NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY GREATER NOIDA, GAUTAM BUDDH NAGAR
(An Autonomous Institute)

Affiliated to

Dr. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY UTTAR PRADESH LUCKNOW

Evaluation Scheme & Syllabus

For

B. Tech in Electronics & Communication Engineering (ECE)

Second Year

(Effective from the Session: 2026-27)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY GREATER NOIDA
(An Autonomous Institute)

B. TECH (ECE)
Evaluation Scheme
SEMESTER III

S. No.	Subject Codes	Subject Name	Type of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	CCSCC0301	Employability Skill Development - I	Mandatory	2	0	0	60	40	100				100	2
2	CEC0304	Signal Systems and Networks	Mandatory	2	0	0	30	20	50		50		100	2
3	CEC0301	Analog and Digital Communication	Mandatory	3	0	0	30	20	50		100		150	3
4	CEC0303	Computational Intelligence	Mandatory	2	0	0	30	20	50		50		100	2
5	CEC0302	CMOS Digital Integrated Circuit	Mandatory	3	0	0	30	20	50		100		150	3
6	CASL0301	Technical Communication	Mandatory	2	0	0	30	20	50		50		100	2
7	CEC0354	Signal Systems and Network Lab	Mandatory	0	0	4				50		50	100	2
8	CEC0351	Analog and Digital Communication Lab	Mandatory	0	0	4				50		50	100	2
9	CEC0352	CMOS Digital Integrated Circuit Lab	Mandatory	0	0	2				25		25	50	1
10	CEC0355	Verilog-HDL	Mandatory	0	0	6				50		100	150	3
11	CEC0359	Internship-I	Mandatory	0	0	2				50			50	1
12	CNC0301 / CNC0302	Artificial Intelligence and Cyber Ethics / Environmental Science	Compulsory Audit	2	0	0	30	20	50				50	NA
		*Massive Open Online Courses (For B. Tech Hons. Degree)	*MOOCs											
			TOTAL	**18**	**1**	**18**			**350**	**225**	**400**	**225**	**1150**	**23**

*** List of MOOCs (Infosys Springboard) Based Recommended Courses for Second year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	CMC0015	Data Structures and Algorithms using Python - Part 1	Infosys Wingspan (Infosys Springboard)	29h 27m	2
2.	CMC0038	Express PCB Training	IIHT	15h 6m	1
3.	CMC0015	Data Structures and Algorithms using Python - Part 1	Infosys Wingspan (Infosys Springboard)	29h 27m	2

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-II and will be assessed during semester-III**
- **Compulsory Audit (CA) Courses (Non-Credit - CNC0301/CNC0302)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The total and obtained marks are not added in the grand total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam, CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit, MOOCs: Massive Open Online Courses.

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
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B. TECH (ECE)
Evaluation Scheme
SEMESTER IV

S. No.	Subject Codes	Subject Name	Type of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	CASCC0401	Employability Skill Development -II	Mandatory	2	0	0	60	40	100				100	2
2	CAS0403	Advanced Engineering Mathematics	Mandatory	3	1	0	30	20	50		100		150	4
3	CEC0402	Electromagnetic Field Theory and Antenna	Mandatory	2	0	0	30	20	50		50		100	2
4	CEC0401	CMOS Analog Integrated Circuit	Mandatory	3	0	0	30	20	50		100		150	3
5	CEC0403	Microprocessor and Microcontroller	Departmental Elective	3	0	0	30	20	50		100		150	3
6		Departmental Elective-I	Mandatory	3	0	0	30	20	50		100		150	3
7	CEC0451	CMOS Analog Integrated Circuit Lab	Mandatory	0	0	4				50		50	100	2
8	CEC0453	Microprocessor & Microcontroller Lab	Mandatory	0	0	2				25		25	50	1
9	CECE455	IoT Workshop	Mandatory	0	0	6				50		100	150	3
10	CEC0459	Mini Project	Mandatory	0	0	2				50		50	50	1
11	CCSCC0452	Problem Solving Approaches	Mandatory	0	0	2				50			50	1
12	CNC0402 / CNC0401	Environmental Science/Artificial Intelligence and Cyber Ethics	Compulsory Audit	2	0	0	30	20	50		50		50	NA
		*Massive Open Online Course (For B. tech Hons. Degree)	*MOOCs											
			TOTAL	**17**	**0**	**16**	**210**	**140**	**350**	**225**	**350**	**175**	**1200**	**25**

*** List of MOOCs (Infosys Springboard) Based Recommended Courses for Second Year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	CMC0061	Internet of Things 201	Infosys Wingspan (Infosys Springboard)	15h 59m	1
2.	CMC0062	IoT Raspberry Pi with Projects	IIHT	12h 25m	0.5
3.	CMC0063	Mobile Apps Development - Advanced Applications	IIHT	14h 23m	1

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-IV and will be assessed during Semester-V**
- **Compulsory Audit (CA) Courses (Non-Credit - CNC0401/CNC0402)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The Total and obtained marks are not added in the Grand Total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam, CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit, MOOCs: Massive Open Online Courses.

List of Department Elective:

S. No.	Subject Code	Subject Name	Bucket Name	Semester
1	CEC0411	Data Analytics	Artificial Intelligence	IV
2	CEC0413	VLSI Technology	VLSI	IV

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
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AICTE Guidelines in Model Curriculum:

A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as Infosys Springboard/NASSCOM/CISCO (as applicable) certifications, or any other online courses recommended by the Institute (Equivalent to 20 credits). During Complete B.Tech. Program Guidelines for credit calculations are as follows.

1. For 6 to 12 Hours =0.5 Credit
2. For 13 to18 =1 Credit
3. For 19 to 24 =1.5 Credit
4. For 25 to 30 =2 Credit
5. For 31 to 35 =2.5 Credit
6. For 36 to 41 =3 Credit
7. For 42 to 47 =3.5 Credit
8. For 48 and above =4 Credit

For registration to MOOCs Courses, the students shall follow Infosys Springboard/NASSCOM/CISCO (as applicable) registration details as per the assigned login and password by the Institute these courses may be cleared during the B. Tech degree program (as per the list provided). After successful completion of these MOOCs courses, the students shall provide their successful completion status/certificates to the Controller of Examination (COE) of the Institute through their coordinators/Mentors only.

The students shall be awarded Honours Degree as per following criterion.

i. If he / she secures 7.50 as above CGPA.
ii. Passed each subject of that degree program in the single attempt without any grace.
iii. Successful completion of MOOCs based 20 credits

Course Code: CCSCC0301	Course Name: Employability Skill Development - I	L	T	P	C
Course Offered in: ECE / EE (VLSI)		2	0	0	2

Pre-requisite:

Course Objectives:

Section A: Develop understanding of computer systems, mathematical foundations, and programming concepts while applying structured problem-solving techniques to design logical solutions effectively.
Section B: Enhance numerical ability and logical reasoning skills through speed mathematics, number systems, and analytical problem-solving techniques for competitive aptitude development.
Section C: To develop the ability to communicate effectively and empathetically in workplace situations while strengthening active listening, adaptability, and cross-cultural awareness for navigating complex professional environments.

Course Outcome:		Blooms Level
CO1	Apply fundamental concepts of computer systems, mathematical foundations, and programming constructs to analyze and solve basic computational problems.	K3
CO2	Design and develop structured solutions for problem statements by applying SDLC principles, logical thinking, and flowchart/pseudocode techniques.	K6
CO3	Apply fundamental number theory concepts such as divisibility, HCF & LCM, remainder theorem, and cyclicity to solve quantitative problems efficiently	K3
CO4	Solve problems involving logical reasoning and analytical thinking, including direction sense, blood relations, series patterns, and time-based puzzles like clocks and calendars.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	2	3	1	-	3	2	2	2	-	-	-
CO2	3	3	3	3	3	2	1	3	2	2	2	-	-	-
CO3	3	3	2	1	-	-	-	1	2	2	2	-	-	-
CO4	-	-	-	-	1	2	-	3	2	2	-	-	-	-

Course Contents / Syllabus

Section-A

Unit 1	Foundations of Computer Systems and Mathematical Concepts	8 hours

Computer System Fundamentals: Introduction to Assembler, Compiler, Interpreter, Role of Loader and Linker in program execution. **Mathematical Foundations for Computing:** Sets, Relations, and Functions: definitions and applications, Principle of Mathematical Induction and its use in proofs.
Basic Concepts of Programming Language: Memory model of C/C++ Program, Activation Record of a function, L-Value/ R-Value concept. Operators, Precedence, Order of Evaluation and Associativity. Pointers and Dynamics Memory Concept, Functions (argument passing, concept of scope), Understanding Recursion, Bitwise Operations.

Unit 2	Design and develop structured solutions for problem statements	8 hours

Introduction to Software Development Life Cycle, Step-by-step solution to simple problems, Developing logic/flowchart/pseudocode. Step-wise refinement and Procedural Abstraction.
Case Study*: Understand the problem statement, identify a feasible solution, and develop the logic along with a flowchart for the proposed solution.

Section-B

Unit 3:	Speed Math and Number System	8 hours

Classification of number, Divisibility Rule, Factorization, HCF & LCM, It's Application, Unit digit (Cyclicity), Last two-digit, Remainder theorem, Factorial and Number of zeroes, Highest power

Unit 4	Analytical and Logical Reasoning	6 hours

Direction and Sense, Blood Relation, Number Series and Letter Series, Coding Decoding.

Total Lectures: 30 hours

**A list of problem statements will be provided by the mentor; you may choose any one.*
***Note:** Students may choose an alternative problem statement with prior approval from the mentor.*

Reference Books:

S. No	Book Title	Author
1.	A Project-Based Introduction to Programming	Access Point Publishing
2.	Programming: Principles and Practice Using C++	Bjarne Stroustrup
3.	Effective Modern C++	Scott Meyers
4.	Quantitative Aptitude	R S Aggarwal
5.	Verbal & Non-Verbal Reasoning	R S Aggarwal

Mode of Evaluation

CIE							ESE	Total
ST1	ST2	ST3	TA1 10	TA2 10	TA3 10	Attendance 10		
60			40					100

Course Code: CEC0304	Course Name: Signal Systems and Networks	L	T	P	C
Course Offered in: B.Tech. ECE		2	0	0	2

Pre-requisite: Application of Differential and Integral Relations. Basic Knowledge of mathematics.

Course Objectives: This course introduces the fundamental concepts of

To provide students with the fundamental concepts of continuous-time and discrete-time signals and systems, including the analysis of linear time-invariant (LTI) systems. The course also aims to develop proficiency in applying Fourier, Laplace, and Z-transforms, and analyzing one-port and two-port networks for engineering applications.

Course Outcome: After completion of the course, the student will be able to		**Blooms Level**
CO1	Explain and classify various types of signals and systems, including continuous-time and discrete-time, periodic and aperiodic, and causal and non-causal signals	K2
CO2	Apply Fourier Series and Fourier Transform techniques to evaluate the frequency-domain representation of continuous-time and discrete-time signals and interpret their properties.	K3
CO3	Apply Laplace transform for Network analysis.	K3
CO4	Identify and analyze two-port network parameters.	K4
CO5	Synthesize the one port and two port networks.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	2	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	3	-	-

Course Contents / Syllabus

Unit 1	**Signal and System**	**6 hours**

Introduction, Classification of Signals; Transformation of independent variables: Time-shifting, time- scaling, time-reversal and combined operations; Singularity functions: Unit step, Unit impulse and Unit ramp functions; Exponential and sinusoidal signals; Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Causal, Anti-causal and Non-Causal Signals; Continuous- Time and Discrete-Time System; Linear and Nonlinear systems, Time varying and Time-invariant systems, causal system, stable system, System with and without memory.

Unit 2	**LTI Systems and Fourier Analysis**	**6 hours**

Linear time-invariant (LTI) systems, characterization of causality and stability of linear shift invariant systems. Fourier series representation of signals, Fourier Transforms, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Properties and Significance of CTFT, CTFT of Common Signals, Inverse CTFT. DFT, Z-Transform: Definition, Convergence of Z-transform and Properties.

Unit 3	**Laplace transforms and its application to network analysis**	**6 hours**

Laplace Transforms- Introduction, Laplace Transforms of common signals, Theorems and properties of Laplace Transforms, Concept of Region of Convergence, Inverse Laplace Transforms. Analysis of RC, RL and RLC network with and without initial conditions with Laplace transforms.

Unit 4	**Two-port networks**	**6 hours**

Parameters of Two Port Networks, Relation between Parameters, Transfer Functions using Two Port network Parameters, Interconnection of Two Port Networks, Reciprocal and Symmetric Networks, terminated Two Port Networks.

Unit 5	**Realizability Theory and Synthesis of Networks**	**6 hours**

Properties of immitance functions, realizability theory: Hurwitz polynomial and positive real function one port network synthesis (Foster's and Cauer's form synthesis). Zeroes of transmission, Synthesis of Y21 and Z21 with 1Ω terminations.	
Total Lecture Hours	**30 hours**

Textbook:

1.A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems," Pearson.
2.Tarun Kumar Rawat, "Signals and Systems", Oxford University Press.
3.Franklin F. Kuo, "Network Analysis and synthesis", 2nd Edition, Wiley India Pvt. Ltd.
4.Charles Alexander, Matthew Sadiku,

Reference Books:

1.Roberts, M.J., "Fundamentals of Signals & Systems", Tata McGraw.
2.R.F. Ziemer, W.H. Tranter and D.R. Fannin,"Signals and Systems".
3.M. E. Van Valkenberg, "Network Analysis", 2nd Edition, Prentice Hall of India Ltd.
4. William H. Hayt, Jack Kemmerly,Engineering Circuit Analysis, McGraw Hill Education; Eighth edition.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://nptel.ac.in/courses/117104074	
Video Lectures	https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100 https://nptel.ac.in/courses/108102042 https://nptel.ac.in/courses/108102042 https://nptel.ac.in/courses/108105139	
Web References	https://nptel.ac.in/courses/108105139	

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0301	Course Name: Analog and Digital Communication	L	T	P	C
Course Offered in: B. Tech ECE		3	0	0	3

Pre-requisite: Basics of Signal Systems and Mathematics

Course Objectives: To know

To provide students with the fundamental concepts of analog and digital communication systems, including modulation, demodulation, and the effects of noise on signal transmission. The course also aims to develop an understanding of information theory, spread spectrum communication, and error-control coding techniques for reliable digital communication systems.

Course Outcome: After completion of the course, the student will be able to		Blooms' Level
CO1	Explain various modulation and demodulation methods of Amplitude Modulation and Angle Modulation.	K2
CO2	Explain various digital modulation techniques.	K3
CO3	Analyze the effect of noise and explain the concept of spread spectrum communication system.	K4
CO4	Apply the fundamental concept of information theory to design various source encoding and to evaluate capacity of AWGN channel.	K3
CO5	Characterize error-control codes and apply the encoding and decoding processes.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	3	-	-	-	-	-	-	-	-	3	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	3	-	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	3	3	3

Course Contents / Syllabus

Unit 1	Analog Modulation	9 hours

Introduction to Communication system, Need for modulation, Amplitude Modulation and Demodulation, Angle Modulation: Frequency and Phase Modulation and Demodulation, Frequency Division Multiplexing (FDM).

Unit 2	Digital Modulation	9 hours

Sampling Theorem, Pulse Code Modulation (PCM), Time Division Multiplexing (TDM)
Digital Communication System: Line coding, Binary ASK, FSK & PSK Modulation and Demodulation, Differential phase shift keying (DPSK), Quadrature phase shift keying (QPSK).

Unit 3	Digital Receiver	9 hours

Noise, Signal to Noise Ratio (SNR), Figure of Merit, Noise Figure, Concept of Matched Filters, BER analysis of BASK, BFSK, BPSK. **Spread Spectrum Communication:** Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS).

Unit 4	Information theory	9 hours

Measure of information: Information, Entropy; Types of Channels, Source encoding: Shannon – Fano Coding, Huffman Coding, Capacity of Additive White Gaussian Noise (AWGN) Channel: Shannon Hartley Law.

Unit 5	Error correcting codes	9 hours

Error Correcting codes: hamming sphere, hamming distance and hamming bound, relation between minimum distance and error detecting and correcting capability, Linear block codes: encoding and syndrome decoding. Convolution coding and decoding.

Total Lecture Hours	45 hours

Textbook:

1.Herbert Taub and Donald L. Schilling, Principles of Communication Systems", Tata McGraw Hill.

2.B.P. Lathi, Modern Digital and Analog communication Systems", 4th Edition, Oxford University Press,2010.

Reference Books:

1. Simon Haykin, "Communication Systems", 4th Edition, Wiley India.
2. H. P. Hsu & D. Mitra," Analog and Digital Communications", 2nd Edition, Tata McGraw- Hill.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	https://www.youtube.com/channel/UCnWGGUyQOZkXylsoI5w-J4Q https://youtube.com/playlist?list=PLbtX56KUSNwTB_27m6HI52rjk8Mz7v23f&si=0-OZ5ktNwpf0MQ7D https://www.youtube.com/channel/UCnWGGUyQOZkXylsoI5w-J4Q https://youtube.com/playlist?list=PLbtX56KUSNwTB_27m6HI52rjk8Mz7v23f&si=0-OZ5ktNwpf0MQ7D https://youtube.com/playlist?list=PLbtX56KUSNwTB_27m6HI52rjk8Mz7v23f&si=0-OZ5ktNwpf0MQ7D	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0303	Course Name: Computational Intelligence	L	T	P	C
Course Offered in: B. Tech ECE		2	0	0	2

Pre-requisite: Students must have logical and practical skill set towards analyzing various problems related to algorithms.

Course Objectives: To know

To provide students with the fundamental concepts of computational intelligence, including artificial neural networks, fuzzy logic, and genetic algorithms. The course also aims to develop the ability to design intelligent systems and apply computational intelligence techniques to solve real-world engineering problems.

Course Outcome: After completion of the course, the student will be able to		**Blooms Level**
CO1	Identify Computational Intelligence techniques and their applications	K2
CO2	Apply neural networks using various learning techniques and formulate the artificial neural network with their different layers.	K3
CO3	Compare the fuzzy sets and crisp sets and apply fuzzy operations in real life problems.	K2
CO4	Design fuzzy controller with the help of fuzzy rules, fuzzifications and defuzzification.	K3
CO5	Discuss the concept of genetic algorithm and its various applications.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	2	-	-	-	-	-	2	2	2	2
CO2	3	3	3	-	2	-	-	-	-	-	2	3	3	2
CO3	2	2	2	-	2	-	-	-	-	-	2	2	3	2
CO4	3	3	3	-	2	-	-	-	-	-	2	3	3	2
CO5	3	2	2	-	2	-	-	-	-	-	2	3	3	3

Course Contents / Syllabus

Unit 1	Introduction to Computational Intelligence	6 hours

Introduction to Computational Intelligence, Various types of Computational Intelligence Techniques, Characteristics of Computational Intelligence, Major Areas of Computational Intelligence, Applications of Computational Intelligence. Introduction to MATLAB / Python Environment for Computational Intelligence Techniques.

Unit 2	Neural Networks	6 hours

Neuron, Biological neurons and its working, Model of Artificial Neuron, Architectures, Taxonomy of ANN Systems, Various Activation Functions, Single Layer ANN System, Multi-Layer ANN System, Recurrent networks. Supervised Learning, Unsupervised Learning, Reinforcement Learning, Perceptron, Adaline, Madaline, and Applications of ANN in research. MATLAB Neural Network Toolbox / Python.

Unit 3	Fuzzy Logic-I	6 hours

Fuzzy Set theory, Operations on sets, Properties, Fuzzy versus Crisp set, Fuzzy Relation, Operations on Fuzzy Relation, Properties, Fuzzy versus Crisp Relations, Introduction & features of membership functions, Max-Min Composition.

Unit 4	Fuzzy Logic-II	6 hours

Introduction to Fuzzy logic, Propositions, If-Then Rules, implications and inferences. Rule based systems, Predicate logic, Fuzzy Inference Systems, Fuzzification, Defuzzification Method, logic controller design, Some applications of Fuzzy logic. Fuzzy Logic MATLAB Toolbox/Python.

Unit 5	Genetic Algorithm (GA)	6 hours

Fundamentals of Genetic Algorithms, Basic concepts, Working Principle, Various Encoding methods, Fitness function, GA Operators: Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA,

Optimization of traveling salesman problem using Genetic Algorithm, Genetic Algorithm MATLAB Toolbox/Python, Hybrid Computational Intelligence.	
Total Lecture Hours	**30 hours**

Textbook:

1.Andries P. Engelbrecht, "Computational Intelligence: An Introduction", Wiley Publication.
2.S. Rajsekaran & GA Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India.
3.Siman Haykin, "Neural Netowrks", Prentice Hall of India.
4.Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India.

Reference Books:

1. Kumar Satish, "Neural Networks", Tata Mc Graw Hill.
2. Fakhreddin O. Karray, Clarence W. De Silva, "Computational Intelligence and Intelligent System Design: Theory Tools and applications", Pearson.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	https://youtube.com/playlist?list=PL5cGuSxneHHd7X4ZbHs8DPbRnoiYixpBA&si=5-gJ8y5aeTwNEuM- https://youtu.be/IOa_AYWa5no?si=pw81VOqelellb_H7 https://youtu.be/R1B1--Z8BSY?si=JfHXxp9uDuCJ2HnL https://youtu.be/-U-QCX2C8T8?si=1PQIL-A2_NjixSBT https://youtu.be/whIR88tAANE?si=jCfZi6CpQi3ed-ai https://youtu.be/n9MTaa-rZr4?si=r4v93aSKeflsq_uu https://youtu.be/OnJRw2EP3_g?si=uxSitK4QFTSn-gOX https://youtu.be/Fs5ZIjp1hUk?si=SYTjG5y_rptppwwD https://youtu.be/fgtUFzxNztA?si=DiEQ7L2PNrQvgC5y	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0302	Course Name: CMOS Digital Integrated Circuit	L	T	P	C
Course Offered in: B. Tech. ECE / EE (VLSI)		3	0	0	3

Pre-requisite: Basis knowledge of MOSFET and Digital Electronics.

Course Objectives:

To provide students with a strong foundation in MOS transistor operation, device characteristics, and CMOS inverter analysis for VLSI circuit design. The course also aims to develop the ability to design and analyze combinational, sequential, and dynamic CMOS logic circuits, along with semiconductor memory architectures used in modern integrated systems.

Course Outcome: After completion of the course, the student will be able to		**Blooms Level**
CO1	Describe the basics of MOS device and its current voltage characteristics	K2
CO2	Explain MOS inverters and its static characteristics.	K3
CO3	Design of Combinational and Sequential MOS logic circuits.	K4
CO4	Design and analysis of dynamic logic circuits.	K3
CO5	Describe the concept of semiconductor memories.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	3	-	-	-	-	-	-	-	-	2	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	2

Course Contents / Syllabus

Unit 1	**VLSI Design Flow and CMOS fabrication**	**9 hours**

VLSI Design flow: VLSI Design flow & Y-Chart, MOS Structure, MOS System under external Bias, Structure and Operation of MOSFET, Basic MOS Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effect, MOSFET capacitances.

Unit 2	**MOS inverter and Static Characteristics**	**9 hours**

Introduction, Resistive-load Inverter, Inverter with N-type MOSFET load, CMOS inverter: Circuit operation, DC transfer characteristics, Noise margin: calculation of VIL, VIH, Vth, Design of CMOS inverter, Supply voltage scaling, Switching characteristic: Delay time definition, calculation of delay times, Power dissipation of CMOS inverter.

Unit 3	**Combinational and sequential MOS logic circuits**	**9 hours**

Combinational MOS Logic Circuits with Depletion NMOS loads, CMOS Logic circuits – Realizing Boolean expressions using CMOS gates, Complex Logic circuits design, Design of Half Adder, Full Adder, CMOS Transmission Gates (Pass Gates). Sequential MOS Logic Circuits: Behavior of Bi-stable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D-latch, and edge triggered flip-flop**.**

Unit 4	**Dynamic logic Circuits**	**9 hours**

Introduction, Basic Principles of Pass Transistor Circuits, Synchronous dynamic circuit techniques: Dynamic Pass Transistor Circuits, CMOS Transmission Gate Logic, High performance Dynamic CMOS Logic Circuits: CMOS Domino Logic, charge sharing problem.

Unit 5	**Introduction to Semiconductor memories and ASIC**	**9 hours**

Semiconductor Memories: Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells.

	Total Lecture Hours	**45 hours**

Textbook:

<table>
<tr><td colspan="3">1. “CMOS Digital Integrated Circuits”, TMH, 3rd Edition, Kang, Leblebici.
2. “Digital Integrated Circuit: A Design Perspective”, PHI; Latest Edition, Rabaey, Chandrakasan and Nikolic.
3. “Principles of CMOS VLSI Design” Addison Wesley, Latest Edition, Weste and Eshraghian.</td></tr>
<tr><td colspan="3">Reference Books:
1. “CMOS VLSI Design”, Weste and Harris
2. “Essentials of VLSI Testing for digital, memory and mixed-signal VLSI Circuits”, Kluwer Academic Publishers. Bushnell and Agrawal</td></tr>
<tr><td colspan="2">Self-Study Content Links:</td><td>Duration (in Hrs)</td></tr>
<tr><td>MOOCs</td><td></td><td></td></tr>
<tr><td>Video Lectures</td><td>Unit 1: https://onlinecourses.nptel.ac.in/noc20_ee29/preview
Unit 2: https://www.youtube.com/watch?v=MuBiC9yz2fc
Unit 3: https://nptel.ac.in/courses/108/106/108106158
Unit 4: https://www.youtube.com/watch?v=UuafwIJAKhY
Unit 5: https://www.youtube.com/watch?v=vD0sNigq1C</td><td></td></tr>
<tr><td>Web References</td><td></td><td></td></tr>
</table>

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CASL0301	Course Name: Technical Communication	L	T	P	C
Course Offered in: B. Tech. All branches (except CSBS)		2	0	0	2

Pre-requisite: Intermediate level and above (CEFR level)

Course Objectives:

1. **Demonstrate effective verbal and non-verbal communication skills** in diverse professional settings, including meetings, presentations, and interpersonal interactions.
2. **Develop and apply clear, concise, and audience-appropriate written communication**, such as emails, letters, memos, resume', using correct grammar, tone, and format.
3. **Adapt communication style based on cultural, organizational, and situational contexts** to foster inclusive and respectful professional relationships.
4. **Employ digital communication tools and platforms** (e.g., video conferencing, business messaging apps) responsibly and effectively in remote or hybrid work environments.

Course Outcome: After completion of the course, the student will be able to

S. No	Course Outcome	Bloom's Level
1	Comprehend the principles and functions of technical communication.	K2
2	Write for specific audience and purpose to fulfil the provided brief.	K3
3	Recognize and produce different kinds of technical documents.	K3
4	Apply effective speaking skills to efficiently carry out official discourses.	K3
5	Demonstrate their understanding of communication through digital media.	K3

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	1	2	3	1	1	-	-	-
CO2	1	1	1	1	1	1	1	2	3	1	1	1	-	1
CO3	1	1	1	1	1	1	1	2	3	1	1	1	2	2
CO4	1	1	1	1	1	1	1	2	3	1	1	1	2	2
CO5	1	1	1	1	1	1	1	2	3	1	1	1	1	2

Course Contents / Syllabus

Unit 1 — **Introduction to Technical Communication** — **06 hours**

- Definition, Process, Types, Levels, Flow and Barriers to Technical Communication with emphasis on gender neutral language and cultural sensitivity
- Significance of audience in technical communication

Unit 2 — **Technical Writing 1** — **06 hours**

- Technical writing skill – characteristics, examples
- Business letters/emails - Content organization, Tone and intent
- Agenda & Minutes of Meetings

Unit 3 — **Technical Writing 2** — **06 hours**

- Job application, Resume'
- Report, proposal
- Technical paper - Abstract
- Ethical Writing – Copy Editing, Referencing and Plagiarism

Unit 4 — **Public Speaking** — **06 hours**

- Components of effective speaking – Simplicity, order, balance in arranging ideas. Importance of *KOPPACT*
- Appearing for a job interview, FAQs
- Telephonic & Online Interviews

Unit 5 — **Virtual/Remote Communication** — **06 hours**

- Remote work – online platforms
- Video conferencing; Virtual etiquette- email ids, usernames

- Writing Blogs & creating Vlogs

Total Lecture Hours	**30 Hours**

Textbook:

1. Technical Communication – Principles and Practices, 4th Edition by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2022, New Delhi.

Reference Books:

1. Technical Communication, 15th Edition by John M. Lannon & Laura J. Gurak, Pearson, 2021.
2. Spoken English- A Manual of Speech and Phonetics (5th Edition) by R K Bansal & J B Harrison, Orient Blackswan, 2024, New Delhi.
3. Business Correspondence and Report Writing by Prof. R C Sharma, Krishna Mohan, and Virendra Singh Nirban (6th Edition), Tata McGraw Hill & Co. Ltd., 2020, New Delhi.
4. Intercultural Communication in Virtual Exchange by Francesca Helm, Cambridge Univ. Press, 2024.

NPTEL/ Youtube/ Faculty Video Link:

Unit 1	https://onlinecourses.nptel.ac.in/noc24_ge37/preview
Unit 2	https://archive.nptel.ac.in/courses/109/106/109106094/
Unit 3	https://www.youtube.com/watch?v=kOJlwMJxEG0&t=8s
Unit 4	https://www.youtube.com/watch?v=Sg7Q_dC_fWU&list=PLPuC5CMHiqmuzq_KQ4aw0V9Q7xJY6aezb
Unit 5	https://www.youtube.com/watch?v=ymLFJDpjgCk&list=PLPuC5CMHiqmuzq_KQ4aw0V9Q7xJY6aezb&index=6

Mode of Evaluation

CIE						**ESE**	**Total**
ST1	**ST2**	**ST3**	**TA1 5**	**TA2 5**	**Attendance 10**		
30			**20**			**50**	**100**

LAB Course Code: CEC0354	LAB Course Name: Signal Systems and Networks Lab	L	T	P	C
Course Offered in: B.Tech. ECE		**0**	**0**	**4**	**2**

Pre-requisite: Basic knowledge of mathematics, signals & systems, electrical circuits, and MATLAB programming**.**

Course Objectives:

To provide hands-on experience in analyzing signals, systems, and linear time-invariant (LTI) systems using MATLAB. The course also aims to develop practical skills in applying Fourier, Laplace, and Z-transforms, analyzing network responses, and performing network synthesis using MATLAB tools.

Course Outcome: After completion of the course, the student will be able to		**Blooms' Level**
CO1	Generate and visualize basic signals and transformations using MATLAB.	K3
CO2	Apply convolution and analyze LTI systems.	K3
CO3	Analyze signals using Fourier and Z-transform.	K4
CO4	Apply Laplace transform to analyze circuits.	K3
CO5	Analyze and synthesize networks using MATLAB tools.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	2	-	3	-	-	-	-	-	3	2	2	2
CO2	3	2	2	-	3	-	-	-	-	-	3	3	2	2
CO3	3	3	2	-	3	-	-	-	-	-	3	3	2	2
CO4	2	3	2	-	3	-	-	-	-	-	3	3	2	2
CO5	3	3	3	-	3	-	-	-	-	-	3	3	3	2

List Of Practical's (Indicative & Not Limited To)	**CO**
1. To write a MATLAB program to generate unit step, unit impulse and ramp signals.	**CO1**
2. To write a MATLAB program to perform time shifting, time scaling and time reversal of signals.	**CO1**
3. To write a MATLAB program to decompose a signal into even and odd components.	**CO1**
4. To write a MATLAB program to determine whether a signal is energy or power signal.	**CO1**
5. To write a MATLAB program to perform linear convolution of two signals.	**CO1**
6. To write a MATLAB program to verify properties of LTI systems (linearity and time invariance).	**CO2**
7. To write a MATLAB program to compute Fourier series of a periodic signal.	**CO2**
8. To write a MATLAB program to compute Fourier transform using FFT and plot magnitude and phase response.	**CO2**
9. To write a MATLAB program to verify convolution theorem in time and frequency domain.	**CO2**
10. To write a MATLAB program to compute Z-transform of a discrete signal.	**CO2**
11. To write a MATLAB program to compute Laplace transform of a given signal.	**CO3**
12. To write a MATLAB program to compute inverse Laplace transform.	**CO3**
13. To write a MATLAB program to analyze RC circuit response using Laplace transform.	**CO3**
14. To write a MATLAB program to analyze RL and RLC circuit response.	**CO3**
15. To write a MATLAB program to calculate Z-parameters of a two-port network.	**CO3**

16. To write a MATLAB program to calculate Y-parameters and ABCD parameters.	**CO3**
17. To write a MATLAB program to analyze cascade and parallel connection of two-port networks.	**CO5**
18. To write a MATLAB program to verify reciprocal and symmetric conditions of networks.	**CO5**
19. To write a MATLAB program to verify whether a function is positive real function.	**CO5**
20. To write a MATLAB program to perform Foster form network synthesis.	**CO5**
21. To write a MATLAB program to perform Cauer form network synthesis.	**CO5**
22. To write a MATLAB program to plot pole-zero diagram of a network function.	**CO5**
Total Hours	**30 Hrs**

LAB Course Code: CEC0351	LAB Course Name: Analog and Digital Communication Lab	L	T	P	C
Course Offered in: B.Tech. ECE		**0**	**0**	**4**	**2**

Pre-requisite: Basic knowledge of analog and digital communication concepts

Course Objectives:

To provide hands-on experience in analog and digital communication techniques, including modulation, demodulation, pulse code modulation (PCM), and digital data encoding. The course also aims to develop practical skills in implementing digital modulation schemes and convolutional coding using MATLAB.

Course Outcome: After completion of the course, the student will be able to		**Blooms' Level**
CO1	Demonstrate and perform amplitude modulation (AM), frequency modulation (FM) and its demodulation.	K3
CO2	Demonstrate and perform Pulse Code Modulation (PCM).	K4
CO3	Encode and decode digital data into different data formats.	K3
CO4	Perform digital modulation techniques.	K3
CO5	Analyze convolutional code using MATLAB.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	2	-	-	-	-	-	2	2	2	2
CO2	3	3	2	-	2	-	-	-	-	-	2	2	3	2
CO3	3	3	3	-	3	-	-	-	-	-	2	3	3	2
CO4	3	3	3	-	3	-	-	-	-	-	2	3	3	2
CO5	3	3	3	-	3	-	-	-	-	-	2	3	3	3

List Of Practical's (Indicative & Not Limited To)

S. No.	Name of Experiment / Programs	CO
1.	Demonstrate amplitude modulation by using balance modulator (MC1496P) & demodulation by using linear diode detector with modulating frequency fm = 1 KHz - 3 KHz and carrier frequency fc = 20 KHz – 1 MHz. (i) Draw its output waveform (ii) Calculate Modulation Index (μ), Carrier Power (Pc) and Transmitted Power (Pt).	**CO1**
2.	Demonstrate frequency modulation and demodulation (using PLL 565) with modulating frequency fm = 1 KHz and carrier frequency fc = 20 KHz – 1 MHz. (i) Draw its output waveform (ii) Determine frequency deviation (iii)Modulation index (β).	**CO1**
3.	Perform and draw the output waveform of Pulse Code Modulation (PCM) and its demodulation with modulating frequency fm = 80 KHz.	**CO2**
4.	Demonstrate and draw the output waveform with input code 10101010 for the Unipolar RZ & NRZ Line Coding.	**CO2**
5.	Demonstrate and draw the output waveform with input code 10101010 for the Polar RZ & NRZ Line Coding.	**CO2**
6.	Demonstrate and draw the output waveform with input code 10101010 for the Manchester line coding technique.	**CO2**
7.	Demonstrate Amplitude Shift Keying (ASK) modulator and demodulator using message signal 10101010 with carrier frequency fc = 20 kHz – 1MHz. (i) Draw and observe its output waveform (ii) Determine Energy per bit (Eb) (iii) Bandwidth (BW).	**CO2**
8.	Demonstrate Frequency Shift Keying (FSK) modulator and demodulator for message signal 10101010 with carrier frequency fc = 940Hz. (i) Draw its output waveform (ii) Determine Energy per bit (Eb) for FSK (iii) Bandwidth (BW) for FSK	**CO2**
9.	Demonstrate Phase Shift Keying (PSK) modulator and demodulator for message signal 10101010 with carrier frequency fc = 1.44MHz. (i) Draw its output waveform (ii) Determine Energy per bit (Eb) for PSK (iii)Bandwidth (BW) for PSK.	**CO2**

10.	Demonstrate Quadrature Phase Shift Keying (QPSK) modulator and demodulator for message signal 10101010 with carrier frequency fc = 960kHz. (i) Draw its output waveform (ii) Determine Energy per bit (Eb) for QPSK (iii) Bandwidth (BW) for QPSK	**CO2**
11.	Calculation of BER of BASK using MATLAB.	**CO3**
12.	Calculation of BER of BFSK using MATLAB.	**CO3**
13.	Calculation of BER of BPSK using MATLAB.	**CO3**
14.	Perform Huffman Coding for given symbols using MATLAB and calculate efficiency.	**CO4**
15.	Perform encoder of (7, 4) Hamming code using MATLAB	**CO4**
16.	Analysis and performance evaluation of convolutional codes using MATLAB for message code = [1 0 1 1].	**CO5**
	Total Hours	**30 Hrs**

LAB Course Code: CEC0352	Course Name: CMOS Digital Integrated Circuit Lab	L	T	P	C
Course Offered in: B. Tech. ECE		0	0	2	1

Pre-requisite: Basis knowledge of MOSFET and Digital Electronics

Course Objectives:

This course provides hands-on experience in the simulation and analysis of MOS devices, CMOS inverters, and digital logic circuits using VLSI design tools. It develops the ability to design, verify, and evaluate CMOS circuits and memory cells while analyzing their performance, power, stability, and reliability characteristics.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Simulate and analyze ID–VGS and ID–VDS characteristics of NMOS and PMOS transistors and extract device parameters	K3
CO2	Analyze the voltage transfer characteristics (VTC) of NMOS and CMOS inverters and determine key parameters such as VOH, VOL, VIH, VIL, and Vth.	K4
CO3	Design and simulate CMOS logic circuits including NOR gates, half adder, and full adder, and verify their truth tables.	K5
CO4	Design and evaluate advanced CMOS circuits such as pass transistor logic, transmission gates.	K5
CO5	Simulate and analyze 6T SRAM cell for functionality and Performance	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	3	-	-	-	-	-	-	3	3	3
CO2	3	2	3	-	3	-	-	-	-	-	-	2	3	2
CO3	3	3	2	-	3	-	-	-	-	-	-	3	3	2
CO4	3	1	2	-	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	3	-	-	-	-	-	-	2	3	3

List Of Practical's (Indicative & Not Limited To)	**CO**
1. Introduction of Cadence tool/Micro wind, Schematic Editor, Layout Editor.	**CO1**
2. Simulation and Analysis of I_D-V_{GS} and I_D-V_{DS} characteristics of NMOS and PMOS transistors	
3. To obtain the NMOSFET parameters: kn, vto, vt, γ.	
4. To analyse the voltage transfer characteristics (VTC) of resistive-load NMOS inverter and calculate VOH, VOL, VIH, VIL and Vth.	**CO2**
5. To analyse the voltage transfer characteristics (VTC) of CMOS inverter.	
6. To obtain the CMOS Inverter parameters: VOH, VOL, VIH, VIL and Vth.	
7. To simulate the CMOS 2 input NOR gates and verify the truth tables	**CO3**
8. To simulate the CMOS 2 input NOR gates and verify the truth tables	
9. To simulate the CMOS Half Adder Circuit and verify the truth tables	
10. To simulate the CMOS full Adder Circuit and verify the truth tables	
11. Design and simulation of a Pass Transistor.	**CO4**
12. Design and simulation of Transmission Gate logic.	**CO5**
13. To design and simulate a 6-transistor SRAM cell**.**	
Total Hours: 15 hrs.	

LAB Course Code: CEC0355	LAB Course Name: Verilog-HDL	L	T	P	C
Course Offered in: B. Tech. EE (VLSI)		**0**	**0**	**6**	**3**

Pre-requisite: Digital System Design

Course Objectives:

This course develops the ability to model, design, and simulate digital circuits and systems using Verilog HDL at different levels of abstraction. It provides hands-on experience in RTL design, switch-level modeling, test bench development, and functional verification of digital systems using simulation tools.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Develop and identify the suitable abstraction level for a particular digital design.	K4
CO2	Develop Verilog codes in gate, dataflow (RTL) modelling levels of abstraction.	K4
CO3	Develop Verilog codes in behavioural (RTL) modelling levels of abstraction	K5
CO4	Design and verify the functionality of digital circuit/system using test benches	K4
CO5	Design and simulate basic Units using switch level modelling.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**
CO2	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**
CO3	**3**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**
CO4	**3**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**
CO5	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**

Course Contents/Syllabus

Unit-1	Evolution of CAD, emergence of HDLs, typical HDL-flow, trends in HDLs, Verilog vs VHDL, Verilog coding vs Software Programming.Top-down and bottom-up design methodology, differences between Units and Unit instances, parts of a simulation, design block, stimulus block.Lexical conventions, data types: value set, registers, vectors, arrays, strings, system tasks, compiler directives. Unit definition, port declaration, connecting ports, hierarchical name referencing	**9 Hrs**
Unit-2	Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays.Continuous assignments, delay specification, expressions, operators, operands, operator types.	**9 Hrs**
Unit-3	Structured procedures, initial and always, blocking and non-blocking statements, delay control, generate statement, event control, conditional statements, Multiway branching, loops, sequential and parallel blocks.	**9 Hrs**
Unit-4	Timing and Delays, Switch-Level Modeling, Logic Synthesis with Verilog HDL, specify block and Timing checks, Verification and Writing test benches, Timing Analysis of Logic circuits, Downloading of Verilog code in FPGA and CPLD.	**9 Hrs**
Unit-5	Concept of switch level abstraction, MOS Transistor as Switch, Modeling NMOS and PMOS transistors as switches in Verilog, Switch ON/OFF conditions and control signals, Verilog Switch-Level Primitives, Understanding Verilog switch primitives: NMOS, PMOS, Syntax and usage of switch primitives in Verilog code.	**9 Hrs**
	Total Hours	**45 Hrs**

List of Practical

<table>
<tr><th>Lab No.</th><th>Program Logic Building</th><th>CO Mapping</th></tr>
<tr><td>1</td><td>Simulate and synthesize following logic gates using gate level modeling
a) AND Gate
b) OR Gate
c) NOT Gate
d) EX-OR Gate
e) NAND Gate
f) NOR Gate</td><td>CO1</td></tr>
<tr><td>2</td><td>Simulate and synthesize following combinational circuits using gate level modeling
a) Half adder
b) Full adder
c) Half Subtractor
d) Full Subtractor
e) 4:1 Multiplexer
f) 4:2 Encoder
g) 1:4 De-multiplexer
h) 2:4 Decoder
i) 1 Bit Comparator
j) 2*2 Bit Multiplier</td><td>CO2</td></tr>
<tr><td>3</td><td>a) Simulate and synthesize binary to gray code converter using gate level modeling.
b) Simulate and synthesize gray to binary code converter using gate level modeling.</td><td>CO 2</td></tr>
<tr><td>4</td><td>Simulate and synthesize following combinational circuits using data flow modeling
a) Half adder
b) Full adder
c) Half Subtractor
d) Full Subtractor
e) 4:1 Multiplexer
f) 4:2 Encoder
g) 1:4 De-multiplexer
h) 2:4 Decoder
i) 1 Bit Comparator
j) 2*2 Bit Multiplier</td><td>CO 2</td></tr>
<tr><td>5</td><td>Simulate and synthesize 4 bit parallel adder/Subtractor using data flow modeling.</td><td>CO 2</td></tr>
<tr><td>6</td><td>Simulate and synthesize following ALU operations using data flow modeling
<table>
<tr><th>OPCODE</th><th>ALU Operation</th></tr>
<tr><td>1.</td><td>A+B</td></tr>
<tr><td>2.</td><td>A-B</td></tr>
<tr><td>3.</td><td>A Complement</td></tr>
<tr><td>4.</td><td>A*B</td></tr>
</table></td><td>CO 2</td></tr>
<tr><td>7</td><td>a) Simulate and synthesize binary to gray code converter using data flow modeling.
b) Simulate and synthesize gray to binary code converter using data flow modeling.</td><td>CO 2</td></tr>
<tr><td>8</td><td>Simulate and synthesize following flip flops using behavioral modeling
a) SR Flip Flop
b) JK Flip Flop
c) D Flip Flop</td><td>CO3</td></tr>
</table>

	d) T Flip Flop	
9	Simulate and synthesize flip flops using behavioral modeling a) Using positive edge and negative edge. b) Using synchronous and asynchronous reset	**CO3**
10	Simulate and synthesize following shift registers using behavioral modeling a) Serial input serial output b) Serial input parallel output **c)** Parallel input serial output d) Parallel input parallel output	**CO3**
11	Simulate and synthesize following universal shift register using behavioral modeling	**CO3**
12	Simulate and synthesize following counters using behavioral modeling a) 2 Bit Counter b) Mod 5 Counter c) Decade Counter d) Ring Counter e) Johnson Counter	**CO3**
13	Simulate and synthesize array multiplier using behavioral modeling	**CO3**
14	Simulate and synthesize 4:1 MUX by using 2:1 MUX a) Using a wire b) Using a reg	**CO3**
15	Simulate and synthesize Moore sequence a) 1010 b) 1011	**CO3**
16	Simulate and synthesize Mealy sequence a) 1010 b) 1011	**CO3**
17	Implementation of logic gates on an FPGA and verify gates functionality.	**CO 4**
18	Implementation of 4:1 multiplexer on a FPGA	**CO 4**
19	Implementation of 2*2 multiplier on a FPGA	**CO 4**
20	Implementation of D flip flop on a FPGA	**CO 4**
21	Design and simulation of CMOS inverter using switch level modeling	**CO 5**
22	Simulate and synthesize following logic gates using switch level modeling a) AND Gate b) OR Gate c) NOT Gate d) EX-OR Gate e) NAND Gate f) NOR Gate	**CO 5**
	Total Hours	**35 Hrs**

Required Software and Tools (Any one) ISE Simulator (Xilinx) / Xilinx Vivado

- AMD-Xilinx-Vivado
- Verilog-XL (Cadence)
- VCS (Synopsys)

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CNC0301	Course Name: Artificial Intelligence and Cyber Ethics	L	T	P	C
Course Offered in: All Branches		**2**	**0**	**0**	**-**

Pre-requisite: Basic understanding of AI, Cybercrime, Computer System and Ethics

Course Objectives:

The course aims to foster critical thinking about ethical issues, promote responsible use of technology, and ensure students can identify, analyze, and address ethical dilemmas in Artificial Intelligence and cyber domains.

Course Outcome: After completion of the course, the student will be able to		**Blooms' Level**
CO1	Learn key principles of AI ethics, summarizing ethical considerations and applications in AI development and deployment.	**K2**
CO2	Apply policies and framework for Fairness in AI and Machine Learning.	**K3**
CO3	Apply privacy and security concepts, risk management and regulatory compliance in the field of AI and Cyber Security.	**K3**
CO4	Understand the nature of cybercrimes, the principles of intellectual property rights (IPR), and the legal measures necessary to address and prevent these issues.	**K2**
CO5	Describe the impact of AI in Society, employment and workforce.	**K2**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Course Contents / Syllabus

Unit 1	**An Overview to AI Ethics**	**5 hours**

Definition of AI Ethical principles in AI, Sources of AI data, Legal implications of AI Security Breaches, Privacy and AI Regulations, Key Principles of Responsible AI, Transparency and Accountability, Dual-Use Dilemma, Human-Centric Design, Introduction to Cyber Laws and Ethics, Historical Development of Cyber laws, Legal frameworks.

Unit 2	**Fairness and Favoritism in Machine Learning**	**6 hours**

Introduction to Fairness and Bias in AI, Types of Fairness and Bias, Impact of Bias and Fairness in AI, Techniques for Measuring Fairness and Bias, Techniques for Mitigating Bias, Current Policies and Frameworks for Fairness in AI, Bias in Data Collection, Fairness in Data Processing, Generative AI, Types of Bias in Generative AI.

Unit 3	**AI Ethics and Cybersecurity Principles**	**5 hours**

Importance of Privacy and Security in AI, AI specific Security Tools and Software, Privacy-Preserving Machine Learning (PPML) and Privacy-Preserving Data Mining (PPDM), Risk Management: Risk Assessment and Incident Response, Regulatory Compliance: GDPR, HIPAA, Case Studies: Implementation of AI Ethics guidelines and best practices in engineering projects

Unit 4	**Cybercrimes, IPR and Legal Measures**	**8 hours**

Types of Cybercrimes and their Impact, Legal measures for Cybercrime Prevention and Prosecution, IPR: Copyrights, Trademarks, Patents, and Trade Secrets, Ethical Implications of Intellectual Property, Cyber Security and Privacy Issues, Cyber Crime Investigations and Digital Evidence Handling, Overview of Indian Cyber Laws (IT Act 2000 and Amendments), Comparative Overview: Indian vs Global Cyber Laws, Case Study: The ATM Heist – Cosmos Bank Cyber Attack (India, 2018).

Unit 5	**AI Contribution to Social Evolution**	**6 hours**

Positive and Negative Political impacts of AI, Role of AI in social media and Communication Platforms, AI-Generated Content and Deepfakes, Key Technical Stakeholders in AI Deployment: Developers, Researchers, Policymakers, Technical Impacts on Employment and Workforce Automation Technologies: Robotic Process Automation (RPA), Autonomous Systems.

Total Lecture Hours	**30 hours**

Textbook:

1. "Artificial Intelligence: A Guide for Thinking Humans", Penguin Books, 2019. Melanie Mitchell
2. "Cyber Ethics: Morality and Law in Cyberspace", 7th Edition (2023). Richard Spinello, Jones & Bartlett Learning.

Reference Books:

1. Artificial Intelligence and Ethics by BPB Publications, 2023,S. B. Kishor, Debajit Biswas.
2. Cyber Security and Cyber Laws Cengage, India, 2022, Alfred Basta, Nadine Basta, Sattwik Panda,

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	Unit 1: https://www.youtube.com/watch?v=VqFqWIqOB1g Unit 2: https://www.youtube.com/watch?v=hVJqHgqF59A Unit 3: https://www.youtube.com/watch?v=O5RX_T4Tg24 Unit 4: https://www.youtube.com/watch?v=RJZ0pxcZsSQ Unit 5: https://www.youtube.com/watch?v=I9FOswjTSGg	
Web References		

Course Code: CASCC0401	Course Name: Employability Skill Development - II	L	T	P	C
Course Offered in: ECE / EE (VLSI)		2	0	0	2

Pre-requisite: Reasoning and Basic Programming

Course Objectives:

Section-A: Develop proficiency in C++ programming, data management, and project development by applying concepts, teamwork, and problem-solving to build practical applications.

Section-B: Enhance quantitative aptitude skills through business mathematics concepts, enabling accurate problem-solving in financial calculations, ratios, and real-world numerical applications

Course Outcome:		Bloom's Level
CO1	Apply C++ programming concepts, file handling, and STL techniques to develop efficient programs for data storage and manipulation.	K3
CO2	Design and implement a C++ -based project by applying planning, teamwork, and problem-solving skills.	K6
CO3	Solve real-life business math problems involving percentages, profit and loss, discounts, interest average calculations and using appropriate mathematical methods	K3
CO4	Solve real-life business math problems involving averages, mixtures, and ratios using appropriate mathematical methods.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	2	3	1	-	3	2	2	2	-	-	-
CO2	3	3	3	3	3	2	1	3	2	2	2	-	-	-
CO3	3	3	2	1	-	-	-	1	2	2	2	-	-	-
CO4	-	-	-	-	1	2	-	3	2	2	-	-	-	-

Course Contents / Syllabus

Section-A

Module 1:	Foundations of C++ Programming and Data Management Techniques	8 hours

Core Fundamentals of C++, Functions & Program Structure, Arrays & Strings, **File Handling:** File streams (ifstream, ofstream, fstream), Reading/writing text files, saving user data (scores, records, logs) **STL Basics:** vector, array, map, unordered_map set Algorithms (sort, find)

Module 2	Project/Game Development	8 hours

Project Planning & Development (Teams, roles, idea pitching and implement in C++), Mini Project, Project Demonstration and Review

Section-B

Module 3	Business Math I	8 hours

Percentage, Profit and Loss, Discount, Simple Interest and Compound Interest, Average

Module 4	Business Math II	6 hours

Ratio & Proportion, Partnership, Mixture & Allegation, Clock, Calendar

Total Lectures: 30 hours

Reference Books:

S. No	Book Title	Author

1.	A Project-Based Introduction to Programming	Access Point Publishing
2.	Programming: Principles and Practice Using C++	Bjarne Stroustrup
3.	Effective Modern C++	Scott Meyers
4.	Quantitative Aptitude	R S Aggarwal
5.	Verbal & Non-Verbal Reasoning	R S Aggarwal

Mode of Evaluation

CIE							ESE	Total
ST1	**ST2**	**ST3**	**TA1 10**	**TA2 10**	**TA3 10**	**Attendance 10**		
60			**40**					**100**

Course Code: CAS0403	Course Name: Advanced Engineering Mathematics	L	T	P	C
Course Offered in: B. Tech ECE/VLSI		3	1	0	4

Pre-requisite: Mathematics I

Course Objectives:

The objective of this course is to familiarize the students with concepts of statistical techniques, complex variables and Fourier Transform. It aims to show case the students with standard concepts and tools from B. Tech to deal with advanced level of mathematics and applications that would be essential for their disciplines.

CO	Course Outcome: After completion of the course, the student will be able to	Bloom's Level
CO1	Apply the concept of skewness and Kurtosis in the relevant application area.	K3
CO2	Apply the concept of Random Variable and Probability Distributions in real world problems.	K3
CO3	Apply the working methods of complex functions for finding analytic functions.	K3
CO4	Apply the concepts of complex functions for finding Taylor's series, Laurent's series and evaluation of definite integrals.	K3
CO5	Apply the concept of Fourier Transform to solve engineering problems.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	1	-	1	2	2	2	2	1	-
CO2	3	2	2	3	1	1	-	1	2	2	2	2	1	-
CO3	3	2	1	2	-	-	-	-	1	1	1	2	1	-
CO4	3	2	2	3	-	-	-	-	2	1	1	2	1	-
CO5	3	2	2	3	1	-	-	-	2	1	1	2	1	-

Course Contents / Syllabus

Module 1	Statistical Techniques-I	9 hours

Introduction: Measures of central tendency: Mean, Median, Mode, Standard deviation, Quartile deviation, Moments, Skewness, Kurtosis.

Module 2	Random Variables and distribution	9 hours

Random Variable: Definition of a Random Variable, Discrete Random Variable, Continuous Random Variable, Expected Value of a Random Variable, Mean, Variance, Moment Generating Function, Binomial, Poisson, Normal distribution.

Module 3	Complex Variable - Differentiation	9 hours

Limit, Continuity and differentiability, Functions of complex variable, Analytic functions, Cauchy- Riemann equations (Cartesian and Polar form), Harmonic function, Method to find Analytic functions.

Module 4	Complex Variable -Integration	9 hours

Complex integrals, Contour integrals, Cauchy-Goursat theorem (Statement), Cauchy integral formula (Statement), Taylor's series, Laurent's series, Liouvilles's theorem (Statement), Singularities, Classification of Singularities, zeros of analytic functions, Residues, Methods of finding residues, Cauchy Residue theorem (Statement).

Module 5	Integral Transforms	9 hours

Complex Fourier transform, Inverse Transforms, Convolution Theorems, Fourier sine and cosine transform.

Total Lecture Hours	45 hours

Textbook:

1. Textbook of Engineering Mathematics- IV, Bali, N.P.
2. Advanced engineering mathematics, Jain, R.K.
3. Higher engineering mathematics, Grewal, B.S.
4. Statistical methods,Gupta, S.P.
5. Advanced engineering mathematics, ZILL, DENNIS G.

Reference Books: 1. Introduction to Probability Models, Ross, Sheldon M 2. Probability, Random Variables and Stochastic Processes, Papoulis, Athanasios 3. Advanced engineering mathematics, Kreyszig, E.		
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	1. https://www.coursera.org/learn/complex-analysis 2. https://www.coursera.org/learn/introductiontoprobability 3. https://www.futureskillsprime.in/course/probability-and-statistics/	10 Hrs 7 Hrs 30 Hrs
Video Lectures	https://youtu.be/xhAdXdkx4IY?si=qmeWymorZjTRP5Gb https://youtu.be/D-ugYU-5KD0?si=5GnIImQh0KZkhdng https://youtu.be/Am7Bu4aytEQ?si=tPOufctBkK0fa-41 https://youtu.be/KQkOxZSZpZw?si=HWag4HVOEnAYFEea https://youtu.be/TL7yAkOA9D0?si=Zpde-JLws0Du9UT4	27 Min 28 Min 28 Min 27 Min 29 Min
Web References	https://ocw.mit.edu/courses/18-04-complex-variables-with-applications-spring-2018/pages/syllabus/	3 hrs

Course Code: CEC0402	Course Name: Electromagnetic Field Theory and Antenna	L	T	P	C
Course Offered in: B.Tech. ECE		**2**	**0**	**0**	**2**

Pre-requisite: Basic Vector Algebra.

Course Objectives:

The course develops a strong foundation in electromagnetic field theory by enabling students to apply vector calculus, coordinate systems, and electromagnetic concepts to engineering problems. It covers static electric and magnetic fields, Maxwell's equations, electromagnetic wave propagation, and the analysis and design of antennas for modern communication systems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's level**
CO1	Develop the ability to apply various coordinate systems and vector calculus in solving problems related to electromagnetic fields.	K3
CO2	Apply the fundamental concepts of static electric and magnetic fields to analyze and solve problems involving charge and current distributions.	K3
CO3	Comprehend Maxwell's equations and explore their applications in electromagnetic theory.	K3
CO4	Analyze fundamental parameters and radiation characteristics of an antenna.	K4
CO5	Evaluate the design, operating principles, and real-world applications of various antenna types	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	2

Course Contents / Syllabus

Unit 1	**Coordinate Systems and Transformation**	**6 hours**

Coordinates transformation: Cartesian, Cylindrical and Spherical. Vector calculus: Differential length, area and volume, line, surface and volume integrals, Del operator, Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem, Laplacian of a scalar.

Unit 2	**Electrostatic fields and Magnetostatic fields**	**6 hours**

Electric field intensity, Electric field due to charge distribution, Electric flux density, Gauss's Law Maxwell's equations, Continuity equation and relaxation time, boundary conditions, Magnetostatic fields, Ampere's circuit law, Maxwell's equation, magnetic scalar and vector potential, Magnetic boundary conditions.

Unit 3	**Electromagnetic waves**	**6 hours**

Maxwell's equations in final form, plane wave propagation in different medium: lossy dielectrics, lossless dielectrics, free space and good conductor, wave polarization, Poynting's theorem, radiation from small current element, power density and radiation resistance of short electric dipole and half wave dipole.

Unit 4	**Electromagnetic waves**	**6 hours**

Introduction, Basic antenna parameters, Patterns, Beam area, Radiation intensity, Beam efficiency, Directivity and Gain, Directivity and resolution, Antenna apertures, Effective height, The radio communication link.		
Unit 5	**Practical Antennas**	**6 hours**
The Loop Antenna, Design and its Characteristic, Application of Loop Antennas. Horn Antennas, Helical Antennas, The Log-Periodic Antenna, Design of Microstrip Antenna, Parabolic Reflector Antennas, Feed Methods for Parabolic Reflectors.		
	Total Lecture Hours	**30 hours**

Textbook:

1. "Elements of Electromagnetics', Oxford University Press, 2014, MNO Sadiku,
2. "Antennas and Wave Propagation", Fourth Edition, Tata McGraw Hill, 2011, John D Kraus, Ronald J Marhefka and Ahmad S. Khan.
3. "Antenna Theory Analysis and Design", John Wiley, 2016, C. A. Balanis,

Reference Books:

1. W. H. Hayt Jr. and J. A. Buck, *Engineering Electromagnetics*, McGraw-Hill Education, 2013.
2. A. R. Harish and M. Sachidananda, *Antennas and Wave Propagation*, Oxford University Press, 2007.
3. R. L. Yadava, *Electromagnetic Waves*, Khanna Publishing House, Delhi, 2018.
4. A. Das and Sisir K. Das, *Microwave Engineering*, Tata McGraw-Hill, 2001.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	Unit 1: https://www.youtube.com/watch?v=3qd1JT7sRG8 Unit2: https://www.youtube.com/watch?v=F5KFYBdjzuE&list=PLVFqK_9GOGXnV8fw Unit 3: https://www.youtube.com/watch?v=7NZhmOIyYQM Unit 4: https://www.youtube.com/watch?v=h51mFbIgZRI&list=PLbRMhDVUMngfytbQXzasPM Unit 5: https://www.youtube.com/watch?v=wx_tIvaajAI&list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMZT	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0401	Course Name: CMOS Analog Integrated Circuits	L	T	P	C
Course Offered in: B. Tech. ECE and EE (VLSI)		3	0	0	3

Pre-requisite: Basic understanding of electronic devices, circuit theory, and operational amplifiers.

Course Objectives: To Know

The course enables students to understand the operation of MOSFETs, including small-signal models and short-channel effects, and to analyse and design single-stage CMOS amplifiers based on gain, impedance, and operating region requirements. Students will develop the ability to design and evaluate differential amplifiers, CMOS current mirrors, and biasing networks for stable analog circuit operation. Additionally, the course strengthens fundamental programming skills, providing a solid foundation for learning and adapting to other programming languages in the future.

Course Outcome: After completion of the course, the student will be able to

Course Outcome		Bloom's Level
CO1	Explain the operation of MOSFETs, including small-signal modeling and short-channel effects.	K2
CO2	Design and evaluate single-stage CMOS amplifiers considering gain, impedance, and operating region constraints.	K4
CO3	Analyze differential amplifier configurations for differential gain, common-mode response, and active load operation.	K4
CO4	Design CMOS current mirrors and biasing networks for stable current generation and analog circuit operation.	K3
CO5	Analyze frequency response and stability-related trade-offs in CMOS analog amplifiers using pole-zero and bandwidth concepts.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	3	-	-	-	-	-	-	-	-	2	3	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	3	-	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	2

Course Contents / Syllabus

Unit 1	Basic MOS Device Physics	9 hours

General Considerations: MOSFET as a Switch, MOSFET Structure, MOS Symbols, MOS I/V Characteristics, Threshold Voltage, Derivation of I/V Characteristics, MOS Transconductance, Second-Order Effects, MOS Device Models, MOS Device Layout, MOS Device Capacitances, MOS Small-Signal Model.

Unit 2	Single-Stage Amplifiers	9 hours

Analytical justification of operating region suitable for amplification/switching, Design of CS amplifier with different loads, Limitations of diode connected load, Improving output impedance of CS amplifier through feedback, Source Follower, Common-Gate, Cascode Stage, Folded Cascode

Unit 3	Differential Amplifiers	9 hours

Single-Ended and Differential Operation, Basic Differential Pair, Qualitative Analysis, Quantitative Analysis, Degenerated Differential Pair, Common-Mode Response, Differential Pair with MOS Loads

Unit 4	Current Mirrors and Biasing Techniques	9 hours

Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors, Large-Signal Analysis, Small-Signal Analysis, Common-Mode Properties, Other Properties of Five-Transistor OTA, Biasing Techniques, CS Biasing, CG Biasing, Source Follower, Differential Pair Biasing		
Unit 5	**Frequency Response of Amplifiers**	**9 hours**
General Considerations, Miller Effect, Association of Poles with Nodes, Common-Source Stage, Source Followers, Common-Gate Stage, Cascode Stage, Differential Pair, Differential Pair with Passive Loads, Differential Pair with Active Load, Gain-Bandwidth Trade-Offs, One-Pole Circuits, Multi-Pole Circuits		
	Total Lecture Hours	**45 hours**
Textbook: 1.Behzad Razavi, Design of Analog CMOS Integrated Circuit, McGraw Hill Education, 2017, 2nd Edition 2.David A. Johns, Ken Martin, Analog Integrated Circuit Design, Wiley Student Edn, 2013.		
Reference Books: 1. Allen, Phillip E., and Douglas R. Holberg, CMOS analog circuit design. Elsevier, 2011. 2. Geiger, Allen and Stradder, VLSI Design Techniques for Analog and Digital Circuits, Tata McGraw-Hill Education, 2010.		
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	https://www.youtube.com/watch?v=dlOlxAcfBo4&list=PLunAuxHqEAijgoKKoo7aYYvXtjiVwbin5&index=1 https://www.youtube.com/watch?v=0OH9d72ZX7s&list=PLunAuxHqEAijgoKKoo7aYYvXtjiVwbin5&index=2 https://www.youtube.com/watch?v=GmhFnm6mdxY&list=PLunAuxHqEAijgoKKoo7aYYvXtjiVwbin5&index=3 https://www.youtube.com/watch?v=jfizMWm3Q0I&list=PLunAuxHqEAijgoKKoo7aYYvXtjiVwbin5&index=4 https://www.youtube.com/watch?v=UTo4IGXxzlk&list=PLunAuxHqEAijgoKKoo7aYYvXtjiVwbin5&index=7 https://www.youtube.com/watch?v=RgpH9_sy5iI&list=PL_b8tSqlo138huGY9amrru2EA28Zcxgyy&index=6 https://www.youtube.com/watch?v=PxsY1U8aMso&t=1982s https://www.youtube.com/watch?v=XbM1-WgGXQc&list=PLZvoNERCg2SxxSN-gBoW7bR_UGQmLj7Fx	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0403	Course Name: Microprocessor & Microcontroller	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basics of digital electronics.

Course Objectives:

The course enables students to understand the fundamentals, architecture, and programming of microprocessors and microcontrollers. It develops the ability to analyze and program the 8086 microprocessor and 8051 micro controllers for embedded and real-time applications. The course also introduces ARM processor architecture and instruction set programming, preparing students to develop solutions for modern embedded systems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain the fundamentals of general microprocessor & microcontroller.	K2
CO2	Explain the fundamentals of 8086 microprocessor.	K2
CO3	Implement 8051 microcontroller for designing various applications.	K3
CO4	Illustrate the fundamentals of ARM Cortex M0 Processor.	K4
CO5	Apply the knowledge of ARM Instruction Set for programming.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	2	2	3	2
CO2	3	3	2	-	-	-	-	-	-	-	2	2	3	2
CO3	3	3	3	-	-	-	-	-	-	-	2	2	3	2
CO4	3	3	3	-	-	-	-	-	-	-	2	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	2	2	2	2

Course Contents / Syllabus

Unit 1	**Basics of Microprocessor and microcontrollers**	**9 hours**

History and Evolution of Microprocessor and microcontrollers, Computer architecture: Harvard & Von Neumann architecture, RISC & CISC architecture, Different Layers of computer architecture, Buses, types of buses, bus architecture, Microprocessor architecture and its operations, address and data bus Multiplexing and Demultiplexing, Instruction format and size.

Unit 2	**Introduction to 8086**	**9 hours**

Introduction to 8086 – Microprocessor architecture, Pipelining Concept, Memory Segmentation, General Purpose Registers, Pointer and Index Registers, Flag Register, Bus Interface Module, 8086 Pin Description, addressing modes, Instruction set and assembler directives, 8086 Interrupt -Software and Hardware Interrupts.

Unit 3	**Introduction to 8051**	**9 hours**

Overview of the 8051, Inside the 8051, Addressing modes, 8051 data types and directives, Instruction set and assembly language programming of 8051 microcontrollers, Programming the 8051 timers, Interfacing of I/O devices (keypad & display) with 8051. Application of 8051 microcontroller.

Unit 4	**ARM Processor 1**	**9 hours**

Arm Processor Families, Arm Cortex-M Series Family, Cortex-M0 Processor: Cortex-M0 Overview, Cortex-M0 Block Diagram, Cortex-M0 Three-stage Pipeline, Cortex-M0 Registers, Cortex-M0 LR, Cortex-M0 PSRs, Cortex-M0 Memory Map, Cortex-M0 Executable Memory Space, Cortex-M0 Device Memory Space, Cortex-M0 Private Peripheral Bus, Cortex-M0 Reserved Memory Space, Cortex-M0 Memory Map Example, Cortex-M0 Endianness.

Unit 5	ARM Processor 2	9 hours
Thumb Instruction Set, Thumb-2 Instruction Set, Cortex-M0 Instruction Set, Register Access: The Move Instruction, Memory Access: The LOAD Instruction, The STORE Instruction, Stack Access: PUSH and POP, Arithmetic instructions (ADD, SUB, MUL, CMP), Logic Operation, Arithmetic Shift Operation, Logical Shift Operation, Rotate Operation, Reverse Ordering Operation, Sleep Mode Related Instructions, CortexM0 Low Power Features: Sleep Mode, Sleep-on-Exit Feature, How to Enable Sleep Features, Processor Wakeup Conditions, Wakeup Interrupt Controller, Enter and Exit Deep Sleep Mode.		
	Total Lecture Hours	**45 hours**

Textbook:

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, 5th Edition, Penram International Publishing (India) Pvt. Ltd.
2. Douglas V. Hall, *Microprocessors and Interfacing: Programming and Hardware*, Tata McGraw-Hill.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, *The 8051 Microcontroller and Embedded Systems*, Pearson Education.

Reference Books:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education.
2. Andrew N. Sloss, Dominic Symes, and Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Elsevier/Morgan Kaufmann Publishers, 2008.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	Unit 1: https://nptel.ac.in/courses/108105102 Unit 2: https://nptel.ac.in/courses/108105102 Unit 3: https://nptel.ac.in/courses/108105102. Unit 4: https://nptel.ac.in/courses/106105193 Unit 5: https://nptel.ac.in/courses/106105193	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0411	Course Name: Data Analytics	L	T	P	C
Course Offered in: B. Tech ECE / EE(VLSI)		3	0	0	3

Pre-requisite: Basic Programming, Basics of digital electronics

Course Objectives:

This course aims to provide students with a strong foundation in data analytics by introducing fundamental concepts, data preprocessing techniques, exploratory data analysis (EDA), and data visualization methods. It enables learners to analyze diverse datasets, extract meaningful patterns and insights, and apply analytical techniques to solve real-world problems across various application domains.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the fundamental concepts of data analytics in the areas that plays major role within the realm of data science	K2
CO2	Explain and exemplify the most common forms of data and its representations.	K2
CO3	Apply data pre-processing techniques on heterogeneous datasets.	K3
CO4	Analyze data using exploratory data analysis	K4
CO5	Apply visualization tool to analyze and draw inference from different types of data sets w.r.t different application scenarios.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	-	-	2	2	2	2
CO2	3	2	2	-	3	-	-	-	-	-	2	2	3	2
CO3	3	3	2	-	3	-	-	-	-	-	2	3	3	2
CO4	3	3	3	-	3	-	-	-	-	-	2	2	3	2
CO5	3	2	3	-	3	-	-	-	-	-	2	2	2	2

Course Contents / Syllabus

Unit 1	**Foundations of Data Science: Concepts, Tools, and Applications**	**9 hours**

Introduction to Data Science, Evolution of Data Science, Skillsets needed, Lifecycle, Need for Data Science, Datafication, Types of Data Analysis, Data Science Tools and technologies, Analysis Vs Analytics Vs Reporting, Applications of Data Science in various fields, Use cases of Data science-Facebook, Netflix, Amazon, Uber, AirBnB.

Unit 2	**Data Types and Statistical Foundations**	**9 hours**

Types of Data: structured, semi-structured, unstructured data, Numeric, Categorical, Graphical, High Dimensional Data, Transactional Data, Spatial Data, Social Network Data, standard datasets, Sources of Data, Data manipulation in various formats, for example, CSV file, import and export data in R/Python. Measure of central tendency (Mean, Median, Mode), Central limit theorem, Skewness, Variance, SD, Covariance, Correlation, Normal distribution, Margin of Error.

Unit 3	**Data Preprocessing and Visualization**	**9 hours**

Form of Data Pre-processing, data Attribute and its types, KDD process, Inconsistent Data, Data Cleaning: Missing Values, Noisy Data, Discretization and Concept hierarchy generation (Binning, Clustering, Histogram), Data Integration and Transformation. Data Reduction: Data Cube, Data Compression, Numerosity Reduction, R-Square, Adjusted R-Square, Significance of p-value.

Unit 4	**Data Cleaning, Transformation, and Exploration**	**9 hours**

Variable Selection, Removing Redundant variables, identifying outliers, Removing Outliers, Time series Analysis, Data transformation and dimensionality reduction techniques such as Principal Component Analysis (PCA), Factor Analysis (FA) and Linear Discriminant Analysis (LDA), Univariate and Multivariate Exploratory Data Analysis. Data Wrangling using R/Python.

Unit 5	Data Visualization with Tableau	9 hours
Introduction to Tableau, Installation and configuration of Tableau. Creating Your First visualization: Getting started with Tableau Software, Using Data file formats, connecting your Data to Tableau, creating basic charts using the Show me panel. Tableau Calculations: Overview of SUM, AVR, and Aggregate Features, Creating custom calculations and fields, Manipulating Data in Tableau: Cleaning-up the data with the Data Interpreter, structuring your data, Sorting, and filtering Tableau data, Pivoting Tableau data. Advanced Visualization Tools: Using Filters, Using the Detail panel, Using the Size panels, customizing filters, Using and Customizing tooltips, formatting your data with colors, Creating Dashboards & Stories, Distributing & Publishing Your Visualization		
	Total Lecture Hours	**45 hours**

Textbook:

1. John F. Elder IV and Dean W. Abbott, *Data Analysis and Data Mining*, 2nd Edition, John Wiley & Sons, 2014.
2. Glenn J. Myatt and Wayne P. Johnson, *Making Sense of Data: A Practical Guide to Exploratory Data Analysis and Data Mining*, John Wiley & Sons, 2009.

Reference Books:

3. Field Cady, The Data Science Handbook, John Wiley & Sons, Inc., 2017.
4. Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2012.

Self-Study Content Links:		Duration (in Hrs)
MOOCs		
Video Lectures	**Unit 1** https://www.youtube.com/playlist?list=PLEiEAq2VkUUKgEFXH1tBbHwq38oWYDScU https://www.youtube.com/watch?v=dcXqhMqhZUo **Unit 2** https://www.youtube.com/watch?v=VaSjiJMrq24 **Unit 3** https://www.youtube.com/watch?v=tDu_KIlXaB0 **Unit 4** https://www.youtube.com/watch?v=ZX8vmcSTCrc **Unit 5** https://www.youtube.com/watch?v=I3450sh1eDo	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: CEC0413	Course Name: VLSI Technology	L	T	P	C
Course Offered in: B. Tech. ECE / EE (VLSI)		3	0	0	3

Pre-requisite: Basic knowledge of Semiconductor materials

Course Objectives:

This course aims to provide students with a comprehensive understanding of IC fabrication processes, cleanroom practices, semiconductor materials, and VLSI manufacturing technologies. It develops knowledge of lithography, thin-film deposition, doping, metallization, and process integration techniques essential for the design and fabrication of modern semiconductor devices and integrated circuits.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the IC fabrication environment, safety practices, and various unit processes involved in VLSI technology.	**K2**
CO2	Demonstrate understanding of semiconductor material growth and oxidation techniques used in device fabrication and evaluate the characteristics of grown epitaxial layers.	**K4**
CO3	Describe pattern transfer methods and thin-film deposition techniques used in semiconductor manufacturing.	**K2**
CO4	Analyze doping techniques and impurity distribution processes in semiconductor fabrication.	**K2**
CO5	Explain metallization processes, metal selection, and interconnect fabrication techniques in VLSI systems.	**K2**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	–	–	–	–	–	–	–	–	2	2	2
CO2	3	2	3	–	–	–	–	–	–	–	–	2	2	2
CO3	3	2	2	–	–	–	–	–	–	–	–	2	2	2
CO4	3	2	3	–	–	–	–	–	–	–	–	2	2	2
CO5	2	2	2	–	–	–	–	–	–	–	–	2	2	2

Course Contents / Syllabus

Unit 1	**Environment for VLSI Technology**	**9 hours**

Environment for VLSI Technology: Clean room and safety requirements, Wafer cleaning processes. Etching Techniques - Wet and Dry Etching, Introduction to Plasma Etch mechanisms, Reactive Plasma Etching, and its applications

Unit 2	**Epitaxy**	**9 hours**

Epitaxy: Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation, Oxidation: Growth Kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxides Properties, High k and low k dielectrics for ULSI

Unit 3	**Lithography**	**9 hours**

Lithography: Optical Lithography, Electron beam lithography, Photo masks, Dielectric and Polysilicon Film Deposition: CVD techniques for deposition of Polysilicon, Silicon Dioxide, Silicon Nitride

Unit 4	**Diffusion**	**9 hours**

Diffusion: Models of diffusion in solids, Fick's 1-Dimensional diffusion equation, Diffusion of Impurities in Silicon and Silicon Dioxide, Diffusion Equations, Diffusion Profiles, Diffusion Furnace, Solid, Liquid, and Gaseous Sources. Ion-Implantation: Ion- Implantation Technique, Range Theory, Implantation Equipment

Unit 5	**Metal film deposition**	**9 hours**

Metal film deposition: Metallization, Metallization Application, Metallization Choices, Failure mechanisms in metal interconnects; multi-level metallization schemes. growth and deposition of various films for use in ULSI. Process integration for NMOS, CMOS and Bipolar circuits; Advanced MOS technologies

Total Lecture Hours	**45 hours**

Textbook:

1. Richard C. Jaeger, *Introduction to Microelectronic Fabrication*, 2nd Edition, Prentice Hall, Upper Saddle River, NJ, 2002.
2. Simon M. Sze and Kwok K. Ng, *Physics of Semiconductor Devices*, 3rd Edition, Wiley, Hoboken, NJ, 20

Reference Books:

1. VLSI technology (2nd ed.). New York, NY: McGraw-Hill, (1981) Sze, S. M
2. Fundamentals of microfabrication (2nd ed.). Boca Raton, FL: CRC Press, (2002) Madou, M. J

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1**: https://youtu.be/PJUNgWmbS9E?si=GRMOkMJ0zYzFEyfn https://youtu.be/wSSfOqEQClc?si=5MEoyfdA9_lgJzD9 **Unit 2**: https://youtu.be/S3e7BHBrOhk?si=tMJkRyL6-ZHCcjyR https://youtu.be/tWq2OF3abNI?si=QPsUDTw_L6jqd8Jv https://youtu.be/Se-rAo3nioU?si=achbYnInhG1bvL3_ https://youtu.be/VaIMp-sZe0U?si=ZBDrlxGjMsaDk **Unit 3**: https://youtu.be/v9eGO5OjC8A?si=7xJ3yhoJ0ygbAR-T https://youtu.be/pcAEEw2Gadg?si=ohNhLWq49XynAC2k https://youtu.be/g3_beYKJqOk?si=SSgl2H4uN7BGJsxD https://youtu.be/g3_beYKJqOk?si=jcQzjvD0BP3ZWp_U **Unit 4:** https://youtu.be/hMZylm9qbgs?si=dxOwJr4eFbJ7cN3h https://youtu.be/XO0gnTxzZoI?si=ELNktE49ZVksua9t https://youtu.be/3pYqPCK0p9w?si=WdDlTJkGuP2hgaZj **Unit 5**: https://youtu.be/Omf26GtJXCI?si=B-Th46DMwO-FvhyZ https://youtu.be/sM2nHyo--zA?si=2lvekVZlChHEbqn8 https://youtu.be/AFpNn0UhSTY?si=muqzOR2Dj_DZna8z	
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: CEC0451	LAB Course Name: CMOS Analog Integrated Circuit Lab	L	T	P	C
Course Offered in: B. Tech. ECE / EE (VLSI)		0	0	4	2

Pre-requisite: Basic understanding of electronic devices, circuit theory, and operational amplifiers. Familiarity with SPICE simulation and mathematical tools like differential equations is also recommended.

Course Objectives: To Know

Students will be able to analyze MOSFET characteristics, extract device parameters, and design CMOS amplifier circuits, including common source, common gate, cascode, differential amplifiers, and current mirrors. They will also evaluate amplifier frequency response and perform schematic simulation and layout design of CMOS inverters using industry-standard EDA tools.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Analyze MOSFET characteristics and extract design parameters.	**K3**
CO2	Design and simulate CMOS amplifier stages (CS, CG, Cascode).	**K3**
CO3	Implement and evaluate differential amplifiers and current mirrors	**K4**
CO4	Analyze the frequency response of amplifier circuits and interpret results.	**K4**
CO5	Design, simulate, and layout of CMOS inverter.	**K3**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**2**
CO2	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	3	3
CO5	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**

List of Practical's (Indicative & Not Limited To)	**CO**
1) Study of NMOS characteristics using DC and transient analysis; extraction of V_{th} and Region of operation.	**CO1**
2) Extraction of MOSFET design parameters (gm, ro) using gm/ID methodology	**CO1**
3) Design and Simulation of Single Stage Common Source Amplifiers with resistive load evaluation of gain and biasing	**CO1**
4) Design and Simulation of Single Stage Common Source Amplifiers with diode connected load	**CO2**
5) Design and Simulation of Single Stage Common Gate Amplifiers analysis of input impedance and bandwidth	**CO2**
6) Design and Simulation of Single Stage Cascode Common Source Amplifiers evaluation of gain enhancement and output resistance	**CO2**
7) Design and Simulation of a Differential Amplifier with active load, Analysis of differential gain and CMRR	**CO3**
8) Design and Simulation of Basic Current Mirror	**CO3**
9) Design and Simulation of Cascode Current Mirror, analysis of output resistance and improved current stability	**CO3**
10) Design of Two Stage CMOS Op-Amp Circuit	**CO4**

11) Analysis of Frequency response of various amplifiers (Common Source, Cascode, Differential Amplifier)	**CO4**
12) Pre-Layout Simulation of CMOS inverter.	**CO4**
13) Design and Simulation of CMOS Differential Pair with Current Mirror Bias	**CO5**
14) Design and Simulation of CMOS Bandgap Reference Circuit	**CO5**
15) Design and Simulation of Folded Cascode Operational Amplifier	**CO5**
Total Lecture Hours	**30 hours**

LAB Course Code: CEC0453	LAB Course Name: Microprocessor & Microcontroller Lab	L	T	P	C
Course Offered in: B.Tech. ECE		0	0	2	1

Pre-requisite: Basic of Digital System and Assembly Language Programming.

Course Objectives:

Develop an understanding of microprocessor and microcontroller architectures through hands-on laboratory experiments. Design, write, and execute assembly language programs using the 8086 microprocessors. Apply ARM instruction set programming to develop and test programs for embedded system applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Apply the knowledge of 8086 Microprocessor for writing assembly level language.	K3
CO2	Implement timer in 8051 microcontrollers for generating waveforms.	K3
CO3	Analyze the interfacing of various I/O devices with programming.	K4
CO4	Apply the knowledge of ARM Instruction Set to write the program for given application.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	2	-	-	-	-	-	2	2	2	2
CO2	3	3	2	-	2	-	-	-	-	-	2	2	2	2
CO3	3	2	2	-	2	-	-	-	-	-	2	3	2	2
CO4	3	2	3	-	2	-	-	-	-	-	2	3	2	2

List of Practical's (Indicative & Not Limited To)	**CO**
1. To study 8086 microprocessor system.	**CO1**
2 Write a program using 8086 Microprocessor for Hexadecimal addition of two 8-bit Numbers.	**CO1**
3. Write a program using 8086 Microprocessor for Hexadecimal subtraction of two 8-bit Numbers.	**CO2**
4. Write a program using 8086 Microprocessor for Hexadecimal addition/subtraction of two 16-bit Numbers.	**CO2**
5. To perform multiplication of two 8-bit numbers using 8086.	**CO3**
6. Write a program of flashing LED connected to port 1 of the 8051 Microcontroller.	**CO3**
7. Write a program to generate 10 kHz square wave using 8051 Microcontroller.	**CO3**
8. Write a program to show the use of INT0 and INT1 of 8051 Microcontroller.	**CO3**
9. Write a program to generate a Ramp waveform of 1 KHz using DAC with 8051 micro controllers.	**CO3**
10. To write and simulate ARM assembly language programs for data transfer, arithmetic and logical operations (Demonstrate with the help of a suitable program).	**CO4**
11. To write and simulate C Programs for ARM microprocessor using KEIL software. (Demonstrate with the help of a suitable program).	**CO4**
Total Hours:	**15 hrs.**

Course Code: CECE455	Course Name: IoT Workshop (Workshop Mode)	L	T	P	C
Course Offered in: B.Tech. ECE		0	0	6	3

Pre-requisite: Basic knowledge of Digital, Sensors and IoT

Course Objectives:

To provide knowledge of Industrial Internet of Things (IIoT) concepts, applications, architectures, and their role in industrial automation and smart manufacturing. To develop the ability to design and implement Industrial IoT solutions using cloud computing, virtual networking, communication protocols, and data acquisition techniques. To enable students to analyze Industrial IoT system components, security challenges, and real-world applications for solving industrial and societal problems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Identify the key opportunities, applications, and benefits of Industrial Internet of Things (IIoT) in modern industries.	**K1**
CO2	Apply virtual networking concepts to demonstrate the role of cloud computing in Industrial IoT environments	**K3**
CO3	Analyze ADC/DAC techniques and Industrial Internet Application Framework (IIAF) components for efficient Industrial IoT system design.	**K4**
CO4	Explain the concepts and applications of IoT protocols and communication technologies used in Industrial IoT systems.	**K2**
CO5	Analyze IoT security challenges and issues, and apply IoT solutions to address real-world societal problems.	**K4**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	3	2	2
CO2	3	3	3	-	-	-	-	-	-	-	-	3	2	-
CO3	3	2	3	-	-	-	-	-	-	-	-	3	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	3	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	3	2	-

Course Contents / Syllabus

Unit 1	**Introduction to IoT and and its basic fundamentals:**	**9 hours**

Introduction to IoT and its Characteristics Industrial Internet- Key IIoT Technologies Innovation and the IIoT - KeyOpport Modules and Benefits -The Digital and Human Workforce – Logistics and the Industrial Internet- IoT Innovations in Retail. Introduction to Integrated Developed Environments.

Unit 2	**Sensor Networks**	**9 hours**

Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT. Cyber Physical Systems (CPS) – IP Mobility – Network Virtualization - SDN (Software Defined Networks)- The Cloud and Fog – Role of Big Data in IIoT - Role of Machine learning and AI in IIoT.

Unit 3	**Arduino and Raspberry pi Programming**	**9 hours**

ADC and DAC Conversion Techniques, Industrial Internet Architecture Framework (IIAF) -Industrial Internet Viewpoints -. Architectural Topology: The Three-Tier Topology- Key System Characteristics- Data Management- Advanced data analytics.

Unit 4	IoT Security and Protocols	9 hours
Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, HART, NFC, Z-Wave, Bacnet, Modbus. IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols, IoT Security, Threat Modelling.		
Unit 5	**Applications of IoT**	**9 hours**
Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Robot surveillance, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.		
	Total Lecture Hours	**45 hours**

Textbook:

1. Margolis, M., Jepson, B., and Weldin, N. R., Arduino Cookbook, 3rd Edition, O'Reilly Media, Inc., 2020.
2. Monk, S., Raspberry Pi Cookbook, 4th Edition, O'Reilly Media, Inc., 2022.

Reference Books:

1. Rajkumar Buyya and Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, Morgan Kaufmann, 2016.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	Unit 1 https://www.youtube.com/watch?v=om-5QTbLCCs Unit 2 https://www.youtube.com/watch?v=BBvG7uzmOV0&t=51s Unit 3 https://www.youtube.com/watch?v=HicZcgdGxZY&t=39s Unit 4 https://www.youtube.com/watch?v=-7dAFWRjCoA Unit 5 https://www.youtube.com/watch?v=SW3Ia5xLmuU	
Web References		

List of Practical's (Indicative & Not Limited To)

S.NO	Name of Experiment	COs
1	Study of IDE and practice of its installation.	CO1
2	Create a traffic light signal with three coloured lights (Red, Orange and Green) with a duty cycle of 5-2-10 seconds.	CO2
3	Simulation of 4-Way Traffic Light with Arduino.	CO2
4	Working with Adafruit Libraries in Arduino.	CO2
5	Connect an LED to GPIO pin 25 and control it through the command line.	CO2
6	The state of LED should toggle with every press of the switch. Use DHT11 temperature sensor and print the temperature and humidity of the room with an interval of 15 seconds.	CO2
7	To study Libraries and their installation.	CO3
8	To interface a servo motor with an Arduino board and control its position using PWM signals.	CO3
9	To learn how to interface a DC motor with an Arduino board and control its speed and direction.	CO3
10	To understand how to interface a relay with an Arduino board and control external devices.	CO3
11	To understand how to interface a stepper motor with an Arduino board and control its rotation.	CO3
12	To detect the presence of LPG or propane gas using the MQ-6 gas sensor and Arduino.	CO3

13	Study and Installation of Raspberry Pi.	CO3
14	Displaying different LED Patterns with Raspberry Pi.	CO3
15	Programming of available GPIO Pins of the corresponding device using native programming language. Interfacing LED and testing the functionality.	CO3
16	To explore BLE communication and data exchange.	CO4
17	Home automation system.	CO5
18	Health care system.	CO5
19	Smart Irrigation System.	CO5
20	Electric Piano.	CO5
	Total Lecture Hours	**35 hours**

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc

LAB Course Code: CCSCC0452	LAB Course Name: Problem Solving Approaches	L	T	P	C
Course Offered in: ECE/EE-VLSI		**0**	**0**	**2**	**1**

Pre-requisite: Programming Language C/C++ or Java or Python

Course Objectives: To know

Problem-solving in computer programming involves a structured approach to identifying, analyzing, and resolving coding challenges. The process typically includes thoroughly understanding the problem, decomposing it into smaller, manageable parts, designing an appropriate algorithm, implementing the solution through code, and performing testing and debugging to ensure correctness and efficiency

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Develop logic-based solutions using control statements, recursion and bit manipulation to solve basic and intermediate computational problems	K6
CO2	Implement and manipulate arrays and strings using fundamental and advanced searching sorting techniques	K3
CO3	Analyze and debug code for logical errors and improve the efficiency of the solution using appropriate data structures and algorithmic Pattern	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	2	2	-	-	2	3	3	2
CO2	3	3	2	2	2	-	2	-	-	-	2	2	2	2
CO3	3	3	2	2	3	1	2	2	-	-	3	3	3	2

List Of Practical's (Indicative & Not Limited To)

Problem Statements need to be discussed in lab session: Control Statements	**CO**

1. Secure Password Generator

A company wants to create a secure password generator for their employees. The password must be based on specific numeric properties to enhance its complexity and security. Write a program to validate and generate a secure password according to the following rules:

1. Prime Number Validation:

- The user must input a 3-digit number. The program should first check if the number is a prime number.
- If it is not a prime number, the user should be prompted to enter another number until a valid prime number is provided**.**

2. Sum of Digits Check:

- Once a valid prime number is entered, calculate the sum of its digits. If the sum of the digits is not divisible by 3, ask the user to enter another prime number until a valid one is found.

3. Armstrong Number Check:

- Check entered prime number is Armstrong or not? If Armstrong are found, prompt the user to enter another prime number and repeat the process.

Password Generation:

Concatenate the 1 if entered prime number is Armstrong otherwise 2 with the sum of the digits of the valid prime number to form the secure password.

Example Scenario:

Sample Input

Enter a 3-digit prime number: 153 Sum of
digits of 153 = 9
The sum is divisible by 3. 153 is Armstrong number ***Sample***

Output

Secure Password: 19

2. Write a function to input electricity unit charges and calculate total electricity bill according to the given condition: For first 50 units Rs. 0.50/unit for next 100 units Rs. 0.75/unit For next 100 units Rs. 1.20/unit For unit above 250 Rs. 1.50/unit an additional surcharge of 20% is added to the bill

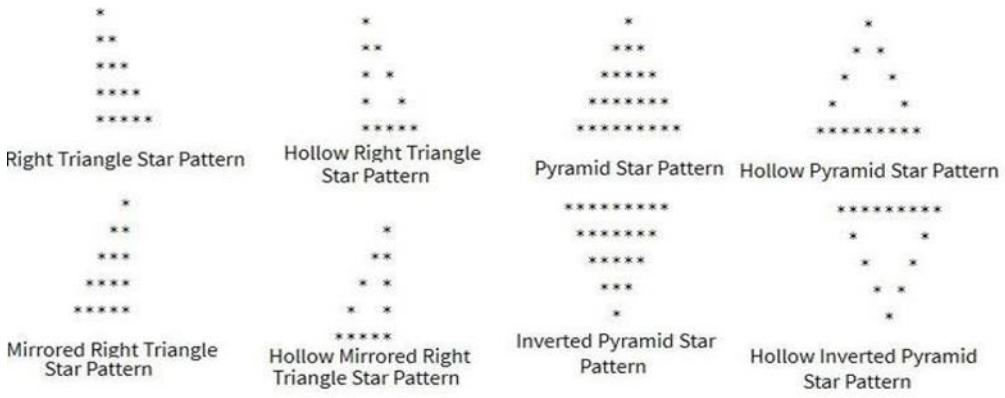
3. Write a method to generate a secure code which the sum of all possible palindrome numbers between given two numbers. For Example:

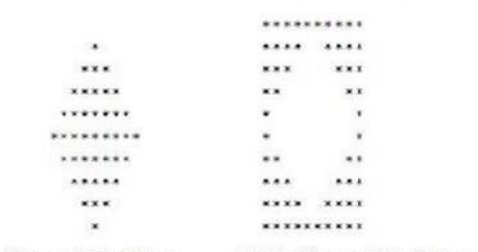
Input: 10, 80

Output: 308

Explanation: All palindrome numbers between 10 & 80 are: 11,22,33,44,55,66,77 Password=
11+22+33+44+55+66+77 = 308

4. Draw **the following Patterns for N=5**

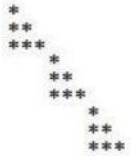




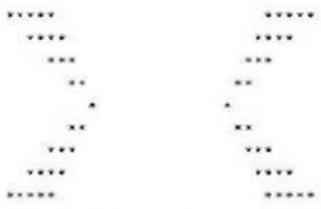
Diamond Star Pattern

Hollow Diamond Star Pattern

Number pattern 18

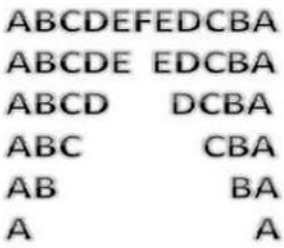


For N=3 print above pattern



Right Arrow Star Pattern

Left Arrow Star Pattern



Problem Statements need to be discussed in lab session: Recursive Approach (Basic)

1. Write a program that takes an integer n as input and prints the multiplication table of n from n * 1 to n * 10. The output should clearly show each multiplication step.
2. Write a program to calculate the sum of all integers from 1 to a given number N. The program should take N as input and output the total sum using iteration or recursion.
3. **Find the GCD of Two Numbers Using Recursion:**
   Write a recursive function to calculate the Greatest Common Divisor (GCD) of two numbers using Euclid's algorithm. The function should take two integers as input and return their GCD.
4. **Find the LCM of Two Numbers Using Recursion:**
   a. Write a program to compute the Least Common Multiple (LCM) of two numbers using recursion. You may use the relationship LCM(a, b) = |a
   * b| / GCD(a, b) and a recursive function for GCD.

Problem Statements need to be discussed in lab session: Bit Manipulation

1. Write a program to count the number of set bits (1s) in the binary representation of a given integer. The program should efficiently use bitwise operations to perform the task without converting the number to a string.
2. Write a program that takes a number and a bit position as input and checks whether the bit at that position is set (1) or clear (0). Use bitwise operators to perform the check
3. Given a number and a position, write a program to toggle (invert) the bit at the given position using bitwise operations. The result should reflect the updated value of the number after flipping the bit
4. Write a program to compute the XOR of all numbers from 1 to n using a mathematical pattern (not a loop). Use bitwise XOR properties to achieve an efficient solution
5. Given an array of size n-1 containing unique elements from 1 to n, find the missing number using bit manipulation (preferably XOR approach) without sorting or using extra space.
6. Given an array where all elements repeat twice except two elements that appear only once, write a program to find the two non-repeating elements using bitwise operations in linear time and constant space.
7. Write a program to check if a given number is a power of two using bit manipulation. A number is a power of two if it has exactly one set bit in its binary representation.

8. Given two integers A and B, write a program to count how many bits need to be flipped to convert A to B. Use XOR to find differing bits and count the number of set bits.

9. Write an efficient program to count the total number of set bits in binary representations of all numbers from 1 to n. Optimize the approach using bitwise logic and recursion.

10. Write a program to calculate the square of a number using only bitwise operations and addition. Do not use multiplication, division, or any power functions.

11. Write a function to add two integers using bitwise operations only. Avoid using the + or - operators. Implement logic using XOR and AND operations for binary addition.

12. Write a program to generate the power set (all subsets) of a given set using bitwise representation. Each subset can be represented by a binary number where each bit indicates inclusion of the corresponding element.

Problem Statements need to be discussed in lab session: Arrays (Try to use sliding window, prefix sum, cadence, recursion, bit manipulation, two pointer approaches)

1. Sarah is assisting the "MathMinds Club" in creating passwords for their online platform. They have a list of numbers, some stable and some unstable. Define a function that can help Sarah calculate the password according to the given scenario.

Scenario:

- There are N numbers provided.
- A number is stable if each digit appears the same number of times.
- A number is unstable if the frequency of its digits is not the same.
- The password is computed as the sum of all stable numbers minus the sum of all unstable numbers.
- Consider only those numbers in the list that have more than equal to three digits.

For example:

Input: N=5 List: 12, 1313, 122, 678, 898

Output: Password: 971

2. Given an array of integers, including possible negative values, you are allowed to modify at most one element by doubling its value. The goal is to find the maximum possible sum of any subarray after making this modification.

Input:

arr = [-2, 1, -3, 4, -1, 2, 1, -5, 4]

Expected Output:

- Original Maximum Subarray Sum: 6 (achieved from [4, -1, 2, 1])

Maximum Sum After Modification: 10(achieved from [8, -1, 2, 1], where the value 4 is doubled to 8).

3. For a given string, generate a pattern based on the following rules:

Input: A string of characters (e.g., "HAT").

Output: Generate patterns by replacing characters with the numeric value 1 and process the patterns as described below:

1. **Replace one character at a time with 1:**
    - For each character in the string, replace it with 1, keeping the other characters unchanged.
    - Example for "HAT":

1AT, H1T, HA1

2. **Replace two characters at a time with 1:**
    - Replace every combination of two characters with 1, keeping the remaining character unchanged.

- If 1s are consecutive, replace them with their sum (e.g., 11T becomes 2T).
- Example for "HAT":

11T → 2T, H11 → H2, 1A1

3. **Replace all characters with 1:**
   - Replace all characters in the string with 1.
   - If there are consecutive 1s, sum them up (e.g., 111 becomes 3).
   - Example for "HAT": 111

→ 3

Final Output

For the string "HAT", the output should be: 1AT, H1T, HA1, 2T, H2, 1A1, 3.

4. Given a sorted array arr [] and a target value, the task is to count triplets (i, j, k) of valid indices, such that arr[i] + arr[j] + arr[k] = target and i < j < k.

Examples:

Input: arr[] = [-3, -1, -1, 0, 1, 2], target = -2

Output: 4

5. You are given an array prices[] where prices[i] represents the price of a given stock on day i. You want to maximize your profit by choosing a single day to buy one stock and choosing a different day in the future to sell that stock. Write a program to return the maximum profit you can achieve from this transaction. If no profit is possible, return 0.

6. Find **the "Kth" max and min element of an array:**

Given k, find the k-th smallest and k-th largest element in the array. Input: arr = [7, 10, 4, 3, 20, 15], k = 3

Output: Kth Smallest: 7, Kth Largest: 10

Given k, find the k-th smallest and k-th largest element in the array. Input: arr = [7, 10, 4, 3, 20, 15], k = 3

Output: Kth Smallest: 7, Kth Largest: 10

7. Sort a binary array with value 0,1 and 2 using constant space and one pass (Dutch national Flag algorithm)

Input: [0, 2, 1, 2, 0]

Output: [0,0,1,2,2]

8. Find **longest consecutive subsequence:**

Return the length of the longest consecutive elements sequence. Input: [1, 9, 3, 10, 4, 20, 2]

Output: 4 (Sequence: 1, 2, 3, 4)

9. Given a number of bits and a number K. In one flip you can toggle exactly K consecutive bits. With only this flip operation available, convert the string into all 1. Input String: 0000110000 and K=3

Following are four flip operations by using which all bits converted into 1's. Flip1-1110110000 Flip2-1110110111

Flip3-1111000111 Flip4- 1111111111

If it is not possible to convert all bits into one's then print "IMPOSSIBLE".

10. Given a list of non-negative integers, arrange them in such a way that they form the largest possible number. Since the result can be very large, return it as a string in **O(N log N)** time complexity.

Example-1	**Example-2**
Input:	**Input**:
N = 5	N = 4
Arr[] = {3, 30, 34, 5, 9}	Arr[] = {54, 546, 548, 60}
Output: 9534330	

	Output: 6054854654	

11. Given an array arr[] of size n containing distinct integers within the range [1, n+2], find the two missing numbers from the first n+2 natural numbers.

Constraints:

- The solution must run in **O(N) time** and use **O(1) extra space**.
- The array does not contain duplicate values.

Examples:

Input: arr[] = [1, 2, 4, 6, 3, 8], n = 6

Output: 5, 7

12. Given a string str of lowercase alphabets and a number k, the task is to print the minimum value of the string after removal of k characters. The value of a string is defined as the sum of squares of the count of each distinct character present in the string. Return the minimum possible required value. **Examples:**

Input: str = "abccc", k = 1

Output: 6

Input: str = "aabcbcbcabcc", k = 3

Output: 27

Expected Time Complexity: O(n+klog(p))

Note: Here n is the length of string and p is number of distinct alphabets and k number of alphabets to be removed

13. Given a non-negative integer **S** represented as a string, remove **K** digits from the number so that the new number is the smallest possible.

Note: The given *num* does not contain any leading zero.

Expected Time Complexity: O(|S|).

Example 1:	Example 2:
Input S="149811, K=3 Output: 111	Input S="1002991, K=3 Output: 21

14. You are given a two-dimensional grid board[][] of size n * m consisting of English letters and a string target. Your task is to determine whether the target word can be formed by sequentially connecting letters from the grid. You may move to adjacent cells **horizontally or vertically** (not diagonally), and **a cell may not be reused** once it is part of the current path.

Examples:

Input:

board [][] = [['C', 'A', 'T'], ['R', 'A', 'K'], ['T', 'O', 'N']],

target = "CART" **Output:**

true **Explanation:**

You can trace the word "CART" through the path: C → A → R → T (moving horizontally and vertically, without repeating cells).

15. Given an encoded string **s**, the task is to decode it. The encoding rule is:

- **k[encodedString],** where the **encodedString** inside the square brackets is being repeated exactly **k** times. Note that **k** is guaranteed to be a positive integer, and encoded String contains only lowercase English alphabets.

Note: The test cases are generated so that the length of the output string will never exceed 10^5.

Examples:

Input: s = "1[b]"

Output: "b"

Input: s = "3[b2[ca]]"

Output: "bcacabcacabcaca"

Competitive coding list will be shared with the students.

Total Hours: 15 hrs.

CIE						ESE	Total
PS1	**PS2**	**PS3**	**TA1** **5**	**TA2** **5**	**Attendance** **10**		
30			**20**			**50**	**100**

Course Code: CNC0302/CNC0402	Course Name: Environmental Science	L	T	P	C
Course Offered in: CSE/CS/IT/CSE(AI)/CSE(AIML)/CSE(IOT)/CSE(AI)/CSE(DS)/CSE-R/M.Tech (Int) / MCT / CSE (CYS)		2	0	0	NA

Pre-requisite: Basic knowledge of biology, chemistry, ecology, geology, mathematics, and understanding of human impacts on natural systems.

Course Objectives:

To help the students in realizing the inter-relationship between man and environment and help the students in acquiring basic knowledge about environment.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Knowledge Level (KL)**
CO1	Understand the basic principles of ecology and the environment. Ecosystem: Basic concepts, components of ecosystems, food chains and food webs. Ecological pyramids	**K2**
CO2	Understand the different types of natural recourses like food, forest, Minerals and energy and their conservation	**K2**
CO3	Understand the different types of pollution, pollutants, their sources, effects, and their control methods.	**K2**
CO4	Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment	**K2**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO MAPPING	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	-	3	3	2	2	-	2	2	2
CO2	3	3	2	2	-	3	3	2	2	-	2	2	2
CO3	3	3	2	2	-	3	3	2	2	-	2	2	2
CO4	3	3	2	2	-	3	3	3	2	-	2	2	2

Course Contents / Syllabus

UNIT 1	**Basic Principle of Ecology and Biodiversity**	**5 HOURS**

Definition, Scope and basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem. Food chains and food. Webs. Ecological pyramids, Energy flow in ecological systems, Characteristics of different ecosystems. Biogeochemical Cycles: Importance, gaseous and sedimentary cycles. Carbon, Nitrogen, Phosphorus and Sulphur Cycles. Biodiversity and their importance, Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book. Strategies for biodiversity conservation, principles of biodiversity conservation in-situ and ex-situ conservation strategies Mega diversity zones and Hot spots, concepts, distribution and importance.

UNIT 2	**Natural Resources and Ecological succession**	**5 HOURS**

Natural resources and associated problems. Forest resources: Use and over- exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and over- grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, and salinity. Land resources: Land as a resource, land degradation, man induced landslides. Equitable use of resources for sustainable lifestyles. Non-Renewable Energy Resources: Fossil fuels and their reserves, Nuclear energy, types, uses and effects, Renewable Energy Resources: hydropower, Solar energy, geothermal, tidal and wind energy, Biomass energy, biogas and its advantages. Ecological succession-Types, stages, examples of ecological succession

UNIT 3	**Pollution and Waste Management**	**5 HOURS**

Air pollution: sources of air pollution, Primary and secondary air pollutants. Origin and effects of SOX, NOX, Cox, CFC, Hydrocarbon, control of air pollution. Water pollution: sources and types of water pollution, Effects of water pollution, Eutrophication, Soil pollution: Causes of soil pollution, Effects of soil pollution, Major sources of and effects of noise pollution on health, Radioactive and thermal pollution sources and their effects on surrounding environment. Solid waste disposal and its effects on surrounding environment, Introduction to E- Waste, Types and classification of E- Waste, Impacts of E- Waste on environment and human health,E-Waste management and recycling., Climate change, global warming, acid rain, ozone layer depletion.

UNIT 4	**Environmental Assessment and Legislation**	**5 HOURS**

Women education, Role of NGOs regarding environmental protection, Bio indicators and their role, Natural disasters and disasters management, Aims and objectives of Environmental Impact Assessment (EIA). Salient features of following Acts: Environmental Protection Act, 1986, Wildlife (Protection) Act, 1972.Water (Prevention and control of pollution) Act, 1974. Forest (Conserving) Act, 1980. Definition and concept of sustainability, impacted areas of sustainable development, Global initiative, and issues on sustainable development UN SDGs, System Thinking and Sustainability.

	Total Lecture Hours	**20 HOURS**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**

1	Brady, N.C. 1990. The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York	Brady, N.C
2	Sodhi G.S. 2005, Fundamentals of Environmental Chemistry: Narosa Publishing House, New Delhi.	Sodhi G.S
3	Dash, M.C. (1994), Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.	Dash, M.C
Reference Books:		
1	Rao M.N. and H.V.N. Rao, 1989 : Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi	Rao M.N. and H.V.N. Rao
2	A Text Book of environmental Science By Shashi Chawla	Shashi Chawla
Self-Study Content Links:		
MOOC'S		
VIDEO LECTURES	https://www.youtube.com/watch?v=T21OO0sBBfc https://www.youtube.com/watch?v=qt8AMjKKPDo https://www.youtube.com/watch?v=brF0RWJyx9w https://www.youtube.com/watch?v=GK_vRtHJZu4	**7 min 42 sec** **15 min** **3 min 25 sec** **4 min 25 sec**
WEB REFERENCES	https://www.youtube.com/watch?v=yqev1G2iy20, https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2g0	**28 min** **31 min 35 sec** **11 min**