

UNIVERSITY OF MUMBAI



Syllabus for
Program: Bachelor of Science
Course: Computer Science

with effect from
Academic Year 2022-2023

Preamble

The revised and restructured curriculum for the Three-year integrated course is systematically designed considering the current industry needs in terms of skills sets demanded under new technological environment. It also endeavors to align the programme structure and course curriculum with student aspirations and corporate expectations. The proposed curriculum is more contextual, industry affable and suitable to cater the needs of society and nation in present day context.

The Core Subjects offers to develop strong theoretical foundations in Computer Science to build computational thinking, analytical, and problem solving skills. Principles of Operating Systems course provides an overview of computer operating systems, their functionalities, processes, and computing resource management. Linear Algebra course covers concepts crucial to many areas of computer science, such as graphics, image processing, cryptography, machine learning, computer vision, optimization, graph algorithms, quantum computation, computational biology, information retrieval and web search. Data Structures course provides an understanding of different types of data structures and how to use them per the requirements of a given application. Advanced Database Concepts course touches the touches security, recovery, and transaction aspects of database. Theory of Computation course helps to develop capabilities to design and develop formulations for computing models and identify its applications in diverse areas. Computer Networks course include topics such as application layer protocols, Internet protocols, network interfaces, local and wide area networks, wireless networks, bridging and routing, among other current topics. Software Engineering course embodies an engineering approach to the development of software. It discusses the nature of software and software projects, software development models, software process maturity, project planning, management, and estimations along with topics on software testing and quality assurance. The course on IoT Technologies will definitely open future area as Embedded Engineer, involvement in IoT projects, Robotics and many more.

Skill Enhancement courses such as Java based Application Development, Web Technologies, Android Application Development and Advanced Application Development cater to present day needs of web and mobile based platforms and applications. These courses aims to produce skilled graduates with a creative mind-set who can recognize a computational problem either in IT industry or society, and develop effective solutions.

The General Elective courses offers the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. The course on Creative Content Writing prepare students to comprehend, refine, and enhance their writing abilities and enter the industry with enhanced skill and substantial competence. The course on Green Technologies emphasizes the use of principles and practices of green services and regulatory standards for addressing the carbon issues and related concerns. The Research Methodology instills basic research skills for students who wish to pursue a research or an academic career. Management & Entrepreneurship course aims to focus on giving students the business management and innovation skills required to succeed in a startup.

We sincerely believe that any student taking this programme will get very strong foundation and exposure to basics, advanced and emerging trends of the subject.

We wholeheartedly thank all experts who shared their valuable feedbacks and suggestions in order to improvise the contents, we have sincerely attempted to incorporate each of them. We further thank Chairperson and members of Board of Studies for their confidence in us.

Special thanks to University Department of Computer Science and colleagues from various colleges, who volunteered or have indirectly helped designing certain specialized courses and the syllabus as a whole.

S.Y.B.Sc. Computer Science Syllabus

Choice Based Credit System (CBCS)

with effect from

Academic year 2022-2023

Semester – III				
Course Code	Course Type	Course Title	Credits	Lectures/Week
USCS301	Core Subject	Principles of Operating Systems	2	3
USCSP301	Core Subject Practical	Principles of Operating Systems – Practical	1	3
USCS302	Core Subject	Linear Algebra	2	3
USCSP302	Core Subject Practical	Linear Algebra – Practical	1	3
USCS303	Core Subject	Data Structures	2	3
USCSP303	Core Subject Practical	Data Structures – Practical	1	3
USCS304	Core Subject	Advanced Database Concepts	2	3
USCSP304	Core Subject Practical	Advanced Database Concepts – Practical	1	3
USCS305	Skill Enhancement Course (SEC)	Java based Application Development	2	3
USCSP305	Skill Enhancement Course (SEC) Practical	Java based Application Development – Practical	1	3
USCS306	Skill Enhancement Course (SEC)	Web Technologies	2	3
USCSP306	Skill Enhancement Course (SEC) Practical	Web Technologies – Practical	1	3
USCS3071	Generic Elective	Creative Content Writing	2	3
USCS3072	Generic Elective	Green Technologies	2	3

** Any one Generic Elective has to be selected by the student.*

S.Y.B.Sc. Computer Science Syllabus

Choice Based Credit System (CBCS)

with effect from

Academic year 2022-2023

Semester – IV				
Course Code	Course Type	Course Title	Credits	Lectures/Week
USCS401	Core Subject	Theory of Computation	2	3
USCSP401	Core Subject Practical	Theory of Computation – Practical	1	3
USCS402	Core Subject	Computer Networks	2	3
USCSP402	Core Subject Practical	Computer Networks – Practical	1	3
USCS403	Core Subject	Software Engineering	2	3
USCSP403	Core Subject Practical	Software Engineering – Practical	1	3
USCS404	Core Subject	IoT Technologies	2	3
USCSP404	Core Subject Practical	IoT Technologies – Practical	1	3
USCS405	Skill Enhancement Course (SEC)	Android Application Development	2	3
USCSP405	Skill Enhancement Course (SEC) Practical	Android Application Development – Practical	1	3
USCS406	Skill Enhancement Course (SEC)	Advanced Application Development	2	3
USCSP406	Skill Enhancement Course (SEC) Practical	Advanced Application Development – Practical	1	3
USCS4071	Generic Elective*	Research Methodology	2	3
USCS4072	Generic Elective*	Management & Entrepreneurship	2	3

** Any one Generic Elective has to be selected by the student.*

Semester III

Course Code	Course Title	Credits	Lectures /Week
USCS301	Principles of Operating Systems	2	3
<p>About the Course: The purpose of this course is to provide an overview of computer operating systems, their functionalities, processes, and computing resource management. In particular, the course will cover processes and threads, mutual exclusion, CPU scheduling, deadlock, memory management, and file systems.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • To learn basic concepts and structure of operating systems • To learn about process and synchronization in operating system level • To learn CPU scheduling algorithms • To learn Memory and File system management 			
<p>Learning Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • Work with any type of operating system • Handle threads, processes, process synchronization • Implement CPU scheduling algorithms • Understand the background role of memory management • Design file system. 			
Unit	Topics	No of Lectures	
I	<p>Introduction to Operating-Systems: Definition of Operating System, Operating System's role, Operating-System Operations, Functions of Operating System, Computing Environments</p> <p>Operating-System Structures: Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, Operating-System Structure</p> <p>Processes: Process Concept, Process Scheduling, Operations on Processes, Inter process Communication</p> <p>Threads: Overview, Multicore Programming, Multithreading Models</p>	15	
II	<p>Process Synchronization: General structure of a typical process, race condition, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors</p>	15	

	<p>CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, SRTF, Priority, RR, Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling), Thread Scheduling</p> <p>Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock</p>	
III	<p>Main Memory: Background, Logical address space, Physical address space, MMU, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table</p> <p>Virtual Memory: Background, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing</p> <p>Mass-Storage Structure: Overview, Disk Structure, Disk Scheduling, Disk Management</p> <p>File-System Interface: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing</p> <p>File-System Implementation: File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management</p>	15
<p>Textbook(s):</p> <ol style="list-style-type: none"> 1. Abraham Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley, 2021 <p>Additional Reference(s):</p> <ol style="list-style-type: none"> 1. Achyut S. Godbole, Atul Kahate, Operating Systems, Tata McGraw Hill, 2017 2. Naresh Chauhan, Principles of Operating Systems, Oxford Press, 2014 3. Andrew S Tanenbaum, Herbert Bos, Modern Operating Systems, 4e Fourth Edition, Pearson Education, 2016 		

Course Code	Course Title	Credits	Lectures /Week
USCSP301	Principles of Operating Systems – Practical	1	3
1	Process Communication: <ol style="list-style-type: none"> a. Write a program to give a solution to the producer–consumer problem using shared memory. b. Write a program to give a solution to the producer–consumer problem using message passing. 		
2	Threads: <ol style="list-style-type: none"> a. Write a program to work with a single thread. b. Write a program to work with multi threads. c. The Fibonacci sequence is the series of numbers 0, 1, 1, 2, 3, 5, 8, ... Formally, it can be expressed as: $fib_0 = 0$, $fib_1 = 1$, $fib_n = fib_{n-1} + fib_{n-2}$. Write a multithreaded program that generates the Fibonacci sequence. 		
3	Synchronization: <ol style="list-style-type: none"> a. Write a program to give a solution to the Bounded buffer problem. b. Write a program to give a solution to the readers–writers problem. 		
4	Write a program that implements FCFS scheduling algorithm.		
5	Write a program that implements (with no preemption) scheduling algorithm.		
6	Write a program that implements RR scheduling algorithm.		
7	Write a program that implements the banker’s algorithm		
8	Write a program that implements the FIFO page-replacement algorithm.		
9	Write a program that implements the LRU page-replacement algorithm.		
10	Write a program to design a File System.		

Course Code	Course Title	Credits	Lectures /Week
USCS302	Linear Algebra	2	3
<p>About the Course: Linear algebra, a branch of mathematics, provides concepts that are crucial to many areas of computer science, such as graphics, image processing, cryptography, machine learning, computer vision, optimization, graph algorithms, quantum computation, computational biology, information retrieval and web search. The course covers topics such as fields, vectors, matrices, eigenvalues and eigenvectors</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • To offer the learner the relevant Linear Algebra concepts through Computer Science applications. • To interpret existence and analyze the solution set of a system of linear equations. • To formulate, solve, apply, and interpret properties of linear systems. • To learn about the concept of linear independence of vectors over a field, and the dimension of a vector space. • To interpret basic concepts of linear transformations, dimension, matrix representation of a linear transformation, and the change of coordinate matrix. 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • Appreciate the relevance and applications of Linear Algebra in the field of Computer Science. • Understand the concepts through program implementation. • Instill a computational thinking while learning linear algebra. • Express clear understanding of the concept of a solution to a system of equations. • Find eigenvalues and corresponding eigenvectors for a square matrix. 			
Unit	Topics	No of Lectures	
I	<p>Field: Introduction to complex numbers, complex numbers in Python, abstracting over fields, Playing with GF (2).</p> <p>Vectors: Vectors are functions, Vector addition, Scalar-vector multiplication, combining vector addition and scalar multiplication, Dictionary-based representations of vectors, Dot-product, Solving a triangular system of linear equations, Support Vector Machine – Introduction, Mechanism.</p> <p>The Vector Space: Linear combination, Span, The geometry of sets of vectors, Vector spaces, Linear systems, homogeneous and otherwise</p>	15	
II	<p>Matrix: Matrices as vectors, Column space and row space, Matrix-vector and vector-matrix multiplication in terms of linear combinations, Matrix-vector multiplication in terms of dot-products, Null space, Computing sparse matrix-vector product, Linear functions, Matrix-matrix multiplication, Inner product and outer product, From function inverse to matrix inverse</p>	15	

	<p>Basis: Coordinate systems, two greedy algorithms for finding a set of generators, Linear dependence, Basis, Unique representation, Change of basis, first look, Computational problems involving finding a basis</p> <p>Dimension: Dimension and rank, Direct sum, Dimension and linear functions, The annihilator</p> <p>Gaussian elimination: Echelon form, Gaussian elimination over GF(2), Solving a matrix-vector equation using Gaussian elimination.</p>	
III	<p>Inner Product: The inner product for vectors over the reals, Orthogonality.</p> <p>Orthogonalization: Projection orthogonal to multiple vectors, projecting orthogonal to mutually orthogonal vectors, Building an orthogonal set of generators, orthogonal complement.</p> <p>Eigenvalues and Eigenvectors: Characteristic Polynomials of degree 2 and 3, Eigenvalues and eigenvectors, Properties of eigenvalues and eigenvectors, Cayley–Hamilton Theorem, Minimal Polynomial. Coordinate representation in terms of eigenvectors, The Internet worm, Markov Chains, Google Page Rank algorithm.</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Coding the Matrix Linear Algebra through Applications to Computer Science, First Edition, Philip N. Klein, Newtonian Press 2013 2. Schaum's Outline of Linear Algebra, Sixth Edition by Seymour Lipschutz, Marc Lipson, McGraw Hill 2017 <p>Additional References:</p> <ol style="list-style-type: none"> 1. Linear Algebra and Probability for Computer Science Applications, First Edition, Ernest Davis, A K Peters/CRC Press, 2012. 2. Linear Algebra and Its Applications, Gilbert Strang, Cengage Learning, 4th Edition, 2007 3. Linear Algebra and Its Applications, David C Lay, Pearson Education India; 3rd Edition, 2002 4. Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Cambridge University Press, 2008. 5. Computer Networking With Internet Protocols and Technology, William Stallings, Pearson Education India, 2013. 		

Course Code	Course Title	Credits	Lectures /Week
USCSP302	Linear Algebra – Practical	1	3
1	Write a program which demonstrates the following: <ul style="list-style-type: none"> • Addition of two complex numbers • Displaying the conjugate of a complex number • Plotting a set of complex numbers • Creating a new plot by rotating the given number by a degree 90, 180, 270 degrees and also by scaling by a number $a = 1/2$, $a = 1/3$, $a = 2$ etc. 		
2	Write a program to do the following: <ul style="list-style-type: none"> • Enter a vector u as a n-list • Enter another vector v as a n-list • Find the vector $au + bv$ for different values of a and b • Find the dot product of u and v 		
3	Vector Applications: Classify given data using support vector machines (SVM)		
4	Basic Matrix Operations: <ul style="list-style-type: none"> • Matrix Addition, Subtraction, Multiplication • Check if matrix is invertible. • If yes then find Inverse 		
5	Write a program to convert a matrix into its row echelon form. (Order 2). Write a program to find rank of a matrix.		
6	Basic Matrix Application – I Representation of Image in Matrix Format and Image Transformations		
7	Basic Matrix Application – II Perform Image addition, multiplication and subtraction		
8	Write a program to do the following: <ul style="list-style-type: none"> • Enter a vector b and find the projection of b orthogonal to a given vector u. • Find the projection of b orthogonal to a set of given vectors 		
9	Write a program to calculate eigenvalue and eigenvector (Order 2 and 3)		
10	Implement Google’s Page rank algorithm.		

Course Code	Course Title	Credits	Lectures /Week
USCS303	Data Structures	2	3
<p>About the Course: The course focuses to give an understanding of different types of data structures that can be used to store data in memory, how to create-manipulate them and to use them in the best possible manner as per the requirements of the application.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • To introduce data abstraction and data representation in memory • To describe, design and use of elementary data structures such as stack, queue, linked list, tree and graph • How and why different data structures are used for different types of problems. 			
<p>Learning Outcomes: After successful completion of this course, students would be able to-</p> <ul style="list-style-type: none"> • Create different types of data structures. • Understand which data structure to be used based on the type of the problem. • Apply combined knowledge of algorithms and data structures to write highly effective programs in various domains. 			
Unit	Topics	No of Lectures	
I	<p>Abstract Data Type: Different Data Types, different types of data structures & their classifications, Introduction to ADT, Creating user-specific ADT</p> <p>Linked Structures: ADT for linked list, Advantages & Disadvantages, Singly Linked List-Traversing, Searching, Prepending and Removing Nodes, applications of linked list like polynomial equation</p> <p>Stacks: Stack ADT for Stack, Advantages & Disadvantages, Applications of stack like balanced delimiter, prefix to postfix notation</p> <p>Queues: Queue ADT, Advantages & Disadvantages, linked representations. Circular Queue operations, Dequeues, applications of queue like job scheduling queues</p>	15	
II	<p>Doubly Linked list: ADT of doubly linked list, Advantages & Disadvantages, Insertion and deletion of nodes at various positions</p> <p>Trees: ADT for Tree Structure. Advantages & disadvantages, Binary Tree-Properties, Implementation and Traversals, Binary Search Tree, Balanced BST, Threaded Binary Trees, AVL Trees, Applications of Tree like Huffman Coding,</p>		

	Priority Queues & Heaps: Priority Queue, Priority Queue ADT, Advantages and Disadvantages, Applications, Heaps, types of heaps, Heapifying the element,	
III	<p>Graph: Introduction, Graph ADT, Advantages and Disadvantages, Graph Representation using adjacency matrix and adjacency list, Graph operations like insertion and deletion of nodes, Graph Traversals using BFS & DFS, Applications of Graphs like shortest path algorithms,</p> <p>Hashing: Hash Table ADT, Advantages & Disadvantages, Concept of hashing, hash table, hash functions, collision, collision avoidance techniques, Applications of hashing</p>	
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Introduction to Algorithm, Thomas H Cormen, PHI 2. Data Structures And Algorithms Made Easy, Narasimha Karumanchi, 2021 <p>Additional References:</p> <ol style="list-style-type: none"> 1. Fundamentals of Computer Algorithms, Sartaj Sahni and Sanguthevar Rajasekaran Ellis Horowitz, Universities Press, 2018 2. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2016 		

Course Code	Course Title	Credits	Lectures /Week
USCSP303	Data Structures – Practical	1	3
1	Write a program to implement Abstract Data Types (ADT)		
2	Write a program to implement Singly Linked list with insertion, deletion, traversal operations		
3	Write a program to implement Doubly Linked list with insertion, deletion, traversal operations		
4	Write a program to implement Stack with insertion, deletion, traversal operations		
5	Write a program to implement Queue with insertion, deletion, traversal operations		
6	Write a program to implement Priority Queue with insertion, deletion, traversal operations		
7	Write a program to implement Binary Tree with insertion, deletion, traversal operations		
8	Write a program to implement Huffman Coding		
9	Write a program to implement Graph with insertion, deletion, traversal operations		
10	Write a program to implement Travelling Salesman Problem		
11	Write a program to create basic Hash Table for insertion, deletion, traversal operations(assume that there are no collisions)		
12	Write a program to create hash table to handle collisions using overflow chaining		

Course Code	Course Title	Credits	Lectures /Week
USCS304	Advanced Database Concepts	2	3
<p>About the Course: This course deals with the basic understanding of programming in database. It touches security, recovery, and transaction aspects of database. The course will increase the confidence among the learner while dealing with database.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> To develop understanding of concepts and techniques for data management and learn about widely used systems for implementation and usage. To develop understanding of Transaction management and crash recovery. To develop concepts of programming concepts of database. 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> Master concepts of stored procedure, functions, cursors and triggers and its use. Learn about using PL/SQL for data management. Use efficiently Collections and records. Understand concepts and implementations of transaction management and crash recovery. 			
Unit	Topics	No of Lectures	
I	<p>Overview of PL/SQL: Advantages of PL/SQL, Main Features of PL/SQL, Architecture of PL/SQL</p> <p>Fundamentals of PL/SQL: Character Sets, Lexical Units, Declarations, References to Identifiers, Scope and Visibility of Identifiers, Assigning Values to Variables, Expressions, Error-Reporting Functions, Data Types.</p> <p>Control Statements: Conditional Selection Statements, LOOP Statements, Sequential Control Statements, GOTO, and NULL Statements.</p> <p>Sequences: creating sequences, referencing, altering, and dropping a sequence.</p> <p>Stored Procedures and Functions: Procedures: Types and benefits of stored procedures, creating stored procedures, executing stored procedures, altering stored procedures, viewing stored procedures. Functions: Calling function and recursion function.</p>	15	
II	<p>Collections and Records: Associative Arrays, Varrays (Variable-Size Arrays), Nested Tables, Collection Constructors, Assigning Values to Collection Variables, Multidimensional Collections, Collection</p>	15	

	<p>Comparisons, Collection Methods, Collection Types Defined in Package Specifications, Record Variables, Assigning Values to Record Variables.</p> <p>Error Handling: Compile-Time Warnings, Overview of Exception Handling, Internally Defined Exceptions, Predefined Exceptions, User-Defined Exceptions, Redeclared Predefined Exceptions, Raising Exceptions Explicitly, Exception Propagation, Unhandled Exceptions.</p> <p>Cursors: Overview of Cursor, Types of cursors, Invalid cursor Exception.</p> <p>Static and Dynamic SQL: Static SQL: Description of Static SQL, Cursors Overview, Processing Query Result Sets, Cursor Variables, CURSOR Expressions, Transaction Processing and Control, Autonomous Transactions. Dynamic SQL: Native Dynamic SQL, DBMS_SQL Package, SQL Injection.</p>	
III	<p>Triggers: Overview of Triggers, implementing triggers – creating triggers, Insert, delete, and update triggers, nested triggers, viewing, deleting, and modifying triggers, and enforcing data integrity through triggers.</p> <p>Packages: Overview of a Package. Need of Packages, Package Specification, Package Body, Package Instantiation and Initialization.</p> <p>Transaction Management: ACID Properties, Serializability, Two-phase Commit Protocol, Concurrency Control, Lock Management, Lost Update Problem, Inconsistent Read Problem, Read-Write Locks, Deadlocks Handling, Two Phase Locking protocol.</p> <p>Crash Recovery: ARIES algorithm. The log-based recovery, recovery related structures like transaction and dirty page table, Write-ahead log protocol, check points, recovery from a system crash, Redo and Undo phases</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Mastering PL/SQL Through Illustrations: From Learning Fundamentals to Developing Efficient PL/SQL Blocks, Dr. B. Chandra, BPB Publication, 2020 2. Oracle Pl/Sql Training Guide., Training guide, BPB Publications, 2016 3. Raghu Ramakrishnam, Gehrke, Database Management Systems, McGraw-Hill,3rd Edition, 2014 4. Abraham Silberschatz, Henry F. Korth,S. Sudarshan , Database System Concepts, 6th Edition 2019 <p>Additional References:</p> <ol style="list-style-type: none"> 1. Ivan Bayross, “SQL, PL/SQL -The Programming language of Oracle”, B.P.B. Publications 2009 2. Ramez Elmasri & Shamkant B.Navathe, Fundamentals of Database Systems, Pearson Education, 2008 		

Course Code	Course Title	Credits	Lectures /Week
USCSP304	Advanced Database Concepts – Practical	1	3
1	Writing PL/SQL Blocks with basic programming constructs by including following: a. Sequential Statements b. unconstrained loop		
2	Sequences: a. Creating simple Sequences with clauses like START WITH, INCREMENT BY, MAXVALUE, MINVALUE, CYCLE NOCYCLE, CACHE NOCACHE, ORDER NOORDER. b. Creating and using Sequences for tables.		
3	Writing PL/SQL Blocks with basic programming constructs by including following: a. If...then...Else, IF...ELSIF...ELSE... END IF b. Case statement		
4	Writing PL/SQL Blocks with basic programming constructs for following Iterative Structure: a. While-loop Statements b. For-loop Statements.		
5	Writing PL/SQL Blocks with basic programming constructs by including a GoTO to jump out of a loop and NULL as a statement inside IF.		
6	Writing Procedures in PL/SQL Block a. Create an empty procedure, replace a procedure and call procedure b. Create a stored procedure and call it c. Define procedure to insert data d. A forward declaration of procedure		
7	Writing Functions in PL/SQL Block. a. Define and call a function b. Define and use function in select clause, c. Call function in dbms_output.put_line d. Recursive function e. Count Employee from a function and return value back f. Call function and store the return value to a variable		
8	Creating and working with Insert/Update/Delete Trigger using Before/After clause.		
9	Write an Implicit and explicit cursor to complete the task.		
10	Create packages and use it in SQL block to complete the task.		
11	Write a SQL block to handle exception by writing: a. Predefined Exceptions, b. User-Defined Exceptions, c. Redeclared Predefined Exceptions,		
12	Create nested tables and work with nested tables.		

Course Code	Course Title	Credits	Lectures /Week
USCS305	Java based Application Development	2	3
<p>About the Course: The objective of this course is to teach the learner how to use Object Oriented paradigm to develop code and understand the concepts of Core Java and explore advanced topic of Java programming for solving problems.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> To provide insight into java based applications using OOP concepts. To provide understanding of developing GUI based desktop applications in java. To provide knowledge of web based applications through servlet and jsp. To provide understanding and implementation of basic JSON 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> Design basic application in java using Graphical User Interface. The learner will be able to develop applications using swings The learner will be able to develop web based applications using servlet and jsp The learner will be able to connect databases with java through The learner will be able to perform programs using JSON objects 			
Unit	Topics	No of Lectures	
I	<p>Introduction: History, Features of Java, Java Development Kit, Java Application Programming Interface, Java Virtual Machine Java Program Structure, Java Tokens.</p> <p>OOPS: Introduction, Class, Object, Static Keywords, Constructors, this keyword, Inheritance, Inner class, Anonymous Inner class, super keyword, Polymorphism (overloading and overriding), Abstraction, Encapsulation, Abstract Classes, Interfaces</p> <p>Packages: Introduction to predefined packages, User Defined Packages, Access specifiers</p> <p>Exception Handling: Introduction, Pre-Defined Exceptions, try-catch-finally, throws, throw, User Defined Exceptions</p> <p>Multithreading: Thread Creations, Thread Life Cycle, Life Cycle Methods, Synchronization, wait() notify() notify all() methods</p>	15	
II	<p>Collection Framework: Introduction, java.util Package interfaces, List, Set, Map, List interface & its classes, Set interface & its classes, Map interface & its classes.</p>	15	

	<p>Introduction to JFC and Swing- Features of the Java Foundation Classes, Swing API Components, JComponent Class, Windows, Dialog Boxes, and Panels, Labels, Buttons, Check Boxes, Menus, Toolbars, Implementing Action interface, Pane, JScrollPane, Desktop pane, Scrollbars, Lists and Combo Boxes, Text-Entry Components, Colors and File Choosers, Tables and Trees, Printing with 2D API and Java Print Service API.</p> <p>Event Handling: Delegation Event Model, Events, Event classes, Event listener interfaces, Using delegation event model, adapter classes.</p> <p>JDBC: Introduction, JDBC Architecture, JDBC Drivers, JDBC Connectivity Model, java.sql package, Using Statement, PreparedStatement, CallableStatement, ResultSet, Scrollable and Updatable ResultSet, Navigating and manipulating data, ResultSetMetaData, Managing Transactions in JDBC, JDBC Exception classes, BLOB & CLOB</p>	
<p style="text-align: center;">III</p>	<p>Servlets: Introduction, Servlet Life Cycle, Types of Servlet, Servlet Configuration with Deployment Descriptor, Working with ServletContext and ServletConfig Object, Attributes in Servlet,, Response and Redirection using Request Dispatcher and using sendRedirect Method, Filter API, Manipulating Responses using Filter API, Session Tracking: using Cookies, HttpSession, Hidden Form Fields and URL Rewriting,Types of Servlet Event: ContextLevel and SessionLevel.</p> <p>Java Server Pages (JSP): Introduction to JSP , Comparison with Servlet, JSP Architecture, JSP Life Cycle, JSP Scripting Elements, JSP Directives, JSP Action, JSP Implicit Objects, JSP Expression Language, JSP Standard Tag Libraries, JSP Custom Tag, JSP Session Management, JSP Exception Handling, JSP CRUD Applications</p> <p>JSON: Overview, Syntax, DataTypes, Objects, Schema, Comparison with XML, JSON with Java</p>	<p style="text-align: center;">15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Herbert Schildt, Java The Complete Reference, Eleventh Edition, McGraw-Hill Education, 2020 2. Bryan Basham, Kathy Sierra, Bert Bates, Head First Servlets and JSP, O’reilly (SPD), 2018 3. Cay S. Horstmann, Gary Cornell, Core Java™ 2: Volume II–Advanced Features Prentice Hall PTR, 2004 4. Ivan Bayross, Web Enabled Commercial Applications Development Using Java 2, BPB Publications 5. Java XML and JSON: Document Processing for Java SE by Jeff Friesen January 2019, Apress <p>Additional References:</p> <ol style="list-style-type: none"> 1. E. Balagurusamy, Programming with Java- A Primer, Tata McGraw-Hill Education India, 2014 2. Programming in JAVA, 2nd Ed, Sachin Malhotra & Saurabh Choudhary, Oxford Press, 2018 3. Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics, Thomson Course Technology (SPD) 4. Eric Jendrock, Jennifer Ball, D Carson and others, The Java EE 5 Tutorial, Pearson Education 5. The Java Tutorials: http://docs.oracle.com/javase/tutorial/ 6. Java Parsing Collection XML JSON: Map List XML JSON Transform by Yang Hu, 2019 		

Course Code	Course Title	Credits	Lectures /Week
USCSP305	Java based Application Development – Practical	1	3
1	<ul style="list-style-type: none"> a. Write a program to create a class and implement the concepts of Constructor Overloading, Method Overloading, Static methods b. Write a program to implement the concept of Inheritance and Method Overriding 		
2	<ul style="list-style-type: none"> a. Write a program to implement the concepts of Abstract classes and methods b. Write a program to implement the concept of interfaces 		
3	Write a program to define user defined exceptions and raise them as per the requirements		
4	<p>Write a program to demonstrate the methods of:</p> <ul style="list-style-type: none"> a. List interface b. Set interface c. Map interface 		
5	Write a program using various swing components design Java application to accept a student's resume. (Design form)		
6	<ul style="list-style-type: none"> a. Write a JDBC program that displays the data of a given table b. Write a JDBC program to return the data of a specified record from a given table c. Write a JDBC program to insert / update / delete records into a given table 		
7	<ul style="list-style-type: none"> a. Construct a simple calculator using the JAVA Swings with minimum functionality. b. Construct a GUI using JAVA Swings to accept details of a record of a given table and submit it to the database using JDBC technology on the click of a button. 		
8	<ul style="list-style-type: none"> a. Write a Servlet that accepts a User Name from a HTML form and stores it as a cookie. Write another Servlet that returns the value of this cookie and displays it. b. Write a Servlet that displays the names and values of the cookie stored on the client. c. Write a Servlet that accepts a User Name from a HTML form and stores it as a session variable. Write another Servlet that returns the value of this session variable and displays it. 		
9	<ul style="list-style-type: none"> a. Write a registration Servlet that accepts the data for a given table and stores it in the database. b. Write a Servlet that displays all the records of a table. 		
10	<ul style="list-style-type: none"> a. Write a JSP that accepts a User Name from a HTML form and stores it as a cookie. Write another JSP that returns the value of this cookie and displays it. b. Write a JSP that displays the names and values of the cookie stored on the client. c. Write a JSP that accepts a User Name from a HTML form and stores it as a session variable. Write another JSP that returns the value of this session variable and displays it. 		

11	<ol style="list-style-type: none">a. Write a JSP code that accepts username and password from HTML file and validates the user from the databaseb. Write a registration JSP that accept the data for a given table and stores it in the database.c. Write a JSP that displays all the records of a table
12	. Write Java application to encoding and decoding JSON in Java.

Course Code	Course Title	Credits	Lectures /Week
USCS306	Web Technologies	2	3
<p>About the Course: The course provides an insight into emerging technologies to design and develop state of the art web applications using client-side scripting, server-side scripting, and database connectivity</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • To understand the concepts of Hyper Text Markup Language and Cascading Style Sheets. • To learn JavaScript for creating dynamic websites. • To learn various operations performed on data among web applications using XML • To learn Server-Side Programming using PHP 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • Design valid, well-formed, scalable, and meaningful pages using emerging technologies. • Understand the various platforms, devices, display resolutions, viewports, and browsers that render websites • Develop and implement client-side and server-side scripting language programs. • Develop and implement Database Driven Websites. • Design and apply XML to create a markup language for data and document centric applications. 			
Unit	Topics	No of Lectures	
I	<p>HTML5: Fundamental Elements of HTML, Formatting Text in HTML, Organizing Text in HTML, Links and URLs in HTML, Tables in HTML, Images on a Web Page, Image Formats, Image Maps, Colors, FORMs in HTML, Interactive Elements, Working with Multimedia - Audio and Video File Formats, HTML elements for inserting Audio / Video on a web page</p> <p>CSS: Understanding the Syntax of CSS, CSS Selectors, Inserting CSS in an HTML Document, CSS properties to work with background of a Page, CSS properties to work with Fonts and Text Styles, CSS properties for positioning an element.</p>	15	
II	<p>JavaScript: Using JavaScript in an HTML Document, Programming Fundamentals of JavaScript – Variables, Operators, Control Flow Statements, Popup Boxes, Functions – Defining and Invoking a Function, Defining Function arguments, defining a return Statement, Calling Functions with Timer, JavaScript Objects - String, RegExp, Math, Date, Browser Objects - Window, Navigator, History, Location, Document, Cookies, Document Object Model, Form Validation using JavaScript</p> <p>XML: Comparing XML with HTML, Advantages and Disadvantages of XML, Structure of an XML Document, XML Entity References, DTD,</p>	15	

	XSLT: XSLT Elements and Attributes - xsl:template, xsl:apply-templates, xsl:import, xsl:call-template, xsl:include, xsl:element, xsl:attribute, xsl:attribute-set, xsl:value-of	
III	<p>AJAX: AJAX Web Application Model, How AJAX Works, XMLHttpRequest Object – Properties and Methods, handling asynchronous requests using AJAX</p> <p>PHP: Variables and Operators, Program Flow, Arrays, working with Files and Directories, working with Databases, Working with Cookies, Sessions and Headers</p> <p>Introduction to jQuery: Fundamentals, Selectors, methods to access HTML attributes, methods for traversing, manipulators, events, effects.</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. HTML 5 Black Book, Covers CSS 3, JavaScript, XML, XHTML, AJAX, PHP and jQuery, 2ed, Dreamtech Press, 2016 2. Web Programming and Interactive Technologies, scriptDemics, StarEdu Solutions India, 2018 3. PHP: A Beginners Guide, Vikram Vaswani, TMH <p>Additional References:</p> <ol style="list-style-type: none"> 1. HTML, XHTML, and CSS Bible Fifth Edition, Steven M. Schafer, WILEY, 2011 2. Learning PHP, MySQL, JavaScript, CSS & HTML5, Robin Nixon, O'Reilly, 2018 3. PHP, MySQL, JavaScript & HTML5 All-in-one for Dummies, Steve Suehring, Janet Valade Wiley, 2018 		

Course Code	Course Title	Credits	Lectures /Week
USCSP306	Web Technologies – Practical	1	3
1	Design a webpage that makes use of <ul style="list-style-type: none"> a. Document Structure Tags b. Various Text Formatting Tags c. List Tags d. Image and Image Maps 		
2	Design a webpage that makes use of <ul style="list-style-type: none"> a. Table tags b. Form Tags (forms with various form elements) c. Navigation across multiple pages d. Embedded Multimedia elements 		
3	Design a webpage that make use of Cascading Style Sheets with <ul style="list-style-type: none"> a. CSS properties to change the background of a Page b. CSS properties to change Fonts and Text Styles c. CSS properties for positioning an element 		
4	Write JavaScript code for <ul style="list-style-type: none"> a. Performing various mathematical operations such as calculating factorial / finding Fibonacci Series / Displaying Prime Numbers in a given range / Evaluating Expressions / Calculating reverse of a number b. Validating the various Form Elements 		
5	Write JavaScript code for <ul style="list-style-type: none"> a. Demonstrating different JavaScript Objects such as String, RegExp, Math, Date b. Demonstrating different JavaScript Objects such as Window, Navigator, History, Location, Document, c. Storing and Retrieving Cookies 		
6	Create a XML file with Internal / External DTD and display it using <ul style="list-style-type: none"> a. CSS b. XSL 		
7	Design a webpage to handle asynchronous requests using AJAX on <ul style="list-style-type: none"> a. Mouseover b. button click 		
8	Write PHP scripts for <ul style="list-style-type: none"> a. Retrieving data from HTML forms b. Performing certain mathematical operations such as calculating factorial / finding Fibonacci Series / Displaying Prime Numbers in a given range / Evaluating Expressions / Calculating reverse of a number c. Working with Arrays d. Working with Files (Reading / Writing) 		
9	Write PHP scripts for		

	<ul style="list-style-type: none">a. Working with Databases (Storing Records / Retrieving Records and Display them)b. Storing and Retrieving Cookiesc. Storing and Retrieving Sessions
10	Design a webpage with some jQuery animation effects.

Course Code	Course Title	Credits	Lectures /Week
USCS3071	Creative Content Writing	2	3
<p>About the Course: With the advent of the internet, content writing has become a very lucrative and promising career. The course is designed to equip students to comprehend, refine, and enhance their writing abilities so that they may become proficient web content developers. The course aims to prepare students to enter the industry with enhanced skill and substantial competence.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • To introduce students to the concepts of content writing. • To connect them with various writing and editing styles and techniques. • To help them develop their creative abilities. • To improve the learners' employability 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • Understand the fundamentals of content creation for Blog, Website etc. • Acquire the ability to write and edit in a variety of styles and procedures • To develop the creative abilities. • To acquire essential language skills for editors. 			
Unit	Topics	No of Lectures	
I	<p>Basics of Content writing: Introduction to Content Writing, Learning Tone in Writing and Its Types, Comprehending style in writing and its Types, Common Grammatical Errors.</p> <p>Best Practices for Writing for the Web: Making our story Elegant, Professional, Write with an Attitude, Keep Verbs Active, List Items, Chunk Information, Title and Subtitle, Organize for Your Audience.</p> <p>Things Marketers Write: The Ideal Length for Blog Posts, Podcast, Facebook Posts, Tweets, and Other Marketing Content.</p>	15	
II	<p>Social Media Writing: Writing for Twitter, writing with Hashtags, Writing Social Media with Humor, writing for Facebook, writing for LinkedIn, Writing Your LinkedIn Profile, writing for Email, Writing Landing Pages, Writing Headlines, writing a Home Page, Writing the About Us Page, Writing Better Blog Posts, Writing Annual Reports.</p> <p>Infographics: Visual Communication- What Are Infographics?, The Science of Visualization, Creating Infographics- Purpose, The Art of Observation, Processing Your Ideas, Designing Your Infographics, Publishing Your Infographics.</p>	15	

III	<p>Content Tools: Research and Knowledge Management Tools, Writing Tools, Productivity Tools, Editing Tools, A Few Great Style Guides, Non-Text Writing Tools, Blog Idea Generators, Google Authorship, Image Sources, Tools for Content Writing.</p> <p>Ethical and Legal aspects of content writing: Learn Legal English, Learn Legal Vocabulary In Legal Writing, IPR Laws, and Copywriting, Plagiarism laws in Content Writing.</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Content Writing Handbook, Author:Kounal Gupta, 2020, Henry Harvin. 2. Feldar, Lynda. Writing for the Web: Creating Compelling Web Content Using Words, Pictures, and Sound. New Riders, CA, USA, 2011 <p>Additional References:</p> <ol style="list-style-type: none"> 1. Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Paperback Ann Handley Pan Macmillan India 2016 2. The Power of Infographics: Using Pictures to Communicate and Connect With Your Audiences Paperback – 15 June 2012 Mark Smiciklas 3. Law Relating to Intellectual Property Rights Book by V. K. Ahuja, 2017 <p>Web Resources:</p> <ol style="list-style-type: none"> 1. https://www.locationrebel.com/b2b-writing/ 2. https://www.mindler.com/blog/how-to-become-a-content-writer-in-india/ 3. https://study.com/articles/What_is_a_Content_Writer.html 4. https://www.mondaq.com/india/contracts-and-commercial-law/445620/legal-contractsagreements-drafting-and-legal-vetting 5. https://www.crazyegg.com/blog/copywriting/ 		

Course Code	Course Title	Credits	Lectures /Week
USCS3072	Green Technologies	2	3
<p>About the Course: This course focuses on familiarizing learners with the need and relevance of Green Computing, Technology, and its practices for creating a sustainable work and production environment for the IT-enabled sector. The course emphasizes the use of principles and practices of green services and regulatory standards for addressing the carbon issues and related concerns.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • Know about Green IT Fundamentals: Business, IT, and the Environment • Green IT Strategies and Significance of Green IT Strategies • Green Enterprise Architecture and Green Information Systems • Sociocultural Aspects of Green IT and Green Compliance 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • Explain drivers and dimensions of change for Green Technology • Appreciate Virtualization; smart meters and optimization in achieving green IT • Gain knowledge about green assets, green processes, and green enterprise architecture • ISO 14001 and related standards for Audit for Green Compliance 			
Unit	Topics	No of Lectures	
I	<p>Green IT Fundamentals: Information Technology and Environment, Business, Environment, and Green Enterprise Characteristics, Green Vision and Strategic Points, Green Value, Green IT Opportunity, Challenges of a Carbon Economy, Environmental Intelligence, Envisioning the Green Future</p> <p>Green IT Strategies: Green strategic alignment, Green IT Drivers-Cost, Regulatory and Legal, Sociocultural and Political, Business ecosystem, New market opportunities, Green IT Business Dimensions, KPIs in Green Strategies</p> <p>Environmentally Responsible Business: Developing ERBS, Policies, Practices, and Metrics, Mobility and Environment, Green It Metrics and Measurements, Green IT Readiness and CMM, Context Sensitivity and Automation in Green IT Measures</p> <p>Green Assets: Introduction, Green Assets, Green IT Hardware, Green Data Centers and ICT Equipment, Server and Data Strategy</p>	15	
II	<p>Green Assets and emerging Trends: Data Servers Optimization and Virtualization, Physical Data Server Organization and Cooling, Cloud Computing and Data Centers, Networking and Communications Infrastructure, End-User Devices, Smart Meters in Real-Time, Managing</p>	15	

	<p>Devices for Central Green Services, Devices and Organizational Boundaries for Measurements, Mobile Devices, and Sustainability</p> <p>Green Business Process Management: Introduction, Green Reengineering, Green Process, Green BPM and standards, Green Business Analysis, Green Requirements Modelling, Green IT Governance, Green Business Process and Applications, QoS, Achieving green BPM, Green Mobile Business Process, Digital Library</p> <p>Green Enterprise Architecture: Green IT and organizational Systems, Aspects of Green Solutions Architecture, Contents and Integration with Service-Oriented Architecture, Green Supply Chain Management, Green Portals in Green Enterprise Architecture, Environmental Intelligence</p>	
<p style="text-align: center;">III</p>	<p>Green Information Systems(GIS): Design and Development Models: Describing GIS, GIS Requirements</p> <p>Sociocultural Aspects of Green IT: Green IT's Social Impact, Learning Organization, Green Social Stakeholders, Role-Based View of Green IT, Green User Practices, Attitude and Subjectivity in Green IT, Green IT Ethics and Code of Conduct, Privacy and Security of Green Information, Green Washing, Communications in Green Transformation Projects, Green HR and Changing Organizational Structures, Green-Collar Workers: Roles and Skill Sets, Green Virtual Communities</p> <p>Green Compliance: Protocols, Standards, and Audits: Protocols and Standards, ISO 14000-2004 Standard, Various initiatives by stakeholders, Green Audits and types, Audit and use of Carbon emission management software</p> <p>Emerging Carbon Issues: Technologies and Future: Future Carbon Landscape, Green ICT and Technology Trends, Cloud Computing, Nanotechnology, Quantum computing, Renewable energies, eco-design, Collaborative environmental intelligence</p>	<p style="text-align: center;">15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Green IT Strategies and Applications Using Environmental Intelligence, Bhuvan Unhelkar, CRC Press, 2016 2. Green Information and Communication Systems for a Sustainable Future, Rajshree Srivastava, Sandeep Kautish, Rajeev Tiwari. CRC Press, 2020 <p>Additional References:</p> <ol style="list-style-type: none"> 1. Emerging Green Technologies, Matthew N. O. Sadiku, Taylor and Francis (CRC Press), 2022 2. Sustainability Awareness and Green Information Technologies, Tomayess Issa, Springer, 2021 3. Environmental Sustainability Role of Green Technologies, P. Thangavel, and G. Sridevi, Springer, 2016 		