

Third Semester						
Group	Paper Code	Paper	L	P	Credits	
<b>Theory Papers</b>						
ES	ES-201	Computational Methods	4		4	
HS/MS	HS-203	Indian Knowledge System*	2		2	
PC	CIC-205	Discrete Mathematics	4		4	
PC	ECC-207	Digital Logic and Computer Design	4		4	
PC	CIC-209	Data Structures	4		4	
PC	CIC-211	Object-Oriented Programming using C++	4		4	
<b>Practical / Viva Voce</b>						
ES	ES-251	Computational Methods Lab		2	1	
PC	ECC-253	Digital Logic and Computer Design Lab		2	1	
PC	CIC-255	Data Structures Lab		2	1	
PC	CIC-257	Object-Oriented Programming using C++ Lab		2	1	
<b>Total</b>			<b>22</b>	<b>8</b>	<b>26</b>	

\***NUES:**All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

Fourth Semester						
Group	Paper Code	Paper	L	P	Credits	
<b>Theory Papers</b>						
BS	BS-202	Probability, Statistics and Linear Programming	4		4	
HS/MS	HS-204	Technical Writing*	2		2	
PC	CIC-206	Theory of Computation	4		4	
PC	EEC-208	Circuits and Systems	4		4	
PC	CIC-210	Database Management Systems	4		4	
PC	CIC-212	Programming in Java	4		4	
<b>Practical / Viva Voce</b>						
BS	BS-252	Probability, Statistics and Linear Programming Lab		2	1	
PC	EEC-254	Circuits and Systems Lab		2	1	
PC	CIC-256	Database Management Systems Lab		2	1	
PC	CIC-258	Programming in Java Lab		2	1	
<b>Total</b>			<b>22</b>	<b>8</b>	<b>26</b>	

\***NUES:**All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

<b>Paper Code(s): ES-201</b>	<b>L</b>	<b>P</b>	<b>C</b>
<b>Paper: Computational Methods</b>	<b>4</b>	<b>-</b>	<b>4</b>

**Marking Scheme:**

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

**Instructions for paper setter:**

1. There should be 9 questions in the term end examinations question paper.
2. The first (1<sup>st</sup>) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

**Course Objectives :**

1. To understand numerical methods to find roots of functions and first order unconstrained minimization of functions.
2. To introduce concept of interpolation methods and numerical integration.
3. To understand numerical methods to solve systems of algebraic equations and curve fitting by splines.
4. To understand numerical methods for the solution of Ordinary and partial differential equations.

**Course Outcomes (CO)**

<b>CO 1</b>	Ability to develop mathematical models of low level engineering problems										
<b>CO 2</b>	Ability to apply interpolation methods and numerical integration.										
<b>CO 3</b>	Ability to solve simultaneous linear equations and curve fitting by splines										
<b>CO 4</b>	Ability to numerically solve ordinary differential equations that are initial value or boundary value problems										

**Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
<b>CO 1</b>	3	2	2	2	2	-	-	-	2	2	2	3
<b>CO 2</b>	3	2	2	2	2	-	-	-	2	2	2	3
<b>CO 3</b>	3	3	3	3	2	-	-	-	2	2	2	3
<b>CO 4</b>	3	3	3	3	2	-	-	-	2	2	2	3

**UNIT-I**

Review of Taylor Series, Rolle 's Theorem and Mean Value Theorem, Approximations and Errors in numerical computations, Data representation and computer arithmetic, Loss of significance in computation  
 Location of roots of equation: Bisection method (convergence analysis and implementation), Newton Method (convergence analysis and implementation), Secant Method (convergence analysis and implementation). Unconstrained one variable function minimization by Fibonacci search, Golden Section Search and Newton's method. Multivariate function minimization by the method of steepest descent, Nelder- Mead Algorithm.

**UNIT-II**

Interpolation: Assumptions for interpolation, errors in polynomial interpolation, Finite differences, Gregory-Newton's Forward Interpolation, Gregory-Newton's backward Interpolation, Lagrange's Interpolation, Newton's divided difference interpolation

Numerical Integration: Definite Integral, Newton-Cote's Quadrature formula, Trapezoidal Rule, Simpson's one-third rule, simpson's three-eight rule, Errors in quadrature formulae, Romberg's Algorithm, Gaussian Quadrature formula.

**UNIT-III**

System of Linear Algebraic Equations: Existence of solution, Gauss elimination method and its computational effort, concept of Pivoting, Gauss Jordan method and its computational effort, Triangular Matrix factorization methods: Dolittle algorithm, Crout's Algorithm, Cholesky method, Eigen value problem: Power method  
Approximation by Spline Function: First-Degree and second degree Splines, Natural Cubic Splines, B Splines, Interpolation and Approximation

**UNIT - IV**

Numerical solution of ordinary Differential Equations: Picard's method, Taylor series method, Euler's and Runge-Kutta's methods, Predictor-corrector methods: Euler's method, Adams-Bashforth method, Milne's method.

Numerical Solution of Partial Differential equations: Parabolic, Hyperbolic, and elliptic equations  
Implementation to be done in C/C++

**Textbook(s):**

1. E. Ward Cheney & David R. Kincaid , "Numerical Mathematics and Computing" Cengage; 7th ed (2013).

**References:**

1. R. L. Burden and J. D. Faires, "Numerical Analysis", CENGAGE Learning Custom Publishing; 10<sup>th</sup> Edition (2015).
2. S. D. Conte and C. de Boor, "Elementary Numerical Analysis: An Algorithmic Approach", McGraw Hill, 3rd ed. (2005).
3. H. M. Antia, "Numerical Methods for Scientists & Engineers", Hindustan Book Agency, (2002).
4. E Balagurusamy "Numerical Methods" McGraw Hill Education (2017).

<b>Paper Code(s): HS-203</b>	<b>L</b>	<b>P</b>	<b>C</b>
<b>Paper: Indian Knowledge System</b>	<b>2</b>	<b>-</b>	<b>2</b>

**Marking Scheme:**

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks
3. This is an NUES paper, hence all examinations to be conducted by the concerned teacher.

**Instruction for paper setter:**

1. There should be 9 questions in the term end examinations question paper.
2. The first (1<sup>st</sup>) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

**Course Objectives :**

1. To understand the Indian knowledge System.
2. To understand the foundational concepts for science and technology.
3. To understand the ancient Indian mathematics and astronomy.
4. To understand the ancient Indian engineering and technology.

**Course Outcomes (CO)**

<b>CO 1</b>	Ability to understand the Indian knowledge System.
<b>CO 2</b>	Ability to understand and apply foundational concepts for science and technology.
<b>CO 3</b>	Ability to understand and apply ancient Indian mathematics and astronomy
<b>CO 4</b>	Ability to understand ancient Indian engineering and technology.

**Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
<b>CO 1</b>	-	-	-	-	-	3	-	-	-	-	-	2
<b>CO 2</b>	-	-	-	-	-	3	-	-	-	2	-	2
<b>CO 3</b>	3	3	-	-	-	-	-	-	-	-	-	2
<b>CO 4</b>	3	3	-	-	-	-	-	-	-	-	-	2

**UNIT-I**

**Indian Knowledge System (IKS) - An Introduction:**

Overview of IKS - Importance of Ancient Knowledge; Defining IKS; The IKS Corpus – A Classification Framework; Chaturdaśa-Vidyāsthāna; History of IKS, Some unique aspects of IKS; The Vedic Corpus – Introduction to Vedas; The Four Vedas and their divisions; Vedāngas; Vedic Life; Philosophical Systems – Indian Philosophical Systems; Vedic Schools of Philosophy; Non-Vedic Philosophical Systems; Wisdom through the Ages – Purāṇas, Itihāsa as source of wisdom, Rāmāyaṇa, Mahābhārata, Niti-śāstras, Subhāssitas.

**UNIT-II**

**Foundational Concepts for Science and Technology:**

Linguistics - Components of Language; Pāṇini's work on Sanskrit Grammar; Phonetics in Sanskrit; Patterns in Sanskrit Vocabulary; Computational Concepts in Astādhyāyi, Logic for Sentence Construction; Importance of Verbs; Role of Sanskrit in Natural Language Processing

Number System and Units of Measurement – Number System in India; Salient Features of the Indian Numeral System; Unique approaches to represent numbers; Measurements for Time, Distance and Weight; Pingala and

the Binary System

Knowledge: Framework and Classification – The Knowledge Triangle; Prameya; Pramāna; Samśaya; Framework for establishing Valid Knowledge

### **UNIT-III**

Mathematic and Astronomy in IKS:

Mathematics – Unique aspects of Indian Mathematics; Great Mathematicians and their Contributions; Arithmetic; Geometry; Trigonometry; Algebra; Binary Mathematics and Combinatorial Problems in Chandahśāstra of Pingala, Magic Squares in India

Astronomy - Unique aspects of Indian Astronomy; Historical Development of Astronomy in India; The Celestial Coordinate System; Elements of the Indian Calendar; Āryabhatiya and the Siddhāntic Tradition; Pancānga; Astronomical Instruments; Jantar Mantar of Rājā Jai Singh Sawai

### **UNIT - IV**

Engineering and Technology in IKS:

Engineering and Technology: Metals and Metalworking – The Indian S & T Heritage; Mining and Ore Extraction; Metals and Metalworking Technology; Iron and Steel in India; Lost wax casting of Idols and Artefacts; Apparatuses used for Extraction of Metallic Components

Engineering and Technology: Other Applications – Literary sources for Science and Technology; Physical Structures in India; Irrigation and Water Management; Dyes and Painting Technology; Surgical Techniques; Shipbuilding; Sixty-four Art Forums; Status of Indigenous S & T

#### **Textbook(s):**

1. B. Mahadevan, Vinayaka Rajat Bhat & Nagendra Pavana R.N., "Introduction to Knowledge System: Concepts and Applications" PHI (2022).

#### **References:**

1. C.M Neelakandhan & K.A. Ravindran, "Vedic Texts and The Knowledge Systems of India", Sri Sankaracharya University of Sanskrit, Kalady (2010).
2. P.P. Divakaran, "The Mathematics of India: Concepts, Methods, Connections", Springer (2018)
3. C.A. Sharma, "Critical Survey of Indian Philosophy", Motilal Banarasidass Publication (1964)
4. G. Huet, A. Kulkarni & P. Scharf, "Sanskrit Computational Linguistics", Springer (2009).
5. A.K. Bag, "History of Technology in India", Indian National Science Academy, Vol 1, (1997)

<b>Paper Code(s): CIC-205</b>	<b>L</b>	<b>P</b>	<b>C</b>
<b>Paper: Discrete Mathematics</b>	<b>4</b>	<b>-</b>	<b>4</b>

**Marking Scheme:**

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

**Instructions for paper setter:**

1. There should be 9 questions in the term end examinations question paper.
2. The first (1<sup>st</sup>) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

**Course Objectives :**

1. To introduce the concept of Mathematical Logic, concepts of sets, relation and functions
2. To introduce the concept of Algorithm and number theory
3. To understand Group theory and related examples
4. To use Graph theory for solving problems

**Course Outcomes (CO)**

<b>CO1:</b>	Ability for constructing mathematical logic to solve problems
<b>CO2:</b>	Ability to Analyze/ quantify the efficiency of a developed solution (algorithm) of a computational problem
<b>CO3:</b>	Ability to Understand mathematical preliminaries to be used in the subsequent courses of the curriculum. This includes Boolean algebra, number theory, group theory, and combinatorics.
<b>CO4:</b>	Ability to Understand diverse relevant topics in discrete mathematics and computation theory with an emphasis on their applicability as mathematical tools in computer science.

**Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
<b>CO 1</b>	3	3	3	2	2	-	-	-	2	2	3	3
<b>CO 2</b>	3	3	3	2	2	-	-	-	2	2	3	3
<b>CO 3</b>	3	3	3	3	2	-	-	-	2	2	3	3
<b>CO 4</b>	3	3	3	3	2	-	-	-	2	2	3	3

**UNIT – I**

**Sets, Logic, and Relation:** Sets, Subsets, powerset, operations on sets, Propositional Logic, Rules of inferences in propositional logic, Quantifiers, Predicates and validity, Predicate Logic, normal forms. Proof Techniques- Direct Proof, Proof by Contraposition, and proof by contradiction. Principle of inclusion and exclusion, pigeonhole principle, permutation and combination. Principle of Well Ordering, principle of mathematical induction, principle of complete induction. Relation, properties of binary relation, equivalence relation and class, closures (symmetric, reflexive, and transitive).

**UNIT – II**

**Functions, Order relations and Boolean Algebra:** Functions, Growth of functions, Permutation functions, Partially ordered sets, lattices, Boolean algebra, Minimization of Boolean Expressions. GCD, LCM, prime numbers.

Recurrence relations, solution methods for linear, first-order recurrence relations with constant coefficients, generating functions, Analysis of Algorithms involving recurrence relations, solution method for a divide-and-

conquer recurrence relation. Masters theorem (with proof).

### **UNIT – III**

**Group theory:** Semi-group, Monoid, Groups, Group identity and uniqueness, inverse and its uniqueness, isomorphism and homomorphism, subgroups, Cosets and Lagrange's theorem, Permutation group and Cayley's theorem (without proof), Normal subgroup and quotient groups. Groups and Coding.

### **UNIT – IV**

**Graph theory:** Graph Terminology, Planar graphs, Euler's formula (proof), Euler and Hamiltonian path/circuit. Chromatic number of a graph, five color theorem (proof), Shortest path and minimal spanning trees and algorithms, Depth-first and breadth first search, trees associated with DFS & BFS, Connected components. Complexity Analysis of the graph MST.

#### **Textbook(s):**

1. B. Kolman, R. C. Busby & S.C. Ross "Discrete Mathematical Structures", 6th edition, PHI/Pearson, 2009.
2. R. L. Graham, D. E. Knuth & O. Patashnik, "Concrete Mathematics", Pearson Education, 2000.

#### **References:**

1. Neal Koblitz, "A course in number theory and cryptography", Springer – Verlag, 1994.
2. J.P. Tremblay & R. Manohar, "Discrete Mathematical Structure with Application to Computer Science," TMH, New Delhi (2000).
3. Norman L. Biggs, "Discrete Mathematics", Second edition, Oxford University Press, New Delhi (2002).
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest "Introduction to Algorithms", 3rd edition, PHI/Pearson.
5. Anne Benoit, Yves Robert, Frédéric Vivien "A Guide to Algorithm Design: Paradigms, Methods, and Complexity Analysis", CRC Press, 2013.

<b>Paper Code(s): ECC-207</b>	<b>L</b>	<b>P</b>	<b>C</b>
<b>Paper: Digital Logic and Computer Design</b>	<b>4</b>	<b>-</b>	<b>4</b>

**Marking Scheme:**

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

**Instructions for paper setter:**

1. There should be 9 questions in the term end examinations question paper.
2. The first (1<sup>st</sup>) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

**Course Objectives :**

1. To introduce basic concepts of Boolean Algebra and Combinational Logic
2. To introduce various sequential circuits, designing with examples
3. To relate combination circuit design and sequential circuit design with respect to the design of a computer system
4. To introduce machine learning, computer arithmetic, modes of data transfer with respect to I/O and Memory organization of a computer

**Course Outcomes (CO) :**

**CO 1** Ability to understand Boolean Algebra and Design Combinational Circuits .

**CO 2** Ability to understand and Design Sequential Circuits.

**CO 3** Ability to understand Design of a basic computer.

**CO 4** Ability to understand Input-Output and Memory Organization of a Computer.

**Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
<b>CO 1</b>	3	2	3	2	2	-	-	-	3	2	2	3
<b>CO 2</b>	3	2	3	2	2	-	-	-	3	2	2	3
<b>CO 3</b>	3	2	3	3	2	-	-	-	3	2	2	3
<b>CO 4</b>	3	3	3	3	3	-	-	-	3	2	2	3

**UNIT – I**

**Boolean Algebra and Combinational Logic:** Review of number systems , signed, unsigned, fixed point, floating point numbers, Binary Codes, Boolean algebra – basic postulates, theorems , Simplification of Boolean function using Karnaugh map and Quine-McCluskey method – Implementations of combinational logic functions using gates, Adders, Subtractors, Magnitude comparator, encoder and decoders, multiplexers, code converters , parity generator/checker, implementation of combinational circuits using multiplexers.

**UNIT – II**

**Sequential Circuits:** General model of sequential circuits, Flip-flops, latches , level triggering, edge triggering, master slave configuration , concept of state diagram , state table, state reduction procedures , Design of synchronous sequential circuits , up/down and modulus counters , shift registers, Ring counter , Johnson counter , timing diagram , serial adder , sequence detector, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Memory Unit, Random Access Memory

**UNIT – III**

**Basic Computer organization:** Stored Program, Organization, Computer registers, bus system, instruction set completeness, instruction cycle, Register Transfer Language, Arithmetic, Logic and Shift Micro-operations, Instruction Codes, Design of a simple computer, Design of Arithmetic Logic unit, shifter, Design of a simple hardwired control unit, Programming the basic computer, Machine language instructions, assembly language, Microprogrammed control, Horizontal and Vertical Microprogramming, Central Processing Unit, instruction sets and formats, addressing modes, data paths, RISC and CISC characteristics.

**UNIT – IV**

Computer Arithmetic, addition, subtraction, multiplication and division algorithms, Input-Output Organization, Modes of data transfer, Interrupt cycle, direct memory access, Input-Output processor, Memory Organization, Memory Hierarchy, Associative Memory, Cache Memory, Internal and external Memory, Virtual Memory.

**Text Book(s)**

1. M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, 2016
2. M. Morris Mano, Rajib Mall "Computer System Architecture", 3<sup>rd</sup> Edition Pearson Education, 2017

**References:**

1. Leach, D. P., Albert P. Malvino, "Digital Principles and Applications", McGraw Hill Education, 8<sup>th</sup> Edition , 2014
2. Jain, R.P. , "Modern Digital Electronics", McGraw Hill Education, 4<sup>th</sup> Edition , 2010
3. Floyd, Thomas L. , "Digital Fundamentals" Pearson Education, 11<sup>th</sup> Edition, 2017
4. M. Rafiquzzaman, "Fundamentals of Digital Logic and Microcomputer Design", Wiley, 5<sup>th</sup> Ed., 2005.

<b>Paper Code(s): CIC-209</b>	<b>L</b>	<b>P</b>	<b>C</b>
<b>Paper: Data Structures</b>	<b>4</b>	<b>-</b>	<b>4</b>

**Marking Scheme:**

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

**Instructions for paper setter:**

1. There should be 9 questions in the term end examinations question paper.
2. The first (1<sup>st</sup>) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

**Course Objectives :**

1. To introduce basics of Data structures (Arrays, strings, linked list etc.)
2. To understand the concepts of Stacks, Queues and Trees, related operations and their implementation
3. To understand sets, heaps and graphs
4. To introduce various Sorting and searching Algorithms

**Course Outcomes (CO)**

**CO 1** To be able to understand difference between structured data and data structure

**CO 2** To be able to create common basic data structures and trees

**CO 3** To have a knowledge of sets, heaps and graphs

**CO 4** To have basic knowledge of sorting and searching algorithms

**Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
<b>CO 1</b>	3	2	2	2	3	-	-	-	2	2	2	3
<b>CO 2</b>	3	2	2	2	3	-	-	-	2	2	2	3
<b>CO 3</b>	3	2	2	2	3	-	-	-	2	2	2	3
<b>CO 4</b>	3	2	2	2	3	-	-	-	2	2	2	3

**UNIT – I**

Overview of data structure, Basics of Algorithm Analysis including Running Time Calculations, Abstract Data Types, Arrays, Arrays and Pointers, Multidimensional Array, String processing, General Lists and List ADT, List manipulations, Single, double and circular lists. Stacks and Stack ADT, Stack Manipulation, Prefix, infix and postfix expressions, recursion. Queues and Queue ADT, Queue manipulation.

**UNIT – II**

Sparse Matrix Representation (Array and Link List representation) and arithmetic (addition, subtraction and multiplication), polynomials and polynomial arithmetic.

Trees, Properties of Trees, Binary trees, Binary Tree traversal, Tree manipulation algorithms, Expression trees and their usage, binary search trees, AVL Trees, Heaps and their implementation, Priority Queues, B-Trees, B\* Tree, B+ Tree

**UNIT – III**

Sorting concept, order, stability, Selection sorts (straight, heap), insertion sort (Straight Insertion, Shell sort), Exchange Sort (Bubble, quicksort), Merge sort (External Sorting) (Natural merge, balanced merge and

polyphase merge). Searching – List search, sequential search, binary search, hashing methods, collision resolution in hashing.

#### **UNIT – IV**

Disjoint sets representation, union find algorithm, Graphs, Graph representation, Graph Traversals and their implementations (BFS and DFS). Minimum Spanning Tree algorithms, Shortest Path Algorithms

##### **Textbook(s):**

1. Richard Gilberg , Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C, 2<sup>nd</sup> Edition, Cengage Learning, Oct 2004
2. E. Horowitz, S. Sahni, S. Anderson-Freed, "Fundamentals of Data Structures in C", 2nd Edition, Silicon Press (US), 2007.

##### **References:**

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2<sup>nd</sup> Edition, Pearson, September, 1996
2. Robert Kruse, "Data Structures and Program Design in C", 2<sup>nd</sup> Edition, Pearson, November, 1990
3. Seymour Lipschutz, "Data Structures with C (Schaum's Outline Series)", McGrawhill, 2017
4. A. M. Tenenbaum, "Data structures using C". Pearson Education, India, 1<sup>st</sup> Edition 2003.
5. Weiss M.A., "Data structures and algorithm analysis in C++", Pearson Education, 2014.

<b>Paper Code(s): CIC-211</b>	<b>L</b>	<b>P</b>	<b>C</b>
<b>Paper: Object-Oriented Programming Using C++</b>	<b>4</b>	<b>-</b>	<b>4</b>

**Marking Scheme:**

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

**Instructions for paper setter:**

1. There should be 9 questions in the term end examinations question paper.
2. The first (1<sup>st</sup>) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

**Course Objectives :**

1. To introduce the basic Concepts of Object Oriented Programming (data types, operators and functions) using C++
2. To introduce concepts of Classes and Objects with the examples of C++ programming
3. To understand object oriented features such as Inheritance and Polymorphism
4. To use various object oriented concepts (exceptional handling) to solve different problems

**Course Outcomes (CO)**

**CO 1** Ability to have an in-depth knowledge of object oriented programming paradigm

**CO 2** To be able to develop basic C++ programming skills

**CO 3** To be able to apply various object oriented features using C++

**CO 4** Ability to have an understanding of generic programming & standard templates

**Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)**

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
<b>CO 1</b>	3	2	2	2	3	-	-	-	3	2	2	3
<b>CO 2</b>	3	2	2	2	3	-	-	-	3	2	2	3
<b>CO 3</b>	3	2	2	2	3	-	-	-	3	2	2	3
<b>CO 4</b>	3	2	2	2	3	-	-	-	3	2	2	3

**UNIT – I**

Object Oriented Programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of Object Oriented Programming, Object Oriented Languages, Applications of Object Oriented Programming, C++ Programming Language, Tokens, Keywords, Identifiers and Constants, Data Types, Type Compatibility, Variables, Operators in C++, Implicit Type Conversions, Operator Precedence, The Main Function, Function Prototyping, Call by Reference, Return by Reference, Inline Functions, Function Overloading, Friend Functions, default parameter value.

**UNIT – II**

Specifying a class, Member Functions, Encapsulation, information hiding, abstract data types, objects & classes, Static Member Functions, Arrays of Objects, Constructors & Destructors, Parameterized Constructors, Copy Constructors, Dynamic Constructors, Destructors, identity and behaviour of an object, C++ garbage collection, dynamic memory allocation, Explicit Type Conversions, Operator Overloading.

**UNIT – III**

Inheritance, inheritance methods, Class hierarchy, derivation – public, private & protected, aggregation,

Inheritance Constructors, composition vs. classification hierarchies, Containership, Initialization List, Polymorphism, categorization of polymorphic techniques, polymorphism by parameter, parametric polymorphism, generic function – template function, function overriding, run time polymorphism, virtual functions.

**UNIT – IV**

Standard C++ classes, using multiple inheritance, persistant objects, streams and files, namespaces, exception handling, generic classes, standard template library: Library organization and containers, standard containers, algorithm and Function objects, iterators and allocators, strings, streams, manipulators, user defined manipulators, vectors.

**Textbook(s):**

1. Stanley B. Lippman, Josée Lajoie, Barbara E. Moo, "C++ Primer", Addison-Wesley Professional, 2012.
2. Ivor Horton, "Using the C++ Standard Template Libraries", Apress, 2015.
3. R. Lafore, "Object Oriented Programming using C++", Galgotia.

**References:**

1. A.R.Venugopal, Rajkumar, T. Ravishankar "Mastering C++", TMH
2. Bjarne Stroustrup, "Programming: principles and practice using C++", Addison-Wesley, 2015.
3. Bjarne Stroustrup, "A Tour of C++", Addison-Wesley Professional, 2018.
4. Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison-Wesley Professional, 2013.
5. Peter Van Weert and Marc Gregoire, "C++17 Standard Library Quick Reference: A Pocket Guide to Data Structures, Algorithms, and Functions", Apress (2019)
6. Rumbaugh et. al. " Object Oriented Modelling & Design", Prentice Hall
7. G . Booch "Object Oriented Design & Applications", Benjamin,Cummings.
8. E.Balaguruswamy, "Object Oriented Programming with C++", TMH
9. Steven C. Lawlor, "The Art of Programming Computer Science with C++", Vikas Publication.
10. Slobodan Dmitrović, Modern C++ for Absolute Beginners":A Friendly Introduction to C++ Programming Language and C++11 to C++20 Standards", Apress, 2020.

Fifth Semester						
Group	Paper Code	Paper	L	P	Credits	
<b>Theory Papers</b>						
HS/MS	HS-301	Economics for Engineers	2		2	
PC	CIC-303	Compiler Design	3		3	
PC	CIC-305	Operating Systems	4		4	
PC	CIC-307	Computer Networks	4		4	
PC	CIC-309	Software Engineering	3		3	
PC	CIC-311	Design and Analysis of Algorithm	4		4	
<b>Practical / Viva Voce</b>						
PC	CIC-351	Compiler Design Lab		2	1	
PC	CIC-353	Operating Systems Lab		2	1	
PC	CIC-355	Computer Networks Lab		2	1	
PC	CIC-357	Software Engineering Lab		2	1	
PC	CIC-359	Design and Analysis of Algorithm Lab		2	1	
PC / Internship	ES-361	Summer Training Report - 1 *			1	
<b>Total</b>		-	<b>20</b>	<b>10</b>	<b>26</b>	

\***NUES:**Comprehensive evaluation of the Summer Training Report – 1 (after 4<sup>th</sup> Semester) shall be done by the committee of teachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

Sixth Semester						
Group	Paper Code	Paper	L	P	Credits	
<b>Theory Papers</b>						
HS/MS	MS-302	Principles of Management for Engineers	3		3	
HS/MS	HS-304	Universal Human Values*	1		1	
PCE		Programme Core Elective Paper (PCE –1)			4	
PCE		Programme Core Elective Paper (PCE – 2)			4	
PCE		Programme Core Elective Paper (PCE – 3)			4	
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 1 /OAE – 1)			4	
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 2 /OAE – 2)			4	
<b>Practical / Viva Voce</b>						
HS/MS	HS-352	NSS / NCC / Cultural Clubs / Technical Society / Technical Club**			2	
<b>Total</b>					<b>26</b>	

\***NUES:**All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

\*\***NUES:** Comprehensive evaluation of the students by the concerned coordinator of NCC / NSS / Cultural Clubs / Technical Society / Technical Clubs, out of 100 as per the evaluation schemes worked out by these activity societies, organizations; the faculty co-ordinators shall be responsible for the evaluation of the same. These activities shall start from the 1<sup>st</sup> semester and the evaluation shall be conducted at the end of the 6<sup>th</sup> semester for students admitted in the first semester. Students admitted in the 2<sup>nd</sup> year (3<sup>rd</sup> semester) as lateral entry shall be evaluated on the basis their performance, by the faculty co-ordinator for the period of 3<sup>rd</sup> semester to 6<sup>th</sup> semester only.