

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

Year: I

Semester: I

Core-I: Python Programming (Common to B.Sc.-CS with AI, CS with DS, Software Appl.& BCA)	125C1A
Credits 5	Lecture Hours:4 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Develop and execute simple Python programs</p> <p>CO2: Write simple Python programs using conditionals and looping for solving problems</p> <p>CO3: Decompose a Python program into functions</p> <p>CO4: Represent compound data using Python lists, tuples, dictionaries etc.</p> <p>CO5: Read and write data from/to files in Python programs</p>	

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.

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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

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Year: I

Semester: I

Core-II: Python Programming Practical (Common to B.Sc.-CS with AI, CS with DS, Software Appl.& BCA)		125C11						
Credits 5	Lecture Hours:5 per week							
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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 								
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: To understand the problem solving approaches</p> <p>CO2: To learn the basic programming constructs in Python</p> <p>CO3: To practice various computing strategies for Python-based solutions to real world problems</p> <p>CO4: To use Python data structures - lists, tuples, dictionaries.</p> <p>CO5: To do input/output with files in Python.</p>								
List of Programs								
<ol style="list-style-type: none"> 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 style="margin-left: 40px;"> * ** *** **** ***** **** *** ** *</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="margin-left: 40px; width: 80%;"> <tr> <td>Grade A: Percentage ≥ 80</td> <td>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. 6. Program to find factorial of the given number using recursive function. 			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								

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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

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Year: I

Semester: I

<p style="text-align: center;">Skill Enhancement Course: Office Automation</p> <p>(Common to B.Sc.-CS with AI, CS with DS, Software Appl.& BCA)</p>	<p>125S1A</p>
Credits 2	Lecture Hours: 2 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>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.</p>	

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.

<p>Learning Resources:</p> <p>Recommended Texts</p> <p>1. Peter Norton, “Introduction to Computers” –Tata McGraw-Hill.</p> <p>Reference Books</p> <p>1. Jennifer Ackerman Kettel, Guy Hat-Davis, Curt Simmons, “Microsoft 2003”, Tata McGraw- Hill.</p> <p>Web resources : Web content from NDL / SWAYAM or open source web resources</p>

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Year: I

Semester: I

Foundation Course: Fundamentals of Computers (Common to B.Sc.-CS with AI, CS with DS, Software Appl. & BCA)	125B1A
Credits 2	Lecture Hours: 2 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Fundamental concepts of computer</p> <p>CO2: Fundamental mathematical techniques and how they relate to computer</p> <p>CO3: The architecture of processing and file storage in a computer system</p> <p>CO4: Basic operations of operating systems</p> <p>CO5: A variety of software packages applicable to an academic, software development and business environment</p>	

Units	Contents
I	<p>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</p>
II	<p>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</p>

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III	<p>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</p>
IV	<p>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</p>
V	<p>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</p>

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

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Year: I

Semester: II

Introduction to Computer Architecture and Microprocessor	125C2A
Credits 5	Lecture Hours:4 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • To introduce the internal organization of Intel 8085 Microprocessor. • To enable the students to write assembly language programs using 8085. • To interface the peripheral devices to 8085 using Interrupt controller and DMA interface. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Remember the Basic binary codes and their conversions. Binary concepts are used in Microprocessor programming and provide a good understanding of the architecture of 8085.</p> <p>CO2: Understanding the 8085 instruction set and their classifications, enables the students to write the programs easily on their own using different logic..</p> <p>CO3: Applying different types of instructions to convert binary codes and analysing the outcome. The instruction set is applied to develop programs on multibyte arithmetic operations.</p> <p>CO4: Analyse how peripheral devices are connected to 8085 using Interrupts and DMA controller.</p>	

Units	Contents
I	Digital Computers - Microcomputer Organization-Computer languages Number Systems: Decimal, Binary, Octal. Hexadecimal. Conversions: Conversion between all four number systems of integer and floating-point values. Data representation: fixed point and floating-point representation - Character codes
II	Addition, subtraction (9's Complement for decimal, 10's complement for decimal, 1's complement, 2's complement methods), multiplication and division of binary numbers. - Differentiate Binary and BCD representations - BCD to Binary and Binary to BCD conversions, BCD addition and Subtraction. 8085 Microprocessor: Architecture, Pinout and Signals – Functional block diagram -
III	8085 Instruction Set and addressing modes- 8085 sample programs using data transfer, arithmetic and JMP instructions– function calls in 8085
IV	The 8085 Interrupts – RIM AND SIM instructions-8259 Programmable Interrupt Controller-Direct Memory Access (DMA) and 8257 DMA controller.
V	Program control- RISC - Pipelining -Arithmetic instruction- RISC pipeline - Vector processing and Array processors.

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TEXT BOOKS:

1. M.M. Mano, "Computer System architecture". Pearson, Third Edition, 2007
2. R. S. Gaonkar- "Microprocessor Architecture- Programming and Applications with 8085"- 5th Edition- Penram- 2009.
3. Tripti Dodiya & Zakiya Malek, "Computer Organization and Advanced Microprocessors", CengageLearning, 2012.

REFERENCE BOOKS:

1. Mathur- "Introduction to Microprocessor"- 3rd Edition- Tata McGraw-Hill-1993.
2. P. K. Ghosh and P. R. Sridhar- "0000 to 8085: Introduction to Microprocessors for Engineers and Scientists"- 2nd Edition- PHI- 1995.
3. NagoorKani- "Microprocessor (8085) and its Applications"- 2nd Edition- RBA Publications- 2006.
4. V. Vijayendran- "Fundamentals of Microprocessors – 8085"- S. Viswanathan Pvt. Ltd.- 2008.

WEB REFERENCES:

NPTTEL & MOOC courses titled Computer organization

<https://nptel.ac.in/courses/106105163/>

<https://nptel.ac.in/courses/106103068>

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Year: I

Semester: II

Introduction to Computer Architecture and Microprocessor Practical		125C21
Credits 5	Lecture Hours:5 per week	
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none">• To introduce the internal organization of Intel 8085 Microprocessor.• To enable the students to write assembly language programs using 8085.• To interface the peripheral devices to 8085 using Interrupt controller and DMA interface.• To provide real-life applications using microcontroller.		
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Remember the Basic binary codes and their conversions. Binary concepts are used in Microprocessor programming and provide a good understanding of the architecture of 8085.</p> <p>CO2: Understanding the 8085-instruction set and their classifications, enables the students to write the programs easily on their own using different logic.</p> <p>CO3: Applying different types of instructions to convert binary codes and analysing the outcome. The instruction set is applied to develop programs on multibyte arithmetic operations.</p> <p>CO4: Analyse how peripheral devices are connected to 8085 using Interrupts and DMA controller.</p>		

List of Programs

Addition and Subtraction

1. 8 - bit addition
2. 16 - bit addition
3. 8 - bit subtraction
4. BCD subtraction

Multiplication and Division

1. 8 - bit multiplication
2. BCD multiplication
3. 8 - bit division

Sorting and Searching

1. Searching for an element in an array.
2. Sorting in Ascending and Descending order.
3. Finding the largest and smallest elements in an array.
4. Reversing array elements.
5. Block move.

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Code Conversion

1. BCD to Hex and Hex to BCD
2. Binary to ASCII and ASCII to binary
3. ASCII to BCD and BCD to ASCII

Applications

1. Square of a single byte Hex number
2. Square of a two-digit BCD number
3. Square root of a single byte Hex number
4. Square root of a two-digit BCD number

TEXT BOOKS:

1. M.M. Mano, "Computer System architecture". Pearson, Third Edition, 2007
2. R. S. Gaonkar- "Microprocessor Architecture- Programming and Applications with 8085"- 5th Edition- Penram- 2009.
3. Tripti Dodiya & Zakiya Malek, "Computer Organization and Advanced Microprocessors", CengageLearning, 2012.

REFERENCE BOOKS:

1. Mathur- "Introduction to Microprocessor"- 3rd Edition- Tata McGraw-Hill-1993.
2. P. K. Ghosh and P. R. Sridhar- "0000 to 8085: Introduction to Microprocessors for Engineers and Scientists"- 2nd Edition- PHI- 1995.
3. NagoorKani- "Microprocessor (8085) and its Applications"- 2nd Edition- RBA Publications- 2006.
4. V. Vijayendran- "Fundamentals of Microprocessors – 8085"- S. Viswanathan Pvt. Ltd.- 2008.

WEB REFERENCES:

NPTEL & MOOC courses titled Computer organization

<https://nptel.ac.in/courses/106105163/>

<https://nptel.ac.in/courses/106103068>

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Year: I

Semester: II

Quantitative Aptitude	125S2A
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 improve the quantitative skills of the students To prepare the students for various competitive exams	
Course Outcomes: (for students: To know what they are going to learn) CO1: To gain knowledge on LCM and HCF and its related problems CO2: To get an idea of age, profit and loss related problem solving. CO3: Able to understand time series simple and compound interests CO4: Understanding the problem related to probability, and series CO5: Able to understand graphs, charts	

Units	Contents
I	Numbers - HCF and LCM of numbers - Decimal fractions - Simplification - Square roots and cube roots - Average - problems on Numbers
II	Problems on Ages - Surds and Indices - percentage - profits and loss - ratio and proportion - partnership - Chain rule.
III	Time and work - pipes and cisterns - Time and Distance - problems on trains - Boats and streams - simple interest - compound interest - Logarithms - Area - Volume and surface area - races and Games of skill.
IV	Permutation and combination - probability - True Discount - Bankers Discount - Height and Distances - Odd man out & Series.
V	Calendar - Clocks - stocks and shares - Data representation - Tabulation - Bar Graphs - Pie charts - Line graphs

Learning Resources:

Recommended Texts

1. "Quantitative Aptitude", R.S. AGGARWAL., S. Chand & Company Ltd.,

Web resources: Authentic Web resources related to Competitive examinations

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Year: I

Semester: II

Problem Solving Techniques	125S2B
Credits 2	Lecture Hours:2 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • To understand the importance of algorithms and programs, and to know of the basic problem-solving strategies. • To learn efficient strategies and algorithms to solve standard problems, thus laying a firm foundation for designing algorithmic solutions to problems. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Understand the systematic approach to problem solving. CO2: Know the approach and algorithms to solve specific fundamental problems. CO3: Understand the efficient approach to solve specific factoring-related problems. CO4: Understand the efficient array-related techniques to solve specific problems. CO5: Understand the efficient methods to solve specific problems related to text processing. Understand how recursion works.</p>	

Units	Contents
I	Introduction: Notion of algorithms and programs – Requirements for solving problems by computer – The problem-solving aspect: Problem definition phase, Getting started on a problem, The use of specific examples, Similarities among problems, Working backwards from the solution – General problem-solving strategies - Problem solving using top-down design – Implementation of algorithms – The concept of Recursion.
II	Fundamental Algorithms: Exchanging the values of two variables – Counting - Summation of a set of numbers - Factorial computation - Sine function computation - Fibonacci Series generation - Reversing the digits of an integer – Base Conversion.
III	Factoring Methods: Finding the square root of a number – The smallest divisor of an integer – Greatest common divisor of two integers - Generating prime numbers – Computing the prime factors of an integer – Generation of pseudo-random numbers - Raising a number to a large power – Computing the nth Fibonacci number.
IV	Array Techniques: Array order reversal – Array counting or histogramming – Finding the maximum number in a set - Removal of duplicates from an ordered array - Partitioning an array – Finding the kth smallest element – Longest monotone subsequence.
V	Text Processing and Pattern Searching: Text line length adjustment – Left and right justification of text – Keyword searching in text – Text line editing – Linear pattern search. Recursive algorithms: Towers of Hanoi – Permutation generation.

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Learning Resources:

Recommended Texts

1. R. G. Dromey, *How to Solve it by Computer*, Pearson India, 2007.

Reference Books

1. George Polya, Jeremy Kilpatrick, *The Stanford Mathematics Problem Book: With Hints and Solutions*, Dover Publications, 2009 (Kindle Edition 2013).
2. Greg W. Scragg, *Problem Solving with Computers*, Jones & Bartlett 1st edition, 1996.

Web resources

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Year: II

Semester: III

Java Programming	225C3A
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
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Understand the basic Object-oriented concepts. Implement the basic constructs of Core Java</p> <p>CO2: Implement inheritance, packages, interfaces and exception handling of Core Java.</p> <p>CO3: Implement multi-threading and I/O Streams of Core Java</p> <p>CO4: Implement AWT and Event handling.</p> <p>CO5: Use Swing to create GUI.</p>	

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

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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.

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Year: II

Semester:III

Java Programming Practical		225C31
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) <ul style="list-style-type: none">• 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

1. Write a Java program that prompts the user for an integer and then prints out all the prime numbers up to that Integer?
2. Write a Java program to multiply two given matrices.
3. Write a Java program that displays the number of characters, lines and words in a text?
4. Generate random numbers between two given limits using Random class and print messages according to the range of the value generated.
5. Write a program to do String Manipulation using Character Array and perform the following string operations:
 - a) String length
 - b) Finding a character at a particular position
 - c) Concatenating two strings
6. Write a program to perform the following string operations using String class:
 - a) String Concatenation
 - b) Search a substring
 - c) To extract substring from given string
7. Write a program to perform string operations using StringBuffer class:
 - a) Length of a string
 - b) Reverse a string
 - c) Delete a substring from the given string
8. 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.
9. Write a threading program which uses the same method asynchronously to print the

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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

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Year: II

Semester: III

Web Page Design Practical		225S31
Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS		
Credits 1	Lecture Hours:1 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">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

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Year: II

Semester: III

Desktop Publishing Practical	225S32
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
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> 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. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1:Understand basics of computer and its related terminology.</p> <p>CO2:Write, Edit & Print documents using MS-WORD & EXCEL</p> <p>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.</p> <p>CO4:Using PageMaker, CorelDraw & Photoshop. Understand Colour concept in Printing</p>	

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

1. Using windows explorer and other windows elements
2. Creating and opening a document in page maker
3. Formatting and editing a document
4. Saving and printing a given document
5. Insertion of text and graphics in a given document from external source
6. Using columns utility, to give the document column look

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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

https://onlinecourses.swayam2.ac.in/cec20_cs05/preview

https://eskillindia.org/Course/course_detail/117206920200221051647

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

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

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Year: II

Semester: IV

Data Structures and Algorithms	225C4A
Credits 5	Lecture Hours:4 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: To introduce the concepts of Data structures and to understand simple linear data structures.</p> <p>CO2: Learn the basics of stack data structure, its implementation and application</p> <p>CO3: Use the appropriate data structure in context of solution of given problem and demonstrate a familiarity with major data structures.</p> <p>CO4: To introduce the basic concepts of algorithms</p> <p>CO5: To give clear idea on algorithmic design paradigms like Divide and conquer and Backtracking,</p>	

Units	Contents
I	<p>INTRODUCTION TO DATA STRUCTURES: Data Structures: Definition- Time & Space Complexity - Arrays: 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 - Circular linked list: implementation, Double linked list implementation, insertion, deletion and searching operations.</p>
II	<p>STACKS and QUEUES: Operations, array and linked representations of stack, stack applications, infix to postfix conversion, postfix expression evaluation - Queues: operations on queues, array and linked representations - Circular Queue: operations, applications of queues.</p>
III	<p>TREES & GRAPHS: Trees: Definitions and Concepts- Representation of binary tree, Binary tree traversals (Inorder, Postorder, preorder), Binary search trees in arrays– Heaps - AVL Trees – B Trees Graphs: Representation of Graphs- Types of graphs</p>
IV	<p>INTRODUCTION TO ALGORITHMS: Definition of Algorithms- Overview and importance of algorithms- pseudocode conventions, Asymptotic notations, practical complexities. Graph Applications: Breadth first traversal – Depth first traversal- -Single source shortest path – Minimal spanning trees – prim’s and kruskal’s algorithms</p>
V	<p>DIVIDE AND CONQUER ALGORITHMS: General Method – Binary Search- Quick Sort- Merge Sort. BACKTRACKING: General method, 8 Queens, Graph coloring, Hamiltonian cycle.</p>

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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.

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Year: II

Semester: IV

Data Structures and Algorithms Practical		225C41
Credits 5	Lecture Hours:4 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• To understand and implement basic data structures using Java• 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 Java CO2: Implement various types of linked lists and their applications CO3: Implement Tree Traversals CO4: Implement various algorithms in Java CO5: Implement different sorting and searching algorithms		

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 Insertion sort, Quick sort and Merge Sort
9. Implementation of Depth-First Search & Breadth-First Search of Graphs.
10. 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.

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Year: II

Semester: IV

Emotional Intelligence	225S4A
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) <ul style="list-style-type: none">• 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) <ol style="list-style-type: none">1. 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.

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Year: II

Semester: IV

Technical Writing	225S4B
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) <ul style="list-style-type: none">• 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) <ol style="list-style-type: none">1. 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).2. 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

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Year: III

Semester: V

OPERATING SYSTEM Common for B.C.A. , B.Sc.-CSc		325C5A
Credits: 3	Lecture Hours:5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• 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) <ol style="list-style-type: none">1. Understand the structure and functions of Operating System2. Compare the performance of Scheduling Algorithms3. Analyse resource management techniques		

Units	Contents
I	Introduction: Views - Types of System - OS Structure – Operations - Services – Interface- System Calls - System Structure - System Design and Implementation. Process Management: Process – ProcessScheduling - Inter-process Communication. CPU Scheduling: CPU Schedulers - Scheduling Criteria -Scheduling Algorithms.
II	Process Synchronization: Critical- Section Problem - Synchronization Hardware Semaphores – ClassicalProblems of Synchronization - Monitors. Deadlocks: Characterization - Methods for Handling Deadlocks- Deadlock Prevention - Avoidance - Detection - Recovery.
III	Memory Management: Hardware - Address Binding – Address Space - Dynamic Loading and Linking - Swapping – Contiguous Allocation - Segmentation - Paging – Structure of the Page Table.
IV	Virtual Memory Management: Demand Paging - Page Replacement Algorithms - Thrashing. File System:File Concept -. Access Methods - Directory and Disk Structure - Protection - File System Structures -Allocation Methods - Free Space Management.
V	I/O Systems: Overview - I/O Hardware - Application I/O Interface - Kernel I/O Subsystem - Transforming 1/0 Requests to Hardware Operations - Performance. System Protection: Goals - Domain - Access matrix. System Security: The Security Problem - 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/>

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Year: III

Semester: V

Operating System Practical		325C51
Credits: 5	Lecture Hours:5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• To learn Process management and scheduling.• To understand the concepts and implementation of memory management policies.• To understand the various issues in Inter Process Communication		
Course Outcomes: (for students: To know what they are going to learn) <ol style="list-style-type: none">1. Understand the process management policies and scheduling process by CPU.2. Analyse the memory management and its allocation policies.3. To evaluate the requirement for process synchronization.		

List of Programs

<ol style="list-style-type: none">1. Basic I/O programming. To implement CPU Scheduling Algorithms: <ol style="list-style-type: none">2. Shortest Job First Algorithm.3. First Come First Served Algorithm.4. Round Robin and Priority Scheduling Algorithms.5. To implement reader/writer problem using semaphore.6. To implement Banker's algorithm for Deadlock avoidance. Program for page replacement algorithms: <ol style="list-style-type: none">7. First In First Out Algorithm.8. Least Recently Used Algorithm.9. To implement first fit, best fit and worst fit algorithm for memory management.10. Program for Inter-process Communication.

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:

NPTTEL & MOOC courses titled Operating Systems – <https://nptel.ac.in/courses/106106144/>

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Year: III

Semester: V

Relational Database Management System Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc	325C5B
Credits 4	Lecture Hours:5 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • Gain a good understanding of the architecture and functioning of Database Management Systems • Understand the use of Structured Query Language (SQL) and its syntax. • Apply Normalization techniques to normalize a database. • Understand the need of transaction processing and learn techniques for controlling the consequences of concurrent data access. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <ol style="list-style-type: none"> 1. Describe basic concepts of database system 2. Design a Data model and Schemas in RDBMS 3. Competent in use of SQL 4. Analyse functional dependencies for designing robust Database 	

Units	Contents
I	Introduction to DBMS– Data and Information - Database – Database Management System – Objectives- Advantages – Components - Architecture. ER Model: Building blocks of ER Diagram –Relationship Degree – Classification – ER diagram to Tables – ISA relationship – Constraints –Aggregation and Composition – Advantages
II	Relational Model: CODD’s Rule- Relational Data Model - Key - Integrity – Relational Algebra Operations – Advantages and limitations – Relational Calculus – Domain Relational Calculus -QBE.
III	Structure of Relational Database. Introduction to Relational Database Design - Objectives – Tools –Redundancy and Data Anomaly – Functional Dependency - Normalization – 1NF – 2NF – 3NF –BCNF. Transaction Processing – Database Security.
IV	Introduction to SQL: Data Definition Commands – Data Manipulation Commands – SELECT Queries – Additional Data Definition Commands – Additional SELECT Query Keywords – Joining Database Tables.Advanced SQL:Relational SET Operators: UNION – UNION ALL – INTERSECT - MINUS.SQL Join Operators: Cross Join – Natural Join – Join USING Clause – JOIN ON Clause – Outer Join.
V	Sub Queries and Correlated Queries: WHERE – IN – HAVING – ANY and ALL – FROM. SQL Functions: Date and Time Function – Numeric Function – String Function – Conversion Function PL/SQL: Structure - Elements – Operators Precedence – Control Structure – Iterative Control -Cursors - Procedure - Function - Packages – Exceptional Handling - Triggers.

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TEXT BOOK:

1. S. Sumathi, S. Esakkirajan, “Fundamentals of Relational Database Management System”, Springer International Edition 2007.

REFERENCE BOOKS:

1. Abraham Silberchatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”, McGrawHill 2019, 7th Edition.

2. Alexis Leon & Mathews Leon, “Fundamentals of DBMS”, Vijay Nicole Publications 2014, 2nd Edition.

WEB REFERENCES:

NPTEL & MOOC courses titled Relational Database Management Systems

<https://nptel.ac.in/courses/106106093/>

<https://nptel.ac.in/courses/106106095/>

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Year: III

Semester: V

Relational Database Management System Practical Common for B.Sc.-SA , B.Sc.-CSc		325C52
Credits 4	Lecture Hours:5 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• Learn the various DDL and DML commands• Understand queries in SQL to retrieve information from data base• Understand PL/SQL statements: Exception Handling, Cursors, and Triggers.• Develop database applications using front-end and back-end tools.		
Course Outcomes: (for students: To know what they are going to learn) <ol style="list-style-type: none">1. Implement the DDL, DML Commands and Constraints2. Create, Update and query on the database.3. Design and Implement simple project with Front End and Back End.		

List of Programs

- 1) DDL commands with constraints.
- 2) DML Commands with constraints.
- 3) SQL Queries: Queries, sub queries, Aggregate function
- 4) PL/SQL : Exceptional Handling
- 5) PL/SQL : Cursor
- 6) PL/SQL : Trigger
- 7) PL/SQL : Packages
- 8) Design and Develop Application for Library Management
- 9) Design and Develop Application for Student Mark Sheet Processing
- 10) Design and Develop Application for Pay Roll Processing

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Year: III

Semester: V

Computer Networks		325E5A
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) <ul style="list-style-type: none">• 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

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Year: III

Semester: V

Mobile Ad-hoc Network	325E5B
<small>Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc , B.Sc.-CSc-wAI , B.Sc.-CSc-wDS</small>	
Credits 3	Lecture Hours: 4 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Understand the basic concepts ad-hoc networks and ad-hoc mobility models.</p> <p>CO2: Acquire knowledge about Medium access protocols and standards like IEEE 802.11a and HIPERLAN.</p> <p>CO3: Identify the significance of Routing protocols and analyze about routing Algorithm.</p> <p>CO4: Understand about the applications of end-end delivery and security issues in ad-hoc networks</p> <p>CO5: Analyze and understand the concept of cross-layer design and parameter optimization techniques.</p>	

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.

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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.

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Year: III

Semester: V

Data Mining and Warehousing	325E5C
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
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: To understand the basic concepts and the functionality of the various data mining and data warehousing component</p> <p>CO2: To know the concepts of Data mining system architectures</p> <p>CO3: To analyse the principles of association rules</p> <p>CO4: To get analytical idea on Classification and prediction methods.</p> <p>CO5: To Gain knowledge on Cluster analysis and its methods.</p>	

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

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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

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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	325E5D
Credits 3	Lecture Hours: 4 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• 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) <ol style="list-style-type: none">1. The students should be able to specify software requirements, design the software using tools2. 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:

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

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Year: III

Semester: V

Software Testing	325E5E
Credits 3	Lecture Hours:4 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • Adapt to various test processes, types of errors and fault models and methods of test generation from requirements for continuous quality improvement of the software system along with Software Quality best practices usage. • Apply software testing cycle in relation to software development and projectmanagement focusing incidents and risks management within a project towardsefficient delivery of software solutions and implement improvements in thesoftware development processes by making use of standards and baselines. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1. Select and classify measurement scales and models, software metrics andmeasures addressing software quality and reliability.</p> <p>CO2. Conduct unit and integration tests by determining test design, test automation, testcoverage criteria using testing frameworks and test adequacy assessment usingcontrol flow, data flow, and program mutations.</p> <p>CO3. Apply suitable higher order testing techniques and methods in order to achieveverified and validated software by following testing best practices.</p> <p>CO4. Demonstrate the skillset as a tester to neutralize the consequences of wickedproblems by narrating effective test cases and test procedures.</p>	

Units	Contents
I	Principles of Testing: Testing Concepts: Purpose of Software Testing, Testing Principles, Goals of Testing, Testing aspects: Requirements, Test Scenarios, Test cases,Test scripts/procedures, Strategies for Software Testing, Testing Activities, Mistakes,Faults & Failures, Planning for Verification and Validation, Software Inspections,Automated Static Analysis, Verification and Formal Methods, Levels of Testing
II	White-Box Testing: Test Adequacy Criteria, Static Testing, Structural Testing, Code Complexity Testing, Mutation Testing, Data Flow Testing - Black-Box Testing: Test Case Design Criteria, Requirement Based Testing, Positive andNegative Testing, Boundary Value Analysis, Equivalence Partitioning State BasedTesting, Domain Testing - Functional Testing: Test Plan, Test Management, Test Execution and Reporting, TestSpecialist Skills, Tester’s Workbench and Tool Categories, Test Maturity Model and TestProcess Assessment,
III	Debugging & Root Cause Analysis, Software Items, Component &Units, Test Bed, Traceability and Testability, Attributes of Testable Requirements, TestMatrix, Types of Testing Documentation, Verification Testing, Validation Testing,Integration Testing, System and Acceptance Testing, GUI Testing,Regression Testing,Selection, Minimization and Prioritization of Test Cases for Regression Testing

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IV	Creating Test Cases from Requirements and Use cases, Software Defects: Origins of Defects, Defect Classes, Defect Repository / Test Design, Defect Repository Higher Order Testing: Object Oriented Testing, Specification Based Testing, Performance Testing, Ad-hoc Testing, Usability and Accessibility Testing, Risk-based Testing, Exploratory Testing, Scenario-based Testing, Random Testing Compatibility Testing,
V	User Documentation Testing, Client–Server System Testing, RAD Testing, Configuration Testing, Testing internal Controls, Multiplatform Environment Testing, Security Testing, Web-based System Testing, Reliability Testing, Efficiency Testing, Maintainability Testing, Portability Testing, Introduction to Performance Testing, Application Performance Testing, Process of Performance Testing, Effective Root-Cause analysis, Testing VS Test Automation, Tool evaluation and selection, Automation team roles, Architectures, Planning and implementing test automation process

Books for References

1. Kshirasagar Naik, Priyadarshi Tripathy, Software Testing and Quality Assurance-Theory and Practice, John Wiley & Sons, Inc., 2008, ISBN 978-0-471-78911-6
2. Fenton, Pfleger, “Software Metrics: A Rigorous and practical Approach”, Thomson Brooks/Cole, ISBN 981-240-385-X.
3. Desikan, Ramesh, “Software Testing: principles and Practices”, Pearson Education, ISBN 81-7758-121-X.
4. Anne Mette Jonassen Hass, Guide to Advanced Software Testing, ARTECH HOUSE, INC., 2008, ISBN-13: 978-1-59693-285-2
5. Ian Molyneaux, The Art of Application Performance Testing, O’Reilly Media, Inc., 2009, ISBN: 978-0-596-52066-3
6. Jamie L. Mitchell, Rex Black, Advanced Software Testing—Vol. 3, 2nd Edition, Rocky Nook, 2015, ISBN: 978-1-937538-64-4
7. G. Gordon Schulmeyer, Handbook of Software Quality Assurance Fourth Edition, ARTECH HOUSE, INC., 2008, ISBN-13: 978-1-59693-186-2

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B.Sc. DEGREE PROGRAMME IN COMPUTER SCIENCE

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Year: III

Semester: V

Digital Image Processing	325E5F
Credits 3	Lecture Hours:4 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • To understand the sensing, acquisition and storage of digital images. • To study the image fundamentals and mathematical transforms necessary for image processing. • To understand the digital processing systems and corresponding terminology. • To understand the base image transformation domains and methods. • To have an understanding of colour models, type of image representations and related statistics. • To study the image enhancement techniques, image compression procedures. • To study image segmentation and representation techniques, image restoration. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1:Be able to understand basic concepts image processing, image storage and types of transformations that can be applied to images.</p> <p>CO2:Be able to compare the domains and methods of image processing.</p> <p>CO3:Be able to check the correctness of algorithms using inductive proofs and loop invariants.</p> <p>CO4:Learn Image Restoration & Enhancement techniques, colour image processing</p>	

Units	Contents
I	<p>Introduction to Computer Graphics: Introduction of Coordinate representation and Pixel - Raster Scan & Random Scan systems - Video controller and raster scan display processor.</p>
II	<p>Introduction to image processing: Fundamentals - Applications - Image processing system components - Image sensing and acquisition - Sampling and quantization - Neighbours of pixel adjacency connectivity -regions and boundaries - Distance measures.</p>
III	<p>Image Enhancement: Frequency and Spatial Domain - Contrast Stretching - Histogram Equalization - Low pass and High pass filtering.</p> <p>Image Restoration: Noise models - mean, order—statistics - adaptive filters - Band reject, Band pass and notch filters</p>
IV	<p>Colour Image Processing: Colour models - Pseudo colour Image processing - Colour transformation and segmentation.</p> <p>Image Compression: Fundamentals – Models - Error free and lossy compression Standards.</p>
V	<p>Morphological Image Processing: Overview Boundary extraction - Region filtering - Connected component extraction - convex hull - Thinning; Thickening; skeletons; pruning; Image segmentation.</p>

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Text Book:

1. Digital Image Processing, Second Edition by Rafael C. Gonzalez and Richard E. Woods, Pearson Education

Reference books:

1. Digital Image Processing by Bhabatosh Chanda and Dwijesh Majumder, PHI
2. Fundamentals of Digital Image Processing by Anil K Jain, PHI

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SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Programming in ASP.NET Common for B.Sc.-SA , B.Sc.-CSc		325C6A
Credits 4	Lecture Hours:6 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• To develop ASP.NET Web application using standard controls.• To create rich database applications using ADO.NET.• To implement file handling operations.• To utilize ASP.NET security features for authenticating the web site.• To handles SQL Server Database using ADO.NET.		
Course Outcomes: (for students: To know what they are going to learn) CO1: To identify and understand the goals and objectives of the .NET framework and ASP.NET with C# language. CO2: To develop web application using various controls CO3: To analyse C# programming techniques in developing web applications. CO4: To assess a Web application using Microsoft ADO.NET. CO5: To develop a software to solve real-world problems using ASP.NET		

Units	Contents
I	Overview of .NET framework: Common Language Runtime (CLR), Framework Class Library- C# Fundamentals: Primitive types and Variables – Operators - Conditional statements -Looping statements – Creating and using Objects – Arrays – Stringoperations.
II	Introduction to ASP.NET - IDE-Languages supported Components -Working with Web Forms – Web form standard controls: Properties and its events – HTML controls -List Controls: Properties and its events.
III	Rich Controls: Properties and its events – validation controls: Properties and its events– File Stream classes - File Modes – File Share – Reading and Writing to files – Creating, Moving, Copying and Deleting files – File uploading
IV	ADO.NET Overview – Database Connections – Commands – Data Reader - Data Adapter - Data Sets - Data Controls and its Properties - Data Binding
V	Grid View control: Deleting, editing, Sorting and Paging. XML classes – Web form to manipulate XML files - Website Security - Authentication - Authorization – Creating a Web application

Recommended Texts

1. SvetlinNakov,VeselinKolev& Co, Fundamentals of Computer Programming with C#,Faber publication, 2019.
2. Mathew, Mac Donald, The Complete Reference ASP.NET, Tata McGraw-Hill ,2015.

Reference Books

1. Herbert Schildt, The Complete Reference C#.NET, Tata McGraw-Hill,2015.
2. Kogent Learning Solutions, C# 2012 Programming Covers .NET 4.5 Black Book, Dreamtech pres,2013.
3. Anne Boehm, Joel Murach, Murach’s C# 2015, Mike Murach& Associates Inc. 2016.
4. DenielleOtey, Michael Otey, ADO.NET: The Complete reference, McGraw Hill,2008.
5. Matthew MacDonald, Beginning ASP.NET 4 in C# 2010, APRESS,2010.

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SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Programming in ASP.NET Practical Common for B.Sc.-SA , B.Sc.-CSc		325C61
Credits 4	Lecture Hours:6 per week	
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• To develop ASP.NET Web application using standard controls.• To create rich database applications using ADO.NET.• To implement file handling operations.• To utilize ASP.NET security features for authenticating the web site.• To handles SQL Server Database using ADO.NET.		
Course Outcomes: (for students: To know what they are going to learn) CO1: To identify and understand the goals and objectives of the .NET framework and ASP.NET with C# language. CO2: To develop web application using various controls. CO3: To analyse C# programming techniques in developing web applications CO4: To assess a Web application using Microsoft ADO.NET. CO5: To develop a software to solve real-world problems using ASP.NET		

List of Programs

1. Create an exposure of Web applications and tools
2. Implement the Html Controls
3. Implement the Server Controls
4. Web application using Web controls.
5. Web application using List controls.
6. Web Page design using Rich control. Validate user input using Validation controls.
Working with File concepts
7. Web application using Data Controls.
8. Data binding with Web controls
9. Data binding with Data Controls.
10. Database application to perform insert, update and delete operations.
11. Database application using Data Controls to perform insert, delete, edit, paging and sorting operation.
12. Implement the Xml classes.
13. Implement Authentication – Authorization.
14. Ticket reservation using ASP.NET controls.

Recommended Texts

1. SvetlinNakov, VeselinKolev& Co, Fundamentals of Computer Programming with C#,Faber publication, 2019.
2. Mathew, Mac Donald, The Complete Reference ASP.NET, Tata McGraw-Hill ,2015.

Reference Books

1. Herbert Schildt, The Complete Reference C#.NET, Tata McGraw-Hill,2015.
2. Kogent Learning Solutions, C# 2012 Programming Covers .NET 4.5 Black Book, Dreamtech pres,2013.
3. Anne Boehm, Joel Murach, Murach's C# 2015, Mike Murach& Associates Inc. 2016.

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Year: III

Semester: VI

Project with Viva Voce
Common for B.Sc.-SA , B.Sc.-CSc

325C62

Credits 4

Lecture Hours: 6 per week

OBJECTIVES:

The aim of the mini project is that the student has to understand the real time software development environment. The student should gain a thorough knowledge in the problem, he/she has selected and the language / software, he/she is using.

Project planning:

B.Sc (Computer Science / Software Application)/BCA Major Project is an involved exercise, which has to be planned well in advance. The topic should be chosen in the beginning of final year itself. Related reading training and discussions of first internal project viva voce should be completed in the first term of final year.

I. Selection of the project work Project work could be of three types.

a) Developing solution for real life problem

In this case a requirement for developing a computer-based solution already exists and the different stages of system development life cycle is to be implemented successfully. Examples are accounting software for particular organization, computerization of administrative function of an organization, web based commerce etc.

b) System Software Project

Projects based on system level implementation. An example is a Tamil language editor with spell checker, compiler design.

b) Research level project

These are projects which involve research and development and may not be as a structured and clear cut as in the above case. Examples are Tamil character recognition, neural net based speech recognizer etc. This type of projects provides more challenging opportunities to students.

II Selection of team

To meet the stated objectives, it is imperative that major project is done through a team effort. Though it would be ideal to select the team members at random and this should be strongly recommended, due to practical consideration students may also be given the choice of forming themselves into teams with three members. A team leader shall be selected. Team shall maintain the minutes of meeting of the team members and ensure that tasks have been assigned to every team member in writing. Team meeting minutes shall form a part of the project report. Even if students are doing project as groups, each one must independently take different modules of the work and must submit the report.

III Selection of Tools

No restrictions shall be placed on the students in the choice of platform/tools/languages to be utilized for their project work, though open source is strongly recommended, wherever possible. No value shall be placed on the use of tools in the evaluation of the project.

IV Project management

Head of the Department / Principal of the college should publish the list of student's project topic, internal guide and external organization and teams agreed before the end of July. Changes in this list may be permitted for valid reasons and shall be considered favorably by the Head of the department / Principal of the college any time before commencement of the project. Students should submit a fortnightly report of the progress, which could be indication of percentage of completion of the project work. The students should ideally keep a daily activity book. Team meeting should be documented and same should be submitted at the end of the project work.

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V Documentation

Three copies of the project report must be submitted by each student (one for department library, one for the organization where the project is done and one for the student himself/herself). The final outer dimensions of the project report shall be 21cm X 30 cm. The color of the flap cover shall be light blue. Only hard binding should be done. The text of the report should be set in 12 pt, Times New Roman, 1.5 spaced.

Headings should be set as follows: CHAPTER HEADINGS 16 pt, Arial, Bold, All caps, Centered.

1. Section Headings 14 pt Bookman old style, Bold, Left adjusted.

1.1 Section Sub-heading 12 pt, Bookman old style.

Title of figures tables etc are done in 12 point, Times New Roman, Italics, centered.

Content of the Project should be relevant and specify particularly with reference to the work. The report should contain the requirement specification of the work, Analysis, Design, Coding, testing and Implementation strategies done.

- Organizational overview (of the client organization, where applicable)
- Description of the present system
- Limitations of the present system
- The Proposed system - Its advantages and features
- Context diagram of the proposed system
- Top level DFD of the proposed system with at least one additional level of expansion
- Program List (Sample code of major functions used)
- Files or tables (for DBMS projects) list. List of fields or attributes (for DBMS projects) in each file or table.
- Program – File table that shows the files/tables used by each program and the files are read, written to, updated, queried or reports were produced from them.
- Screen layouts for each data entry screen.
- Report formats for each report.

Some general guidelines on documentation are:

1. Certificate should be in the format: "Certified that this report titled.....is a bonafide record of the project work done by Sri/ Kumunder our supervision and guidance, towards partial fulfillment of the requirement for award of the Degree of B.Sc Computer Science/BCA/BSc Software Applications of XXX College" with dated signature of internal guide, external guide and also Head of the Department/ College.
2. If the project is done in an external organization, another certificate on the letterhead of the organization is required: "Certified that his/her report titledis a bonafide record of the project work done by Sri/Kum.....under my supervision and guidance, at thedepartment of..... (Organization) towards partial fulfillment of the requirement for the award of the Degree of B.Sc (Computer Science/Software Applications) / BCA of XXX College.
3. Page numbers shall be set at right hand bottom, paragraph indent shall be set as 3.
4. Only 1.5 space need be left above a section or subsection heading and no space may be left after them.
5. References shall be IEEE format (see any IEEE magazine for detail) While doing the project keep note of all books you refer, in the correct format and include them in alphabetical order in your reference list.

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VI Project Evaluation:

Internal Assessment

There shall be six components that will be considered in assessing a project work with weightage as indicated.

1. Timely completion of assigned tasks as evidenced by team meeting minutes 20%
2. Individual involvement, team work and adoption of industry work culture 10%
3. Quality of project documentation (Precision, stylistics etc) 10%
4. Achievement of project deliverables 20%
5. Effective technical presentation of project work 10%
6. Viva 30%

Based on the above 6 components internal mark 40 can be awarded.

External Assessment

Dissertation/Project submitted at the end of third year shall be valued by two examiners appointed by the Controller for the conduct of practical exam. The board of examiners shall award 60 marks based on the following components.

1. Achievement of project deliverables - 20 Marks
2. Effective technical presentation of project work - 20 Marks
3. Project Viva - 20 Marks

There shall be a common written examination conducted for all the candidates in each group together for a minimum of 10 minutes.

- (i) Requirement Specification of Project
- (ii) Design of Project
- (iii) Testing and Implementation of Project

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SYLLABUS WITH EFFECT FROM 2023-2024

Year: III

Semester: VI

Artificial Intelligence	325E6A
Credits 3	Lecture Hours:5 per week
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • To Acquire Knowledge on various AI Techniques and Expert Systems • To have enriched knowledge regarding heuristic search, Knowledge representation and Expert systems 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Develop an understanding of modern concepts in AI and where they can be used</p> <p>CO2: Design, implement and apply novel AI techniques based on emerging real-world requirements</p> <p>CO3: Develop an understanding of where and how AI can be used.</p>	

Units	Contents
I	Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.
II	Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems -Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games
III	Knowledge Representation First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation –Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories -Reasoning with Default Information
IV	Software Agents Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.
V	Representing knowledge using rules: Procedural Vs Declarative knowledge – Logic programming – Forward Vs Backward reasoning – Matching – Control knowledge Brief explanation of Expert Systems- Definition- Characteristics-architecture- Knowledge Engineering- Expert System Life Cycle-Knowledge Acquisition Strategies- Expert System Tools.

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Learning Resources:

Recommended Texts

1. Elaine Rich and Kevin Knight, Shiva Shankar Nair, “Artificial Intelligence”, McGraw-Hill Companies, 3rd edition.

Reference Books

1. Stuart Russell & Peter Norvig , “*Artificial Intelligence A Modern Approach*”, Perason, 2nd Edition.
2. George F Luger , “*Artificial Intelligence*”, Pearson 2002, 4th Edition.
3. V S Janaki Raman, K Sarukesi, P Gopalakrishnan, “*Foundations of Artificial Intelligent and Expert Systems*”, MacMillan India limited.

Web resources

1. NPTEL & MOOC courses titled Artificial Intelligence and Expert Systems
2. <https://nptel.ac.in/courses/106106140/>
3. <https://nptel.ac.in/courses/106106126/>

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Year: III

Semester: VI

Introduction To Data Science Common for B.C.A. , B.Sc.-SA , B.Sc.-CSc	325E6B
Credits 3	Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">• An understanding of the data operations• An overview of simple statistical models and the basics of machine learning techniques of regression.• An understanding good practices of data science• Skills in the use of tools such as python, IDE• Understanding of the basics of the Supervised learning	
Course Outcomes: (for students: To know what they are going to learn) <ol style="list-style-type: none">1. Clean and reshape messy datasets2. Use exploratory tools such as clustering and visualization tools to analyze data3. Perform linear regression analysis4. Use methods such as logistic regression, nearest neighbours, decision trees, support vector machines, and neural networks to build a classifier5. Apply dimensionality reduction tools such as principal component analysis	

Units	Contents
I	Introduction: Introduction to Data Science – Evolution of Data Science – Data Science Roles – Stages in aData Science Project – Applications of Data Science in various fields – Data Security Issues.
II	Data Collection and Data Pre-Processing: Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning – DataIntegration and Transformation – Data Reduction – Data Discretization.
III	Exploratory Data Analytics: Descriptive Statistics – Mean, Standard Deviation, Skewness and Kurtosis – Box Plots –Pivot Table – Heat Map – Correlation Statistics – ANOVA.
IV	Model Development: Simple and Multiple Regression – Model Evaluation using Visualization – Residual Plot –Distribution Plot – Polynomial Regression and Pipelines – Measures for In-sampleEvaluation – Prediction and Decision Making.
V	Model Evaluation: Generalization Error – Out-of-Sample Evaluation Metrics – Cross Validation – Overfitting –Under Fitting and Model Selection – Prediction by using Ridge Regression – TestingMultiple Parameters by using Grid Search

Books for References

1. Jojo Moolayil, “Smarter Decisions : The Intersection of IoT and Data Science”,PACKT, 2016.
2. Cathy O’Neil and Rachel Schutt , “Doing Data Science”, O’Reilly, 2015.
3. David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big data Analytics”,EMC 2013
4. Raj, Pethuru, “Handbook of Research on Cloud Infrastructures for Big DataAnalytics”, IGI Global.

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Year: III

Semester: VI

Internet of Things and its Applications	320E6C
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

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Learning Resources:

Recommended Texts

1. Vijay Madiseti 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. WaltenequsDargie, ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice" 4..CunoPfister, "Getting Started with the Internet of Things", O"Reilly Media 2011

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Year: III

Semester: VI

Cloud Computing	325E6D
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
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • 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. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: To understand the concepts and technologies involved in Cloud Computing.</p> <p>CO2: To understand the concepts of various cloud services and their implementation in the Amazon, Microsoft and Google cloud computing platforms.</p> <p>CO3: To understand the aspects of application design for the Cloud.</p> <p>CO4: To understand the concepts involved in benchmarking and security on the Cloud.</p> <p>CO5: To understand the way in which the cloud is used in various domains.</p>	

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 Beanstack - Amazon CloudFormation Identity and Access Management Services: Amazon Identity and Access Management

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	- 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 Madiseti, *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.

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Year: III

Semester: VI

Big Data Analytics	320E6E
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
<p>Learning Objectives: (for teachers: what they have to do in the class/lab/field)</p> <ul style="list-style-type: none"> • To know the fundamental concepts of big data and analytics. • To explore tools and practices for working with big data. 	
<p>Course Outcomes: (for students: To know what they are going to learn)</p> <p>CO1: Work with big data tools and its analysis techniques.</p> <p>CO2: Analyse data by utilizing clustering and classification algorithms.</p> <p>CO3: Learn and apply different mining algorithms and recommendation systems for large volumes of data.</p> <p>CO4: Perform analytics on data streams.</p> <p>CO5: Learn NoSQL databases and management.</p>	

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

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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/El sevier Publishers, 2013.
2. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.

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Year: III

Semester: VI

Block Chain Technology	325E6F
Credits 3	Lecture Hours:5 per week
Learning Objectives: (for teachers: what they have to do in the class/lab/field) <ul style="list-style-type: none">To understand the concepts of block chain technologyTo understand the consensus and hyper ledger fabric in block chain technology.	
Course Outcomes: (for students: To know what they are going to learn) <ol style="list-style-type: none">State the basic concepts of block chainParaphrase the list of consensus and Demonstrate and Interpret working of Hyper ledger FabricImplement SDK composer tool and explain the Digital identity for government	

Units	Contents
I	History: Digital Money to Distributed Ledgers -Design Primitives: Protocols, Security, Consensus, Permissions, Privacy- : Block chain Architecture and Design-Basic crypto primitives: Hash, Signature Hash chain to Block chain-Basic consensus mechanisms.
II	Requirements for the consensus protocols-Proof of Work (PoW)-Scalability aspects of Block chain consensus protocols: Permissioned Block Chains-Design Goals-Consensus protocols for Permissioned Block chains.
III	Decomposing the consensus process-Hyper ledger fabric components-Chain code Design and Implementation: Hyper ledger Fabric II:-Beyond Chain code: fabric SDK and Front End-Hyper ledger composer tool.
IV	Block chain in Financial Software and Systems (FSS): -Settlements, -KYC, -Capital Markets-Insurance Block chain in trade/supply chain: Provenance of goods, visibility, trade/supply chain finance, invoice management/discounting.
V	Block chain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system / social welfare systems: Block chain Cryptography: Privacy and Security on Block chain.

TEXT BOOKS:

1. Mark Gates, "Block chain: Ultimate guide to understanding block chain, bit coin, crypto currencies, smart contracts and the future of money", Wise Fox Publishing and Mark Gates 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Block chain with Hyper ledger: Building decentralized applications with Hyperledger Fabric and Composer", 2018.
3. Bahga, Vijay Madiseti, "Block chain Applications: A Hands-On Approach", Arshdeep Bahga, Vijay Madiseti publishers 2017.