Curriculum for Undergraduate Degree (B.Tech.) in Information Technology (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Fourth Semester

Course Name:	**Discrete Mathematics**		
Course Code:	ES-IT401	**Category:**	Engineering Science Course
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To use mathematical logics and Boolean algebra in the field of computer applications.
2	To know about Set-Relation-Function and Group theory.
3	To learn counting techniques and number theory.
4	To use the concept of graph theory in engineering problems.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Sets-Relation-Function:** ➢ Operations and Laws of Sets ➢ Cartesian Products, Binary Relation, Equivalence Relation, Partial Ordering Relation, Lattice **Number Theory** ➢ Proofs by Mathematical Induction ➢ The Division Algorithm, Prime Numbers, The Greatest Common Divisor, Euclidean Algorithm, The Fundamental Theorem of Arithmetic	**10L**
2	**Combinatorics:** ➢ Basic Counting Techniques, Inclusion and Exclusion Theorem ➢ Permutation and Combination ➢ Pigeon-Hole Principle	**6L**
3	**Propositional Logic and Proofs:** ➢ Basic Connectives and Truth Tables of propositional logics, Disjuntive and Conjuntive Normal Form using	**8L**

	truth table, Argument ➢ Quantifiers and their uses ➢ Proofs; Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof by Mathematical Induction ➢ The Laws of Logic, Logical Implication, Rules of Inference	
4	**Algebraic Structures and Boolean Algebra:** ❖ **Algebraic Structures with one Binary Operator** ➢ Group, Subgroup, Cyclic group, Permutation group, Symmetric group. ➢ Coset, Lagrange's Theorem, Normal Subgroup, Quotient group ➢ Homomorphism and Isomorphism of groups ❖ **Algebraic Structures with two Binary Operators** ➢ Rings, Integral Domain and Fields ❖ **Boolean Algebra** ➢ Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form ➢ Switching network from Boolean expression using Logic Gates ➢ Karnaugh Map	**10L**
5	**Advanced Graph Theory:** ➢ Planar and Dual graph: Kuratowski's graphs, Euler's formulae for connected and disconnected planar graphs, Detection of planarity ➢ Graph Coloring: Vertex coloring, Chromatic number of complete graph, circuit and bipartite graph, Chromatic polynomial ➢ Connectivity and matching	**6L**
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Express a logic sentence in terms of predicates, quantifiers, and logical connectives
2	Derive the solution for a given problem using deductive logic and prove the solution based on logical inference
3	Classify its algebraic structure for a given a mathematical problem,
4	Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra
5	Develop the given problem as graph networks and solve with techniques of graph theory

Learning Resources:	
1	Russell Merris, Combinatorics, Wiley-Interscience series in Discrete Mathematics and Optimisation.
2	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
3	Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning
4	Gary Chartrand and Ping Zhang – Introduction to Graph Theory, TMH
5	J.K. Sharma, Discrete Mathematics, Macmillan
6	Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PRSEAON.
7	S. K. Chakraborty and B. K. Sarkar, Discrete Mathematics, OXFORD University Press.
8	Douglas B. West, Introduction to graph Theory, PHI
9	C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
10	R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
11	R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.
12	N. Deo, Graph Theory, Prentice Hall of India, 1974.
13	S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.
14	J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997.
15	Higher Algebra - S.K. Mapa
16	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
17	S.B. Singh, Discrete Structures – Khanna Publishing House (AICTE Recommended Textbook – 2018)
18	S.B. Singh, Combinatorics and Graph Theory, Khanna Publishing House (AICTE Recommended Textbook – 2018)

Course Name:	**Database Management System**		
Course Code:	PC-IT401	**Category:**	Professional Core
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Data Structure & Algorithms and Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand the different issues involved in the design and implementation of a database system.
2	To understand the physical and logical database designs, database modeling, relational, hierarchical, and network models
3	To understand the different constraints , i.e., the candidate keys, super-keys, that exists in a given real world problem and design the entity relationship diagram to graphically represent entities and their relationships to each other, typically used in computing in regard to the organization of data within databases or information systems
4	To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Database Model, Schema and system architecture:** Overview of database and DBMS, Advantages of using DBMS approach, Database Users, Database Administrator, Database applications. Data Models and its categories, Schema, Instances, Database Languages, Three Schema architecture of DBMS, Data independence, Centralized and client server architecture for DBMS.	**4L**
2	**Entity-Relationship Model:** Basic concepts, Design Issues, Cardinality, Super Keys, Candidate keys, Entity types, Entity sets, attributes and keys. Relationship types, Relationship sets, Attributes of relationship types, Weak Entity Sets , ER diagram design issues, Extended E-R modeling: generalization, specialization, aggregation.	**5L**
3	**Relational Model:** Concepts of domains, attributes, tuples, relations. Operators in relational algebra: select, project, rename, Cartesian product, different types of Join, Division, Intersect, Union, Minus. Tuple relational calculus, Domain relational calculus. **Operators in relational algebra**: Select, Project, Rename, Cartesian product, different types of Join, Division, Intersect, Union, Minus. Tuple relational calculus, Domain relational calculus.	**6L**
4	**Query processing**: Concept of DDL, DML, and DCL. Query structure, concept of sub query, group functions. View. PL/SQL basic structure, Control structure, Cursor, Triggers. .	**4L**
5	**Relational Database Design:** Domain constraints, entity integrity, referential integrity constraints. Concept of null and not null constraint Basic concept of functional dependency, Axioms, Closure, Attribute closure, Equivalent set of FD, Cover, Canonical cover.	**4L**
6	**Normalization:** Concept of Super keys, Candidate keys, primary keys.	**8L**

	Determining candidate keys from FD. Different anomalies in designing Database. 1NF, 2NF,3NF and Boyce-Codd Normal Form. Normalization using multi-value dependencies and join dependency. Dependency preservation, Lossless decomposition, De-normalization in Databases, Query Optimization.	
7	**Transaction processing:** ACID property, States, Concurrency control techniques, Serializability of scheduling, Locking and timestamp based schedulers, Database recovery.	**8L**
8	**Storage strategies:** File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .	**5L**
Total		**44L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the terms related to Database Design and Management.
2	Construct and normalized conceptual database model.
3	Understand database concept, structure and the issues related to database performance.

Learning Resources:	
1	Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2	Elmasri Ramez and Navathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing Company.
3	Ramakrishnan: Database Management System , McGraw-Hill
4	Gray Jim and Reuter Address, "Transaction Processing: Concepts and Techniques", Moragan Kauffman . Publishers.
5	Jain: Advanced Database Management System CyberTech
6.	Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
7.	Ullman JD., "Principles of Database Systems", Galgottia Publication.
8	James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
9	"Fundamentals of Database Systems", Ramez Elmasri, Shamkant B. Navathe, Addison Wesley Publishing Edition
10	"Database Management Systems", Arun K. Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

Course Name:	**Design and Analysis of Algorithms**

Course Code:	PC-IT402	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	3
L-T-P:	3-1-0	**Pre-Requisites:**	PC-IT301(Data Structure & Algorithm)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To analyse the asymptotic performance of algorithms.
2	To be familiar with major algorithms and data structures.
3	To apply important algorithmic design paradigms and methods of analysis.
4	To Synthesize efficient algorithms in common engineering design situations.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Characteristics of algorithm; Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behaviour; Performance measurements of Algorithm, Time and space trade-offs; Analysis of recursive algorithms through recurrence relations: Iterative method, Substitution method, Recursion tree method and Masters' theorem.	**8L**
2	**Fundamental Algorithmic Strategies:** Divide and Conquer, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem.	**10L**
3	**Graph and Tree Algorithms:** Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.	**10L**
4	**Tractable and Intractable Problems:** Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques.	**8L**
5	**Advanced Topics:** Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE	**4L**
Total		**40L**

Course Outcomes:

After completion of the course, students will be able to:	
1	Analyse a given algorithm for worst-case running times based on asymptotic analysis and justify the correctness of algorithms.
2	Describe the different categories of algorithm and explain when an algorithmic design needs call for an appropriate category, also to synthesize and analyse it in terms of computational complexity
3	Model a given engineering problem using graph and write the corresponding algorithm to solve the problems.
4	Explain the ways to analyse randomized algorithms (expected running time, probability of error).
5	Explain what an approximation algorithm is and to compute the approximation factor of an approximation algorithm

Learning Resources:	
1	"Algorithm Design", 1ST Edition, Jon Kleinberg and Éva Tardos, Pearson.
2	"Algorithm Design: Foundations, Analysis, and Internet Examples", Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
3	"Algorithms - A Creative Approach", 3RD Edition, Udi Manber, Addison-Wesley, Reading, MA
4	"Fundamentals Of Computer Algorithms" by Horowitz, Sahani, Universities Press

Course Name:	**Formal Language and Automata Theory**		
Course Code:	PC-IT403	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Elementary discrete mathematics, principle of mathematical induction
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Be able to construct finite state machines and the equivalent regular expressions.
2	Be able to prove the equivalence of languages described by finite state machines and regular expressions
3	Be able to construct push down automata and the equivalent context free grammars.
4	Be able to prove the equivalence of languages described by push down automata and context free grammars.
5	Be able to construct Turing machines and Post machines.
6	Be able to prove the equivalence of languages described by Turing machines and Post machines

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.	**4L**
2	**Regular languages and finite automata:** Regular expressions and languages, deterministic finite automata(DFA) and equivalence with regular expressions, non-deterministic finite automata(NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata)	**9L**
3	**Context-free languages and push down automata:** Context-free grammars(CFG) and languages(CFL),Simplification of CFG, Chomsky and Greibach normal forms, non-deterministic push down automata(PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic push down automata, push down automata and CFL, closure properties of CFLs.	**9L**
4	**Context-sensitive languages:** Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	**4L**
5	**Turing machines:** The basic model for Turing machines(TM),Turing recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, non- deterministic TM sand equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines,TMs as enumerators	**9L**
6	**Undecidability:** Church Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice's theorem, un decidable problems about languages	**5L**
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Design FAs, NFAs, RE, Grammars, languages modeling
2	Design PDA and CFL modeling
3	Describe the formal relationships among machines, languages and grammars

Learning Resources:	
1	John E. Hopcroft, Rajeev Motwani and Jeffrey D.Ullman, Introduction to Automata

	Theory, Languages, and Computation, Pearson Education Asia.
2	Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.
3	Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
4	Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
5	John Martin, Introduction to Languages and The Theory of Computation, Tata McGraw Hill., PEARSON.
6	Dr. R.B. Patel, Theory of Computation, Khanna Publishing House
7	Mishra, Theory of Computers, PHIP ublications

Course Name:	**Numerical Methods**		
Course Code:	BSM-404	**Category:**	Basic Science Course
Semester:	Fourth	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus and statistics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To compute different numerical errors in computations.
2	To learn interpolation techniques.
3	To apply the techniques for solving integrations, ODEs.
4	Solve linear and non-linear equations.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Approximation in numerical computation:** Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors.	**2L**
2	**Interpolation:** Newton's Forward Interpolation, Newton's Backward Interpolation, Lagrange's Interpolation, Newton's Divided Difference Interpolation	**4L**
3	**Numerical integration:** General Quadrature Formula, Trapezoidal Rule, Simpson's1/3Rule, Expression for corresponding error terms	**3L**
4	**Numerical solution of a system of linear equations:** Gauss Elimination Method, Matrix Inversion, LU Factorization Method, Gauss-Seidel Iterative Method	**6L**
5	**Numerical solution of Non-Linear equation:** Bisection Method,	**4L**

	Regula-Falsi Method, Newton-Raphson Method	
6	**Numerical solution of ordinary differential equation:** Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, Finite Difference Method	**5L**
7	**Measure of Central Tendency and Dispersion:** Mean, median, mode and S.D.	**3L**
8	**Curve Fitting by Method of Least Square:** Fitting a straight line of the form $y = a + bx$, Fitting a curve of the form $y = ax + bx^2$, $y = ab^x$, $y = ae^{bx}$, $y = ax^b$.	**3L**
Total		**30L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2	Apply numerical methods to obtain approximate solutions to mathematical problems.
3	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4	Analyse and evaluate the accuracy of common numerical methods.

Learning Resources:	
1	C.Xavier: C Language and Numerical Methods.
2	A. K. Jalan and Utpal Sarkar, Numerical Methods - A Programming Based Approach, Orient Blackswan Private Ltd.
3	Dutta & Jana: Introductory Numerical Analysis.
4	J.B. Scarborough: Numerical Mathematical Analysis.
5	Jain, Iyengar & Jain: Numerical Methods (Problems and Solution).
6	Balagurusamy: Numerical Methods, Scitech.
7	Baburam: Numerical Methods, Pearson Education.
8	N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
9	Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
10	Srimanta Pal: Numerical Methods, OUP

Course Name:	**Biology**		
Course Code:	BS-BIO401	Category:	Basic Science Course
Semester:	Fourth	Credit:	2
L-T-P:	2-0-0	Pre-Requisites:	Basic knowledge of Physics, Chemistry and Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Bring out the fundamental differences between science and engineering
2	Discuss how biological observations of 18th Century that lead to major discoveries

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Module 1- Introduction to Biology:** To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	**2L**
2	**Module2-Classification System in Biology:** The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. *E. coli, S. cerevisiae, D. melanogaster, C. elegance, A. thaliana, M. musculus.*	**2L**
3	**Module 3: Genetics:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics.	**2L**

	Emphasis to be given not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Importance of stem cell research.	
4	**Module 4: Biomolecules**: To convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA.	**4L**
5	**Module 5: Enzymes:** To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Discuss at least two examples.	**2L**
6	**Module 6: Information Transfer:** The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	**4L**
7	**Module 7: Macromolecular analysis:** How to analyse biological processes at the reductionist level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	**4L**
8	**Module 8: Metabolism:** ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.	**2L**
9	**Module 9: Microbiology:** Concept of microscopic organisms. Concept of species and strains. Identification and classification of microorganisms. Sterilization and media compositions. Growth kinetics. Microscopy: simple, compound, phase-contrast, SEM, TEM, Confocal: principle and applications.	**2L**
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	State different engineering applications from biological perspective.

2	Classify biological systems and identify different organisms and microorganisms depending on their morphological, biochemical and ecological criterion.
3	Explain the concept of recessiveness and dominance during the passage of genetic material from parent to offspring and describe DNA as a genetic material in the molecular basis of information transfer.
4	Discuss structures of different biomolecules starting from basic units and hence understand different biological processes at the reductionistic level.
5	Describe protein structures and enzymology and also compare different mechanisms of enzyme action.
6	Describe energy transformation processes in biological systems.

Learning Resources:	
1	Biology for Engineers. Arthur T. Johnson. CRC Press.
2	Biology and Engineering of Stem Cell Niches. A K Vishwakarma and Jefferey Karp, Elsevier.
3	Environmental Biology for Engineers and Scientists. David A. Vaccari, P. P. Storm and J. F Alleman. ELBS
4	Biology for Engineers. G. K. Suraishkumar. Oxford.

Course Name:	**Database Management System Lab**		
Course Code:	PC-IT491	**Category:**	Professional Core
Semester:	Fourth	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Basic concepts of Data Structure & Algorithms
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Creating database objects
2	Modifying database objects
3	Manipulating the data
4	Retrieving the data from the database server
5	Experiment with implementing event oriented programming using PL/SQL TRIGGER and CURSOR, and also implement user defined functions to solve real world problem.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Creating Database objects:** Creating a Table, Specifying Relational Data Types, Specifying Constraints, DROP, ALTER statements, Creating an object structure from another existing structure.	4P
2	**Table and Record Handling:** INSERT statement, DELETE, UPDATE, TRUNCATE statements, Populating data from other tables using insert and select together	8P
3	**Retrieving Data from a Database:** The SELECT statement, Using the WHERE clause, Using Logical Operators in the WHERE clause ,Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING Clause, Using Aggregate Functions , Combining Tables Using JOINS , Sub-queries.	8P
4	**Database Management:** Creating Views, Creating Column Aliases, Creating Database Users, Using GRANT and REVOKE.	4P
5	**Writing Oracle PL / SQL Stored Procedures:** Conditional /Iterative Statements, Introduction to Functions and Stored procedures Exception Handling.	12P
6	**Cursors in Oracle PL / SQL:** Cursor and its application. Triggers.	8P
Total		**44P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Design and implement a database schema for a given problem-domain
2	Create and maintain tables using PL/SQL
3	Populate and query a database.

Learning Resources:	
1	SQL, PL/SQL the Programming Language of Oracle by Ivan Bayross.
2	SQL in 10 Minutes, Sams Teach Yourself (4th Edition)
3	SQL The Complete Reference by Groff James.
4	SQL: Quick Start Guide – The Simplified Beginner's Guide To SQL by Clydebank Technology
5	Oracle PL/SQL Programming by Feuerstein, Steven.

Course Name:	**Design and Analysis of Algorithms Lab**		
Course Code:	PC-IT492	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	PC-IT391(Data Structure & Algorithm Lab)
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To develop skills to design and analyse fundamental algorithms
2	To strengthen the ability to identify and apply the suitable algorithm for the given real world problem
3	To gain knowledge in practical applications and role of computational complexity to determine the efficiency of an algorithm

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
UNIT - I Divide and Conquer Methodology:		
1,2	Implement Binary Search algorithm using recursive call to a function. Find Maximum and Minimum element of an array of integers using recursive call to a function.	**4P**
3,4	Implement Merge Sort algorithm using recursive call to a function. Implement Quick Sort algorithm using recursive call to a function.	**4P**
UNIT - II Dynamic Programming Technique :		
5,6	Find the minimum number of scalar multiplications needed for multiplying chain of matrices. Implement Traveling Salesman problem.	**4P**
UNIT – IIIGreedy Methods:		
7,8	Implement Knapsack Optimization problem. Implement optimization problem of Job Sequencing with Deadlines.	**4P**
UNIT - IV Graph Algorithm :		
9-15	Implement Breadth First Search (BFS) algorithm. Implement Depth First Search (DFS) algorithm. Find the Minimum Cost Spanning Tree of a graph by applying Prim's algorithm. Find the Minimum Cost Spanning Tree of a graph by applying Kruskal's algorithm. Implement Single Source shortest path finding algorithm for a graph	**12P**

	proposed by Dijkstra. Implement Single Source shortest path finding algorithm for a graph proposed by Bellman-Ford. Implement all pair of shortest path finding algorithm of a graph proposed by Floyed &Warshall.	
UNIT - V Branch and Bound Technique :		
16	Implement 15-Puzzle problem.	**4P**
UNIT - VI Backtracking :		
17-19	Implement the problem of placing 8 Queens on a chess board in non-attacking positions. Implement the problem of Colouring a Graph using minimum number of colours. Implement the algorithm for finding the presence of Hamiltonian cycle in a graph.	**8P**
Total		**40P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Design and analyze the time and space efficiency of the algorithm.
2	Identity and analyze the appropriate algorithm for given problem.
3	Have practical knowledge on the application of efficient algorithm.

Learning Resources:	
1	"Algorithm Design", 1ST Edition, Jon Kleinberg and Éva Tardos, Pearson.
2	"Algorithm Design: Foundations, Analysis, and Internet Examples", Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
3	"Algorithms -- A Creative Approach", 3RD Edition, Udi Manber, Addison-Wesley, Reading, MA
4	"Fundamentals Of Computer Algorithms", by Horowitz, Sahani, Universities Press

Course Name:	**Numerical Methods Lab**

Course Code:	BSM494	**Category:**	Basic Science Course
Semester:	Fourth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus and statistics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To compute different numerical errors in computations.
2	To learn interpolation techniques.
3	To apply the techniques for solving integrations, ODEs.
4	Solve linear and non-linear equations.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Assignments on Interpolation:** Newton's Forward Interpolation, Newton's Backward Interpolation, Lagrange's Interpolation	**4P**
2	**Assignments on Numerical Integration:** Trapezoidal Rule, Simpson's 1/3 Rule	**4P**
3	**Assignments on Solution of Transcendental Equations:** Bisection Method, Regula-Falsi Method, Newton-Raphson Method	**4P**
4	**Assignments on ODEs:** Euler's Method, Runge-Kutta Method of Order Four	**4P**
5	**Curve Fitting by the Method of Least Squares:** Fitting a straight line of the form $y = a + bx$, Fitting a curve of the form $y = ax + bx^2$, $y = ab^x, y = ae^{bx}, y = ax^b$	**4P**
6	**Measure of Central Tendency:** Mean and Standard Deviation, Median and Mode	**2P**
7	**Assignments on Numerical Solution of a system of Linear Equations:** Gauss Elimination Method, Gauss-Seidel Method	**2P**
Total		**24P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2	Apply numerical methods to obtain approximate solutions to mathematical problems.
3	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4	Analyse and evaluate the accuracy of common numerical methods.

Learning Resources:	
1	C. Xavier: C Language and Numerical Methods.
2	A. K. Jalan and Utpal Sarkar, Numerical Methods - A Programming Based Approach, Orient Blackswan Private Ltd.
3	Dutta & Jana: Introductory Numerical Analysis.
4	J.B.Scarborough: Numerical Mathematical Analysis.
5	Jain, Iyengar, & Jain: Numerical Methods (Problems and Solution).
6	Balagurusamy: Numerical Methods, Scitech.
7	Baburam: Numerical Methods, Pearson Education.
8	N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
9	Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
10	Srimanta Pal: Numerical Methods, OUP

Course Name:	**Environmental Sciences**		
Course Code:	MC471	**Category:**	Basic Science Courses
Semester:	Fourth	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Basic concepts of Environmental Science
Full Marks:	100		
Examination Scheme:	Semester Examination: 100		

Course Objectives:	
1	Purpose: We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times.

2	Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two types of activities.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**(a) Awareness Activities:** i) Small group meetings about any of the topic. ii) Slogan making event iii) Poster making event iv) Seminar on any of the topic. v) Preparation of a report on any of the topic regarding current scenario.	4L 2L 5L 4L 4L
2	**(b) Actual Activities:** i) Plantation ii) Gifting a tree to see its full growth iii) Cleanliness drive iv) Drive for segregation of waste v) Shutting down the fans and ACs of the campus for an hour or so	5L
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain basic concepts, man, society & environment, their interrelationship, mathematics of population growth and associated problems, steady state conservation system.
2	Demonstrate natural environmental hazards like flood, earthquake, landslide-causes, effects and control/management.
3	Classify air pollution, water pollution, land pollution, noise pollution and their controls.
4	Study Elements of ecology and environmental management.

Learning Resources:	
1	M. P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House, New

	Delhi, 2019
2	Environmental science by Gillbert G. Master