



University of Madras

Chepauk, Chennai 600 005

[Est. 1857, State University, NAAC 'A⁺⁺' Grade, CGPA 3.59, NIRF 2019 Rank: 20]

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Undergraduate Programme in Computer Science with Data Science

Syllabus for
B.Sc. Computer Science with Data Science
(With effect from the Academic Year 2023 -24)

Learning Outcome Based Curriculum Framework

Note: The Committee is designed Learning Outcome Based Curriculum Framework of Undergraduate Computer Science Programmes prescribed by UGC

I Preamble

Bachelor of Computer Science with Artificial Intelligence is a 3 – Year Undergraduate Programme spread over six semesters. The course is designed to achieve a high degree of technical skills in Problem solving and Modern application development. The course develops requisite professional skills and problem solving along with developing the analytical abilities for pursuing a successful career in software industry and forms the required basics for further higher studies in Computer Science specifically in the area of Artificial Intelligence.

II Eligibility

A pass in the Higher secondary Examination (Academic Stream) conducted by the Government of Tamil Nadu with Mathematics as one of the subjects.

III Programme Objectives

PO1	Disciplinary knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study
PO2	Communication Skills: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
PO3	Critical thinking: Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.
PO4	Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.
PO5	Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

PO6	Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation
PO7	Cooperation/Team work: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team
PO8	Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
PO9	Reflective thinking: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.
PO10	Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

IV Programme Specific Objectives

PSO1	To enable students to apply basic microeconomic, macroeconomic and monetary concepts and theories in real life and decision making.
PSO2	To sensitize students to various economic issues related to Development, Growth, International Economics, Sustainable Development and Environment.
PSO3	To familiarize students to the concepts and theories related to Finance, Investments and Modern Marketing.
PSO4	Evaluate various social and economic problems in the society and develop answer to the problems as global citizens.
PSO5	Enhance skills of analytical and critical thinking to analyze effectiveness of economic policies.

B.Sc. COMPUTER SCIENCE WITH DATA SCIENCE**COURSE STRUCTURE****YEAR – I SEMESTER – I**

Part	Sub. Code	List of Courses	Credit	Hrs	Int.	Ext.	Total
Part-I	----	Language Paper-I	3	6	25	75	100
Part-II	100L1Z	English Paper-I	3	6	25	75	100
Part-III	127C1A	CC- I: Python Programming @#%&	5	4	25	75	100
	127C11	CC- II: Python Programming Practical @#%&	5	5	40	60	100
	127E1A 127E1B 127E1C	EC-I Generic / Discipline Specific Mathematics-I @#%& / Statistics-I @#%& / Financial Accounting-I @#& /	3	5	25	75	100
Part-IV	127S1A	SEC- I: Office Automation @#%&*	2	2	25	75	100
	100S1A	Basic Tamil-I (Other Language Students) *					
	100S1B	Advanced Tamil-I *					
	127B1A	FC: Fundamentals of Computers @#%&	2	2	25	75	100
			23	30			

*** PART-IV: SEC-1 / Basic Tamil / Advanced Tamil (Any one)**

1. Students who have studied Tamil upto XII STD and also have taken Tamil in Part I shall take SEC-I.
2. Students who have not studied Tamil upto XII STD and have taken any Language other than Tamil in Part-I shall take Basic Tamil comprising of Two Courses (level will be at 6th Std.).
3. Students who have studied Tamil upto XII STD and have taken any Language other than Tamil in Part-I shall take Advanced Tamil comprising of Two Courses.

YEAR – I SEMESTER – II

Part	Sub. Code	List of Courses	Credit	Hrs	Int.	Ext.	Total
Part-I	----	Language Paper-II	3	6	25	75	100
Part-II	100L2Z	English Paper-II	3	6	25	75	100
Part-III	127C2A	CC- III: Java Programming @#%&	5	4	25	75	100
	127C21	CC- IV: Java Programming Practical @#%&	5	5	40	60	100
	127E2A 127E2B 127E2C	EC - II Generic / Discipline Specific : Mathematics II @#%& / Statistics II @#%& / Financial Accounting-II @#&	3	5	25	75	100
Part-IV	127S21	SEC-II: Office Automation Practical @#%& *	2	2	40	60	100
	100S2A	Basic Tamil-II (Other Language Students) *			25	75	100
	100S2B	Advanced Tamil- II *			25	75	100
	127S2A	SEC- III: Quantitative Aptitude @#%&	2	2	25	75	100
			23	30			

YEAR – II SEMESTER – III

Part	Sub. Code	List of Courses	Credit	Hrs	Int.	Ext.	Total
Part-I	----	Language Paper-III	3	6	25	75	100
Part-II	200L3Z	English Paper-III	3	6	25	75	100
Part-III	227C3A	CC- V: Data Structures @%&	5	4	25	75	100
	227C31	CC- VI: Data Structures Practical @%&	5	5	40	60	100
	227E3A 227E3B 227E3C	EC - III Generic / Discipline Specific: Mathematics I @#\$%& / Statistics I @#\$%& / Resource Management Techniques-I	3	5	25	75	100
Part-IV	227S31	SEC- IV: (Entrepreneurial Based): Web Page Design Practical @#\$%&	1	1	40	60	100
	227S32	SEC- V: Desktop Publishing Practical @#\$%&	2	2	40	60	100
	----	Environmental Science	--	1	--	--	--
			22	30			

YEAR – II SEMESTER – IV

Part	Sub. Code	List of Courses	Credit	Hrs	Int.	Ext.	Total
Part-I	----	Language Paper-IV	3	6	25	75	100
Part-II	200L4Z	English Paper-IV	3	6	25	75	100
Part-III	227C4A	CC- VII: Data Science Essentials &	5	4	25	75	100
	227C41	CC-VIII: Data Science using Python Practical &	5	4	40	60	100
	227E4A 227E4B 227E4C	EC-IV Generic / Discipline Specific Mathematics II @#\$%& / Statistics II @#\$%& / Resource Management Techniques-II	3	5	25	75	100
Part-IV	227S4A	SEC-VI: Emotional Intelligence @#\$%&	2	2	25	75	100
	227S4B	SEC-VII: Technical Writing @#\$%&	2	2	25	75	100
	---	Environmental Science	2	1	25	75	100
			25	30			

YEAR – III SEMESTER – V

Part	Sub. Code	List of Courses	Credit	Hrs	Int.	Ext.	Total
Part- III	327C5A	CC- IX: Data Visualization &	4	5	25	75	100
	327C51	CC- X: Data Visualization Practical &	4	5	40	60	100
	327C5B	CC- XI: R Programming @#&	4	5	25	75	100
	327C52	CC- XII: R Programming Practical @#&	4	5	40	60	100
	327E5A 327E5B 327E5C	EC -V: Computer Networks #\$\$%& / Software Engineering @#\$\$%& / Computing System Fundamentals #%%&	3	4	25	75	100
	327E5D 327E5E 327E5F	EC -VI: Cloud Computing @#\$\$%& / Big Data Analytics @#\$\$%& / Data Mining and Warehousing @#\$\$%&	3	4	25	75	100
Part-IV	---	Value Education	2	2	25	75	100
	---	Internship / Industrial Training (During summer vacation at the end of IV semester)	2	--	--	--	--
			26	30			

YEAR – III SEMESTER – VI

Part	Sub. Code	List of Courses	Credit	Hrs	Int.	Ext.	Total
Part- III	327C6A	CC - XIII: Data Analytics &	4	6	25	75	100
	327C61	CC - XIV: Data Analytics Practical &	4	6	40	60	100
	327C6B	CC - XV: Natural Language Processing %&	4	6	25	75	100
	327E6A 327E6B 327E6C	EC -VII: Mobile Ad-hoc Network @#\$\$%& / Artificial Neural Networks %& / Grid Computing @&	3	5	25	75	100
	327E6D 327E6E 327E6F	EC-VIII: Internet of Things and its Applications @#\$\$%& / Robotics and Its Applications @#%& / Information Security %&	3	5	25	75	100
Part-IV	327S61	Professional Competency Skill Course: Mini Project @%&	2	2	40	60	100
	---	Extension Activity	1	--	--	--	--
			21	30			

@ - Common to B.C.A.

- Common to B.Sc. Software Applications

\$ - Common to B.Sc. Computer Science

% - Common to B.Sc. Computer Science with Artificial Intelligence

& - Common to B.Sc. Computer Science with Data Science

-X-X-X-

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
 SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: I

Core-I: Python Programming (Common to B.Sc.-CS, CS with AI, Software Appl. & BCA)	127C1A
Credits 5	Lecture Hours:4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Describe the core syntax and semantics of Python programming language. • Discover the need for working with the strings and functions. • Illustrate the process of structuring the data using lists, dictionaries, tuples and sets. • Understand the usage of packages and Dictionaries	
Course Outcomes: (for students: To know what they are going to learn) CO1: Develop and execute simple Python programs CO2: Write simple Python programs using conditionals and looping for solving problems CO3: Decompose a Python program into functions CO4: Represent compound data using Python lists, tuples, dictionaries etc. CO5: Read and write data from/to files in Python programs	

UNITS	CONTENTS
I	Introduction: The essence of computational problem solving – Limits of computational problem solving-Computer algorithms-Computer Hardware-Computer Software-The process of computational problem solving-Python programming language - Literals - Variables and Identifiers - Operators - Expressions and Data types, Input / output.
II	Control Structures: Boolean Expressions - Selection Control - If Statement-Indentation in Python- Multi-Way Selection -- Iterative Control- While Statement- Infinite loops- Definite vs. Indefinite Loops- Boolean Flag. String, List and Dictionary, Manipulations Building blocks of python programs, Understanding and using ranges.
III	Functions: Program Routines- Defining Functions- More on Functions: Calling Value-Returning Functions- Calling Non-Value-Returning Functions- Parameter Passing - Keyword Arguments in Python - Default Arguments in Python-Variable Scope. Recursion: Recursive Functions.
IV	Objects and their use: Software Objects - Turtle Graphics – Turtle attributes-Modular Design: Modules - Top-Down Design - Python Modules - Text Files: Opening, reading and writing text files – Exception Handling.
V	Dictionaries and Sets: Dictionary type in Python - Set Data type. Object Oriented Programming using Python: Encapsulation - Inheritance – Polymorphism. Python packages: Simple programs using the built-in functions of packages matplotlib, NumPy, pandas etc.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Charles Dierbach, "Introduction to Computer Science using Python - A computational Problem-solving Focus", Wiley India Edition, 2015.
2. Wesley J. Chun, "Core Python Applications Programming", 3rd Edition , Pearson Education, 2016

Reference Books

1. Mark Lutz, "Learning Python Powerful Object Oriented Programming", O'reilly Media 2018, 5th Edition.
2. Timothy A. Budd, "Exploring Python", Tata McGraw Hill Education Private Limited 2011, 1 st Edition.
3. John Zelle, "Python Programming: An Introduction to Computer Science", Second edition, Course Technology Cengage Learning Publications, 2013, ISBN 978-1590282410
4. Michel Dawson, "Python Programming for Absolute Beginners" , Third Edition, Course Technology Cengage Learning Publications, 2013, ISBN 978-143545500

Web resources

1. https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: I

Core-II: Python Programming Practical (Common to B.Sc.-CS, CS with AI, Software Appl. & BCA)	127C11						
Credits 5	Lecture Hours: 5 per week						
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Acquire programming skills in core Python. • Acquire Object-oriented programming skills in Python. • Develop the skill of designing graphical-user interfaces (GUI) in Python. • Develop the ability to write database applications in Python. • Acquire Python programming skills to move into specific branches							
Course Outcomes: (for students: To know what they are going to learn) CO1: To understand the problem solving approaches CO2: To learn the basic programming constructs in Python CO3: To practice various computing strategies for Python-based solutions to real world problems CO4: To use Python data structures - lists, tuples, dictionaries. CO5: To do input/output with files in Python.							
List of Programs							
1. Program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user's choice. 2. Write a Python program to construct the following pattern, using a nested loop <pre> * ** *** **** ***** **** *** ** *</pre> 3. Program to calculate total marks, percentage and grade of a student. Marks obtained in each of the five subjects are to be input by user. Assign grades according to the following criteria: <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Grade A: Percentage ≥ 80</td> <td style="width: 50%;">Grade B: Percentage ≥ 70 and < 80</td> </tr> <tr> <td>Grade C: Percentage ≥ 60 and < 70</td> <td>Grade D: Percentage ≥ 40 and < 60</td> </tr> <tr> <td>Grade E: Percentage < 40</td> <td></td> </tr> </table> 4. Program, to find the area of rectangle, square, circle and triangle by accepting suitable input parameters from user. 5. Write a Python script that prints prime numbers less than 20.		Grade A: Percentage ≥ 80	Grade B: Percentage ≥ 70 and < 80	Grade C: Percentage ≥ 60 and < 70	Grade D: Percentage ≥ 40 and < 60	Grade E: Percentage < 40	
Grade A: Percentage ≥ 80	Grade B: Percentage ≥ 70 and < 80						
Grade C: Percentage ≥ 60 and < 70	Grade D: Percentage ≥ 40 and < 60						
Grade E: Percentage < 40							

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

6. Program to find factorial of the given number using recursive function.
7. Write a Python program to count the number of even and odd numbers from array of N numbers.
8. Write a Python class to reverse a string word by word.
9. Given a tuple and a list as input, write a program to count the occurrences of all items of the list in the tuple. (Input: tuple = ('a', 'a', 'c', 'b', 'd'), list = ['a', 'b'], Output: 3)
10. Create a Savings Account class that behaves just like a Bank Account, but also has an interest rate and a method that increases the balance by the appropriate amount of interest (Hint: use Inheritance).
11. Read a file content and copy only the contents at odd lines into a new file.
12. Create a Turtle graphics window with specific size.
13. Write a Python program for Towers of Hanoi using recursion
14. Create a menu driven Python program with a dictionary for words and their meanings.
15. Devise a Python program to implement the Hangman Game.

Learning Resources:

Recommended Texts

1. Charles Dierbach, "Introduction to Computer Science using Python - A computational Problem-solving Focus", Wiley India Edition, 2015.
2. Wesley J. Chun, "Core Python Applications Programming", 3rd Edition , Pearson Education, 2016

Reference Books

1. Mark Lutz, "Learning Python Powerful Object Oriented Programming", O'reilly Media 2018, 5th Edition.
2. Timothy A. Budd, "Exploring Python", Tata McGraw Hill Education Private Limited 2011, 1 st Edition.
3. John Zelle, "Python Programming: An Introduction to Computer Science", Second edition, Course Technology Cengage Learning Publications, 2013, ISBN 978- 1590282410
4. Michel Dawson, "Python Programming for Absolute Beginners", Third Edition, Course Technology Cengage Learning Publications, 2013, ISBN 978-1435455009

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: I

Foundation Course: Fundamentals of Computers (Common to B.Sc.-CS, CS with AI, Software Appl. & BCA)	127B1A
Credits 2	Lecture Hours: 2 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • to understand fundamentally the general scope of the computer system • to interact effectively with the computer • to know the uses of the basic components of the computer • to manage the system to some extent before involving an expert • to know some basic things about the computer and the world	
Course Outcomes: (for students: To know what they are going to learn) CO1: Fundamental concepts of computer CO2: Fundamental mathematical techniques and how they relate to computer CO3: The architecture of processing and file storage in a computer system CO4: Basic operations of operating systems CO5: A variety of software packages applicable to an academic, software development and business environment	

Units	Contents
I	Understanding the Computer: - Introduction - Evolution of Computers - Generations of Computers - Classification of Computers - Computing Concepts - The Computer System - Applications of Computers. Computer Organisation and Architecture: - Introduction - Central Processing Unit - Internal Communications - Machine Cycle - The Bus - Instruction Set. Memory and Storage Systems: - Introduction - Memory Representation - Random Access Memory - Read Only Memory - Storage Systems - Magnetic Storage Systems - Optical Storage Systems - Magneto Optical Systems - Solid-state Storage Devices - Storage Evaluation Criteria. Input Devices: - Introduction - Keyboard - Pointing Devices - Scanning Devices - Optical Recognition Devices - Digital Camera - Voice Recognition System - Data Acquisition Sensors - Media Input Devices. Output Devices: - Introduction - Display Monitors - Printers - Impact Printers - Non-impact Printers - Plotters - Voice Output - Systems - Projectors - Terminals
II	Computer Codes: - Introduction - Decimal System - Binary System - Hexadecimal System - Octal System - Binary Coded Decimal (BCD) Systems – Unicode. Computer Arithmetic: - Introduction - Binary Addition - Binary Multiplication - Binary Subtraction - Binary Division - Signed/unsigned Numbers - Complements of Binary Numbers - Binary Subtraction Using Complements - Representing Numbers - Integer Arithmetic - Floating-point Arithmetic

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

III	Boolean Algebra of Switching Circuits: - Introduction - Elements of Boolean Algebra - Basic Postulates of Boolean Algebra - Boolean Operations - Principle of Duality - Basic Laws of Boolean Algebra - De Morgan's Theorem - Boolean Expressions. Logic Gates and Digital Circuits: - Introduction - Basic Logic Gates - Derived Logic Gates - Conversion of Boolean Functions - Adder Circuits - Flip-flop Circuits - Application of Flip-flops. Computer Software: - Introduction - Types of Computer Software - System Management Programs - System Development Programs - Standard Application Programs - Unique Application Programs - Problem Solving - Structuring the Logic - Using the Computer
IV	Operating Systems: - Introduction - History of Operating Systems - Functions of Operating Systems - Process Management - Memory Management - File Management - Device Management - Security Management - Types of Operating Systems - Providing User Interface - Popular Operating Systems. Programming Languages: - Introduction - History of Programming Languages - Generations of Programming Languages - Characteristics of a Good Programming Language - Categorisation of High-level Languages - Popular High-level Languages - Factors Affecting the Choice of a Language - Developing a Program - Running a Program
V	Data Communications and Networks: - Introduction - Data Communication Using Modem - Computer Network - Network Topologies - Network - Protocols and Software - Applications of Network. The Internet and World Wide Web: - Introduction - History of Internet - Internet Applications - Understanding the World Wide Web - Web Browsers - Browsing the internet - Using a Search Engine - Email Service - Protocols Used for the Internet

Learning Resources:

Recommended Texts

1. E Balagurusamy. Fundamentals Of Computers, Tata McGraw Hill Publishing Company Limited
2. Fundamentals of Computers (Paperback), 2019, Manallah Abid, Mohammad Amjad, Dreamtech Press

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: I

Skill Enhancement Course: Office Automation (Common to B.Sc.-CS, CS with AI, Software Appl. & BCA)	127S1A
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Credits 2 **Lecture Hours: 2 per week**

Learning Objectives: (for teachers: what they have to do in the class/lab/field)

- The major objective in introducing the Computer Skills course is to impart training for students in Microsoft Office which has different components like MS Word, MS Excel and Power point.
- The course is highly practice oriented rather than regular class room teaching.
- To acquire knowledge on editor, spread sheet and presentation software.

Course Outcomes: (for students: To know what they are going to learn)

CO1: Understand the basics of computer systems and its components.

CO2: Understand and apply the basic concepts of a word processing package.

CO3: Understand and apply the basic concepts of electronic spreadsheet software.

CO4: Understand and apply the basic concepts of database management system.

CO5: Understand and create a presentation using PowerPoint tool.

UNITS	CONTENTS
I	Introductory concepts: Hardware and Software - Memory unit – CPU-Input Devices: Key board, Mouse and Scanner. Output devices: Monitor, Printer. Introduction to Operating systems - Introduction to Programming Languages.
II	Word Processing: File menu operations - Editing text – tools, formatting, bullets and numbering - Spell Checker - Document formatting – Paragraph alignment, indentation, headers and footers, printing – Preview, options, merge.
III	Spreadsheets: Excel – opening, entering text and data, formatting, navigating; Formulas – entering, handling and copying
IV	Charts – creating, formatting and printing, analysis tables, preparation of financial statements, introduction to data analytics.
V	Power point: Introduction to Power point - Features – Understanding slide typecasting & viewing slides – creating slide shows. Applying special object – including objects & pictures – Slide transition – Animation effects, audio inclusion, timers.

Learning Resources:

Recommended Texts

1. Peter Norton, “Introduction to Computers” –Tata McGraw-Hill.

Reference Books

1. Jennifer Ackerman Kettel, Guy Hat-Davis, Curt Simmons, “Microsoft 2003”, Tata McGraw- Hill.

Web resources : Web content from NDL / SWAYAM or open source web resources

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: II

Java Programming		127C2A
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		
Credits 5	Lecture Hours:4 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • To provide fundamental knowledge of object-oriented programming. • To equip the student with programming knowledge in Core Java from the basics up. • To enable the students to use AWT controls, Event Handling and Swing for GUI.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Understand the basic Object-oriented concepts. Implement the basic constructs of Core Java CO2: Implement inheritance, packages, interfaces and exception handling of Core Java. CO3: Implement multi-threading and I/O Streams of Core Java CO4: Implement AWT and Event handling. CO5: Use Swing to create GUI.		

Units	Contents
I	Introduction: Review of Object-Oriented concepts - Java buzzwords (Platform independence, Portability, Threads)- JVM architecture –Java Program structure - – Java main method - Java Console output(System.out) - simple java program - Data types - Variables - type conversion and casting- Java Console input: Buffered input - operators - control statements - Static Data - Static Method - String and String Buffer Classes
II	Java user defined Classes and Objects – Arrays – constructors - Inheritance: Basic concepts - Types of inheritance - Member access rules - Usage of this and Super key word - Method Overloading - Method overriding - Abstract classes - Dynamic method dispatch - Usage of final keyword -Packages: Definition - Access Protection - Importing Packages - Interfaces: Definition – Implementation – Extending Interfaces
III	Exception Handling: try – catch - throw - throws – finally – Built-in exceptions - Creating own Exception classes - garbage collection, finalise -Multithreaded Programming: Thread Class - Runnable interface – Synchronization – Using synchronized methods – Using synchronized statement - Interthread Communication – Deadlock.
IV	The AWT class hierarchy - Swing: Introduction to Swing - Hierarchy of swing components. Containers - Top level containers - JFrame - JWindow - JDialog - JPanel - JButton - JToggleButton - JCheckBox - JRadioButton - JLabel,JTextField - JTextArea - JList - JComboBox – JscrollPane - Event Handling: Events - Event sources - Event Listeners - Event Delegation Model (EDM) - Handling Mouse and Keyboard Events
V	Adapter classes - Inner classes -Java Util Package / Collections Framework:Collection & Iterator Interface- Enumeration- List and ArrayList- Vector- Comparator

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

Herbert Schildt, The Complete Reference, Tata McGraw Hill, New Delhi, 7th Edition, 2010.

Gary Cornell, Core Java 2 Volume I – Fundamentals, Addison Wesley, 1999.

Reference Books

Head First Java, O’Rielly Publications, Y. Daniel Liang, Introduction to Java Programming, 7th Edition, Pearson Education India, 2010.

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: II

Java Programming Practical		127C21
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		
Credits 5		Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To gain practical expertise in coding Core Java programs - To become proficient in the use of AWT, Event Handling and Swing.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Code, debug and execute Java programs to solve the given problems CO2: Implement multi-threading and exception-handling CO3: Implement functionality using String and StringBuffer classes CO4: Demonstrate Event Handling. CO5: Create applications using Swing and AWT		

List of Programs
- Write a Java program that prompts the user for an integer and then prints out all the prime numbers up to that Integer? - Write a Java program to multiply two given matrices. - Write a Java program that displays the number of characters, lines and words in a text? - Generate random numbers between two given limits using Random class and print messages according to the range of the value generated. - Write a program to do String Manipulation using Character Array and perform the following string operations: - String length - Finding a character at a particular position - Concatenating two strings - Write a program to perform the following string operations using String class: - String Concatenation - Search a substring - To extract substring from given string - Write a program to perform string operations using StringBuffer class: - Length of a string - Reverse a string - Delete a substring from the given string - Write a java program that implements a multi-thread application that has three threads. First thread generates random integer every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

9. Write a threading program which uses the same method asynchronously to print the numbers 1 to 10 using Thread1 and to print 90 to 100 using Thread2.
10. Write a program to demonstrate the use of following exceptions.
 - a) Arithmetic Exception
 - b) Number Format Exception
 - c) Array Index Out of Bound Exception
 - d) Negative Array Size Exception
11. Write a Java program that reads on file name from the user, then displays information about whether the file exists, whether the file is readable, whether the file is writable, the type of file and the length of the file in bytes?
12. Write a program to accept a text and change its size and font. Include bold italic options. Use frames and controls.
13. Write a Java program that handles all mouse events and shows the event name at the center of the window when a mouse event is fired. (Use adapter classes).
14. Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -, *, % operations. Add a text field to display the result. Handle any possible exceptions like divide by zero.
15. Write a Java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green with radio buttons. On selecting a button, an appropriate message with “stop” or “ready” or “go” should appear above the buttons in a selected color. Initially there is no message shown.

Learning Resources:

Recommended Texts

Herbert Schildt, The Complete Reference, Tata McGraw Hill, New Delhi, 7th Edition, 2010.
Gary Cornell, Core Java 2 Volume I – Fundamentals, Addison Wesley, 1999.

Reference Books

Head First Java, O’Rielly Publications, Y. Daniel Liang, Introduction to Java Programming, 7th Edition, Pearson Education India, 2010.

Web resources: Web resources from NDL Library, E-content from open-source libraries

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: I

Semester: II

Office Automation Practical		127S21
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		
Credits 2	Lecture Hours:2 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • The major objective in introducing the Computer Skills course is to impart training for students in Microsoft Office which has different components like MS Word, MS Excel and Power point. • The course is highly practice oriented rather than regular class room teaching. • To acquire knowledge on editor, spread sheet and presentation software.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Understand the basics of computer systems and its components. CO2: Understand and apply the basic concepts of a word processing package. CO3: Understand and apply the basic concepts of electronic spreadsheet software. CO4: Understand and apply the basic concepts of database management system. CO5: Understand and create a presentation using PowerPoint tool.		

Contents
WORD 1. Create and save a document using MSWORD Deletion of Character, Word, line and block of text - Undo and redo process - Moving, Copying and renaming 2. Format the Text document Character formatting - Paragraph formatting - Page formatting 3. Spell check the document Finding and Replacing of text - Bookmarks and Searching for a Bookmarks - Checking Spelling and Grammar automatically - Checking Spelling and Grammar using Dictionary 4. Print the document Print Preview - Print Dialog box 5. Mail Merge in Ms-word Create main document and data file for mail merging - Merging the files - From letters using mail merging - Mailing labels using mail merging 6. Table creation in Ms-word Create a table in the document - Add row, column to a table - Changing column width and row height - Merge, split cells of table - Use formulae in tables - Sorting data in a table - Formatting a table. EXCEL 1. Create and save a new work book in Excel 2. Entering Data into Work sheet 3. Editing data of Worksheet 4. Formatting the text in the cells 5. Formatting the numbers in the cells.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

6. Formatting cells.
7. Copying format of cell along with data format.
8. Changing the height and width of cells.
9. Freezing Titles, splitting screen
10. Enter formulae for calculation in the cells.
11. Copying the formula over a range of cells.
12. Inserting built-in functions in to the cells.
13. Create graphs for the data using ChartWizard.
14. Format graphs in Excel.
15. Printing of work sheet.

POWER POINT

1. Create and save a new presentation using MS Power Point
 - a) layout of opening screen in PowerPoint
 - b) the tool bars in MS PowerPoint
2. Choose Auto Layout for a new slide.
3. Insert text and pictures into a blank slide.
4. Insert new slides into the presentation.
5. Apply slide transition effects.
6. Slide show.

Set animation to text and pictures in a slide - Set the sounds, order and timing for animation

Learning Resources:

Learning Resources:

Recommended Texts

1. Peter Norton, "Introduction to Computers" –Tata McGraw-Hill.

Reference Books

1. Jennifer Ackerman Kettel, Guy Hat-Davis, Curt Simmons, "Microsoft 2003", Tata McGraw- Hill.

Web resources : Web content from NDL / SWAYAM or opensource web resources

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: III

Data Structures Common for B.C.A. , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	227C3A
Credits 5	Lecture Hours:4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To impart the basic concepts of data structures and algorithms. - To acquaint the student with the basics of the various data structures - This course also gives insight into the various algorithm design techniques	
Course Outcomes: (for students: To know what they are going to learn) CO1: To introduce the concepts of Data structures and to understand simple linear data structures. CO2: Learn the basics of stack data structure, its implementation and application CO3: Use the appropriate data structure in context of solution of given problem and demonstrate a familiarity with major data structures. CO4: To introduce the basic concepts of algorithms CO5: To give clear idea on algorithmic design paradigms like Divide and conquer and Backtracking,	

Units	Contents
I	INTRODUCTION TO DATA STRUCTURES: Representation of arrays, Applications of arrays, sparse matrix and its representation - Linear list: Singly linked list implementation, insertion, deletion and searching operations on linear list
II	Circular linked list: implementation, Double linked list implementation, insertion, deletion and searching operations. STACKS and QUEUES: Operations, array and linked representations of stack, stack applications, infix to postfix conversion, postfix expression evaluation
III	Queues: operations on queues, array and linked representations - Circular Queue: operations, applications of queues. TREES & GRAPHS: Trees: Definitions and Concepts- Representation of binary tree, Binary tree traversals (Inorder, Postorder, preorder), Binary search trees in arrays
IV	Heaps - AVL Trees – B Trees Graphs: Representation of Graphs- Types of graphs
V	Graph Applications: Breadth first traversal – Depth first traversal- -Single source shortest path – Minimal spanning trees – prim’s and kruskal’s algorithms

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Ellis Horowitz , Sartaj Sahni, Susan Anderson Freed, Second Edition ,
“Fundamentals of Data in C”, Universities Press
2. E. Horowitz, S. Sahni and S. Rajasekaran, Second Edition , “Fundamentals of
Computer Algorithms “ Universities Press

Reference Books

1. Seymour Lipschutz ,”Data Structures with C”, First Edition, Schaum’s outline series
in computers, Tata McGraw Hill.
2. R.Krishnamoorthy and G.Indirani Kumaravel, Data Structures using C, Tata
McGrawHill – 2008.
3. A.K.Sharma, Data Structures using C , Pearson Education India,2011.
4. G. Brassard and P. Bratley, “Fundamentals of Algorithms”, PHI, New Delhi, 1997.
5. A.V. Aho, J.E. Hopcroft, J.D. Ullmann,, “The design and analysis of
ComputerAlgorithms”, Addison Wesley, Boston, 1974
6. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to
Algorithms, Third edition, MIT Press, 2009
7. Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill,
2008.

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: III

Data Structures Practical Common for B.C.A. , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		227C31
Credits 5	Lecture Hours:5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • To understand and implement basic data structures using C++ • To apply linear and non-linear data structures in problem solving. • To learn to implement functions and recursive functions by means of data structures • To implement searching and sorting algorithms		
Course Outcomes: (for students: To know what they are going to learn) CO1: Implement data structures using C++ CO2: Implement various types of linked lists and their applications CO3: Implement Tree Traversals CO4: Implement various algorithms in C++		
List of Programs		
Implement the following exercises using Java Programming language: 1. Array implementation of stacks 2. Array implementation of Queues 3. Linked list implementation of stacks 4. Linked list implementation of Queues 5. Covert infix expression to postfix. 6. Binary Tree Traversals (Inorder, Preorder, Postorder) 7. Implementation of Linear search and binary search 8. Implementation of Depth-First Search & Breadth-First Search of Graphs. 9. Finding single source shortest path of a Graph.		
Learning Resources: Learning Resources: Recommended Texts 1. Ellis Horowitz , Sartaj Sahni, Susan Anderson Freed, Second Edition , “Fundamentals of Data in C”, Universities Press 2. E. Horowitz, S. Sahni and S. Rajasekaran, Second Edition , “Fundamentals of Computer Algorithms “ Universities Press		
Reference Books 1. Seymour Lipschutz ,”Data Structures with C”, First Edition, Schaum’s outline series in computers, Tata McGraw Hill. 2. R.Krishnamoorthy and G.Indirani Kumaravel, Data Structures using C, Tata McGrawHill – 2008. 3. A.K.Sharma, Data Structures using C , Pearson Education India,2011. 4. G. Brassard and P. Bratley, “Fundamentals of Algorithms”, PHI, New Delhi, 1997.		

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: III

Web Page Design Practical Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	227S31
Credits 1	Lecture Hours:1 per week

Learning Objectives: (for teachers: what they have to do in the class/lab/field)

- To develop the skill & knowledge of Web page design.
- Students will understand the knowhow and can function either as an entrepreneur or can take up jobs in the multimedia and Web site development studio and other information technology sectors.

Course Outcomes: (for students: To know what they are going to learn)

CO1:Define the principle of Web page design

CO2:Define the basics in web design

CO3:Visualize the basic concept of HTML.

CO4:Recognize the elements of HTML.

CO5:Introduce basics concept of CSS.

Units	Contents
I	What is HTML? - HTML Documents - Basic structure of an HTML document - Creating an HTML document - Mark up Tags - Heading-Paragraphs - Line Breaks - HTML Tags.
II	Introduction to elements of HTML: Working with Text - Working with Lists, Tables and Frames - Working with Hyperlinks, Images and Multimedia - Working with Forms and controls.
III	Concept of CSS: Creating Style Sheet - CSS Properties - CSS Styling(Background, Text Format, Controlling Fonts) - Working with block elements and objects - Working with Lists and Tables - CSS Id and Class - Box Model(Introduction, Border properties, Padding - Properties, Margin properties) -
IV	CSS Advanced (Grouping, Dimension, Display,Positioning, Floating, Align,Pseudo class, Navigation Bar,Image Sprites, Attribute sector)- CSS Color- Creating page Layout and Site Designs
V	Introduction to Web Graphics: Creating a Web Photo Album - Creating a Button- Creating a Web Page Banner

Learning Resources:

Text Books

- Kogent Learning, Solutions Inc., HTML 5 in simple steps Dreamtech Press
- A beginner's guide to HTML NCSA,14th May,2003
- Murray,Tom/Lynchburg Creating a Web Page and Web Site College,2002

Reference Books

- Web Designing & Architecture-Educational Technology Centre, University of Buffalo
- Steven M. Schafer HTML, XHTML, and CSS Bible, 5ed Wiley India
- John Duckett Beginning HTML, XHTML, CSS, andJavaScript, Wiley India

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: III

Desktop Publishing Practical		227S32
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		
Credits 2		Lecture Hours:2 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • The objective of the course is to provide the participants understanding of the techniques essential to build their career in desktop publishing using suitable hardware and software tools. • This course offers a range of topics of immediate relevance to industry and makes the participants exactly suitable for DTP Industry.		
Course Outcomes: (for students: To know what they are going to learn) CO1:Understand basics of computer and its related terminology. CO2:Write, Edit & Print documents using MS-WORD & EXCEL CO3:Understand various software used for Desktop Publishing and would be able to create and design documents with text and graphics like newspaper ad, wedding cards, visiting cards, greeting cards etc. CO4:Using PageMaker, CorelDraw & Photoshop. Understand Colour concept in Printing		

Units	Contents
I	Computer Fundamentals - Generations of Computer, Advantage and disadvantage of Computer, Block Diagram of a Computer, Description of Different parts of a computer. System Software and Application Software MS Office Introduction to MS Office, Word Processing Software, Electronic Spreadsheet, MS Paint
II	PageMaker Introduction to various versions, concepts and applications of PageMaker Guides & rulers. Drawing tools. Fills & outlines Photo Shop -History & introduction, the file menu, the tools, Drawing lines & shapes Photo editing inserting starting with Setting Up, introduction of layers, Understanding Design principles and color theory
III	Coral Draw-Drawing-lines, shapes inserting-pictures, objects, tables, templates, Use of various tools such as Pick tools, Zoom tools, Free hand tool, square tool, rectangle tool, Text tool, Fill tool etc. and all fonts used in designing of monograms, logos, posters, stickers, greeting cards, wedding cards, visiting cards, etc Design Principles & Color Harmony Introduction to colors Primary and Secondary in both RGB & CMYK schemes/modes
List of Programs	
- Using windows explorer and other windows elements - Creating and opening a document in page maker - Formatting and editing a document - Saving and printing a given document - Insertion of text and graphics in a given document from external source	

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

6. Using columns utility, to give the document column look
7. Using various fonts and styles to make a document more beautiful
8. Use of page maker to make transparencies
9. Saving and printing a file that has been created
10. Formatting a given file by using undo/redo, repeat, cut, copy, paste, delete, duplicate and clone utilities
11. Inserting objects in the drawing, aligning, ordering, grouping and ungrouping of those objects
12. Use of combine, break apart, weld, intersection, trim and separate tools in given drawing
13. Use of mode edit tools ie, to line, to curve, to stretch, and rotate
14. Creating special effects i.e, transform roll-up, envelop roll up, add perspective, extrude roll up, contour roll up, power line, power clip, clear effects
15. To insert character and paragraph text in a drawing and frame, setting of tabs, indents, bullets and spacing in paragraph text
16. Filling of text to a given path, aligning it to base line, straighten text and edit text
17. Using tools such as spell checker, and thesaurus
18. Using find and replace text utility and type assist
19. Adding various symbols to a drawing and creating different pattern

Learning Resources:

1. Desk Top Publishing From A to Z by Bill Grout and Osborne; McGraw Hill
2. DTP (Desk Top Publishing) for PC user by Houghton; Galgotia Publishing House Pvt. Ltd., Daryaganj, New Delhi.
3. ADOBE PAGEMAKER 6.5 - Shashank Jain & Satish Jain - First Edition 2001, BPB Publications
4. DESKTOP PUBLISHING ON PC-M.C. Sharma, BPB Publications
5. Corel draw the Official Guide By Gray David Bouton, Corel Press.
6. The complete Reference Getting Started with Page Maker, McGraw-Hills
7. Adobe Photoshop CS2 Classroom In A Book (2020), Adobe Press.
8. Computers Today S.K.Basandra, Galgotia Publications.
9. Microsoft Office: Will Train, Gini Courter, Annette Marquis BPB Publication.

Suggested equivalent online courses:

[http://www.nptelvideos.com/adobe/adobe photoshop tutorials.php](http://www.nptelvideos.com/adobe/adobe%20photoshop%20tutorials.php)

[https://onlinecourses.swayam2.ac.in/cec20 cs05/preview](https://onlinecourses.swayam2.ac.in/cec20%20cs05/preview)

[https://eskillindia.org/Course/course detail/117206920200221051647](https://eskillindia.org/Course/course%20detail/117206920200221051647)

<https://www.udemy.com/course/desktop-publishing-for-you/>

<https://www.youtube.com/watch?v=FJYgNUYUvZe>

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: IV

Year: 11		Semester: 1
Data Science Essentials		227C4A
Credits 5	Lecture Hours: 4 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Provide a strong foundation for data science and application areas related to it. • Understand the underlying core concepts and emerging technologies in data science. • Learn the process of working with data on large scale. • Explore the concepts of Data Processing. • Learn basic concepts of Machine Learning. • Prepare students for advanced courses in Data Science.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Understand the fundamental concepts of data science. CO2: Evaluate the data analysis techniques for applications handling large data and Demonstrate the data science process. CO3: Understand the concept of machine learning used in the data science process. CO4: Visualize and present the inference using various tools. CO5: Learn to think through the ethics surrounding privacy, data sharing.		

Units	Contents
I	Exploring different types of data and their characteristics - Techniques for assessing data quality and reliability - Exploring methods for sourcing and gathering data - Understanding the concept, sources, and characteristics of Big Data.
II	Building upon Python basics, delve deeper into advanced concepts such as list comprehensions, lambda functions, decorators, and iterators - Understanding the usage and creation of Python modules and packages for efficient data analysis Techniques for handling errors and debugging Python code in the context of data science applications - Exploring methods for reading and writing data from various file formats.
III	Utilizing lists for managing CSV file data efficiently, including nested lists for structured data representation - Leveraging tuples for immutable storage of CSV data and handling specific data segments effectively - Exploring array implementations to perform numerical computations and analysis on CSV data - Advanced dictionary techniques for storing, indexing, and transforming CSV data efficiently - Using sets to maintain data integrity, handle duplicates, and perform unique value operations when working with CSV files - Techniques for parsing CSV data, manipulating strings, and using regular expressions for pattern matching during data extraction and cleaning.
IV	Leveraging mathematical and statistical functions for data analysis - nd-Arrays and Array Operations: Understanding Numpy's powerful array operations - Pandas Features: Introduction to series and data frames for efficient data manipulation - Data Manipulation with Pandas: Techniques for creating, transforming, and manipulating data frames.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

V	Matplotlib for Plotting: Creating different types of plots and customizing their attributes. Seaborn for Statistical Visualization: Utilizing Seaborn for advanced statistical plotting. Interactive Visualization: Introduction to Plotly and Dash for interactive data visualization.
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Learning Resources:

TEXT BOOK:

Joel grus, “Data Science from Scratch”, O’Reilly,2015

Mark Lutz, “ Programming in Python”, O’Reilly,2010

REFERENCES:

Wes Mckinney, “Python for data Analysis”, O’Reilly,2012

Shai vaingast,”Beginning Python on visualization, A Press 2014

WEB REFERENCES

NPTEL online course– Data Science for Engineers - <https://nptel.ac.in/courses/106106179/>

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: IV

Semester IV		Semester IV	
Data Science using Python Practical		227C41	
Credits 5		Lecture Hours: 4 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Know the fundamentals of programming. • Understand the importance of different data types in programming • Analyse how data extraction is possible using regular expression • Use file concepts when retrieving or storing data is required in python • Know how object oriented concepts helps in organizing the coding structure.			
Course Outcomes: (for students: To know what they are going to learn) CO1: Demonstrate proficiency in handling of loops and creation of functions. CO2: Identify the methods to create and manipulate lists, tuples and dictionaries. CO3: Discover the commonly used operations involving regular expressions and file System CO4: Interpret the concepts of Object-Oriented Programming as used in Python			

LIST OF EXERCISES

1. Editing and executing Programs involving Flow Controls.
2. Editing and executing Programs involving Functions.
3. Program in String Manipulations
4. Creating and manipulating a Tuple
5. Creating and manipulating a List
6. Creating and manipulating a Dictionary
7. Object Creation and Usage
8. Program involving Inheritance
9. Program involving Overloading
10. Reading and Writing with Text Files and Binary Files
11. Combining and Merging Data Sets
12. Program involving Regular Expressions
13. Data Aggregation and GroupWise Operations

Learning Resources:

1. Python Crash Course, 2nd Edition, By Eric Matthes, May 2019
2. NumPy Essentials, By Leo Chin and Tanmay Dutta, April 2016
4. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012.
5. *Kenneth A. Lambert, (2011), "The Fundamentals of Python: First Programs", Cengage Learning*
6. Jake Vanderplas. Python Data Science Handbook: Essential Tools for Working with Data 1st Edition.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: IV

Emotional Intelligence	227S4A
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 2	Lecture Hours: 2 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To enable the students to understand the concepts of emotional intelligence - To teach the students on aspects relating to personality Analysis Self-analysis, Positive and Negative traits	
Course Outcomes: (for students: To know what they are going to learn) After completion of subjects students understand and application of Emotional Intelligence.	

Units	Contents
I	Introduction – Emotional Intelligence – Meaning, Benefits, *Importance of emotions – Self –awareness and competencies Psychological Needs, Emotional quotient Vs. IntelligenceQuotient.
II	Personality Analysis – Distinct Personality Type – Handwriting Analysis, color preference,listening, profile, self-esteem, *Will Power, Confidence.
III	Negative Traits – Anger Management – Negative Syndrome and Attitude - Negativethinking – Guilt Quotient Stress and Emotion, Adapting to Loneliness.
IV	Positive Traits – Humor and Happiness – Empathetic ability - Sensitivity profile – Empowered personality, Self – Empowerment.
V	Self-analysis: Psychological growth and adjustment - Personal Development Plan – Successful negotiator personal SWOT Analysis, Celebrating Life.

Reference Books:

1. Dr. Aparna Chattopadhyaym What's Your Emotional IQ, Pustak Mahal, May 2004.
2. Jill Dann, Hodder & Stoughton, Emotional Intelligence In a Week, 10 Edition, 2007.
3. Daniel Goleman, Emotional Intelligence: Why It can matter More than IQ.

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: II

Semester: IV

Technical Writing	227S4B
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 2	Lecture Hours: 2 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - This course is designed to guide students towards rhetorical, professional, and compositional competencies necessary to ethically and effectively create and analyse technical documents and communication. - Technical communication competency will be accomplished through a structured exploration of professional/technical contexts and through the production of several documents and projects typical to many forms of technical writing	
Course Outcomes: (for students: To know what they are going to learn) - Students will learn to analyse communication-related problems and develop solutions through the composition of technical documents from a number of genres and within several settings (i.e., print, web, interactive software) and contexts (e.g., academic, corporate, non-profit, governmental). - Students will explore rhetorical and professional strategies in order to discover how to clearly identify and address audiences and stakeholders, organizational contexts, and ethical concerns in the act of communication	

Units	Contents
I	What is technical writing? Difference between technical writing and other forms of writing. Qualities and qualifications of technical writers.
II	End products of technical writing. Professionals involved - project manager/editor, writers, graphic artists; liaison with product engineers/scientists and clients.
III	Roles and responsibilities of writers, editors/project managers. 7 Cs of effective writing: Document formats – hard and soft copy versions designs.
IV	Principles of technical writing; styles in technical writing; clarity, precision, coherence and logical sequence in writing.
V	Stages of Technical writing. Document development process, Technical documentation, Planning, Tools, architecture, templates, content development, technical reviews, editorial reviews. Quality control.

Books for References

1. Technical writing style by – Dan Jones , Sam Dragga
2. Handbook of Technical writing by- Walter.E.ollu -1976
3. Technical Writing by- Serena Henning
4. Technical writing process by – Kieran Morgan and Sanja Spejic -2015
5. A guide to technical writing by – T.A. Rickard

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
 SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Data Visualization		327C5A
Credits 4	Lecture Hours: 5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Explore how to design and create data visualizations based on data available data modelling, data processing (such as aggregation and filtering) • Mapping data attributes to graphical attributes • To learn to evaluate the effectiveness of visualization designs, and think critically about each design decision • To create their own data visualizations, and learn to use Python visualization tools.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Design and create data visualizations. CO2: Conduct exploratory data analysis using visualization. CO3: Craft visual presentations of data for effective communication. CO4: Use knowledge of perception and cognition to evaluate visualization design alternatives. CO5: Design and evaluate color palettes for visualization based on principles of perception. CO6: Apply data transformations such as aggregation and filtering for visualization. CO7: Use Python to develop interactive visualizations		

Units	Contents
I	INTRODUCTION TABLEAU Introduction to Tableau: Advantages of Tableau Analytics Platform, Data Preparation Tableau workspace, Working with measures and dimensions. Data types - Data collection - Setting up a Data Connector - Selecting Data Tables – Joins – Unions - Data extracts and live connections - Editing the model's metadata.
II	CREATING BASIC DATA VISUALIZATIONS Creating Charts - Chart types -Bar Charts, Legends, Filters and Hierarchies - Line Charts - Highlight Tables - Heat Maps - Bullet Charts - Cumulative Sums with Waterfall Charts.
III	CREATING ADVANCED DATA VISUALIZATIONS Aggregate Functions - Calculated Fields - Aggregations in Calculated Fields - Text Operator - Data fields - Logical functions – Parameters - Types of calculations - Quick Table calculations - Level of detailed expression
IV	CREATING MAPS Creating Symbol Maps - Filled Maps - Density Maps - Map Layers - Maps embedded with Pie Charts.
V	CREATING INTERACTIVE DASHBOARDS Creating a Dashboard - Dashboard Title - Navigation Buttons - Dashboard Actions - Templates for visualizing Cloud data.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

TEXT BOOK:

1. Claus O. Wilke, “Fundamentals of Data Visualization”, O’Reilly, 2019.

REFERENCE BOOK:

1. Alexander Loth, “Visual Analytics with Tableau”, Wiley, 2019.
2. Davy Cielen, Arno D. B. Meysman and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
3. D J Patil, Hilary Mason & Mike Loukides, Ethics and Data Science, O’ Reilly, 2018.

WEB REFERENCES:

1. <https://www.tableau.com/sites/default/files/media/designinggreate-visualizations.pdf>
2. <https://flowingdata.com/2017/01/24/one-dataset-visualized-25-ways/>
3. <https://www.tableau.com/learn/tutorials/ondemand/gettingstarted?playlist=554268&signi n=4bec05bc7a876b95af7722b08fff9224>
4. <https://public.tableau.com/en-us/s/resources>

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Data Visualization Practical		327C51
Credits 4	Lecture Hours: 5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To recognize good (and bad) data visualizations - To interpret a data visualization - To Use shapes, colors, text and layout appropriately		
Course Outcomes: (for students: To know what they are going to learn) CO1: Describe the main concepts of data visualization CO2: Create ad-hoc reports, data visualizations, and dashboards using Tableau Desktop CO3: Identifying stories and insights in data CO4: Preparing data for visualization CO5: Creating several different charts using Tableau		

LIST OF EXERCISES

1. Working with Data Types and Data Connector
2. Working with Tables: Joins, Unions, Data Extracts
3. Building Bar Charts with Legends, Filters and Hierarchies
4. Line Charts
5. Heat Maps
6. Bullet Charts
7. Waterfall Charts.
8. Working with Aggregate Functions
9. Working with Logical Functions
10. Creating Symbol Maps
11. Creating Filled Maps
12. Creating Density Maps
13. Constructing Maps embedded with Pie Charts
14. Creating a Dashboard with Title and Navigation Buttons
15. Working with Dashboard Actions
16. Visualizing Cloud data

Learning Resources:

BOOKS:

1. Claus O. Wilke, "Fundamentals of Data Visualization", O'Reilly, 2019.
2. Alexander Loth, "Visual Analytics with Tableau", Wiley, 2019.
3. Davy Cielen, Arno D. B. Meysman and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
4. D J Patil, Hilary Mason & Mike Loukides, Ethics and Data Science, O' Reilly, 2018.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
 SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Year: III		Semester: IV	
R-Programming Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc-wDS		327C5B	
Credits 4		Lecture Hours:5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • To understand and able to use basic programming concepts • To automate data analysis, working collaboratively and openly on code • To know how to generate dynamic documents			
Course Outcomes: (for students: To know what they are going to learn) CO1: To understand the problem solving approaches CO2: To learn the basic programming constructs in R Programming CO3: To learn the basic programming constructs inR Programming CO4: To use R Programming data structures - lists, tuples, dictionaries. CO5: To do input/output with files in R Programming.			

Units	Contents
I	Introduction to R programming: What is R? - Installing R and R Studio – R Studio Overview - Working in the Console - Arithmetic Operators – Logical Operations - Using Functions - Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors -Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors -Special Values.
II	CONTROL STRUCTURES AND VECTORS -Control structures, functions, scoping rules, dates and times, Introduction to Functions, preview of Some Important R Data Structures, Vectors, Character Strings, Matrices, Lists, Data Frames, Classes Vectors: Generating sequences, Vectors and subscripts, Extracting elements of a vector using subscripts, Working with logical subscripts, Scalars, Vectors, Arrays, and Matrices, Adding and Deleting Vector Elements, Obtaining the Length of a Vector, Matrices and Arrays as Vectors Vector Arithmetic and Logical Operations, Vector Indexing, Common Vector Operations
III	Math Functions, Calculating a Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions for Statistical Distributions Data Visualization using R: Scatter Plots - Box Plots - Scatter Plots and Box and-Whisker Plots Together -Customize plot axes, labels, add legends, and add colours
IV	Descriptive statistics in R: Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group. Testing of Hypothesis using R: T-test, Paired Test, correlation, Chi Square test, Analysis of Variance and Correlation
V	Predictive Analytics: linear Regression model, Non-Linear Least Square, multiple regression analysis, Logistic Regression, Panel Regression Analysis, ARCH Model, GARCH models, VIF model

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Roger D. Peng, "R Programming for in", 2012
2. Norman Matloff, "The Art of R Programming- A Tour of Statistical Software Design", 2011

Reference Books

1. Garrett Golemund, Hadley Wickham, "Hands-On Programming with R: Write Your Own Functions and Simulations", 1st Edition, 2014
2. Venables, W.N., and Ripley, "S programming", Springer, 2000.

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

R-Programming Practical Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc-wDS		327C52
Credits 4		Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Acquire programming skills in core R Programming • Acquire Object-oriented programming skills in R Programming. • Develop the skill of designing graphical-user interfaces (GUI) in R Programming • Acquire R Programmingskills to move into specific branches		
Course Outcomes: (for students: To know what they are going to learn) CO1: To understand the problem solving approaches CO2: To learn the basic programming constructs in R Programming CO3: To practice various computing strategies for R Programming -based solutions to real world problems CO4: To use R Programming data structures - lists, tuples, dictionaries. CO5: To do input/output with files in R Programming		

List of Exercises

1. Data In R
2. Reading And Writing Data
3. R And Databases
4. Dates
5. Factors
6. Subscribing
7. Character Manipulation
8. Data Aggregation
9. Reshaping DataBasics
10. The R Environment
11. Probability And Distributions
12. Descriptive Statistics And Graphics
13. One- And Two-Sample Tests
14. Regression And Correlation
15. Analysis Of Variance And The Kruskal–Wallis Test
16. Tabular Data
17. Power And The Computation Of Sample Size
18. Advanced Data Handling
19. Multiple Regression
20. Linear Models
21. Logistic Regression
22. Survival Analysis
23. Rates And Poisson Regression
24. Nonlinear Curve Fitting

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Roger D. Peng, "R Programming for Data Science", 2012
2. Norman Matloff, "The Art of R Programming- A Tour of Statistical Software Design", 2011

Reference Books

1. Garrett Golemund, Hadley Wickham, "Hands-On Programming with R: Write Your Own Functions and Simulations", 1st Edition, 2014
2. Venables, W.N., and Ripley, "S programming", Springer, 2000.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Data Analytics		327C6A
Credits 4	Lecture Hours: 6 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • This course introduces the methods for data preparation and data understanding. • It covers essential exploratory techniques for understanding multivariate data by summarizing it through statistical methods and graphical methods. • Supports to Summarize the insurers use of predictive analytics, data science and Data Visualization		
Course Outcomes: (for students: To know what they are going to learn) CO1: Handle missing data in the real world data sets by choosing appropriate methods. CO2: Summarize the data using basic statistics. Visualize the data using basic graphs and plots. CO3: Identify the outliers if any in the data set. 4.Choose appropriate feature selection and dimensionality reduction CO4: Techniques for handling multi-dimensional data		

Units	Contents
I	Introduction: Big Data - Characteristics of Big Data - Types of Data: Structured, Unstructured and Semi structured - Measurement Scales: Nominal, Ordinal, Interval scale and ratio - Scope of Exploratory Data Analysis-Steps involved in Exploratory Data Analysis.
II	Univariate Graphical and Statistical Analysis: Bar chart, Pie chart, Histogram, Stem and leaf plot, Box Whisker Plot-Measures of Averages, Mean, Median and Mode- Measures of dispersion, Range, Mean Deviation, Quartile Deviation, Standard deviation and variance-Skewness and Kurtosis.
III	Bivariate Graphical and Statistical Analysis: Scatter Plot- Covariance and Correlation Coefficient-Assumptions-Karl Pearson's correlation coefficient-Spearman's Correlation coefficient- Regression coefficients and fitting of Regression lines
IV	Data Pre-processing: Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning: Dealing with missing values and outliers – Data Integration and Transformation – Data Reduction – Data Discretization.
V	Model Development: Simple and Multiple Regression – Model Evaluation using Visualization – Residual Plot – Distribution Plot –Measures for In-sample Evaluation –Over fitting and Cross Validation- Prediction and Decision Making.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

TEXT BOOKS:

1. John Tukey, “Exploratory Data Analysis”, Addison-Wesley Series, 2019.
2. Gupta. S.C. & Kapoor, V.K. , Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi, 2002.
3. Suresh Kumar Mukhiya and Usman Ahmed,” Exploratory Data Analysis with Python”, PACKT, 2020.

REFERENCE BOOKS:

1. Dr Anil Maheshwari, Data Analytics Made Accessible, Publisher: Amazon.com Services LLC.
2. Joel Grus, Data Science from Scratch: First Principles with Python, O’Reilly, 1st edition, 2015.
3. Cathy O’Neil, Rachel Schutt, Doing Data Science, Straight Talk from the Frontline, O’ Reilly, 1st edition, 2013.
4. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2nd edition, 2014.
5. Eric Siegel, Predictive Analytics The Power to Predict Who Will Click, Buy, Lie, or Die, 2nd Ed., Wiley.

WEB REFERENCES:

1. <https://flowingdata.com/>
2. <https://www.analyticsvidhya.com/>
3. <https://www.r-bloggers.com/>
4. <https://www.datasciencecentral.com/>

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Data Analytics Practical		327C61
Credits 4	Lecture Hours:6 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Aims to equip Students with essential skills in decision science using Python. • The course will focus on Python and how to achieve the statistical results with Python. • It is expected to provide some background in basic statistics.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Will be able to understand and use python data science libraries as a tool for data analytics CO2: Will be able to create Python codes for the above techniques CO3: Will be create visualizations using python		

LAB EXERCISES:
GENERATING UNIVARIATE & BIVARIATE PLOTS 1. BAR CHART 2. PIE CHART 3. HISTOGRAM 4. STEM AND LEAF PLOT 5. BOX-WHISKER PLOT 6. SCATTER DIAGRAM 7. HEAT MAPS SUMMARY STATISTICS 8. MEAN, MEDIAN AND MODE 9. STANDARD DEVIATION 10. SKEWNESS AND KURTOSIS DATA PREPROCESSING 11. IMPUTATION OF MISSING VALUES 12. CODING CATEGORICAL VARIABLES 13. DATA TRANSFORMATION AND DISCRETIZATION GENERATING MODELS 14. CORRELATION ANALYSIS 15. REGRESSION MODELS WITH EVALUATION METRICS-R SQUARE, MSE, RMSE

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Natural Language Processing Common for B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		327C6B
Credits 4	Lecture Hours: 6 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • To grasp the significance of natural language processing in solving real-world problems. • To map the appropriate processing technique to a problem and implement the technique. • To demonstrate required design skills for large collection sets. • To appreciate the theoretical formulation of the natural language processing techniques.		
Course Outcomes: (for students: To know what they are going to learn) CO1: Describe the fundamental concepts and techniques of natural language processing. CO2: Distinguish among the various techniques, taking into account the assumptions, strengths, and weaknesses of each. CO3: Use appropriate descriptions, visualizations, and statistics to communicate the problems and their solutions. CO4: Analyse large volume text data generated from a range of real-world applications.		

Units	Contents
I	Introduction: Overview: Origins and challenges of NLP- Theory of Language - Features of Indian Languages – Issues in Font –Models and Algorithms- NLP Applications.
II	MORPHOLOGY AND PARTS-OF-SPEECH: Phonology – Computational Phonology - Words and Morphemes – Segmentation – Categorization and Lemmatisation – Word Form Recognition – Valency - Agreement - Regular Expressions – Finite State Automata – Morphology- Morphological issues of Indian Languages – Transliteration.
III	PROBABILISTIC MODELS: Probabilistic Models of Pronunciation and Spelling – Weighted Automata – N- Grams – Corpus Analysis – Smoothing – Entropy - Parts-of-Speech – Taggers – Rule based – Hidden Markov Models – Speech Recognition.
IV	SYNTAX: Basic Concepts of Syntax – Parsing Techniques – General Grammar rules for Indian Languages – Context Free Grammar – Parsing with Context Free Grammars – Top Down Parser – Earley Algorithm – Features and Unification - Lexicalised and Probabilistic Parsing.
V	SEMANTICS AND PRAGMATICS: Representing Meaning – Computational Representation – Meaning Structure of Language – Semantic Analysis – Lexical Semantics – WordNet – Pragmatics – Discourse – Reference Resolution – Text Coherence – Dialogue Conversational Agents.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

TEXT BOOK:

Ronald Hausser, “Foundations of Computational Linguistics”, Springer-Verleg, 1999.

REFERENCES:

1. Daniel Jurafsky and James H. Martin “Speech and Language Processing”, Prentice Hall, 2009.
2. Christopher D.Manning and Hinrich Schutze, “Foundation of Statistical Natural Language Processing”, MIT Press, 1999.
3. James Allen, “Natural Language Understanding”, Benjamin/Cummings Publishing Co. 1995.
4. Applied Natural Language Processing with Python: Implementing Machine Learning and Deep Learning Algorithms for Natural Language Processing, By Taweh Beysolow II, September 2018

WEB REFERENCES:

1. <https://blog.algorithmia.com/introduction-natural-language-processingnlp/>
2. [https://www.udacity.com/course/natural-language-processingnanodegree--nd892.](https://www.udacity.com/course/natural-language-processingnanodegree--nd892)
<https://www.coursera.org/learn/language-processing>
3. <https://towardsdatascience.com/a-practitioners-guide-to-naturallanguage-processing-part-i-processing-understanding-text-9f4abfd13e72>
4. <https://www.edx.org/course/natural-language-processing>

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Computer Networks		327E5A
Common for B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		
Credits 3		Lecture Hours:4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • To understand the concept of Data communication and Computer network • To get a knowledge on routing algorithms. • To impart knowledge about networking and inter networking devices • To gain the knowledge on Security over Network communication		
Course Outcomes: (for students: To know what they are going to learn) CO1: To Understand the basics of Computer Network architecture, OSI and TCP/IP reference models CO2: To gain knowledge on Telephone systems and Satellite communications CO3: To impart the concept of Elementary data link protocols CO4: To analyse the characteristics of Routing and Congestion control algorithms CO5: To understand network security and define various protocols such as FTP, HTTP, Telnet, DNS		

Units	Contents
I	Introduction – Network Hardware – Software – Reference Models – OSI and TCP/IP Models – Example Networks: Internet, ATM, Ethernet and Wireless LANs - Physical Layer – Theoretical Basis for Data Communication - Guided Transmission Media
II	Wireless Transmission - Communication Satellites – Telephone System: Structure, Local Loop, Trunks and Multiplexing and Switching. Data Link Layer: Design Issues – Error Detection and Correction.
III	Elementary Data Link Protocols - Sliding Window Protocols – Data Link Layer in the Internet - Medium Access Layer – Channel Allocation Problem – Multiple Access Protocols – Bluetooth
IV	Network Layer - Design Issues - Routing Algorithms - Congestion Control Algorithms – IP Protocol – IP Addresses – Internet Control Protocols.
V	Transport Layer - Services - Connection Management - Addressing, Establishing and Releasing a Connection – Simple Transport Protocol – Internet Transport Protocols (ITP) - Network Security: Cryptography.

Learning Resources:

Recommended Texts

1. S. Tanenbaum, "Computer Networks", 4th Edition, Prentice-Hall of India, 2008.

Reference Books

1. B. A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 4th Edition, 2015.
2. F. Halsall, "Data Communications, Computer Networks and Open Systems", Pearson Education, 2008.
3. D. Bertsekas and R. Gallager, "Data Networks", 2nd Edition, PHI, 2008.
4. Lamarca, "Communication Networks", Tata McGraw- Hill, 2002

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Software Engineering Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	327E5B
Credits 3	Lecture Hours: 4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • To introduce the software development life cycles • To introduce concepts related to structured and objected oriented analysis & design co • To provide an insight into UML and software testing techniques	
Course Outcomes: (for students: To know what they are going to learn) 1. The students should be able to specify software requirements, design the software using tools 2. To write test cases using different testing techniques.	

Units	Contents
I	Introduction – Evolution – Software Development projects – Emergence of Software Engineering. Software Life cycle models – Waterfall model – Rapid Application Development – Agile Model – Spiral Model
II	Requirement Analysis and Specification – Gathering and Analysis – SRS – Formal System Specification
III	Software Design – Overview – Characteristics – Cohesion & Coupling – Layered design – Approaches Function Oriented Design – Structured Analysis – DFD – Structured Design – Detailed design
IV	Object Modeling using UML – OO concepts – UML – Diagrams – Use case, Class, Interaction, Activity, State Chart – Postscript
V	Coding & Testing – coding – Review – Documentation – Testing – Black-box, White-box, Integration, OO Testing, Smoke testing.

TEXT BOOK:

1. Rajib Mall, “Fundamentals of Software Engineering”, PHI 2018, 5th Edition.

REFERENCE BOOKS:

1. Roger S. Pressman, “Software Engineering - A Practitioner’s Approach”, McGraw Hill 2010, 7th Edition.

2. Pankaj Jalote, “An Integrated Approach to Software Engineering”, Narosa Publishing House 2011, 3rd Edition.

WEB REFERENCES:

NPTEL online course – Software Engineering - <https://nptel.ac.in/courses/106105182/>

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Computing System Fundamentals Common for B.Sc.-SA , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		327E5C
Credits 3		Lecture Hours: 4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To understand the fundamental concepts and role of Operating System. - To learn the Process Management and Scheduling Algorithms - To understand the Memory Management policies - To gain insight on I/O and File management techniques		
Course Outcomes: (for students: To know what they are going to learn) 1. Understand the structure and functions of Operating System 2. Compare the performance of Scheduling Algorithms 3. Analyse resource management techniques		
Units	Contents	
I	Introduction to System Views and Types - Basics of OS Structure, Operations, and Services - Process Management: Processes, Scheduling, Inter-process Communication	
II	CPU Scheduling: Schedulers, Criteria, Algorithms - Process Synchronization: Critical-Section Problem, Semaphores	
III	Classical Problems of Synchronization: Monitors - Deadlock Characterization, Handling Methods: Prevention, Avoidance, Detection, Recovery	
IV	Memory Management: Hardware, Address Binding, Space Allocation - Virtual Memory: Demand Paging, Page Replacement, Thrashing - File System Concepts: Access Methods, Directory Structure, Protection	
V	Overview of I/O Hardware, Application Interface - Kernel I/O Subsystem: Handling I/O Requests - System Protection: Goals, Domain, Access Matrix - System Security: Threats, Encryption, User Authentication	
TEXT BOOK: 1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, “Operating System Concepts”, Wiley India Pvt. Ltd 2018, 9th Edition,.		
REFERENCES: 1. William Stallings, “Operating Systems Internals and Design Principles”, Pearson, 2018, 9th Edition. 2. Andrew S. Tanenbaum, Herbert Bos, “Modern Operating Systems”, Pearson 2014, 4th Edition.		
WEB REFERENCES: NPTEL & MOOC courses titled Operating Systems — https://nptel.ac.in/courses/106106144/		

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Cloud Computing	327E5D
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 3	Lecture Hours:4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To impart fundamental concepts of Cloud Computing. - To impart a working knowledge of the various cloud service types and their uses and pitfalls. - To enable the students to know the common features and differences in the service offerings of the three major Cloud Computing service providers, namely Amazon, Microsoft and Google. - To provide know-how of the various aspects of application design, benchmarking and security on the Cloud.	
Course Outcomes: (for students: To know what they are going to learn) CO1: To understand the concepts and technologies involved in Cloud Computing. CO2: To understand the concepts of various cloud services and their implementation in the Amazon, Microsoft and Google cloud computing platforms. CO3: To understand the aspects of application design for the Cloud. CO4: To understand the concepts involved in benchmarking and security on the Cloud. CO5: To understand the way in which the cloud is used in various domains.	

Units	Contents
I	Introduction to Cloud Computing: Definition of Cloud Computing – Characteristics of Cloud Computing – Cloud Models – Cloud Service Examples – Cloud-based Services and Applications. Cloud Concepts and Technologies: Virtualization – Load balancing – Scalability and Elasticity – Deployment – Replication – Monitoring – Software Defined Networking – Network Function Virtualization – MapReduce – Identity and Access Management – Service Level Agreements – Billing.
II	Compute Services: Amazon Elastic Computer Cloud - Google Compute Engine - Windows Azure Virtual Machines. Storage Services: Amazon Simple Storage Service - Google Cloud Storage - Windows Azure Storage Database Services: Amazon Relational Data Store - Amazon Dynamo DB - Google Cloud SQL - Google Cloud Data Store - Windows Azure SQL Database - Windows Azure Table Service Application Services: Application Runtimes and Frameworks - Queuing Services - Email Services - Notification Services - Media Services Content Delivery Services: Amazon CloudFront - Windows Azure Content Delivery Network Analytics Services: Amazon Elastic MapReduce - Google MapReduce Service - Google BigQuery - Windows Azure HDInsight Deployment and Management Services: Amazon Elastic Beanstalk - Amazon CloudFormation

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

	Identity and Access Management Services: Amazon Identity and Access Management - Windows Azure Active Directory Open Source Private Cloud Software: CloudStack – Eucalyptus - OpenStack
III	Cloud Application Design: Introduction – Design Consideration for Cloud Applications – Scalability – Reliability and Availability – Security – Maintenance and Upgradation – Performance – Reference Architectures for Cloud Applications – Cloud Application Design Methodologies: Service Oriented Architecture (SOA), Cloud Component Model, IaaS, PaaS and SaaS Services for Cloud Applications, Model View Controller (MVC), RESTful Web Services – Data Storage Approaches: Relational Approach (SQL), Non-Relational Approach (NoSQL).
IV	Cloud Application Benchmarking and Tuning: Introduction to Benchmarking – Steps in Benchmarking – Workload Characteristics – Application Performance Metrics – Design Consideration for Benchmarking Methodology – Benchmarking Tools and Types of Tests – Deployment Prototyping. Cloud Security: Introduction – CSA Cloud Security Architecture – Authentication (SSO) – Authorization – Identity and Access Management – Data Security : Securing data at rest, securing data in motion – Key Management – Auditing.
V	Case Studies: Cloud Computing for Healthcare – Cloud Computing for Energy Systems - Cloud Computing for Transportation Systems - Cloud Computing for Manufacturing Industry - Cloud Computing for Education.

Learning Resources:

Recommended Texts

1. Arshdeep Bahga, Vijay Madisetti, *Cloud Computing – A Hands On Approach*, Universities Press (India) Pvt. Ltd., 2018.

Reference Books

1. Anthony T Velte, Toby J Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, Tata McGraw-Hill, 2013.
2. Barrie Sosinsky, *Cloud Computing Bible*, Wiley India Pvt. Ltd., 2013.
3. David Crookes, *Cloud Computing in Easy Steps*, Tata McGraw Hill, 2012.
4. Dr. Kumar Saurabh, *Cloud Computing*, Wiley India, Second Edition 2012.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
 SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Big Data Analytics	327E5E
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 3	Lecture Hours:4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To know the fundamental concepts of big data and analytics. - To explore tools and practices for working with big data.	
Course Outcomes: (for students: To know what they are going to learn) CO1: Work with big data tools and its analysis techniques. CO2: Analyse data by utilizing clustering and classification algorithms. CO3: Learn and apply different mining algorithms and recommendation systems for large volumes of data. CO4: Perform analytics on data streams. CO5: Learn NoSQL databases and management.	

Units	Contents
I	INTRODUCTION TO BIG DATA : Evolution of Big data — Best Practices for Big data Analytics — Big data characteristics — Validating — The Promotion of the Value of Big Data — Big Data Use Cases- Characteristics of Big Data Applications — Perception and Quantification of Value -Understanding Big Data Storage — A General Overview of High-Performance Architecture — HDFS — MapReduce and YARN — Map Reduce Programming Model
II	CLUSTERING AND CLASSIFICATION: Advanced Analytical Theory and Methods: Overview of Clustering — K-means — Use Cases — Overview of the Method — Determining the Number of Clusters — Diagnostics — Reasons to Choose and Cautions. - Classification: Decision Trees — Overview of a Decision Tree — The General Algorithm — Decision Tree Algorithms — Evaluating a Decision Tree — Decision Trees in R — Naïve Bayes — Bayes? Theorem — Naïve Bayes Classifier
III	ASSOCIATION AND RECOMMENDATION SYSTEM:Advanced Analytical Theory and Methods: Association Rules — Overview — Apriori Algorithm — Evaluation of Candidate Rules — Applications of Association Rules — Finding Association& finding similarity — Recommendation System: Collaborative Recommendation- Content Based Recommendation — Knowledge Based Recommendation- Hybrid Recommendation Approaches
IV	STREAM MEMORY: 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. Using Graph Analytics for Big Data: Graph Analytics

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

V	NOSQL DATA MANAGEMENT FOR BIG DATA AND VISUALIZATION: 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 — Analyzing big data with twitter — Big data for E-Commerce Big data for blogs — Review of Basic Data Analytic Methods using R.
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Learning Resources:

Recommended Texts

1. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CambridgeUniversity Press, 2012.

Reference Books

1. David Loshin, “Big Data Analytics: From Strategic Planning to Enterprise Integration withTools, Techniques, NoSQL, and Graph”, Morgan Kaufmann/Elsevier Publishers, 2013.
2. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: V

Data Mining and Warehousing	327E5F
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 3	Lecture Hours: 4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To provide the knowledge on Data Mining and Warehousing concepts and techniques. - To study the basic concepts of cluster analysis - To study a set of typical clustering methodologies, algorithms, and applications	
Course Outcomes: (for students: To know what they are going to learn) CO1: To understand the basic concepts and the functionality of the various data mining and data warehousing component CO2: To know the concepts of Data mining system architectures CO3: To analyse the principles of association rules CO4: To get analytical idea on Classification and prediction methods. CO5: To Gain knowledge on Cluster analysis and its methods.	

Units	Contents
I	Introduction: Data mining – Functionalities – Classification – Introduction to Data Warehousing – Data Pre-processing: Pre-processing the Data – Data cleaning – Data Integration and Transformation – Data Reduction
II	Data Mining, Primitives, Languages and System Architecture: Data Mining – Primitives – Data Mining Query Language, Architecture of Data mining Systems. Concept Description, Characterization and Comparison: Concept Description, Data Generalization and Summarization, Analytical Characterization, Mining Class Comparison – Statistical Measures
III	Mining Association Rules: Basic Concepts – Single Dimensional Boolean Association Rules From Transaction Databases, Multilevel Association Rules from transaction databases – Multi dimension Association Rules from Relational Database and Data Warehouses
IV	Classification and Prediction: Introduction – Issues – Decision Tree Induction – Bayesian Classification – Classification of Back Propagation. Classification based on Concepts from Association Rule Mining – Other Methods. Prediction – Introduction – Classifier Accuracy.
V	Cluster Analysis: Introduction – Types of Data in Cluster Analysis, Partitioning Methods – Hierarchical Methods-Density Based Methods – GRID Based Method – Model based Clustering Method

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Han and M. Kamber, “Data Mining Concepts and Techniques”, 2001, Harcourt India Pvt. Ltd, New Delhi.

Reference Books

1. K.P. Soman, Shyam Diwakar, V. Ajay “Insight into Data Mining Theory and Practice”, Prentice Hall of India Pvt. Ltd, New Delhi
2. Parteek Bhatia, ‘Data Mining and Data Warehousing: Principles and Practical Techniques’, Cambridge University Press, 2019

Web resources: Web resources from NDL Library, E-content from open-source libraries

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Mobile Ad-hoc Network	327E6A
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 3	Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To develop the skills to gain a basic understanding of neural network theory and fuzzy logic theory. - To introduce students to artificial neural networks and fuzzy theory from a theoretical perspective	
Course Outcomes: (for students: To know what they are going to learn) CO1: Understand the basic concepts ad-hoc networks and ad-hoc mobility models. CO2: Acquire knowledge about Medium access protocols and standards like IEEE 802.11a and HIPERLAN. CO3: Identify the significance of Routing protocols and analyze about routing Algorithm. CO4: Understand about the applications of end-end delivery and security issues in ad-hoc networks CO5: Analyze and understand the concept of cross-layer design and parameter optimization techniques.	

Units	Contents
I	Introduction: Introduction to ad-hoc networks – definition, characteristics features, applications. Characteristics of wireless channel, ad-hoc mobility models indoor and out-door models.
II	Medium Access Protocol: MAC Protocols: Design issues, goals and classification. Contention based protocols – with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.
III	Network Protocols : : Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, energy aware routing algorithm, hierarchical routing, QoS aware routing.
IV	End – end delivery and security: Transport Layer: Issues in designing – Transport layer classification, ad-hoc transport protocols. Security issues in ad-hoc networks: issues and challenges, network security attacks, secure routing protocols.
V	CROSS -LAYER DESIGN: Need for cross layer design, cross layer optimization, parameter optimization techniques, cross layer cautionary perspective. Integration of ad-hoc with Mobile IP networks.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. C. Siva Ram Murthy and B. S. Manoj, Ad hoc Wireless Networks Architecture and Protocols II edition, Pearson Edition, 2007.
2. Charles E. Perkins, Ad hoc Networking, Addison – Wesley, 2000.

Reference Books

1. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, Mobile ad-
2. hoc networking, Wiley-IEEE press, 2004.
3. Mohammad Ilyas, The handbook of ad-hoc wireless networks, CRC press, 2002.
4. T. Camp, J. Boleng, and V. Davies “A Survey of Mobility Models for Ad-hoc Network”
5. Research, “Wireless Commn. and Mobile Comp - Special Issue on Mobile Ad-
6. hoc networking Research, Trends and Applications”, Vol. 2, no. 5, 2002, pp. 483 – 502.
7. A survey of integrating IP mobility protocols and Mobile Ad-hoc networks, Fekri
8. M. bduljalil and Shrikant K. Bodhe, IEEE communication Survey and tutorials, no:12007.

Web resources

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Artificial Neural Networks Common for B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	327E6B
Credits 3	Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To understand the biological neural network and to model equivalent neuron models. - To understand the architecture, learning algorithms - To know the issues of various feed forward and feedback neural networks. - To explore the Neuro dynamic models for various problems.	
Course Outcomes: (for students: To know what they are going to learn) CO1: Upon completing this course, the student will be able to CO2: Understand the similarity of Biological networks and Neural networks CO3: Perform the training of neural networks using various learning rules. CO4: Understanding the concepts of forward and backward propagations. CO5: Understand and Construct the Hopfield models	

Units	Contents
I	Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process
II	Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron – Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection
III	Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning
IV	Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification
V	Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, restricted boltzmen machine.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Text Books

1. Neural Networks a Comprehensive Foundations, Simon S Haykin, PHI Ed.,.
2. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Reference Books

1. Neural Networks in Computer Inteligance, Li Min Fu TMH 2003
2. Neural Networks -James A Freeman David M S Kapura Pearson Ed., 2004.
3. Artificial Neural Networks – B. Vegnanarayana Prentice Hall of India P Ltd 2005

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Grid Computing Common for B.C.A. , B.Sc.-CSc-wDS	327E6C
Credits 3	Lecture Hours:5 per week

Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To provide the knowledge on the basic construction and use of Grid computing. - To know and understand the grid computing applications. - To assess the efficiency of the grid computing in solving large scale scientific problems Course Outcomes: (for students: To know what they are going to learn) CO1: To understand the basic elements and concepts related to Grid computing CO2: To identify the Grid computing toolkits and Framework. CO3: To know about the concepts of Virtualization CO4: To analyse the concept of service oriented architecture. CO5: To Gain knowledge on grid and web service architecture.

Units	Contents
I	Introduction: Early Grid Activity, Current Grid Activity, Overview of Grid Business areas, Grid Applications, Grid Infrastructures.
II	Grid Computing organization and their Roles: Organizations Developing Grid Standards, and Best Practice Guidelines, Global Grid Forum (GCF), Organization Developing Grid Computing Toolkits and Framework, Organization and building and using grid based solutions to solve computing, commercial organization building and Grid Based solutions.
III	Grid Computing Anatomy: The Grid Problem, The conceptual of virtual organizations, Grid Architecture and relationship to other distributed technology
IV	The Grid Computing Road Map: Autonomic computing, Business on demand and infrastructure virtualization, Service-Oriented Architecture and Grid, Semantic Grids.
V	Merging the Grid services Architecture with the Web Services Architecture: Service-Oriented Architecture, Web Service Architecture, XML messages and Enveloping, Service message description Mechanisms, Relationship between Web Services and Grid Services, Web services Interoperability and the role of the WS-I Organization.

Learning Resources:

Recommended Texts

1. Joshy Joseph and Craig Fellenstein, Grid computing, Pearson / IBM Press, PTR, 2004.

Reference Books

2. Ahmer Abbas and Graig computing, A Practical Guide to technology and applications, Charles River Media, 2003.

• Web resources

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Internet of Things and its Applications	327E6D
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 3	Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) To understand the concepts of Internet of Things and the application of IoT	
Course Outcomes: (for students: To know what they are going to learn) CO1: Use of Devices, Gateways and Data Management in IoT. CO2: Design IoT applications in different domain and be able to analyse their performance CO3: Implement basic IoT applications on embedded platform CO4: To gain knowledge on Industry Internet of Things CO5: To Learn about the privacy and Security issues in IoT	

Units	Contents
I	IoT & Web Technology, The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.
II	M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.
III	IoT Architecture -State of the Art – Introduction, State of the art, Architecture. Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views
IV	IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.
V	Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: (A Hands-on Approach)", Universities Press (INDIA) Private Limited 2014, 1st Edition.

Reference Books

1. Michael Miller, "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World", kindle version.
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications 2013, 1st Edition,.
3. WaltenegusDargie, ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice" 4..CunoPfister, "Getting Started with the Internet of Things", O'Reilly Media 2011

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Robotics and Its Applications	327E6E
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	
Credits 3	Lecture Hours: 5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) - To make the students familiar with the various drive systems of robots, sensors and their applications in robots - To introduce the parts of robots, basic working concepts and types of robots	
Course Outcomes: (for students: To know what they are going to learn) CO1: Describe the different physical forms of robot architectures CO2: Kinematically model simple manipulator and mobile robots CO3: Mathematically describe a kinematic robot system. CO4: Analyse manipulation and navigation problems using knowledge of coordinate frames,	

Units	Contents
I	Introduction: Introduction, brief history, components of robotics, classification, workspace, work-envelop, motion of robotic arm, end-effectors and its types, service robot and its application, Artificial Intelligence in Robotics.
II	Actuators and sensors: Types of actuators, stepper-DC-servo-and brushless motors-model of a DC servo motor-types of transmissions-purpose of sensor-internal and external sensor-common sensors-encoders tachometers-strain gauge-based force torque sensor-proximity and distance measuring sensors Kinematics of robots: Representation of joints and frames, frames transformation, homogeneous matrix, D-H matrix, Forward and inverse kinematics: two link planar (RR) and spherical robot (RRP). Mobile robot Kinematics: Differential wheel mobile robot
III	Localization: Self-localizations and mapping - Challenges in localizations – IR based localizations – vision-based localizations – Ultrasonic based localizations - GPS localization systems.
IV	Path Planning: Introduction, path planning-overview-road map path planning-cell decomposition path planningpotential field path planning-obstacle avoidance-case studies Vision system: Robotic vision systems-image representation-object recognition-and categorization-depth measurement- image data compression-visual inspection-software considerations
V	Application: Ariel robots-collision avoidance robots for agriculture-mining-exploration-underwater-civilian- and military applications-nuclear applications-space applications-Industrial robots-artificial intelligence in robots-application of robots in material handling-continuous arc welding-spot welding-spray painting-assembly operation-cleaning-etc.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Learning Resources:

Recommended Texts

1. Richard D. Klafter, Thomas Achmielewski and Mickael Negin, Robotic Engineering and Integrated Approach, Prentice Hall India-New Delhi-2001
2. Saeed B. Nikku, Introduction to robotics, analysis, control and applications, Wiley-India, 2nd edition 2011

Reference Books

1. Industrial robotic technology-programming and application by M.P. Groover et.al, McGrawhill 2008
2. Robotics technology and flexible automation by S.R. Deb, THH-2009

UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH DATA SCIENCE

SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Information Security Common for B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	327E6F
Credits 3	Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) • Learn fundamentals of cryptography and its application to network security. • Understand network security threats, security services, and countermeasures. • Understand vulnerability analysis of network security. • Acquire background on hash functions; authentication; firewalls; intrusion detection techniques. • Gain hands-on experience with programming and simulation techniques for security protocols.	
Course Outcomes: (for students: To know what they are going to learn) CO1: Understand and explain the risks faced by computer systems and networks. CO2: Identify and analyse security problems in computer systems and networks. CO3: Explain how standard security mechanisms work. CO4: Develop security mechanisms to protect computer systems and networks. CO5: Write programs that are more secure. CO6: Use cryptography algorithms and protocols to achieve computer security.	

Units	Contents
I	Introduction to Information Security : Attacks, Vulnerability, Security Goals, Security Services and mechanisms
II	Conventional Cryptographic Techniques : Conventional substitution and transposition ciphers, One-time Pad, Block cipher and Stream Cipher, Steganography
III	Symmetric and Asymmetric Cryptographic Techniques :DES, AES, RSA algorithms Authentication and Digital Signatures : Use of Cryptographyfor authentication, Secure Hash function, Key management – Kerberos
IV	Program Security : Nonmalicious Program errors – Bufferoverflow, Incomplete mediation, Time-of-check to Time-of- use Errors, Viruses, Trapdoors, Salami attack, Man-in-the- middle attacks, Covert channels
V	Security in Networks : Threats in networks, Network SecurityControls – Architecture, Encryption, Content Integrity, StrongAuthentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design andTypes of Firewalls, Personal Firewalls, IDS, Email Security – PGP,S/MIME

Learning Resources:

1. Security in Computing, Fourth Edition, by Charles P. Pfleeger, Pearson Education
2. Cryptography And Network Security Principles And Practice, Fourth or Fifth Edition, William Stallings, Pearson
3. Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall.
4. Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall.

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE WITH
DATA SCIENCE
SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Mini Project Common for B.C.A. , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS	327S61
Credits 2	Lecture Hours: 2 per week

Student Mini-Project Instructions:

Objective:

Mini-project aims to demonstrate student's understanding and application of course concepts. It consists of three components: a comprehensive report, software development, and an external presentation (viva).

Development Process:

- **Planning:** Define project scope, objectives, and required functionalities.
- **Execution:** Follow a structured development process with clear milestones.
- **Documentation:** Maintain a detailed report covering methodology, design, implementation, and testing.

Components for Evaluation:

1. **Mini-Project Report:** Ensure completeness, clarity, and adherence to guidelines.
2. **Software Development:** Create a fully functional application meeting specified requirement.
3. **External Presentation (Viva):** Communicate and defend your project effectively to external evaluators.

Specifications:

- **Functional Requirements:** List essential features the software must incorporate.
- **Non-functional Requirements:** Consider performance, security, usability, etc.
- **Technologies:** Specify programming languages, frameworks, and tools to be used.

Submission Guidelines:

- Follow a prescribed report format and submission method for the software.
- Prepare concise and engaging materials for the external presentation.

Support and Integrity:

- Seek guidance from mentors and utilize available resources.
- Ensure originality and adhere to ethical standards in your work.

Evaluation Criteria:

- Creativity, functionality, documentation quality, and presentation skills are key assessment areas.