Curriculum for Undergraduate Degree (B.Tech.) in Electronics and Communication (VLSI Design) (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Third Semester

Course Name:	**Analog Electronic Circuits**		
Course Code:	PC-EC302	**Category:**	Professional Core
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electrical & Electronics ES-EE 101
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To impart basic concept of diode circuits and transistor biasing.
2	To impart knowledge about low frequency transistor models, using such models for estimation of transistor performance parameters.
3	To understand the different feedback topologies and amplifier classes.
4	To understand the basic principle of operation of various oscillators.
5	To develop an insight into the construction and working of OPAMPS and its applications.
6.	To explain design aspects of simple circuits.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Diode Circuits and Transistor Amplifier**: Rectifiers & Filters , Clipper, Clamper. Biasing schemes for BJT, JFET and MOSFET amplifiers, bias stability of CE/CS configuration, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance, design procedure for particular specifications, h-parameter analysis, Darlington Pair, Multi Stage Amplifier RC Coupled & Transformer Coupled ,Frequency response - effect of coupling and bypass capacitor, Current source biasing(Current mirror circuits).	12
2	**Amplifier Models and Feedback Topologies:** High frequency transistor models, frequency response of single stage amplifiers, CE Short Circuit current gain, Concept of Gain & bandwidth product.	10

	Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth, I/P & O/P impedance, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans resistance.	
3	**OPAMP**: Basic structure and characteristics, Differential amplifier: Basic structure and principle of operation, frequency response of OPAMP, Application of Current Mirror biasing in OPAMP, Output Stage, Single pole model. OP-AMP applications: Inverting and non-inverting amplifiers, Integrator and differentiator, summing amplifier, Log-Antilog amplifiers, Comparator, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop.	10
4	**Oscillators & Power Amplifiers**: Review of the basic concept Barkhausen criterion, RC oscillators(phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), Multivibrators (Monostable, Astable and Bistable),Study on 555 timer ICs, Various classes of operation (Class A, B, AB, C etc.), Harmonic distortion, Power Output , Push-Pull Amplifier, Complementary Symmetry circuits.	10
Total		**42**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the operation of simple circuits with transistor, op-amp, amplifiers, oscillators.
2	Design of simple circuits with op-amp, amplifiers and oscillators.
3	Solve simple design based problems related to circuits using diodes, transistors and OPAMPS.
4	Analyze simple circuits with transistor and op-amps.

Learning Resources:	
1	Boylestade & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
2	Millman & Halkias - Electronics Devices and Circuits- TMH
3	Sedra & Smith-Microelectronic Circuits- Oxford UP
4	Malvino—Electronic Principles , 6/e , McGraw Hill
5	Franco—Design with Operational Amplifiers & Analog Integrated Circuits , 3/e, McGraw Hill
6	Schilling & Belove—Electronic Circuit:Discrete & Integrated , 3/e , McGraw Hi

Course Name:	**Signals and Systems**		
Course Code:	PC-EC303	**Category:**	Professional Core
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	BS-M201 Mathematics-II
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Knowledge about basic signal and system modeling concept and definitions.
2	Knowledge about the application and use of mathematical transform in order to solve Electronics Engineering problems.
3	Knowledge in the use of a modern computation software tool for the analysis of Electronics engineering problems.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1.	**Introduction to signal:** Overview of Continuous and discrete time Signals, Introduction to elementary Signals: unit Impulse, unit Step, Ramp, Exponential, Sinusoidal etc., Classification of Signals: Even and Odd, Energy and Power, Periodic and Aperiodic etc., Mathematical Operations on Signals: Folding, Time Scaling, Time Shifting etc.	6
2.	**Introduction to Systems & Signal Transformation:** Overview of System, Classification of Continuous and Discrete Time Systems, System properties: Linearity, Causality, Time Invariance and Stability, Overview of Impulse response and System Response in LTI System, Linear and Circular Convolution, Interconnections of Continuous and Discrete Time Systems.	6
3.	**Laplace Transform:** Introduction to Laplace Transform, Region of Convergence (ROC), Properties of Laplace Transform, Representation of Poles and Zeros in 'S' Plane, Analysis of Continuous LTI system using Laplace Transform, Convolution & De-Convolution using Laplace Transform, Stability in 'S' Domain, Structure Realization of Continuous LTI system in 'S' Domain.	4
4.	**Fourier Series:** Introduction to Fourier Series, Dirichlet's Conditions, Determination of Trigonometric and Exponential Fourier Series Coefficients of various Types of Periodic Signals.	4
5.	**Fourier Transform:** Introduction to Fourier Transform, Properties of Fourier Transform, Discrete time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Overview of FFT algorithm, Gibbs Phenomenon, Parseval's Theorem, System Characterized by Linear	6

	Constant Co-efficient Differential Equations.	
6.	**Sampling Theorem:** Representation of Continuous Time Signals by its Sample –Types of Sampling, Sampling theorem. Reconstruction of a Signal from its Samples, Aliasing –Sampling of Band pass signals.	4
7.	**Z-Transforms**: Introduction to Z- Transformation Technique, Properties of Z-transform, Relationship between Z- transform and Fourier Transform, Region of Convergence (ROC), Properties of ROC, Inverse Z-Transform, Structure realization of LTI discrete Time Systems in Z-Domain.	6
8.	**Random Signal Theory and Noise Signal**: Basic Concept of Probability Density Function, Cumulative Distribution Function, Mean and Variance, Introduction to Gaussian Function, White Gaussian Noise.	4
Total		**40**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Analyze different types of Signals.
2	Represent continuous and discrete systems in time and frequency domain using different transforms.
3	Investigate the stability of the systems.
4	Sampling and Reconstruction of Signals.

Learning Resources:	
1	A.Nagoor Kani- Signals and Systems- McGraw Hill
2	P.Ramesh Babu & R.Anandanatarajan- Signals and Systems 4/e- Scitech
3	A.V.Oppenheim, A.S.Willsky and S.H.Nawab -Signals & Systems, Pearson
4	S.Haykin & B.V.Veen, Signals and Systems- John Wiley

Course Name:	**Network Theory**		
Course Code:	PC-EC304	**Category:**	Professional Core
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electrical and Electronics Engineering ES-EE101
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To have a basic knowledge in the analysis of DC & AC Networks
2	To solve the given circuit with various theorems and methods
3	To relate various two port parameters and transform them
4	To analysis the transient and steady state characteristics of RC-RL-RLC circuits
5	To design and develop different passive low pass, high pass and band passfilters
6	To synthesize the AC networks from driving point Impedance and admittance

Course Contents:

Module No.	Description of Topic	Contact Hrs.
01	Basic knowledge of Mesh and Node, KCL and KVL analysis, Thevenin's, Norton's, Superposition, reciprocity, Millman's, Maximum power Transfer, compensation,Reciprocity and Tallegen's theorem as Applied to DC and AC. circuits.	9
02	Network graph theory, Cut-set and Tie set networks and its approach to the network containing voltage and current sources	3
03	Transient and steady state condition of AC networks for DC source analysis, analysis of RC, RL and RLC networks with initial condition	4
04	Laplace transform and its application in RL, RC, RLC network analysis, Initial and final value theorems, DC Circuit Analysis, Poles and Zeros analysis of driving point impedance & admittance function.	3
05	Trigonometric and exponential Fourier series: Dirichlet's condition Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs	3
06	Magnetic coupling, polarity of coils, polarity of induced voltage, concept of Self and mutualinductance, Coefficient of coupling	3
07	Two port networks; Z,Y, h and ABCD parameters and their analysis	4
08	Resonant Circuits: Series and Parallel resonance, Impedance and Admittance Characteristics, Quality Factor, Half Power Points, Bandwidth, Phasor diagrams	3
09	Introduction of low pass, high pass and band pass passive filters	2
10	Basic idea of circuit synthesis by using Foster and Cauer rule	2
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand of basic electrical circuit with nodal and mesh analysis
2	Appreciate different network theorems
3	Apply Laplace transform for transient and steady state behavior
4	Analyze passive circuits using various network parameters
5	Design different types of passive AC networks and filters

Learning Resources:	
1	M.E. Vanvulkenburg, NETWORK THEORY, prentice hall of india
2	Hayt & Kimmerly, Enginnering circuit analysis, McGraw-hill education
3	Edminister J.A.: "Theory & Problems of Electric Circuits", McGraw-Hill Co.
4	Sudhakar: "Circuits & Networks:Analysis & Synthesis" 2/e TMH

Course Name:	**Data Structure and Algorithm**		
Course Code:	ES-CS301	**Category:**	Engineering Science
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming for Problem Solving (ES-CS201)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To impart basic concepts of data structures and algorithms.
2	To understand the concepts of searching and sorting techniques.
3	To understand basic concepts of stack, queue, list, tree and graph.
4	To develop capability of writing algorithm to solve a given problem with the help of fundamental data structures.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Basic Terminologies, Elementary Data Organizations Data Structure Operations: insertion, deletion, traversal etc.; Application of these on arrays. Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Sorting: Bubble sort algorithm and its complexity analysis. Searching: Linear Search and Binary Search Techniques and their complexity analysis.	6
2	ADT Stack and its operations: Algorithms and their complexity analysis Applications of Stacks: Expression Conversion and evaluation -corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.	8
3	Linked List: Singly linked lists: Representation in memory Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. Trees: Basic Tree	12

	Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Header nodes Binary Search Tree, AVL Tree, Tree operations on each of the Trees and their algorithms with complexity analysis. Application of Binary Trees, B Tree, B+ Tree: definitions, algorithms and analysis.	
4	Sorting: Objective and properties of different sorting algorithms: Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis, Shortest path algorithms. Hashing: Objective, Different methods of hashing, Collision: Different collision resolution methods, Application of hashing.	10
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Analyze an algorithm to determine the computational complexity.
2	Select and implement an appropriate technique to solve a given searching problem.
3	Implement the operation of stack, queue and linked list and analyze them to determine the computational complexity.
4	Implement different sorting algorithms and analyze their performance in terms of space and time complexities.
5	Implement and analyze the operation of different algorithms for trees and graphs.

Learning Resources:	
1	Data Structure through C, Seymour Lipschutz, Schaum's Outline Series, McGraw Hill, 2017
2	Data Structure Using C, Reema Thereja, Oxford University Press, 2nd Edition, 2014
3	Data Structure using C++, A. Tanenbaum, Pearson, 2nd Edition, 2015
4	Data Structure and Program Design in C, R. L. Kruse, B. P. Leung, C. L. Tondo, Prentice Hall of India, 1st Edition, 1990
5	Data Structure through C language, Samiran Chattopadhyay, Debabrata Ghosh Dastidar, Matangini Chattopadhyay, BPB Publications, 2010
6	Data Structures & Algorithms using C, R.S. Salaria, Khanna Publishing House, New Delhi, 5th Edition, 2018

Course Name:	**Discrete Mathematics**		
Course Code:	ES-CS302	**Category**:	Engineering Science
Semester:	Third	**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	10
2	**Combinatorics** Basic Counting Techniques, Inclusion and Exclusion Theorem, Permutation and Combination, Pigeon-Hole Principle	6
3	**Propositional Logic and Proofs** • Basic Connectives and Truth Tables of propositional logics, Disjunctive and Conjunctive Normal Form using truth table, Argument • Quantifiers and their uses • Proofs; Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof by Mathematical Induction	8

	• 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, Disjuntive and Conjuntive Normal Form • Switching network from Boolean expression using Logic Gates • Karnaugh Map	10
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	6
Total		40

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	S.B. Singh, Discrete Structures – Khanna Publishing House (AICTE Recommended Textbook – 2018)
17	S.B. Singh, Combinatorics and Graph Theory, Khanna Publishing House (AICTE Recommended Textbook – 2018).

Course Name:	**Numerical Methods**		
Course Code:	BS-M304	**Category**:	Basic Science
Semester:	Third	**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.	2
2	Interpolation: Newton's Forward Interpolation, Newton's Backward Interpolation, Lagrange's Interpolation, Newton's Divided Difference Interpolation	4
3	Numerical integration: General Quadrature Formula, Trapezoidal Rule, Simpson's 1/3 Rule, Expression for corresponding error terms	3
4	Numerical solution of a system of linear equations: Gauss Elimination Method, Matrix Inversion, LU Factorization Method, Gauss-Seidel Iterative Method	6
5	Numerical solution of Algebraic equation: Bisection Method, Regula-Falsi Method, Newton-Raphson Method	4
6	Numerical solution of ordinary differential equation: Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, Finite Difference Method	5
7	Measure of Central Tendency and Dispersion: Mean, median, mode and S.D.	3
8	Curve Fitting by Method of Least Square: Linear and Non-linear.	3
Total		**30**

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 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:	**Analog Electronic Circuits Lab**		
Course Code:	PC-EC392	**Category:**	Professional Core
Semester:	Third	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Basic Electrical & Electronics lab ES-EE191
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To impart concept of constructing circuits on breadboard with diodes, BJT and OPAMPs
2	To impart knowledge about amplifier and oscillator design.
3	To impart practical knowledge on OPAMP characteristics and application.
4	To be able to perform the experiments in sequential steps for determining various circuit parameters.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Conduct experiment to test diode clipping (single/double ended) and clamping circuits (positive/negative).	2
2	Design and set up the following rectifiers with and without filters and to determine ripple factor and rectifier efficiency: (a) Center Tap Full-wave Rectifier (b) Bridge Rectifier	4
3	Design a two-stage R-C coupled amplifier & determine of it's gain & Bandwidth.	4

4	Study the working of a class A and class B amplifier and calculate the efficiency.	2
5	Study of OPAMP741: characteristics-input bias current, input offset current, output offset voltage, offset null, CMRR, Slew Rate.	4
6	Study on OPAMP applications - summing amplifier, subtractor, active first order low pass and high pass filter.	6
7	Design a Wien Bridge Oscillator and determine the frequency of oscillation.	2
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain application and demonstrate diode as a clipper and clamper.
2	Experimentally determine efficiency and ripple factor of rectifiers.
3	Design amplifier and oscillator circuits, implement them practically & determine parameters from graph or calculation.
4	Characterize practical OPAMP and apply it to operational and filter circuits

Learning Resources:	
1	Boylestade & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
2	Millman & Halkias - Electronics Devices and Circuits- TMH
3	Sedra & Smith-Microelectronic Circuits- Oxford UP
4	Malvino—Electronic Principles , 6/e , McGraw Hill
5	Franco—Design with Operational Amplifiers & Analog Integrated Circuits , 3/e, McGraw Hill
6	Schilling & Belove—Electronic Circuit:Discrete & Integrated , 3/e , McGraw Hi
7.	Handbook of Analog Circuit Design Paperback .

Course Name:	**Network Theory Lab**		
Course Code:	PC-EC394	**Category:**	Professional Core
Semester:	Third	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Basic Electrical & Electronics lab ES-EE191
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To impart basic concept of constructing circuits on breadboard with passive and active components
2	To impart knowledge about circuit design.
3	To familiarize using modern tools & software

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	Transient response of R-L and R-C network: simulation with software/ hardware	2
2	Transient response of R-L-C series and parallel circuit: simulation with software/hardware	2
3	Determination of Impedance (Z) and Admittance (Y) parameter of two-port network: simulation/ hardware.	2
4	Frequency response of LP and HP filters: simulation & hardware.	2
5	Frequency response of BP and BR filters: simulation/ hardware.	2
6	Generation of Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, Ramp signal using MATLAB in both discrete and analog form.	2
7	Determination of Laplace transform and Inverse Laplace transform using MATLAB.	2
8	Amplitude and Phase spectrum analysis of different signals using MATLAB.	2
9	Verification of Network theorems(Thevenin's , Norton, Superposition) using software/ hardware with AC & DC source	2
Total		**18**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Analyze amplitude and phase spectrum of different signals.
2	Verify the network theorems. construct circuits with appropriate instruments and safety precautions
3	Apply the hardware knowledge for verification of circuits and systems
4.	Apply the modern tools for study of different transformation and circuits .

Learning Resources:	
1	Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers by Rudra Pratap (Author)
2	Getting Started With Matlab 7 by Rudra Pratap
3	Spice Circuits Electronics Pspice Paperback – Import, 1 October 1989 by M.H. Rashid

Course Name:	**Data Structure Lab**		
Course Code:	ES-CS391	**Category:**	Engineering Science
Semester:	Third	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Programming for Problem Solving Lab (ES-CS291)
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To handle arrays and matrices.
2	To implement different searching and sorting techniques.
3	To implement linked list, stack and queue.
4	To create and traverse BST and AVL trees.
5	To generate Hash table using hash function and collision resolution methods.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	Insert, delete and display an array and find the maximum and minimum elements of it.	2
2	Representing sparse matrix in 3-tupple format.	2
3	Linear search and binary search using array.	2
4	Sorting elements of an array using bubble sort, selection sort, insertion sort, quick sort and merge sort algorithms.	2
5	Insert, delete and display elements of a singly linked list.	2
6	Insert, delete and display elements of a doubly linked list.	2
7	Implementing stack (push, pop and display operations) using linked list.	2
8	Convert infix to postfix expression using stack.	2
9	Evaluate postfix expression using stack.	2
10	Implementing linear queue using linked list	2
11	Implementing circular queue using array.	2

12	Creating Binary Search Tree and traverse it in in-order, pre-order and post-order fashion.	2
13	Creating AVL Tree and traverse it in in-order, pre-order and post-order fashion.	2
14	Implementing Hash table incorporating collision resolution method.	2
Total		**28**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Handle arrays and matrices.
2	Implement different searching and sorting techniques.
3	Implement linked list, stack and queue.
4	Create and traverse BST and AVL trees.
5	Generate Hash table using hash function and collision resolution methods.

Learning Resources:	
1	Data Structure through C, Seymour Lipschutz, Schaum's Outline Series, McGraw Hill, 2017
2	Data Structure Using C, Reema Thereja, Oxford University Press, 2nd Edition, 2014

Course Name:	**Numerical Methods Lab**		
Course Code:	BS-M394	**Category:**	Basic Science
Semester:	Third	**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: 60	Continuous Assessment: 35	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(Ordinary Differential Equation).
4	Solve linear and non-linear equations

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	Assignments on Interpolation: Newton's Forward Interpolation, Newton's Backward Interpolation, Lagrange's Interpolation	4

2	Assignments on Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule	4
3	Assignments on Solution of Transcendental Equations: Bisection Method, Regula-Falsi Method, Newton-Raphson Method	4
4	Assignments on ODEs: Euler's Method, Runge-Kutta Method of Order Four	4
5	Curve Fitting by the Method of Least Squares: Fitting a straight line of the form, Fitting a curve of the form. $y = ax + bx^2$, $y = ab^x$,$y = ae^{bx}$,$y = ax^b$	4
6	Measure of Central Tendency: Mean and Standard Deviation, Median and Mode	2
7	Assignments on Numerical Solution of a system of Linear Equations: Gauss Elimination Method, Gauss-Seidel Method	2
Total		**24**

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 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	A. K. Jalan and Utpal Sarkar, Numerical Methods-A Programming Based Approach, Orient Blackswan Private Ltd.

Course Name:	**Environmental Sciences**		
Course Code:	MC371	**Category:**	Basic Science Courses
Semester:	Third	**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 type 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.	 4 2 5 4 4
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	 1 1 1 1 1
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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