such as medical robotics and autonomous vehicles.	L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1									1	3	2
CO-2	2	3	3	2								1	3	2
CO-3	2	3	3	2								1	3	3
CO-4	2	2	3	2	3							1	3	3
CO-5	2	2	3	3	3							1	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Robots and Robotics: Definitions of Robots, Robotics, Motivation, A Brief History of Robotics, A Robot System, Interdisciplinary Areas in Robots, DOF of Joints and Robotic System, Classification of Robots, Workspace of Manipulator Workspace of Manipulator, Resolution, Accuracy and Repeat Ability; Applications of Robots	07
Module-II	Kinematics of Robotic Motion: Introduction to Robot Motion Planning, Basics of Serial robotic arms and Mobile robots, Transformations, Robot Kinematics: Properties of Rotation Matrix, Cylindrical and Spherical Coordinate, D- H Parameters Setting, Forward Kinematics, Inverse Kinematics, Trajectory Planning, Singularity Checking, Jacobian Matrix	08
Module-III	Dynamics of Robotic Motion: Robot Dynamics: Earliest Bug Algorithms, Configuration Space, Manifold, Topology of Configuration Space, Dynamics (Inertia Tensor), Inverse Dynamics, Forward Dynamics, Inertia Tensor.	07
Module-IV	Motion Control: Control Scheme, Sensors, Robot Vision, Robot Motion Planning, Intelligent Robot: Biped Walking.	07

Module-V	Applications of Motions in Robots: Motion planning for Multi robotic systems, motion planning in 3D. Applications of robotics in active perception, medical robotics, autonomous vehicles, and other areas.	07

Learning Resources:

Text Books	1. Principles of Robot Motion: Theory, Algorithms, and Implementations, H. Choset, K. M. Lynch, S. Hutchinson, G. A. Kantor, W. Burgard, L. E. Kavraki, S. Thrun, MIT Press, Cambridge, MA, 2005
Reference Books	1. Planning Algorithms, S. M. LaValle, Cambridge University Press, NY, 2006 2. On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems, R. Kala, Elsevier, Waltham, MA, 2016
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Study the components of a robotic system, identify degrees of freedom (DOF), and classify robots based on structure and applications.
2	Measure and analyze the workspace, resolution, accuracy, and repeatability of a robotic manipulator.
3	Implement forward kinematics for a 2-DOF or 3-DOF robotic arm using D-H parameters.
4	Solve inverse kinematics for a simple robotic arm and validate the results using simulation.
5	Perform trajectory planning for a robotic arm to move between two predefined points in its workspace.
6	Simulate the configuration space of a robotic arm in a 2D environment.
7	Implement a basic PID control scheme for controlling the position of a robotic joint.
8	Interface a proximity or IR sensor with a robotic system to detect obstacles and trigger actions.
9	Develop a simple vision-based system to detect and track an object using a camera.
10	Simulate multi-robot motion planning in a 2D environment to achieve collision-free navigation.

Course Title:	**Artificial Intelligence & Machine Learning**
Course Code:	**CSLB 420**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Able to generate, analyze and interpret data summaries	L5
CO-2	Able to carry out analysis on machine learning algorithms	L4
CO-3	Able to design and implement classifiers for machine learning applications	L3, L6
CO-4	Able to design and implement frequent itemset mining systems	L3, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	3	2	-	-	-	-	-	-	-	3	-	2
CO-2	2	3	3	2	-	-	-	-	-	-	-	3	-	3
CO-3	3	2	2	3	-	-	-	-	-	-	-	2	-	1
CO-4	3	2	3	3	-	-	-	-	-	-	-	2	-	2

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Measuring the central tendency – measuring the dispersion of data – graphic displays of basic descriptive data Summaries – Missing values – noisy data- data cleaning as a process – Data integration – data transformation – Data cube aggregation – attribute subset selection – dimensionality reduction.	09
Module-II	Cluster Analysis using k–Means – k–Medoids – single link- age – complete linkage – UPGMA and expectation Maximization – Assessing clustering tendency – determining the number of clusters – measuring clustering quality k– nearest neighbor – Bayes – decision tree and Support Vector Machines (SVM) classifiers – Classifier accuracy Measures – evaluating the accuracy of a Classifier.	10
Module-III	Efficient and Scalable Frequent Itemset Mining Methods- Mining Various Kinds of Association Rules- From Association Mining to Correlation Analysis- Constraint-Based Association Mining.	09
Module-IV	Experiments on machine learning and artificial intelligence algorithms using Matlab / Python.	09

Learning Resources:

Text Books	1. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers (Elsevier), 2011. 2. K.P Soman, R. Loganathan, V. Ajay, "Machine Learning with SVM and other Kernel Methods", PHI Learning Private Ltd., New Delhi, 2009.
Reference Books	1. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Pearson Education India, 2015. 2. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
Other Suggested Readings	

Course Title:	**Internet of Things**
Course Code:	**CSBB 421**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	To provide an understanding of the technologies and the standards relating to the Internet of Things	L2
CO-2	Illustrate functioning of hardware devices and sensors used for IoT.	L3
CO-3	Apply IoT for developing real life applications using Ardunio programming.	L3
CO-4	Analyze network communication aspects and protocols used in IoT.	L4

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1	-	-	-	-	-	-	-	-	3	2
CO-2	1	3	2	-	1	-	-	-	-	-	-	-	2	3
CO-3	2	1	3	-	1	-	-	-	-	-	-	-	3	2
CO-4	2	2	2	-	2	-	-	-	-	-	-	-	2	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Internet of Things (IoT): Vision, Definition, Conceptual Framework, Architectural view, technology behind IoT, Sources of the IoT, M2M Communication, IoT Examples. Design Principles for Connected Devices: IoT/M2M systems layers and design standardization, communication technologies, data enrichment and consolidation, ease of designing and affordability	08
Module-II	IoT Physical Devices and Endpoints - Introduction to Arduino and Raspberry Pi-Installation, Interfaces (serial, SPI, I2C) Programming the Arduino: Arduino Plat- form Boards Anatomy, Arduino IDE, coding, using emulator, using libraries, additions in Arduino, programming the Arduino for IoT.	09
Module-III	Challenges in IoT Design challenges: Development Challenges, Security Challenges, Other challenges IoT Applications: Smart Metering, E-health, City Automation, Automotive Applications, home automation, smart cards, communicating data with H/W units, mobiles, tablets, Designing of smart streetlights in smart city.	06
Module-IV	Network & Communication aspects in IoT: Wireless Medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination	06
Module-V	IoT Physical Servers and Cloud Offerings– Introduction to Cloud Storage models and communication APIs Web Server – Web server for IoT, Cloud for IoT, Python web	07

	application framework Designing a RESTful web API	

Learning Resources

Text Books	1. Hurwitz, Kaufman, and Bowles, "Cognitive Computing and Big Data Analytics", Wiley, Indianapolis. 2. Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-on Approach Universities Press. 3. Raj Kamal, INTERNET OF THINGS, McGraw-Hill, 1ST Edition, 2016
Reference Books	1. Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-on Approach, Universities Press, 2015 2. Adrian McEwen, Hakin Cassimally, Designing the Internet of Things, Wiley India 3. Matt Richardson & Shawn Wallace, Getting Started with Rasp- berry Pi, O'Reilly (SPD), 2014
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Study of Arduino IDE, demonstrate setup (), loop (), serial and serial.begin (), serial.print (), serial.available (), serial.read (), serial.write (), serial.analogRead (), user defined functions.
2	Design Led Control Using Arduino Board.
3	Interface for controlling LED blink rate with Arduino.
4	Interface of Servo motor with Arduino.
5	Interface of Temperature Sensor with LM35 with Arduino.
6	Interface of Potentiometer and Ir Sensor with Arduino.
7	Interface for Tds Sensor with Arduino.
8	Interface of active buzzer with Arduino.
9	Interface of relay with Arduino.
10	Building Intrusion Detection with Arduino.
11	Directional control of DC motor using Arduino.
12	Displaying humidity and temperature data on a web-based application.

Course Title:	**Big Data Analytics**
Course Code:	**CSBB 422**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understand the fundamental principles of soft computing, including fuzzy logic, artificial neural networks	L2
CO-2	Explain applications and operations of Fuzzy Logic in real life Problems	L4
CO-3	Analyze and evaluate the performance of different soft computing models for specific applications.	L4
CO-4	Design and implement soft computing solutions using appropriate tools and techniques for practical and innovative problem-solving	L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	3	1	1	-	-	3	-	-	-	-	1	2
CO-2	2	3	3	3	1	-	-	-	-	-	-	3	3	2
CO-3	2	3	3	3	1	-	-	-	-	-	-	3	3	2
CO-4	2	2	3	3	1	-	-	3	-	-	-	3	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Big Data: - Evolution of big data, best practices for big data analytics, big data characteristics; Validating, Promotion of the value of big data, big data use cases. Characteristics of big data applications, Perception and quantification of value. Big Data Tools and Techniques: Understanding big data storage, General overview of high- performance architecture, HDFS, Map Reduce and YARN; Map Reduce programming model; Review of basic data analytic methods using R.	07
Module-II	Regression and Classification: Advanced analytical theory and methods, Regression: Linear regression, Logistic regression; Classification: Decision trees, Overview of a decision tree, Decision tree algorithms, Evaluating a decision tree, Decision trees in R, Naive Bayes, Bayes 'theorem, Naive Bayes classifier in R.	07
Module-III	Data Stream Analysis: Introduction to streams concepts: Stream data model and architecture, Stream computing, Sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting oneness in a window, Decaying window; Real Time Analytics Platform (RTAP) applications, Case studies: Real time sentiment analysis, Stock market predictions.	07

Module-IV	Frequent Itemset and Clustering: Mining frequent item- set: Market based model, Apriori algorithm, handling large datasets in main memory, Limited Pass algorithm, counting frequent itemset in a stream, Clustering techniques: Hierarchical, k-Means, Clustering high dimensional data.	07
Module-V	NoSQL Data Management for Big Data: NoSQL databases: Schema-less models, increasing flexibility for data manipulation, Key value stores, Document stores, Tabular stores, Object data stores, Graph databases; Hive; Sharding; HBase; Case Study: Analyzing big data with twitter, big data for E-Commerce Big data for blogs.	08

Learning Resources:

Text Books	1. Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, David Loshin, Morgan Kaufmann/Elsevier Publishers, 2013 2. Mining of Massive Datasets, Anand Rajaraman and Jeffrey David Ullman, Cambridge University Press, 2012
Reference Books	1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley, 2015 2. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Beasan Bart, Wiley, 2015
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	Study and Configuration Hadoop-based distributed architecture for Big Data Analytics.
2	Map Reduce Programming Examples Word Count. Union, Intersection and Difference. Matrix Multiplication.
3	Installation and Creation of MongoDB for Schema-less database.
4	Study and Implementation of Regression-based algorithms for Big Data Analytics.
5	Study and Implementation of Clustering-based algorithms for Big Data Analytics.
6	Implement and Perform Streaming Data Analysis for X data (formerly twitter), chat data, weblog analysis.
7	Implementation of Visualization techniques for Interpreting Big Data and its Analytics.

Course Title:	**Deep Learning and Applications**
Course Code:	**CSBB 424**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**CSL501**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	Understand foundational concepts of deep learning, including neural networks, training methods, and optimization techniques	L1, L2, L3
CO-2	Develop and evaluate convolutional neural networks (CNNs) for image classification and object detection.	L4, L5, L6
CO-3	Design recurrent neural networks (RNNs) and Transformer models for NLP and time-series analysis.	L4, L5, L6
CO-4	Implement advanced deep learning techniques for generative modeling, speech recognition, and gesture recognition	L4, L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO-2	2	2	3	3	3	-	-	-	-	-	-	-	3	3
CO-3	2	2	3	3	3	-	-	-	-	-	-	-	3	3
CO-4	3	2	3	3	3	-	-	-	-	-	-	-	3	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Deep Learning: Overview of Deep Learning and its comparison with Machine Learning. Artificial Neural Networks (ANNs): Structure, perceptrons, limitations, forward propagation, backpropagation, activation functions (e.g., ReLU, Softmax), loss functions, and optimization techniques (e.g., SGD, Adam). Regularization methods (L1/L2, Dropout, Batch Normalization), hyperparameter tuning, and implementation frameworks (e.g., TensorFlow, PyTorch).	07
Module-II	Convolutional Neural Networks (CNNs): Key concepts, convolution, padding, pooling, and CNN layers. Architectures: AlexNet, VGG, ResNet, MobileNet, and others. Applications: Image classification, transfer learning, object detection (e.g., YOLO, RCNN), and image segmentation (e.g., Mask RCNN). Regularization and data augmentation techniques.	08
Module-III	Recurrent Neural Networks (RNNs): RNN architecture such as LSTM, GRU, and their challenges (e.g., vanishing gradients). Applications: NLP tasks (e.g., sentiment analysis, text generation).	07
Module-IV	Transformers: Encoder-decoder architecture, self-attention, and multi-head attention. Applications: NLP tasks (e.g., translation, summarization, sentiment analysis) and	07

	Vision Transformers (ViTs). Pre-trained models: BERT, GPT, and their use cases	
Module-V	Advanced Topics GANs: Architecture and applications. Time Series Forecasting: ARIMA, SARIMA, deep learning approaches (LSTM, GRU), and case studies. Advanced topics: LLMs, federated learning, and real-world implementations in speech and gesture recognition	07

Learning Resources:

Text Books	1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016
Reference Books	1. Machine Learning: An Algorithmic Perspective, Second Edition, Stephen Marsland, Chapman and Hall/CRC, 2014 2. Introduction to Probability for Data Science, Stanley H. Chan, Michigan Publishing, Springer, May 2021
Other Suggested Readings	

Lab Experiments

Exp. No.	List of Experiments
1	MNIST Digit Classification: Train a simple neural network.
2	Image Classification with CNN: Use CNNs for CIFAR-10 classification.
3	Transfer Learning with Pre-trained CNN: Fine-tune models for custom datasets.
4	Object Detection with YOLO: Implement YOLO for real-time object detection.
5	Incremental Learning with CNNs: Update models with new data without retraining.
6	Instance Segmentation with Mask RCNN: Apply Mask RCNN for image segmentation.
7	Time Series Forecasting with LSTM: Predict trends using LSTM models.
8	Sentiment Analysis with LSTM and BERT: Analyze text sentiment using LSTM and BERT models.
9	Generative Adversarial Networks (GANs): Generate images using GANs.
10	Time Series Forecasting with SARIMA: Compare SARIMA and LSTM for forecasting.
11	Implement speech and gesture recognition systems using deep learning.

Course Title:	**Information Security and Privacy**
Course Code:	**CSBB 425**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	To understand the fundamentals of classical cryptography, modern block and stream ciphers, and cryptographic hash functions.	L2
CO-2	To explore public key cryptography, digital signatures, key management systems, and authentication protocols.	L2
CO-3	To introduce advanced cryptographic techniques including secret sharing schemes and homomorphic encryption for se- cure data sharing and computation.	L3
CO-4	To analyze system and network vulnerabilities, study malware types, and understand security mechanisms such as access control models and secure communication protocols.	L4

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	-	-	-	-	-	-	-	-	-	3	2
CO-2	3	3	2	-	1	-	-	-	-	-	-	-	3	3
CO-3	2	3	3	-	2	-	-	-	-	-	-	-	3	3
CO-4	2	2	2	-	2	-	-	-	-	-	-	-	2	3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Cryptographic Fundamentals and Classical Techniques: Security goals: confidentiality, integrity, avail- ability, threats, vulnerabilities, attacks, classical ciphers: Affine, Playfair, Hill, introduction to symmetric cryptography, Data Encryption Standard (DES), Advanced Encryption Standard (AES), stream ciphers: RC4, A5/1, block cipher modes: ECB, CBC, CFB, OFB, CTR.	09
Module-II	Hashing, Message Authentication, and Public-Key Cryptography: Cryptographic hash functions: SHA-512, Message Authentication Code (MAC), public-key cryptography fundamentals, RSA algorithm, digital signatures: DSS, key management concepts, digital certificates, Public Key Infrastructure (PKI).	09
Module-III	Authentication and Secure Protocols: Authentication mechanisms: one-way, mutual, centralized authentication, attacks: dictionary and replay, authentication protocols: Needham-Schroeder, Kerberos, secure communication protocols: IPSec, SSL, TLS.	06
Module-IV	Threshold secret sharing, Shamir's Secret Sharing Scheme, applications in image security and secure access control, se- cure multiparty computation, homomorphic encryption concepts, partially, fully homomorphic encryption, Paillier encryption, applications in cloud data security and privacy- preserving computation.	06

Module-V	System Security and Emerging Threats: Network threats: DoS, DDoS, session hijacking, IP spoofing, ARP spoofing, DNS attacks, software vulnerabilities: buffer over- flow, XSS, SQL injection, phishing, malware: viruses, worms, trojans, botnets, mobile malware, access control models: DAC, MAC, RBAC, Selinux, emerging trends: RFID, e-passports, secure electronic payments.	06

Learning Resources:

Text Books	1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, Tata McGraw-Hill, 2nd Edition, 2013 2. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 6th Edition, 2014
Reference Books	1. Bruce Schneier, Applied Cryptography: Protocols, Algorithms and Source Code in C, Wiley-India, 2nd Edition, 2007 2. Douglas R. Stinson, Cryptography: Theory and Practice, Chap- man and Hall/CRC Press, 3rd Edition, 2006
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1	Implement and analyze classical ciphers such as Caesar, Affine, Playfair, and Hill cipher using a programming language (e.g., Python or C).
2	Implement the DES (Data Encryption Standard) algorithm for encryption and decryption of a given plaintext.
3	Implement AES (Advanced Encryption Standard) using 128-bit keys and analyze the round-wise transformation.
4	Simulate stream cipher RC4 and analyze its keystream generation and encryption process.
5	Implement different block cipher modes (ECB, CBC, CFB, OFB, CTR) using AES and compare ciphertext patterns.
6	Write a program to implement the RSA algorithm for secure message transmission (key generation, encryption, decryption).
7	Simulate the Digital Signature Standard (DSS) for message authentication and integrity verification.
8	Implement a cryptographic hash function (e.g., SHA-512) and generate message digests for different inputs.
9	Simulate Needham-Schroeder or Kerberos authentication protocol and analyze its security against replay or man-in-the-middle attacks.
10	Implement Shamir's Secret Sharing Scheme and reconstruct the secret using thresh- old shares.
11	Simulate partially homomorphic encryption (e.g., Paillier encryption) and perform addition over encrypted values.
12	Demonstrate real-world attacks such as ARP spoofing, DNS poisoning, or SQL injection using tools like Wireshark, Scapy, or DVWA (Damn Vulnerable Web App), and suggest countermeasures.

Course Title:	**Business Intelligence and Analytics**
Course Code:	**CSBB 426**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes

CO	Course Outcomes	Cognitive Levels
CO-1	Explain the fundamental concepts, architectures, and components of Business Intelligence (BI) systems and their role in organizational decision-making.	L2
CO-2	Apply analytical techniques such as OLAP, data warehousing, and data mining to transform raw data into actionable insights.	L3
CO-3	Analyze business problems and decompose them into data models, comparing and selecting appropriate BI tools and technologies to derive meaningful insights	L4
CO-4	Evaluate BI strategies and analytical models for effective- ness, scalability, and alignment with organizational goals.	L5

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	-	-	1	1	-	1	1	2	1	1	-	2
CO-2	2	2	2	2	2	-	-	1	1	2	1	1	2	2
CO-3	2	3	3	2	2	-	-	1	2	2	2	2	2	2
CO-4	2	2	2	3	2	1	-	2	2	2	2	2	2	2

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Business Intelligence & Analytics (BIA), drivers of BIA, types of analytics: descriptive to prescriptive, vocabulary of business analytics, technical architecture of BIA, case analysis of AT&T Long distance, fundamentals of data management, Online Transaction Processing (OLTP), design process of databases	08
Module-II	Relational databases, normalization, SQL queries, Shop-sense case of management questions, data ware- housing, Online Analytical Processing (OLAP), data cube, Descriptive analytics, and visualization, customer analytics, survival analysis, customer lifetime value, case study	09
Module-III	Data mining process, introduction to statistical learning, data pre-processing, data quality, overview of data mining techniques, case study using regression analysis, Introduction to classification, classification techniques, scoring models, classifier performance, ROC and PR curves, Introduction to decision trees, tree induction, measures of purity, tree algorithms, pruning, ensemble methods	09
Module-IV	Cluster analysis, measures of distance, clustering algorithms, K-means and other techniques, cluster quality, A store segmentation case study using clustering, implementation in Python, profiling clusters, cluster interpretation and actionable insights, RFM sub- segmentation for customer loyalty, Text mining, process, key concepts,	10

	sentiment scoring, text mining using R-the case of a movie discussion forum, summary	

Learning Resources:

Text Books	1. Han, J., Pei, J. and Tong H. (2023). Data Mining Concepts and Techniques, 4th ed, New Delhi: Elsevier. 2. James, G., Witten, D., Hastie, T. and Tibshirani,R. (2013) An Introduction to Statistical Learning with Applications in R, Springer: NY
Reference Books	1. Sharda, Delen and Turban, “Decision Support and Business Intelligence Systems”, 10th ed, Pearson Education. 2. Rick Sherman, “Business Intelligence Guidebook: From Data Integration to Analytics”, 1st ed, Morgan Kaufmann
Other Suggested Readings	

Lab Experiments:

Exp. No.	List of Experiments
1	Import CSV/Excel files into Power BI/Tableau and visualize raw tables.
2	Design a small star schema in MySQL/PostgreSQL and populate it with sample transactional data.
3	Build a dashboard with simple charts, filters, and slicers in a BI tool.
4	Create an Extract–Transform–Load pipeline using Talend, Pentaho, or Python scripts.
5	Implement slice, dice, drill-down, and roll-up on a sales cube.
6	Apply k-means clustering to segment customers based on purchasing behavior.
7	Build a churn prediction model using decision trees on telecom data and visualize churn probabilities.
8	Use a healthcare dataset to identify patterns in-patient admissions and treatment outcomes.
9	Perform text mining on product reviews to extract sentiment scores and visualize them in a dashboard.
10	Simulate pricing changes and analyze impact on revenue in a BI tool.
11	Develop a scorecard dashboard for an organization's strategic objectives.
12	Start with a raw dataset, perform cleaning, warehouse design, analysis, and create a final interactive BI dashboard with insights.

Course Title:	**Advanced Databases**
Course Code:	**CSBB 427**
L-T-P:	**3-0-2**
Credits:	**04**
Pre-requisites:	**Database Management System**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the concept of Active Databases in Starburst, Oracle, and DB2. (L2)	L2
CO-2	Understand the concepts of Temporal and Object Databases-SQL. (L2)	L2
CO-3	Apply the Concepts of Relational calculi, relational algebra and recursion. (L3)	L3
CO-4	Explore the concept of Spatial, Text and Multimedia Databases. (L3)	L3
CO-5	Analyze the concept of Uncertainty in Databases. (L4)	L4

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2											3	
CO-2	3	2			2								3	
CO-3	3	2	2		2								3	
CO-4	3	2	2		3								2	2
CO-5	3	3		2										3

Scale: 1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Active Databases: Syntax and Semantics (Starburst, Oracle, DB2): Taxonomy, applications, integrity management, workflow management, business rules, design principles, properties, rule modularization, rule debugging, IDEA methodology, open problems.	08
Module-II	Temporal and Object Databases: Overview- Time domain, data types, associating facts with time, temporal query language; Transact-SQL (TSQL): Time ontology,	07

	data model, language constructs; Implementation: System architecture, temporal support, support for TSQL2.	
Module-III	Complex Queries and Reasoning: Logic of Query Languages- Relational calculi, relational algebra, recursive rules, syntax and semantics of data log, fix point semantics. Implementation Rules and Recursion: Rule rewriting methods, compilation and optimization, recursive queries in SQL, open issues.	07
Module-IV	Spatial Text and Multimedia Databases: Traditional Indexing Methods: Secondary keys, spatial access methods, text retrieval; Multimedia indexing: 1D time series, 2D color images, sub pattern matching.	07
Module-V	Uncertainty in Databases and Knowledge Bases: Introduction: Uncertainty in image database, uncertainty in temporal database, uncertainty in null value; Models of uncertainty; Uncertainty in relational databases: Lattice based relational databases, probabilistic relational databases.	07

Learning Resources.

Text Books:	1. Carlo Zaniolo, Stefano Ceri, "Advanced Database Systems", Morgan Kauffmann Publishers, VLDB Journal, 1st Edition, 1997.
Reference Books:	1. Raghu Ramakrishnan, "Database Management System", McGraw-Hill Publications, 3rd Edition, 2000.
	2. Abraham Silberschatz, Henry F. Korth and S.Sudharshan, "Database System Concepts", Tata McGrawHill, 6th Edition, 2010.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	To write NOSQL QUERIES to understand the concept of Open-Source Database Management System such as Mongo DB/ CASSANDRA.
2.	To write a Query for MySQL Database Creation, Table Creation and Some other Queries Execution.
3.	To apply MYSQL replication technique in Distributed database.
4.	To implement Partial data storage and retrieval in MYSQL.
5.	To Create a Temporal data storage and retrieve that data in mysql.
6.	To implement object storage and retrieval in MYSQL using Python programming language.
7.	To Create a XML Databases in that create a XML Table and process the XQuery FLOWR Expressions.
8.	To write a program for Mobile Database Query Processing using open-source DB using MongoDB

Course Title:	**Chemistry for Computer Science Engineers**
Course Code:	CSLB 359
L-T-P:	3 - 0 - 1
Credits:	4
Pre-requisites:	NIL

Course Outcomes:

Course Outcomes:		Cognitive Levels
CO-1	Understand the principles and working of various sensors and energy systems including batteries and solar cells.	K1,K2
CO-2	Explain the materials and mechanisms used in memory and display systems such as organic memory devices, LCDs, OLEDs, and QLEDs.	K1,K2
CO-3	Analyze corrosion processes, methods of prevention, and the working of different electrode systems and analytical techniques.	K3,K4
CO-4	Apply concepts of polymers and green fuels for modern technological and environmental applications and evaluate e-waste management techniques and the environmental impact of electronic waste and recycling methods.	K3,K4,K5

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	1						1	1	2	3
CO-2	3	3	3	3	1	2					1	1	2	3
CO-3	3	3	3	3	1	2				1	2	2	2	3
CO-4	3	3	3	3	1	3	2	2	1	2	2	3	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	Detailed Syllabus	Contact Hours

Module-I	Sensors and Energy Systems: Introduction to sensors: definitions and terminologies of transducers, actuators, and sensors. Working principles and applications of electrochemical sensors, thermometric sensors (flame photometer), conductometric sensors (conductometry), and optical sensors (colorimetry). Measurement of dissolved oxygen (DO) using electrochemical sensors with electrode reactions. Electrochemical gas sensors for SOx and NOx with working principles. Disposable sensors (DS): definition and advantages. Detection of biomolecules such as ascorbic acid and pesticides (glyphosate) using electrochemical methods. Energy Systems: Introduction to batteries, construction, working, and applications of lithium-ion and sodium-ion batteries. Quantum Dot Sensitized Solar Cells (QDSSC): principle, properties, and applications.	8
Module-II	Materials for Memory and Display Systems: Introduction to electronic memory and classification of memory devices (transistor-type, capacitor-type, resistor-type, and charge transfer type). Organic memory materials: p-type (pentacene) and n-type (perfluoropentacene). Polymeric memory materials such as polyimide (donor–triphenylamine and acceptor–phthalimide). Display Systems: Photoactive and electroactive materials: definition and principle. Optoelectronic devices: working principle. Nanomaterials (silicon nanocrystals) and organic materials such as P3HT and PVK. Liquid crystals (LCDs): classification, properties, and applications. OLEDs and QLEDs: properties and applications.	8
Module-III	Corrosion and Electrode System: Introduction to corrosion, its ill effects, and electrochemical theory (iron example). Types of corrosion: differential metal corrosion and differential aeration corrosion. Corrosion control methods: galvanization, anodization, and sacrificial anode method. Corrosion Penetration Rate (CPR): definition, formula, and numerical problems. Electrode System: Types of electrodes, ion-selective electrode (glass electrode): construction, working, and applications. Determination of pH using glass electrode. Reference electrode (calomel electrode): construction and working. Concentration cells: working and numerical problems. Analytical Techniques: Conductometry (estimation of weak acid) and potentiometry (estimation of iron).	8

Module-IV	Polymer and Green Fuels : Polymers: introduction, molecular weight (number average and weight average) with numericals. Conducting polymers: synthesis and mechanism of polyacetylene and its applications. Kevlar: preparation, properties, and applications. Green Fuels: Types of fuels and future perspective. Solar photovoltaic cell: construction, working, advantages, and disadvantages. Green hydrogen: properties and production by electrolysis of water with reactions and advantages	8
Module-V	E-Waste Management: Introduction to e-waste, sources, composition, and characteristics. Need for e-waste management from a global perspective. Toxic materials in electronic products and associated health hazards. Recycling and recovery methods: mechanical separation, thermal treatment, hydrometallurgy, pyrometallurgy, and direct recycling. Extraction of gold from e-waste: principle and procedure. Role of stakeholders (producers, consumers, recyclers, and government bodies) in e-waste management.	8

Learning Resources:

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Text Books:	[T1] Wiley Engineering Chemistry, Wiley India Pvt. Ltd. New Delhi, 2013- 2nd Edition. [T2] Engineering Chemistry, Satyaprakash& Manisha Agrawal, Khanna Book Publishing, Delhi. [T3] A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd.
Reference Books:	[R1] Essentials of Physical Chemistry, Bahl&Tuli, S.Chand Publishing. [R2] Applied Chemistry, Sunita Rattan, Kataria 5. Engineering Chemistry, Baskar, Wiley.

Tutorials:

1. Involvement of faculty and students in identifying the problems & solutions.
2. PPT presentations by the students/faculty about the applications of the different materials used in Computer Science Engineering
3. Guidance to the students for self-study topics through illustrative examples.

Course Title:	**DIGITAL ELECTRONICS AND LOGIC DESIGN**
Course Code:	**ECBB 206**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand and examine the structure of various number systems and their application in digital design.	Understanding (Level –II)
CO-2	Understand the basic logic gates and various reduction techniques of the digital logic circuit in detail and the fundamental concepts and techniques used in digital electronics. Minimize the digital circuits by simplification of the expression using Boolean algebra.	Analyzing (Level- IV)
CO-3	The ability to understand, apply and design various combinational and sequential circuits.	Applying (Level- III)
CO-4	Identify and prevent various hazards and timing problems in a digital design and develop skills to build and troubleshoot digital circuits.	Remembering (Level- I)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-2	**3**	**3**	**2**	**2**								**2**	**3**	**2**
CO-3	**3**	**3**	**2**	**2**								**2**	**3**	**2**
CO-4	**2**	**3**	**3**	**3**	**1**							**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Number System: Various number systems-decimal, Binary, Hex and Octal with mutual conversion, binary arithmetic in computers, addition, subtraction, multiplication and division. Binary Codes: Weighted, non-weighted codes, error detecting and correcting codes, alphanumeric codes, ASCII codes. Boolean Algebra: AND, OR, NOT, NAND, NOR, XOR, operations and gates, laws of Boolean algebra, reduction of Boolean expression, logic diagram, universal building blocks, negative logic.	**12**
Module-II	Digital Logic Families: Parameters of Logic Families. Introduction to logic Families: DTL, RTL, ECL, TTL, CMOS. **Combinational circuits and system** Combinational logic: Minterms and maxterms, Truth table and Karnaugh mapping, reduction of Boolean expression with SOP, POS and mixed terms, incompletely specified functions multiple output minimization, variable mapping, minimization by labular/ Quine Mc clustery method. Encoders, Decoders, Multiplexers, Demultiplexers, code convertors, Binary address Digital comparator, parity checker/generator, programming logic Array (PLA).	**12**
Module-III	**Sequential circuits system:** State tables and diagrams, flip flop and its various types- JK, RS, T, D, pulse and edge triggered flip flops transition and excitation tables, timing diagrams. Shift registers: Series and parallel data transfer, ripple counters, synchronous counters, Modulo N counter design, Up down counters, Ring counter.	**12**
Module-IV	**Memory & A/D Conversion system** Semiconductor ROM, Bipolar and MOS RAM, organization of RAM memory subsystem. Timing circuit, clock circuit and IC Timer. Analog/Digital conversion: Digital to analog conversion, dual slope integration successive approximation, parallel and parallel/ series conversion, converter specifications.	**12**

Learning Resources:

Text Books:	J. F. Wakerly, Digital Design, Principles and Practices T.C. Bratee, Digital Computer Fundamentals
Reference Books:	M Morris Mano, Digital Logic & Computer Design
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Verification of basic logic gates and universal gates (NAND, NOR).
2.	Verification of De Morgan's theorems using logic gates.
3.	Design and implementation of half adder and full adder circuits.
4.	Design and implementation of multiplexers, demultiplexers, encoders, and decoders.
5.	Verification of the Sampling Theorem using MATLAB/Simulink.
6.	Verification of SR, JK, D, and T flip-flops.
7.	Design and implementation of synchronous and asynchronous counters.
8.	Design and implementation of shift registers.
9.	Study of ROM, RAM, and programmable logic devices using simulation tools.
10.	Mini Project: Design and simulation of a digital system using Logisim, Multisim, Proteus, or Verilog HDL.

Course Title:	**Communication System**
Course Code:	**ECBB 254**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**-NA**

Course Outcomes		**Cognitive Levels**
CO-1	Explain the fundamentals of communication systems and signal representation.	Understanding (Level –II)
CO-2	Analyze analog modulation and demodulation techniques such as AM, FM, and PM.	Analyzing (Level- IV)
CO-3	Understand pulse modulation, multiplexing, and digital communication techniques.	Evaluate (Level- V)
CO-4	Identify and prevent various hazards and timing problems in a digital design and develop skills to build and troubleshoot digital circuits.	Applying (Level- III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-2	**3**	**3**	**2**	**2**								**2**	**3**	**2**
CO-3	**3**	**3**	**2**	**2**								**2**	**3**	**2**
CO-4	**2**	**3**	**3**	**3**	**1**							**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Elements of communication systems, communication channels, types of signals, baseband and passband transmission, frequency spectrum, bandwidth, signal representation, Fourier series and Fourier transform, energy and power signals, introduction to noise.	**8**
Module-II	Amplitude Modulation (AM), DSB-SC, SSB, Vestigial Sideband (VSB), Frequency Modulation (FM), Phase Modulation (PM), generation and detection of AM and FM, comparison of analog modulation techniques.	**10**
Module-III	Types of noise, noise figure, signal-to-noise ratio (SNR), noise bandwidth, noise in AM and FM receivers, pre-emphasis and de-emphasis, threshold effect, receiver performance analysis.	**8**
Module-IV	Sampling theorem, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Pulse Code Modulation (PCM), Delta Modulation (DM), Adaptive Delta Modulation (ADM), Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM).	**8**
Module-V	Introduction to digital communication systems, ASK, FSK, PSK, QPSK, QAM, Bit Error Rate (BER), eye diagram, introduction to OFDM, applications in modern wireless communication systems.	**8**

Learning Resources:

Text Books:	Simon Haykin, Communication Systems, 5th Edition, Wiley, 2009. B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, 2009.
Reference Books:	John G. Proakis and Masoud Salehi, Fundamentals of Communication Systems, 2nd Edition, Pearson, 2014.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Study of basic communication system components and signal generation.
2.	Generation and demodulation of Amplitude Modulation (AM) signals.
3.	Generation and demodulation of Frequency Modulation (FM) signals.
4.	Study and implementation of Double Sideband Suppressed Carrier (DSB-SC) modulation and demodulation.
5.	Verification of the Sampling Theorem using MATLAB/Simulink.
6.	Implementation of Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), and Pulse Position Modulation (PPM).
7.	Design and simulation of Pulse Code Modulation (PCM) encoder and decoder.
8.	To write a program for Mobile Database Query Processing using open-source DB using MongoDB
9.	Implementation and performance analysis of Delta Modulation (DM).
10.	Generation and detection of digital modulation schemes: ASK, FSK, and PSK.
11.	Performance analysis of communication systems over an AWGN channel using Bit Error Rate (BER) measurements.
12.	Implementation of Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

Course Title:	**PROBABILITY AND STATISTICS**
Course Code:	**MALB 202**
L-T-P	**3-1-0**
Credits:	**Credits: 4**
Pre-requisites:	**Na**

Course Outcomes		**Cognitive Levels**
CO-1	Explain the fundamentals of probability, random variables, and probability distributions.	Understanding (Level –II)
CO-2	Apply probability distributions and mathematical expectation to solve engineering problems.	Apply (Level- III)
CO-3	Analyze statistical data using descriptive statistics, correlation, and regression techniques.	Analyze (Level- VI)
CO-4	Evaluate statistical inference methods including estimation and hypothesis testing.	Evaluate (Level- V)
CO-5	Solve real-world engineering problems using probability and statistical models.	Create (Level- VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**										**2**	**3**	**2**
CO-2	**3**	**3**	**2**	**2**	**2**							**2**	**3**	**2**
CO-3	**2**	**3**	**2**	**3**	**2**									**2**
CO-4	**2**	**3**	**2**	**3**	**2**							**2**	**3**	**3**
CO-5	**2**	**3**	**3**	**3**	**3**							**2**	**3**	**3**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Sample space, events, axioms of probability, addition and multiplication laws, conditional probability, independence of events, Bayes' theorem, counting principles (permutations and combinations), random experiments and applications.	**9**
Module-II	Discrete and continuous random variables, probability mass function (PMF), probability density function (PDF), cumulative distribution function (CDF), mathematical expectation, moments, variance, Binomial, Poisson, Uniform, Exponential, and Normal distributions.	**10**
Module-III	Collection and presentation of data, measures of central tendency (mean, median, mode), measures of dispersion (range, variance, standard deviation), moments, skewness, kurtosis, correlation, and simple linear regression.	**8**
Module-IV	Sampling distributions, Central Limit Theorem, point estimation, interval estimation, confidence intervals, hypothesis testing, tests for means and proportions, Chi-square test, Student's t-test, and F-test.	**9**
Module-V	Analysis of Variance (ANOVA), goodness-of-fit test, non-parametric tests, reliability concepts, statistical quality control, applications of probability and statistics in engineering, science, and decision-making.	**8**

Learning Resources:

Text Books:	K. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Second edition (2002), Wiley. Athanasios Papoulis, S. Unnikrishna Pillai, Probability, Random Variables, and Stochastic Processes, Tata McGraw-Hill Education, 2002. Robert V Hogg, Joseph McKean, Allen T Craig, Introduction to Mathematical Statistics, Seventh Edition, Pearson.
Reference Books:	Sheldon M Ross, Introduction to Probability and Statistics for Engineers and Scientists, Fifth Edition, Elsevier. Michael Mitzenmacher, Eli Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press.
Other Suggested Readings:	

Lab Experiments:

Exp. No.	List of Experiments
1.	Problems on sample space, events, probability axioms, and counting principles (permutations and combinations).
2.	Applications of conditional probability, Bayes' theorem, and independent events.
3.	Computation of probabilities using discrete and continuous random variables.
4.	Numerical problems on Binomial, Poisson, Uniform, Exponential, and Normal distributions.
5.	Computation of mean, variance, standard deviation, skewness, and kurtosis from datasets.
6.	Data visualization using frequency distributions, histograms, bar charts, and box plots.
7.	Correlation and simple linear regression analysis using real-world datasets.
8.	Confidence interval estimation and hypothesis testing (Z-test, t-test, Chi-square test, and F-test).
9.	One-way ANOVA and goodness-of-fit test using statistical software (Excel/R/Python/MATLAB).
10.	Case study on applying probability and statistical methods to engineering or scientific data analysis.

Course Title:	**Professional Communication**
Course Code:	**HMBB 251**
L-T-P	**2-0-2**
Credits:	**Credits: 3**
Pre-requisites:	**Na**

Course Outcomes		**Cognitive Levels**
CO-1	Demonstrate effective listening, reading, speaking, and writing skills for academic and professional communication.	Understanding (Level –II)
CO-2	Apply appropriate verbal, non-verbal, and written communication techniques in professional and workplace situations.	Apply (Level- III)
CO-3	Analyze communication scenarios and prepare professional documents such as reports, emails, résumés, and presentations.	Analyze (Level- VI)
CO-4	Evaluate interpersonal communication, teamwork, leadership, and interview performance in professional settings.	Evaluate (Level- V)
CO-5	Create effective presentations and deliver professional communication with confidence, ethics, and audience awareness.	Create (Level- VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1					**1**							**2**	**3**	**2**
CO-2		**1**	**1**		**2**							**2**	**3**	**3**
CO-3	**1**	**2**	**2**	**2**	**2**									**2**
CO-4		**2**	**2**	**3**	**2**							**2**	**3**	**3**
CO-5		**2**	**3**	**2**	**2**							**2**	**3**	**3**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Communication process, types and principles of communication, verbal and non-verbal communication, barriers to communication, listening skills, reading skills, vocabulary development, grammar essentials for professional communication.	**8**
Module-II	Business correspondence, professional emails, notices, circulars, agendas and minutes of meetings, report writing, technical writing, résumé (CV) preparation, cover letters, statement of purpose (SOP), and official documentation.	**8**
Module-III	Public speaking, presentation techniques, seminar presentation, group discussion, interview skills, pronunciation, voice modulation, body language, confidence building, and effective questioning techniques.	**8**
Module-IV	Interpersonal communication, teamwork, leadership communication, conflict resolution, negotiation skills, workplace etiquette, cross-cultural communication, professional ethics, and emotional intelligence.	**8**
Module-V	Corporate communication, digital communication, LinkedIn and professional networking, portfolio development, aptitude communication, career planning, workplace case studies, and communication in multicultural organizations.	**8**

Learning Resources:

Text Books:	Meenakshi Raman and Sangeeta Sharma, Technical Communication: Principles and Practice, 3rd Edition, Oxford University Press, 2017. Ashraf Rizvi, Effective Technical Communication, 2nd Edition, McGraw-Hill Education, 2018.
Reference Books:	Shirley Taylor, Communication for Business: A Practical Approach, 5th Edition, Pearson Education, 2019. Lesikar, Flatley, and Rentz, Business Communication: Connecting in a Digital World, 13th Edition, McGraw-Hill Education, 2018.

Course Title:	**Tiny ML**
Course Code:	**CSLB 361**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basic Python programming and some exposure to electronics/circuits.**

Course Outcomes

Course Outcomes:		Cognitive Levels
CO1	Explain the fundamental of Machine Learning and Embedded System	L2
CO2	Apply machine learning technique using the tensor flow library and optimization the model for variety of embedded devices	L3
CO3	Analyze and understand how to run ML on embedded hardware with sensors with real case studies and projects	L4
CO4	Develop apps and learn skills across the ML life cycle to understand speech for keyword spotting, detect objects in images and identify anomalies in sensor data	L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	2	1								3	2
CO-2	2	2	2	2	1				1				3	2
CO-3	2	2	1	2	1								3	3
CO-4	2	2	1	2	1								3	3

Syllabus

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	What is (tiny) Machine Learning, TinyML Applications, TinyML Challenges, Intro to Software/Hardware, Finding Patterns, Fitting Lines & Loss, Gradient Descent, Intro to Neural Networks, Single-Layer & Multi-Layer Neural Networks, Regression, Classification, Dataset Split (Train,Validation,Test), Convolutions, Convolutional Neural Networks, Mapping Features to Labels, Image Datasets, Overfitting, Image Augmentation, Dropout, Explore other Loss Functions & Optimizers, CV Application, Goal, User Requirements, Ethics	10

Module-II	AI Infrastructure (Data Engineering, Model Engineering, Model Deployment), Model Workflow Pipeline, TensorFlow Lite Converter. Post Training Quantization (PTQ), Quantization Aware Training (QAT), Inference using TF vs. TFLite, Model Conversion and Deployment, TensorFlow Lite Optimizations, and Quantization, Quantization Aware Training (QAT),	08
Module-III	Transfer Learning, Neural Network Architecture, Unsupervised Learning (K-mean & Autoencoder), Keyword Spotting (KWS), Visual Wake Words (VWW), Anomaly Detection. Data Engineering, Responsible AI Development	08
Module-IV	Overview of Embedded systems, Comm Protocols, Memory, Software, Frameworks, Usage, Interpreter, Model Format, Serialization Libraries, Memory Allocation, NN Operations, Architecture, Preprocessing, Inference, Model Post processing, End to End design, Custom dataset engineering, Component Architecture, Preprocessing, Multimodal, Multi tenancy, TFLite Micro, TinyML Ecosystem, Magic Wand Architecture, Preprocessing, Deployment	07
Module-V	ML Accelerators in Compilers and Hardware, MemoryX Neural Processing Units, Moral Decision Making with ML-enabled Systems	03

Learning Resources

Text Books:	1. TinyML:Machine Learning With Tensorflow Lite on Arduino and Utralowpower Microcontroller, Pete Warden, Daniel Situnayake, OREILLY Publisher. 2. TinyML Cookbook: Combine machine learning with microcontrollers to solve real-world problems, Gian Marco Lodice, Packt Publishing, 2nd edition 3. Tiny Machine Learning Quickstart Machine Learning for Arduino Microcontrollers, Apress Publisher, 2025
Reference Books:	1. TinyML Cookbook: Combine machine learning with microcontrollers to solve real-world problems, Gian Marco Lodice, Packt Publishing, 2nd edition 2. Tiny Machine Learning Quickstart Machine Learning for Arduino Microcontrollers, Apress Publisher, 2025
Other Suggested Readings:	1. HarvardX: Fundamentals of TinyML 2. Tiny Machine Learning for Embedded Systems, University of Pennsylvania

Course Title:	**Network Security and Cryptographic Protocols**
Course Code:	**CSLB 362**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes		**Cognitive Levels**
CO1	Explain network security services, attacks, mathematical basis of one-way cryptographic functions	L2
CO2	Apply cryptographic primitives and authentication mechanisms for securing distributed systems	L3
CO3	Analyze security protocols (IPsec, SSL/TLS, Kerberos, PKI, Emails, Wireless) and identify vulnerabilities	L4
CO4	Design and propose security protocols and mechanisms to meet security goals of real-world applications	L5, L6

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	2	1								3	2
CO-2	2	2	2	2	1				1				3	2
CO-3	2	2	1	2	1								3	3
CO-4	2	2	1	2	1								3	3

2 - Moderately; 3 – Substantially

Syllabus		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Overview of Network Security & Security Requirements of Distributed Systems, Security Services & Security Mechanisms, Attacks: Sniffing, Spoofing, DDoS, Man-in-the-Middle, TCP/UDP exploits, routing exploits, One-Way Functions & Secret Sharing Concepts, OS Security Violations and Prevention Methods	07
Module-II	Mathematical foundation: Discrete logs, Prime numbers, RSA, ECC, Block & Stream Ciphers, Block Cipher Modes, MAC, Hash functions — MD5, SHA, RIPEMD, HMAC, Pseudorandom Number Generators (PRNG)	07
Module-III	Digital Signatures, Nonce, Timestamps, Challenge-Response Protocols, Kerberos, X.509 Certificates, PKI, Authenticated Diffie-Hellman, Group Key Establishment Protocols, Security protocol verification: Strand Space Theory	08
Module-IV	Secure Communication Services : IP Security — AH & ESP, Transport Security — SSL/TLS, SSH Protocol, Web Security: HTTPS, Secure Electronic Transactions (SET), Email Security — PGP, S/MIME	07

Module-V	Network Defence, Wireless & Emerging Threats: Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS) Malware: Viruses, Worms, Trojans, Spyware Firewalls, Honeypots, Honeynets Wireless Network Security: Threats, WEP, WPA, WPA2, WLAN security practices	07

Learning Resources

Text Books:	William Stallings, Network Security: Private Communication in a Public World, Pearson. Behrouz A. Forouzan, Cryptography and Network Security, McGraw-Hill. Charlie Kaufman, Radia Perlman & Mike Speciner, Network Security: Private Communication in a Public World, Pearson.
Reference Books:	William Stallings, Cryptography and Network Security: Principles & Practice, Pearson. Bruce Schneier, Applied Cryptography, Wiley. Atul Kahate, Cryptography and Network Security, McGraw-Hill. Mark Stamp, Information Security: Principles and Practice, Wiley. Alfred Menezes, Paul van Oorschot, Scott Vanstone, Handbook of Applied Cryptography.

Course Title:	**Cryptography and Network Security**
Course Code:	**CSPB 461**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basic programming, Computer Networks**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand fundamental concepts of cryptography and network security	L2
CO-2	Apply mathematical foundations to analyze cryptographic algorithms	L3
CO-3	Analyze and implement symmetric and asymmetric cryptographic techniques	L3
CO-4	Evaluate network security mechanisms, protocols and modern cryptographic applications	L4

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2			1									2
CO-2	3	3	2	2	3									2
CO-3	2	3	2	3	3									2
CO-4	2	3	3	3	3									3
CO-5	2	3	3	3	3									3

2 - Moderately; 3 – Substantially

Course Articulation Matrix:

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Cryptography, Classical Cryptosystems, Block and Stream Ciphers, DES, Triple DES, Modes of Operation, LFSR-based Stream Ciphers, Mathematical Background.	07
Module-II	Number Theory: Modular Arithmetic, Euclid Algorithm, Fermat and Euler Theorems, AES, Public Key Cryptosystems, Diffie–Hellman, ElGamal, Elliptic Curve Cryptography.	08
Module-III	Advanced Public Key Cryptosystems, Message Authentication, Hash Functions, SHA, Digital Signatures, DSS, Key Management.Differential	07

	and Linear Cryptanalysis, Attacks on Stream Ciphers, Secret Sharing, Identity-based and Attribute-based Encryption.	
Module-IV	Network Security, Attacks on network security- passive and active attacks, Services used to handle these attacks and related Mechanisms, A model for network security.	07
Module-V	Electronic Mail Security-PGP, IP security-Overview, Firewalls,SSL/TLS, Side-channel Attacks, Quantum Cryptography, Blockchain and Cryptocurrency.	07

Learning Resources:

Text Books:	William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Behrouz A. Forouzan, Cryptography and Network Security, McGraw-Hill.
Reference Books:	Douglas R. Stinson, Cryptography: Theory and Practice, CRC Press. Katz and Lindell, Introduction to Modern Cryptography, CRC Press.
Other Suggested Readings:	NPTEL / SWAYAM Courses on Cryptography and Network Security.

Course Title:	**Information Security**
Course Code:	**CSBB 335**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Basic Programming, Computer Networks, Operating Systems**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Explain information security fundamentals including CIA triad, terminology, roles, and responsibilities.	L2
CO-2	Analyze threats, vulnerabilities, risks and recommend suitable mitigation strategies.	L4
CO-3	Interpret and explain information security policies, standards, procedures, and governance mechanisms.	L3
CO-4	Demonstrate security technologies, assessment procedures, and evaluation methods for systems and networks.	L4
CO-5	Apply basic cryptographic techniques and access control mechanisms in practical scenarios.	L3

Course Articulation Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2												2
CO-2	3	3	2	2	3									2
CO-3	2	3	2	3	3									2
CO-4	2	2	1	2	1									3
CO-5	2	3	3	3	3									3

2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Information Security, need of Information Security, Confidentiality, Integrity, Availability (CIA) principles, elements of information security, People, process, and technology model, Security roles and responsibilities (management, users, security staff), Overview of security governance	07
Module-II	Threats, vulnerabilities, and risk concepts, Common threat sources and attack types, Information security policy types: Program-level policy, Issue-specific policy, System-specific policy. Standards, procedures, and guidelines. Administrative, technical, and physical controls.	07
Module-III	Risk Management, Assurance & Legal Issues: Risk assessment and risk management lifecycle, Risk mitigation strategies, Security assurance and audit concepts, Incident handling and response basics, Contingency planning and disaster recovery overview, Legal and ethical aspects of information security (IT Act 2000 – overview)	08
Module-IV	Operational Security & System Controls: Personnel security and security awareness, Configuration management and backups, Media protection and physical/environmental security, Identification and authentication mechanisms, Access control principles, System operation and maintenance security	07
Module-V	Applied Security Techniques: Purpose and uses of cryptography, Symmetric vs asymmetric concepts,data integrity, Digital signatures and authentication, Key management basics, cryptography demonstrations (classical ciphers).	07

Learning Resources:

Text Books:	Michael E. Whitman & Herbert J. Mattord, Principles of Information Security, 4th Edition, 2011
Reference Books:	William Stallings, Cryptography and Network Security, 7th Edition, Pearson Education, 2017. Behrouz A. Forouzan, Cryptography and Network Security,2nd Edition, McGraw-Hill Education, 2010 Ross Anderson, Security Engineering,2nd Edition, Wiley, 2008. Mark Stamp, Information Security: Principles and Practice, 2nd Edition, Wiley, 2011.

Other Suggested Readings:	NPTEL: Introduction to Information Security – IIT Madras NIST SP 800-12 Rev.1: An Introduction to Information Security

List of Experiments:

S. No.	Experiments
1	Study of Linux commands and basic security tools
2	Classical cryptography implementation (Caesar/substitution cipher)
3	Hashing and integrity verification using SHA
4	RSA key generation and simple encryption/decryption
5	Digital signature creation and verification
6	Firewall configuration and rule testing
7	IDS basics and log analysis
8	Access control and permission management
9	Simple risk assessment case study

Assignment: Mini project / security audit report