NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA, G.B. NAGAR
(AN AUTONOMOUS INSTITUTE)

Affiliated to

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, UTTAR PRADESH, LUCKNOW

Evaluation Scheme & Syllabus

For

Bachelor of Technology

Electronics & Communication Engineering (ECE)

Second Year

(Effective from the Session: 2025-26)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA

(AN AUTONOMOUS INSTITUTE)

Bachelor of Technology

Electronics & Communication Engineering

EVALUATION SCHEME

SEMESTER-III

S. No.	Subject Codes	Subject Name	Type of Subject	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BCSCC0301	Employability Skill Development – I	Mandatory	2	0	0	60	40	100				100	2
2	BASL0301N	Technical Communication	Mandatory	2	0	0	30	20	50		50		100	2
3	BEC0301Z	Digital System Design	Mandatory	2	0	0	30	20	50		50		100	2
4	BEC0302Z	Analog Circuits	Mandatory	3	0	0	30	20	50		100		150	3
5	BEC0306	Data Structures	Mandatory	2	0	0	30	20	50		50		100	2
6	BEC0304	Computational Intelligence	Mandatory	3	0	0	30	20	50		100		150	3
7	BEC0351	Digital System Design Lab	Mandatory	0	0	4				50		50	100	2
8	BEC0352	Analog Circuits Lab	Mandatory	0	0	4				50		50	100	2
9	BEC0356	Data Structures Lab	Mandatory	0	0	2				25		25	50	1
10	BEC0355	IoT Workshop	Mandatory	0	0	6				50		100	150	3
11	BEC0359X	Social Internship	Mandatory	0	0	2				50			50	1
12	BNC0301Y/ BNC0302Y	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		**14**	**1**	**18**			**350**	**225**	**350**	**225**	**1150**	**23**

*** List of MOOCs Based Recommended Courses for Second year (Semester-III) B. Tech Students**

Sr. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0012	Data Structures and Algorithms using Python - Part 1	Infosys Wingspan (Infosys Springboard)	29h 27m	2
2	BMC0020	Express PCB Training	Infosys Wingspan (Infosys Springboard)	15h 6m	1

PLEASE NOTE: -

- **A 3–4-week Internship shall be conducted during summer break after semester-II and will be assessedduring semester-III**
- **Compulsory Audit (CA) Courses (BNC0301Y/BNC0302Y)**
  - 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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Bachelor of Technology
Electronics & Communication Engineering
EVALUATION SCHEME
SEMESTER-IV

S. No.	Subject Codes	Subject Name	Type of Subject	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BASCC0401	Employability Skill Development – II	Mandatory	2	0	0	60	40	100				100	2
2	BEC0401	Analog and Digital Communication	Mandatory	3	0	0	30	20	50		100		150	3
3	BEC0403	CMOS Digital Integrated Circuit	Mandatory	3	0	0	30	20	50		100		150	3
4	BEC0402N	Microprocessor & Microcontroller	Mandatory	3	0	0	30	20	50		100		150	3
5		Department Elective 1	Elective	3	0	0	30	20	50		100		150	3
6	BAS0403	Advance Engineering Mathematics	Mandatory	3	1	0	30	20	50		100		150	4
7	BEC0452	Microprocessor & Microcontroller Lab	Mandatory	0	0	4				50		50	100	2
8	BEC0451N	Analog and Digital Communication Lab	Mandatory	0	0	2				25		25	50	1
9	BEC0455	Verilog-HDL	Mandatory	0	0	6				50		100	150	3
10	BCSCC0452	Problèm Solving Approches	Mandatory	0	0	2				50			50	1
11	BEC0459	Mini Project	Mandatory	0	0	2				50			50	1
12	BNC0402Y/ BNC0401Y	Environmental Science / Artificial Intelligence and Cyber Ethics	Compulsory Audit	2	0	0	30	20	50				50	NA
		*Massive Open Online Courses (For B.Tech. Hons. Degree)	*MOOCs											
		TOTAL		**18**	**1**	**16**			**350**	**225**	**500**	**175**	**1250**	**26**

*** List of MOOCs Based Recommended Courses for Second year (Semester-IV) B. Tech Students**

Sr. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0023	Internet of Things 201	Infosys Wingspan (Infosys Springboard)	15h 59m	1
2	BMC0021	IoT Raspberry Pi with Projects	Infosys Wingspan (Infosys Springboard)	12h 25m	0.5
3	BMC0022	Mobile Apps Development - Advanced Applications	Infosys Wingspan (Infosys Springboard)	14h 23m	1

PLEASE NOTE: -

- **A 3–4-week Internship shall be conducted during summer break after semester-IV and will be assessed during Semester-V**
- **Compulsory Audit (CA) Courses (BNC0401Y/BNC0402Y)**
  - 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 Departmental Electives

Sr. No.	Departmental Electives	Subject Codes	Subject Name	Bucket Name
1	Elective-I	BEC0412	Introduction to Robotics and it’s Applications	Embedded & Robotics
2	Elective-I	BEC0411	Artificial Intelligence	Artificial Intelligence
3	Elective-I	BEC0413	VLSI Technology	Embedded & VLSI

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Bachelor of Technology
Electronics & Communication and Engineering

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 Coursera 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 Coursera 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: BCSCC0301	Course Name: Employability Skill Development – I	L	T	P	C
Course Offered in: B.Tech		2	0	0	2

Pre-requisite: Programming Language C

Course Objectives: This course introduces computer system fundamentals, basic mathematics for computing, and software development principles. It emphasizes algorithm design and C++ programming skills. Through hands-on practice and project-based learning, students develop problem-solving abilities and teamwork while creating real-world applications, mini-games, and simulations, enhancing both technical and collaborative competencies

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Apply sets, relations, functions to computational problem-solving	K3
CO2	Understand and implement the steps in the software development life cycle using logical reasoning and flowcharts.	K3
CO3	Design and develop small-scale software projects or games using structured programming and project-based approaches.	K6
CO4	Collaborate in teams to plan, develop, and present a complete software project, demonstrating problem-solving and communication skills.	K6

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	PSO3
CO1	3	3	2	2	-	-	-	2	-	-	-	-	-	-
CO2	3	3	3	2	-	-	-	2	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	2	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	2	-	-	-	-	-	-

Course Contents / Syllabus

Module 1	**Foundations of Computer Systems and Mathematical Concepts**	**4 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.

Module 2	**Software Development Fundamentals**	**6 hours**

Introduction to Software Development Life Cycle, Step-by-step solution to simple problems, Developing logic/flowchart/pseudocode, simple games, puzzles, Step-wise refinement and Procedural Abstraction

Module 3	**Project-Based Learning**	**10 hours**

Introduction to the basics of C++, Implementation of control structures through practical tasks such as creating a number guessing game using loops and conditions, Functions and scope demonstrated by developing a menu-driven applications using user-defined functions, implement simple logic-based games including puzzles, tic-tac-toe, Hangman etc., the concept of pointers and dynamic memory allocation is introduced by creating a dynamic leader board to store player scores. File handling in C++ to save high scores or game states to external files.

Module 4	**Project/Game Development**	**10 hours**

Project Planning & Development (Teams, roles, idea pitching, develop C++ game or simulation), Mini Project, Project Demonstration and Review

	Total Lecture Hours	**30 hours**

Reference Books:

S.No	Book Title with publication agency & year	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

Course Code: BASL0301N	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 (CEFR) and above

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

1. Comprehend the principles and functions of technical communication.
2. Write for specific audience and purpose to fulfil the provided brief.
3. Recognize and produce different kinds of technical documents.
4. Apply effective speaking skills to efficiently carry out official discourses.
5. Demonstrate their understanding of communication through digital media.

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	PSO3
CO1	1	1	1	1	1	2	1	1	2	3	1	2	-	-
CO2	1	1	1	1	1	1	1	1	2	3	1	2	-	-
CO3	1	1	1	1	1	1	1	1	2	3	1	2	-	-
CO4	1	1	1	1	1	1	1	1	2	3	1	2	-	-
CO5	1	1	1	1	1	1	1	1	2	3	1	2	-	-

Course Contents / Syllabus

Module 1	Introduction to Technical Communication	4 Hours

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

Module 2	Technical Writing 1	5 Hours

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

Module 3	Technical Writing 2	5 Hours

Job application, **Resume'**; **Report, proposal**; **Technical paper**: Abstract; **Ethical Writing:** Copy Editing, Referencing and Plagiarism

Module 4	Public Speaking	6 Hours

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

Module 5	Virtual/Remote Communication	4 Hours

Remote work: online platforms; **Video conferencing**; **Virtual etiquette**: email ids, usernames; **Writing Blogs & creating Vlogs**

	Total Lecture Hours	24 Hours

Textbook:

S.No	Book Title with publication agency & year	Author
1.	Technical Communication – Principles and Practices, 4th Edition by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2022, New Delhi.	

Reference Books:

S.No	Book Title with publication agency & year	Author

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.

Intercultural Communication in Virtual Exchange by Francesca Helm, Cambridge Univ. Press, 2024.

NPTEL/ You tube/ Faculty Video Link:

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

Course Code: BEC0301Z	Course Name: Digital System Design	L	T	P	C
Course Offered in: B.Tech. ECE/VLSI		2	0	0	2

Pre-requisite: Basic concept of number systems, Boolean Algebra, Digital logic families.

Course Objectives: The student will learn about Boolean algebra, logic function minimization by K map, binary codes, Designing and analysis of combinational and sequential circuits, Synchronous & Asynchronous Sequential Circuits, Semiconductor memories and programmable logic devices.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Verify the logic operations and apply the optimization techniques to implement logic functions.	K3
CO2	Design and analyze combinational logic circuits.	K4
CO3	Explain different types of flip-flops and apply to implement sequential circuits.	K3
CO4	Design and analyze Synchronous & Asynchronous Sequential Circuits.	K4
CO5	Explain the concept of Semiconductor Memories and implement the digital logic functions using PLDs.	K4

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	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	-	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	-	-	-	-	-	-	-	-	1	2	2
CO4	3	3	2	-	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	-	-	-	-	-	-	-	-	1	1	2

Course Contents / Syllabus

Module 1	**Logic Simplification and Binary Codes**	**8 hours**

Number Systems, Complements of Numbers, Boolean Algebra, De Morgan's Theorem, Logic Gates, SOP & POS Forms, Canonical Forms, Karnaugh Maps upto 5 Variables, Multilevel NAND/NOR realizations, Binary Codes.

Module 2	**Combinational Logic Circuits**	**8 hours**

Code Conversion, Comparators, Adders: Half Adder, Full Adder, Carry Look Ahead Adder, Subtractors: Half Subtractor, Full Subtractor, Serial And Parallel Adders, BCD Adder, Multiplexers, Demultiplexers, Encoders, and Decoders.

Module 3	**Sequential Logic and Its Applications**	**8 hours**

Sequential Circuits Fundamentals: Basic Building Blocks of Sequential circuits like SR Latch, Flip Flops: SR, JK, JK Master Slave, D and T Type Flip Flops, Excitation and characteristics Table of all Flip Flops, Conversion from one type of Flip-Flop to another. Shift Registers, Ring and Twisted Ring Counter.

Module 4	**Synchronous & Asynchronous Sequential Circuits**	**8 hours**

Synchronous Sequential Circuits: Design and analysis of clocked sequential circuits, state reduction and assignments, Design of sequence detector and Counter.

Asynchronous Sequential Circuits: Design and analysis of asynchronous sequential circuits, circuit with latches, reduction of state and flow table, race-free state assignment, hazards.

Module 5	**Programmable Logic Devices**	**8 hours**

Semiconductor Memories: Basic concepts and hierarchy of Memory, Memory elements-ROM, RAM, comparison, Designing and circuit implementation using programmable logic devices: PROM, PAL, PLA, Introduction of CPLD and FPGA.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	"Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.	R.P. Jain,
2	"Digital Design, 6th Edition" Pearson India 2018.	M. Morris Mano and Michael D. Ciletti

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Digital Design: Principles and Practices, Pearson, (2000).	John F Wakerly

2	"Digital Electronics- An introduction to theory and practice", PHI, 2nd edition ,2006.	W.H. Gothmann
3	Theory and Logic Design", PHI, 2013.	A. Anand Kumar

NPTEL/ Youtube/ Faculty Video Link:	
Module 1	https://www.youtube.com/watch?v=juJR_JDJRa0
Module 2	https://www.youtube.com/watch?v=sUutDs7FFeA
Module 3	https://www.youtube.com/watch?v=ibQBb5yEDlQ
Module 4	https://www.youtube.com/watch?v=ntiv1g7G_C4
Module 5	https://www.youtube.com/watch?v=4GpWA_hmRhw

Course Code: BEC0302Z	Course Name: Analog Circuits	L	T	P	C
Course Offered in: B.Tech ECE/VLSI		3	0	0	3

Pre-requisite: Basic knowledge of Semiconductor devices.

Course Objectives: Students will learn about AC analysis of Transistors amplifiers, Analysis and design of Power and Negative feedback amplifiers, Applications of Operational Amplifier, current mirrors and Sinusoidal & non-sinusoidal oscillators.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Design and analyze the different transistor amplifier circuits.	K4
CO2	Analyze the different power and negative feedback amplifiers.	K3
CO3	Design and Explain the applications of Operational amplifier required in electronic systems.	K4
CO4	Analyze different types of current mirrors used in designing of analog circuits.	K3
CO5	Design and analyze the different types of sinusoidal and non- sinusoidal oscillators.	K4

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	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	1	2	1
CO2	3	3	3	1	-	-	-	-	-	-	-	2	2	1
CO3	3	3	3	-	-	-	-	-	-	-	-	2	2	2
CO4	3	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	3	3	2

Course Contents / Syllabus

Module 1	**AC Analysis of Small Signal Amplifier**	**8 hours**

Review of BJT and FET, low frequency transistor models, estimation of voltage gain, current gain, input resistance, output resistance of single stage CE and CS amplifier, low frequency response of single and multistage amplifiers. High frequency transistor models, high frequency response of single stage and multistage amplifiers, cascode amplifier.

Module 2	**Large Signal and Negative Feedback Amplifiers**	**8hours**

Power Amplifier: Various classes of operation (Class A, B, AB, C), Figure of merits, power efficiency and linearity issues.
Negative Feedback Amplifiers: Block diagram, Advantages, Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc.

Module 3	**Operational Amplifier Applications**	**8 hours**

Review of op-amp, Inverting and Non-inverting amplifiers, Voltage follower, Adder, Subtractor, Integrator, Differentiator, Log–Anti Log Amplifiers, Precision rectifier, Comparator, Schmitt trigger.
Active Filters: Frequency response of Low Pass, High Pass, Band Pass, Band Stop, and All Pass Filters, advantages over passive filter. Design guidelines.

Module 4	**Current Mirrors**	**8 hours**

Current Mirrors: Simple current mirror, Base current compensation current mirror, Wilson and Improved Wilson current mirrors, Widlar current source and Cascode current mirror. Design of various stages of operational amplifier.

Module 5	**Oscillators**	**8 hours**

Sinusoidal oscillators (Op-Amp Based): Concept of positive feedback, Barkhausen criterion, RC oscillators (Phase shift, Wien bridge), LC oscillators (Hartley, Colpitt, Clapp). Non-sinusoidal oscillators: Square wave generator: Astable multivibrator using IC 555, Triangular wave generator.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Design of Analog Circuits, Khanna Publishing House, 2022.	A.V.N. Tilak
2	Microelectronic Circuits, Saunder's College Publishing, Edition IV	A.S. Sedra and K.C. Smith

Reference Books:

S.No	Book Title with publication agency & year	Author
1	L.P.Huelsman and GAKorn, Introduction to Operational Amplifier theory and applications, McGraw Hill,1992.	J.V.Wait
2	The Art of Electronics, 2nd edition, Cambridge University Press, 1989.	P. Horowitz and W. Hill

3	Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition	Paul R.Gray & Robert G.Meyer
NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=2bprLH4cUSo	
Module 2	https://www.youtube.com/watch?v=XDy-rD5AJl0	
Module 3	https://www.youtube.com/watch?v=dHSaPhQIQqE	
Module 4	https://nptel.ac.in/courses/117101106	
Module 5	https://www.youtube.com/watch?v=2bprLH4cUSo	

Course Code: BEC0306	**Course Name: Data Structure**	**L**	**T**	**P**	**C**
Course Offered in: ECE		**2**	**0**	**0**	**2**

Pr-requisite: Knowledge of C, data types and their organization.

Course Objectives: This course focuses on the basic concepts of algorithm analysis, along with implementation of linear and non-linear data structures and file structures.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the concept of time and space complexity along with the linear data structure array and linked lists.	K2
CO2	Understand the concept of stack and queue with their memory representations.	K2
CO3	Apply the knowledge of the nonlinear data structure- tree and their operation.	K3
CO4	Analyze the basics of graph with their different traversal ways.	K4
CO5	Apply the concepts of searching, sorting and file structure.	K3

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	PSO3
CO1	3	3	2	2	2	-	-	-	-	2	-	3	2	1
CO2	3	3	3	1	2	-	-	-	-	1	-	3	2	1
CO3	3	3	3	2	2	-	-	-	-	1	-	3	3	1
CO4	3	3	2	2	2	-	-	-	-	1	1	3	3	2
CO5	3	3	3	3	2	-	-	-	-	2	1	3	3	2

Course Contents / Syllabus

UNIT 1	**Introduction to data structures, Arrays and Linked lists**	**8 hours**

Introduction: Basic Terminology, Elementary Data Organization, Built in Data Types in C/python. Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic notations: Big Oh, Big Theta and Big Omega, Abstract Data Types (ADT)
Arrays: Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Index Formulae for 1-D,2-D,3-D and n-D Array Application of arrays, Sparse Matrices and their representations.
Linked lists: Array Implementation of Singly Linked Lists, Doubly Linked List, Circularly Linked List, Operations on a Linked List. Insertion, Deletion, Traversal. Polynomial Representation and Addition Subtraction & Multiplications of Single variable.

UNIT 2	**Stack and Queues**	**8 hours**

Stacks: Abstract Data Type, Primitive Stack operations: Push & Pop, Array and Linked Implementation of Stack, Application of stack: Prefix and Postfix Expressions, Evaluation of postfix expression, Iteration and Recursion- Principles of recursion, Tail recursion, Removal of recursion Problem solving using iteration and recursion with examples of binary search, Fibonacci numbers, and Hanoi towers. Tradeoffs between iteration and recursion.
Queues: Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, Dequeue and Priority Queue.

UNIT 3	**Trees**	**8 hours**

Basic terminology used with Tree, Binary Trees, Binary Tree Representation: Array Representation and Pointer (Linked List) Representation, Binary Search Tree, Strictly Binary Tree, Complete Binary Tree, An Extended Binary Trees. Tree Traversal algorithms: In-order, Pre-order and Post-order. Constructing Binary Tree from given Tree Traversal, Operation of Insertion, Deletion, Searching & Modification of data in Binary Search tree, Introduction of Binary Heaps, Threaded Binary trees, Traversing Threaded Binary trees, AVL Tree, B-Tree.

UNIT 4	**Graphs**	**8 hours**

Graphs: Terminology used with Graph, Data Structure for Graph Representations, Adjacency matrices, Adjacency List. Graph Traversal: Depth First Search and Breadth First Search. Connected Component, Spanning Trees, Minimum Cost Spanning Trees: Prim's and Kruskal's algorithm. Shortest Path algorithms: Dijkstra Algorithm.

UNIT 5	**Searching and Sorting**	**8 hours**

Searching: Concept of Searching, Sequential search, Index Sequential Search, Binary Search. Concept of Hashing.
Sorting: Insertion Sort, Selection, Bubble Sort, Quick Sort, Merge Sort, Heap Sort and Radix Sort.
File Structure: Concepts of files, records and files, Sequential, Indexed and Random File.

		Total Lecture Hours | **40 hours**
Textbook:		
S.No	**Book Title with publication agency & year**	**Author**
1	"Data Structures and Algorithms in Python: An Indian Adaptation", 1st Edition, 2021.	Michael T. Goodrich, Roberto Tamassia
2	"Fundamentals of Data Structures", Computer Science Press, 1st Edition, 1993.	Horowitz and Sahani
3	"Data Structures" Schaum's Outline Series, Tata McGraw-hill Education (India) Pvt. Ltd, 2nd Edition, 2017.	Lipschutz
Reference Books:		
S.No	**Book Title with publication agency & year**	**Author**
1	"Data Structure Using C", Oxford University Press, 2nd Edition, 2014.	Reema Thareja
2	"Data Structure Using C", Pearson Education India, 2nd Edition,2011.	AK Sharma
3	"C and Data structure", Wiley Dreamtech Publication, 1st Edition, 2004.	P. S. Deshpandey
NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F https://www.youtube.com/watch?v=LQx9E2--p5c&pp=ygUMYXJyYXlzIG5wdGVs https://www.youtube.com/watch?v=K7VIKlUdo20&pp=ygUPbGluayBsaXN0IG5wdGVs	
Module 2	https://www.youtube.com/watch?v=g1USSZVWDsY&list=PLBF3763AF2E1C572F&index=2 https://www.youtube.com/watch?v=g1USSZVWDsY&list=PLB3CD0BBB95C1BF09&index=2&pp=iAQB	
Module 3	https://www.youtube.com/watch?v=tORLeHHtazM&list=PLBF3763AF2E1C572F&index=6 https://youtu.be/tORLeHHtazM?si=rPsohifPQuFaJXg4	
Module 4	https://www.youtube.com/watch?v=9zpSs845wf8&list=PLBF3763AF2E1C572F&index=24	
Module 5	https://www.youtube.com/watch?v=4OxBvBXon5w&list=PLBF3763AF2E1C572F&index=22 https://www.youtube.com/watch?v=cR4rxllyiCs&list=PLBF3763AF2E1C572F&index=23 https://www.youtube.com/watch?v=KW0UvOW0XIo&list=PLBF3763AF2E1C572F&index=5	

Course Code: BEC0304	Course Name: Computational Intelligence	L	T	P	C
Course Offered in: B.Tech ECE		3	0	0	3

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

Course Objectives: The purpose of this course is to provide an introductory understanding of the fundamental principles, techniques, and applications of Computational Intelligence. By the end of the course, students will gain knowledge in designing intelligent systems and grasp the key concepts in areas such as Artificial Neural Networks, Fuzzy Logic, and Genetic Algorithms. Additionally, students will acquire the necessary mathematical skills to optimize neural network learning. Moreover, through engaging in a research or design project, students will develop familiarity with current research problems and gain experience in utilizing research methods within the field of Computational Intelligence.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Identify Computational Intelligence techniques and their applications.	K1
CO2	Apply neural networks using various learning techniques and Formulate the artificial neural network with their different layers.	K4
CO3	Compare the fuzzy sets and crisp sets and apply fuzzy operations in real life problems.	K4
CO4	Design fuzzy controller with the help of fuzzy rules, fuzzifications and defuzzification.	K5
CO5	Discuss the concept of genetic algorithm and its various applications.	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	PSO3
CO1	2	2	-	1	1	-	-	-	-	2	1	2	2	1
CO2	3	3	3	2	2	-	-	-	-	2	1	3	3	2
CO3	2	2	2	1	1	-	-	-	-	1	1	2	3	2
CO4	3	3	3	2	2	-	-	-	-	1	1	3	3	2
CO5	3	2	2	2	2	-	-	-	-	2	2	3	3	3

Course Contents / Syllabus

Module 1	**Introduction to Computational Intelligence**	**8 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.

Module 2	**Neural Networks**	**8hours**

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.

Module 3	**Fuzzy Logic-I**	**8 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.

Module 4	**Fuzzy Logic-II**	**8 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

Module 5	**Genetic Algorithm (GA)**	**8 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	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	"Computational Intelligence: An Introduction", Wiley Publication.Data Structures and Algorithms in Python (An Indian Adaptation), Wiley Publication (15 July 2014)	Andries P. Engelbrecht

2	"Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India.	S. Rajsekaran & GA Vijayalakshmi Pai
3	"Neural Netowrks", Prentice Hall of India	Siman Haykin
4	"Fuzzy Logic with Engineering Applications", Wiley India.	Timothy J. Ross

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	"Neural Networks", Tata Mc Graw Hill.	Kumar Satish
2	"Computational Intelligence and Intelligent System Design: Theory Tools and applications", Pearson.	Fakhreddin O. Karray, Clarence W. De Silva

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://youtu.be/fgtUFzxNztA?si=DiEQ7L2PNrQvgC5y
Module 2	https://www.youtube.com/watch?v=xbYgKoG4x2g&list=PL53BE265CE4A6C056
Module 3	https://www.youtube.com/watch?v=K7S3TgfqnX0&list=PLFW6lRTa1g81F7CJ-CdlsyWKKAa43T62j
Module 4	https://www.youtube.com/watch?v=JrRWdPvG7yk&list=PLFW6lRTa1g81F7CJ-CdlsyWKKAa43T62j&index=2
Module 5	https://www.youtube.com/watch?v=d86McbWXh4E&list=PLwdnzlV3ogoWyi7exLIe26JhueiVQXq_S

LAB Course Code: BEC0351	LAB Course Name: Digital System Design Lab	L	T	P	C
Course Offered in: B.Tech ECE/VLSI		0	0	4	2

Pre-requisite: Basics concept of arithmetic operations, Basics of decimal number system

Course Objectives:

The student will learn about Verification of truth table of various type of logic gates. Designing and verification of different type of combinational circuits. Implementation and verification of truth table of various type of flip-flops. Designing and implementation of different types of sequential circuits.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Verify truth table of various type of Logic Gates.	K2
CO2	Design, implement and verify combinational logic circuits	K4
CO3	Implement and verify truth table of various types of flip-flops	K3
CO4	Design and implement different types of sequential logic circuits.	K4

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	PSO3
CO1	3	2	-	-	2	-	-	3	2	-	2	1	2	2
CO2	3	3	3	-	2	-	-	3	2	-	2	1	2	2
CO3	3	2	3	-	2	-	-	3	2	-	2	1	2	2
CO4	3	3	3	-	2	-	-	3	2	-	2	1	2	2

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

1. Verification of the truth tables of Basic Logic Gates and Universal Logic Gates using TTL ICs. a) AND (7408) b) OR (7432) c) NOT (7404) d) NAND (7400) e) NOR (7402)	CO1
2. Implementation of the given Boolean function using TTL Logic Gates (NOT, AND and OR Gates) in SOP for following Boolean expressions: a) Y1 = AB' + A'B b) Y2 = ABC + A'B'C' + A'C c) F(A, B, C, D) = ∑(0,2,5,7,8,10,13,15)	CO1
3. Implementation of the given Boolean function using TTL Logic Gates (NOT, AND and OR Gates) in POS forms for following Boolean expressions: a) Y1 = (A'+B)(A+B') b) Y2 = (A+B+C)(A'+B'+C')(A'+C) c) F(A, B, C, D) = M(0,2,5,7,8,10,12,15)	CO1
4. Implement and verify 4-bit Binary to Gray code converter and 4- bit Gray to Binary code converter.	CO1
5. Implementation of Half-adder, Full-adder and Full-adder using two Half – adder with TTL Logic Gates (EXOR-7486, AND-7408, OR-7432) and verify its truth table.	CO2
6. Implementation of Half-subtractor, Full-subtractor and Full-subtractor using two Half-subtractor with TTL Logic Gates (EXOR-7486, AND-7408, OR-7432) and verify its truth table.	CO2
7. Implementation of 4-bit Parallel adder using 7483 IC and verify the output for the given inputs. a) A = 1011, B = 1001 b) A = 0011, B = 0010	CO2
8. Implementation of 2:4 Decoder, 1:4 Demultiplexer using Logic Gates (NOT gate- 7404, AND gate- 7408) and verify its truth table.	CO2

9. Implementation of 4:2 Encoder , 4:1 multiplexer using logic gate (OR gate-7432) and verify its truth table.	CO2
10. Implement and verify F (A,B,C) = $\sum$ (3, 5, 6, 7) using a) 8:1 multiplexer. b) 4:1 multiplexer.	CO2
11. Implement 2 Bit magnitude comparator using logic gates and verify the truth table.	CO2
12. Verification of truth table of flip-flop using NAND gate (7400) & NOR gates (7402). a) RS Flip Flop b) JK Flip Flop c) D Flip Flop d) T Flip Flop	CO3
13. Implement D flip flop using SR flip flop and verify the truth table.	CO3
14. Design and implement 4-bit ring counter using D flip flop and verify the result.	CO3
15. Design MOD 5 asynchronous counter using T flip flop and verify the truth table.	CO3
16. Design MOD 5 synchronous counter using T flip flop and verify the truth table.	CO4
17. Realize a) Design Mod – N Synchronous Up Counter & Down Counter using 7476 JK Flip-flop b) Mod-N Counter using IC7490 / 7476 c) Synchronous counter using IC74192	CO4
18. Design Pseudo Random Sequence generator using 7495.	CO4

LAB Course Code: BEC0352	LAB Course Name: Analog Circuit Lab	L	T	P	C
Course Offered in: B.Tech ECE/VLSI		0	0	4	2

Pre-requisite: The operation and characteristics of semiconductor devices.

Course Objectives: The course aims to equip students with knowledge and hands-on experience in designing, implementing, and verifying various characteristics of transistor amplifiers. It also focuses on the design and implementation of diverse applications of operational amplifiers (Op-amps) and oscillators. Additionally, students will learn to simulate electronic circuits using simulation software and gain an introduction to circuit design using PCB design software such as PCB Express and KiCad.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Design and plot frequency response of amplifiers	K4
CO2	Design and verify Op- Amp base circuits	K4
CO3	Design and implementation of oscillators.	K4
CO4	Simulate the Electronic circuits on simulation software.	K3
CO5	Design and implement electronics circuits by PCB design software (PCB Express, Ki cad).	K4

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	PSO3
CO1	3	3	1	-	2	2	-	2	2	2	2	1	2	2
CO2	3	3	2	-	3	2	-	2	2	2	2	1	2	2
CO3	3	3	2	-	2	2	-	2	2	2	2	1	2	2
CO4	3	3	2	-	3	2	-	2	2	2	2	1	2	2
CO5	3	3	3	-	2	2	-	2	2	2	2	1	2	2

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

1. Design and implement a CE (BC-107) amplifier with potential divider biasing (for Vi = 20 mV, R1=100KΩ R2= 10KΩ, RC= 4.7 KΩ, RE= 1KΩ). Verify the following parameters with the theoretical values: a) Voltage gain Av b) Current gain Ai c) Input Resistance (Ri) d) Output Resistance (Ro)	CO1
2. Design and analysis of Single stage common source MOSFET amplifier with potential divider biasing (for Vi = 20 mV, R1=1MΩ R2= 1KΩ, RD= 4.7 KΩ, Rs= 1KΩ) and Plot Gain (dB) Vs frequency curve, also measure following parameters a) Bandwidth b) Input impedance c) Maximum signal handling capacity (MSHC).	CO1
3. Design a single-stage CE and a multistage (CE-CE) amplifiers with Voltage Divider Bias for 10 mV input ac signal and plot the Frequency Response curves using BC 547, VCC = 12V, Stability factor (S) =10 and RL= 10 KΩ. Observe the effect on gain and bandwidth.	CO1
4. Design current series/Voltage shunt Feedback amplifier with basic voltage gain 100 and feedback factor 0.1-0.2 also analyze the effect of feedback on gain, bandwidth input and output impedance.	CO1
5. Design Voltage series Feedback amplifier with basic voltage gain 100 and feedback factor 0.1-0.2 also analyze the effect of feedback on gain, bandwidth, input and output impedance.	CO1
6. Design and analyze the output voltage V0 for OP-AMP (IC 741) as: a) Inverting and Non-inverting amplifier for input voltage 0.5V with input Resistance (Ri) of 10 KΩ and feedback Resistance (Rf) of 100 KΩ. b) Voltage follower circuits for input voltage 1V.	CO2
7. Design a differential amplifier with ±12V DC power supply and calculate Common mode gain, differential mode gain, CMRR and slew-rate.	CO2
8. Design and analyze OP-AMP applications as a difference amplifier, integrator and differentiator Circuits for 1 KHz input signal.	CO2
9. Draw the input and output waveforms of a given full wave precision rectifier.	CO2

10. Design and implement of 2nd order Active Low pass filter for cut-off frequency 1KHz and pass band gain of 1.586, also draw the frequency response curve and verify cutoff frequency.	CO2
11. Design and implement of 2nd order Active High pass filter for cut-off frequency 1KHz and pass band gain of 1.586, also draw the frequency response curve and verify the cutoff frequency.	CO2
12. Design the following RC sinusoidal oscillators; Also verify the theoretical and practical Oscillating frequency. a) RC phase shift oscillator, if its frequency of oscillation is 955 Hz and R1=R2=R3 =680KΩ. b) Wien bridge oscillator uses R=4.7KΩ, C=0.01μF, and RF =2R1	CO3
13. Design the following LC oscillators; Also verify the theoretical and practical Oscillating frequency. a) For a Hartley oscillator, self-inductance of the two coils are L1=100mH, L2=1mH and mutual inductance between the two coils is 20μH. its output for a capacitor of value 20pF. b) For a Colpitts oscillator in which feedback network consists of two capacitors of 100 pF and 20 pF with 100 mH coil across these capacitors.	CO3
14. Design and implement square wave generator (Astable Multivibrator) for 1 MHz using, a) Op-amp b) IC 555.	CO3
15. Design and implement a triangular wave generator using dual op-amp, for oscillation frequency f_0 =1.5 KHz and Vout (P-P) =6V, use Vsat = 13.5 V.	CO3
16. Design and simulate single-stage CE amplifiers with Voltage Divider Bias for 10mV input ac signal and plot the Frequency Response curves using BC 547, VCC= 12V, Stability factor (S)=10 and RL= 10 KΩ. (TARGET, PSPICE-1etc.)	CO4
17. Simulation of Multistage stage (CE-CE) amplifier (designed in experiment1) using any available simulation software and also find the Voltage gain, Input impedance, Output impedance, and bandwidth. (TARGET, PSPICE-1etc.)	CO4
18. Design and simulate current series/Voltage shunt Feedback amplifier with basic voltage gain 100 and feedback factor 0.1-0.2 also analyze the effect of feedback on gain and bandwidth.	CO4
19. Design and simulate Voltage series Feedback amplifier with basic voltage gain 100 and feedback factor 0.1-0.2 also analyze the effect of feedback on gain and bandwidth.	CO4
20. Design and simulate of 2nd order Active Low pass filter for cut-off frequency 1KHz and pass band gain of 1.586, also draw the frequency response curve and verify the cutoff frequency.	CO4
21. Design and simulate of 2nd order Active High pass filter for cut-off frequency 1KHz and pass band gain of 1.586, also draw the frequency response curve and verify the cutoff frequency.	CO4
22. Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.	CO5
23. PCB Lab: Artwork & printing of a simple PCB.	CO5
24. Etching & drilling of PCB.	CO5
25. Wiring & fitting shop: Fitting of power supply along with a meter in cabinet.	CO5
26. Mini Project: Design a mini project using the applications of this Lab.	CO5
27. Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.	CO5
Total Hours: 40 hrs.	

LAB Course Code: BEC0356	LAB Course Name: Data Structure Lab	L	T	P	C
Course Offered in: B.Tech. ECE/VLSI		0	0	2	1

Pre-requisite: Basic knowledge of programming concepts using C/C++ and understanding of fundamental algorithms.

Course Objectives: Objective of this course is implementing fundamental data structures such as arrays, linked lists, stacks, queues, trees, and graphs. It aims to enhance problem-solving abilities through efficient algorithm design and code optimization.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Implementing Single and Multi-dimensional array with their applications like searching and Sorting techniques.	K3
CO2	Implement Link list, Stack and Queues with their applications.	K3
CO3	Implementation of tree data structures for basic operations like insertion, deletion, searching and traversal.	K4
CO4	Implementation and analysis of various operation like searching, sorting, hashing in data structures for solving real world problems.	K4

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	PSO3
CO1	3	2	3	2	3	-	-	-	-	2	-	3	3	1
CO2	3	3	3	2	3	-	-	-	-	1	-	3	3	1
CO3	3	3	3	2	3	-	-	-	-	1	-	3	3	1
CO4	3	3	3	3	3	-	-	-	-	2	1	3	3	2

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

S.No	Program Description	CO
1	Construct a code to find the maximum element in an array.	CO1
2	Construct a code to calculate the sum of all elements in an array.	CO1
3	Construct a code to reverse the elements of an array.	CO1
4	Construct a code to count the occurrence of a specific element in an array.	CO1
5	Construct a code for creation and traversal of 2D array in row major and column major order.	CO1
6	Program to find if a given matrix is sparse or not and print sparse matrix.	CO1
7	Construct a code to represent a sparse matrix in triplet form.	CO1
8	Construct a Python program to print Fibonacci series using recursion.	CO2
9	Construct a code to implement Tower of Hanoi.	CO2
10	Construct a program to implement priority queue.	CO2
11	Construct a program to implement queue using array.	CO2
12	Construct a code for implementing a circular queue.	CO2
13	Construct a program to implement queue using stack.	CO2
14	Create a single linked list and perform basic operations (insertion, deletion, traversal).	CO2
15	Create a double linked list and perform basic operations (insertion, deletion, traversal).	CO2
16	Create a circular linked list and perform basic operations (insertion, deletion, traversal).	CO2
17	Write a program to implement an in-order traversal of a binary tree and print the nodes.	CO3
18	Write a program to implement a pre-order traversal of a binary tree and print the nodes.	CO3
19	Write a program to implement a post-order traversal of a binary tree and print the nodes.	CO3
20	Write a program to count number of nodes in a binary tree.	CO3
21	Write a program to find the height of the tree.	CO3
22	Write a Program to search a number in Binary Search Tree (BST).	CO3
23	Write a program to insert a node in a Binary Search Tree (BST).	CO3
24	Write a program to delete a node from a Binary Search Tree (BST).	CO3
25	Write a program to implement Prims Algorithm.	CO4
26	Write a program to implement Kruskal Algorithm.	CO4
27	Write a program to implement Dijkstra Algorithm.	CO4
28	Write a program to perform Depth-First Search (DFS) on a graph.	CO4
29	Write a program to perform Breadth-First Search (BFS) on a graph.	CO4
30	Construct a program to implement merge sort with recursion and iteration.	CO4

31	Construct a program to implement quick sort with recursion and iteration.	CO4
32	Construct a code to implement linear search.	CO4
33	Construct a code to implement binary search.	CO4
34	Construct a program to implement bubble sort.	CO4
35	Write a program to implement a max-heap and perform heap sort on an array of integers.	CO4
		Total Hours: 48 hrs.

Course Code: BEC0355	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 students with a good depth of knowledge of Designing Industrial IoT Systems for various applications.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Identify the Key opportModuleies and benefits in Industrial IoT.	K1
CO2	Apply virtual network to demonstrate the use of Cloud in Industrial IoT.	K3
CO3	To analyze ADC/DAC techniques and IIAF components for efficient industrial IoT system design.	K4
CO4	Explain the concept and use of various IoT protocols and communication technologies.	K2
CO5	Analyze challenges, and issues related to IoT Security and apply IoT on social society problems.	K4

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	PSO3
BEC0355.1	3	2	2	-	-	-	-	-	-	-	-	3	2	2
BEC0355.2	3	3	3	-	-	-	-	-	-	-	-	3	2	-
BEC0355.3	3	2	3	-	-	-	-	-	-	-	-	3	2	-
BEC0355.4	3	2	1	-	-	-	-	-	-	-	-	3	2	-
BEC0355.5	3	2	1	-	-	-	-	-	-	-	-	3	2	-

Course Contents / Syllabus

Module 1	**Introduction to IoT and IIoT and its basic fundamentals:**	**8 hours**

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

Module 2	**Sensor Networks**	**8hours**

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.

Module 3	**Arduino and Raspberry pi Programming**	**8 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.

Module 4	**IoT Security and Protocols**	**8 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.

Module 5	**Applications of IoT**	**8 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	**40 hours**

Textbook:

1	Arduino Cookbook, 3rd Edition by Michael Margolis, Released April 2020.Publisher(s): O'Reilly Media, Inc. Andrea Goldsmith, "Wireless	Brian Jepson, Nicholas Robert Weldin

	Communications", Cambridge University Press, 2005.	
2	Raspberry Pi Cookbook, 4th Edition Released December 2022.Publisher(s): O'Reilly Media, Inc.	Simon Monk
Reference Books:		
1	Internet of Things: Principles and Paradigms,Morgan Kaufmann, 2016.	Rajkumar Buyya, Amir Vahid Dastjerdi
NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=om-5QTbLCCs	
Module 2	https://www.youtube.com/watch?v=BBvG7uzmOV0&t=51s	
Module 3	https://www.youtube.com/watch?v=HicZcgdGxZY&t=39s	
Module 4	https://www.youtube.com/watch?v=-7dAFWRjCoA	
Module 5	https://www.youtube.com/watch?v=SW3Ia5xLmuU	

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.	CO 2
3	Simulation of 4-Way Traffic Light with Arduino	CO 2
4	Working with Adafruit Libraries in Arduino.	CO 2
5	Connect an LED to GPIO pin 25 and control it through the command line.	CO 2
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.	CO 2
7	To study Libraries and their installation.	CO 3
8	To interface a servo motor with an Arduino board and control its position using PWM signals.	CO 3
9	To learn how to interface a DC motor with an Arduino board and control its speed and direction.	CO 3
10	To understand how to interface a relay with an Arduino board and control external devices.	CO 3
11	To understand how to interface a stepper motor with an Arduino board and control its rotation.	CO 3
12	To detect the presence of LPG or propane gas using the MQ-6 gas sensor and Arduino.	CO 3
13	Study and Installation of Raspberry Pi.	CO 3
14	Displaying different LED Patterns with Raspberry Pi.	CO 3
15	Programming of available GPIO Pins of the corresponding device using native programming language. Interfacing LED and testing the functionality.	CO 3
16	To explore BLE communication and data exchange.	CO 4
17	Home automation system	CO 5
18	Health care system	CO 5
19	Smart Irrigation System	CO 5

20	Electric Piano	CO 5
21	Design and simulate of 2nd order Active High pass filter for cut-off frequency 1KHz and pass band gain of 1.586, also draw the frequency response curve and verify the cutoff frequency.	CO4
22	Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.	CO5
23	PCB Lab: Artwork & printing of a simple PCB.	CO5
24	Etching & drilling of PCB.	CO5
25	Wiring & fitting shop: Fitting of power supply along with a meter in cabinet.	CO5
26	Mini Project: Design a mini project using the applications of this Lab.	CO5
27	Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.	CO5
		Total Hours: 40 hrs.

Course Code: BNC0401Y	Course Name: Artificial Intellgence and Cyber Ethics	L	T	P	C
Course Offered in: B. Tech.		2	0	0	2

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		Bloom's Knowledge Level (KL)
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

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	PSO3
CO1	-	1	-	-	-	1	2	-	-	-	2	1	1	1
CO2	2	3	2	-	2	1	2	-	2	1	2	2	1	1
CO3	2	3	2	1	2	3	3	-	2	2	2	2	2	1
CO4	2	2	-	-	1	3	3	-	2	2	2	2	1	1

Course Contents / Syllabus

Module 1	**An Overview to AI Ethics**	**6 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.

Module 2	**Fairness and Favoritism in Machine Learning**	**8 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.

Module 3	**AI Ethics and Cybersecurity Principles**	**8 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.

Module 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).

	Total Lecture Hours	**30 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1.	Artificial Intelligence: A Guide for Thinking Humans by Penguin Books, 2019.	Melanie Mitchell
2.	Cyber Ethics: Morality and Law in Cyberspace, 7th Edition (2023)	Richard Spinello, Jones & Bartlett Learning

Reference Books:

S.No	Book Title with publication agency & year	Author
1.	Artificial Intelligence and Ethics by, BPB Publications, 2023.	S. B. Kishor, Debajit Biswas
2.	Cyber Security and Cyber Laws by, Cengage India, 2022.	Alfred Basta, Nadine Basta, Sattwik Panda

NPTEL/ YouTube/ Faculty Video Link:	
1.	https://www.youtube.com/watch?v=VqFqWIqOB1g
2.	https://www.youtube.com/watch?v=hVJqHgqF59A
3.	https://www.youtube.com/watch?v=O5RX_T4Tg24
4.	https://www.youtube.com/watch?v=RJZ0pxcZsSQ

Course Code: BASCC0401	Course Name: Employability Skill Development - II	L	T	P	C
Course Offered in: B.Tech		2	0	0	2

Pre-requisite: Basic understanding of elementary mathematics

Course Objectives:

The objective of this course is to develop students' quantitative aptitude and logical reasoning skills through number theory, analytical puzzles, and business mathematics, enabling them to solve real-world and competitive exam problems with speed, accuracy, and logical thinking.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Apply fundamental number theory concepts such as divisibility, HCF & LCM, remainder theorem, and cyclicity to solve quantitative problems efficiently.	K2, K3
CO2	Solve problems involving logical reasoning and analytical thinking, including direction sense, blood relations, series patterns, and time-based puzzles like clocks and calendars.	K3
CO3	Solve real-life business math problems involving percentages, profit and loss, discounts, interest average calculations and using appropriate mathematical methods	K2, K3
CO4	Solve real-life business math problems involving averages, mixtures, and ratios using appropriate mathematical methods	K2, K3

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

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO3	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO4	1	1	1	1	-	-	-	-	-	-	-	-	-	-

Course Contents / Syllabus

Module 1	**Speed Math and Number System**	**8 hours**

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

Module 2	**Analytical and Logical Reasoning**	**8 hours**

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

Module 3	**Business Math I**	**8 hours**

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

Module 4	**Business Math II**	**8 hours**

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

Total Lecture Hours	**32 hours**

Reference Books:

S.No	Book Title	Author
1	Quicker math	M. Tyra (BSC publication co. Pvt. Ltd)
2	Quantitative Aptitude	RS Aggarwal
3	Verbal & Non-Verbal Reasoning	RS Aggarwal
4	Quantitative Aptitude - Quantum CAT	Sarvesh K Verma

Course Code: BEC0401	Course Name: Analog and Digital Communication	L	T	P	C
Course Offered in: B.Tech		**3**	**0**	**0**	**3**

Pre-requisite: Basic understanding of signal and systems & mathematics.

Course Objectives:

The objective of this course is the fundamental of different analog and digital modulation and demodulation techniques (AM, FM, PM ASK, FSK, PSK, DPSK and QPSK). The performance of digital modulation techniques in terms of noise and basics of spread spectrum techniques. Also, the concept of information theory and various source encoding techniques and error correcting codes.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO 1	Explain various modulation and demodulation methods of Amplitude Modulation and Angle Modulation.	K2
CO 2	Implement various digital modulation techniques.	K3
CO 3	Analyze the effect of noise and explain the concept of spread spectrum communication system.	K4
CO 4	Apply the fundamental concept of information theory to design various source encoding and to evaluate capacity of AWGN channel.	K5
CO 5	Characterize error-control codes and apply the encoding and decoding processes.	K5

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	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	3	-	3
CO2	3	3	2	-	-	-	-	-	-	-	-	2	-	3
CO3	2	3	2	2	-	-	-	-	-	-	-	2	-	3
CO4	3	3	3	2	-	-	-	-	-	-	-	2	-	3
CO5	3	2	1	-	-	-	-	-	-	-	-	2	-	3

Course Contents / Syllabus

Module 1	**Analog Modulation**	**8 hours**

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

Module 2	**Digital Modulation**	**8 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).

Module 3	**Digital Receiver**	**8 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).

Module 4	**Information theory**	**8 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.

Module 5	**Error correcting codes**	**8 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	**40S hours**

Text Books:

S.No	Book Title	Author
1	Principles of Communication Systems", Tata McGraw Hill.	Herbert Taub and Donald L. Schilling
2	Modern Digital and Analog communication Systems", 4th Edition, Oxford University Press,2010.	B.P. Lathi

Reference Books:

S.No	Book Title	Author
1	Communication Systems", 4th Edition, Wiley India.	Simon Haykin
2	Analog and Digital Communications", 2nd Edition, Tata McGraw- Hill.	H.P.Hsu& D. Mitra
NPTEL/ Youtube/ Faculty Video Link:		
1	https://nptel.ac.in/courses/117/101/117101051/	
2	https://www.youtube.com/channel/UCnWGGUyQOZkXylsoI5w-J4Q	
3	https://youtube.com/playlist?list=PLbtX56KUSNwTB_27m6HI52rjk8Mz7v23f&si=0-OZ5ktNwpf0MQ7D	

Course Code: BEC0403	Course Name: CMOS Digital Integrated Circuit	L	T	P	C
Course Offered in: B.Tech ECE/VLSI		3	0	0	3

Pre-requisite: Basis knowledge of MOSFET and Digital Electronics

Course Objectives: The students will learn about the basics of MOS device, CMOS fabrication steps, CMOS characteristics. They will learn to apply the knowledge of basic CMOS cell to implement and design combinational and sequential circuits and will understand the concepts of dynamic CMOS logics and semiconductor memories. Students will also be introduced with the concept of FPGA implementation of all the logics covered during the full course.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Describe the basics of MOS device and CMOS fabrication steps.	K1
CO2	Explain CMOS inverter and its switching characteristics.	K3
CO3	Design of Combinational and Sequential MOS logic circuits.	K4
CO4	Explain and design dynamic logic circuits.	K4
CO5	Describe the concept of semiconductor memories and ASIC.	K4

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	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	3	2	-
CO4	3	1	2	-	-	-	-	-	-	-	-	3	-	2
CO5	3	3	3	-	-	-	-	-	-	-	-	3	-	2

Course Contents / Syllabus

Module 1	**VLSI Design Flow and CMOS fabrication**	**8 hours**

VLSI Design flow: VLSI Design flow & Y-Chart, MOS Transistor Basic, MOS switch, Basic MOS Device design equation, MOSFET capacitances, Parasitic capacitances, latch-up, Second order effects.
Fabrication Process Flow: Basic Steps, The CMOS n-Well Process,SOI.

Module 2	**CMOS inverter and Switching Characteristics**	**8hours**

CMOS inverter: Circuit operation, DC transfer characteristics, Noise margin: calculation of VIL, VIH, Vth, Design of CMOS inverter, Supply voltage scaling, Device sizing. Switching characteristic: Delay time definition, calculation of delay times, inverter design with delay constraints, Power dissipation of CMOS inverter.

Module 3	**Combinational and sequential MOS logic circuits**	**8 hours**

Combinational MOS Logic Circuits: Complex Logic circuits design – Realizing Boolean expressions using CMOS gates, AOI and OAI gates, Design of Half Adder, Full Adder, Multiplexers, Demultiplexers using CMOS.
Sequential MOS Logic Circuits: Behaviour of bi-stable elements, D latch, SR Latch, Clocked latch and flip flop circuits, CMOS, and edge triggered flip-flop.

Module 4	**Dynamic logic Circuits**	**8 hours**

Dynamic Logic: CMOS Domino Logic, Domino Logic, charge sharing problem, Pass-Transistor Logic, Synchronous dynamic circuit techniques, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS. Clocking issues, clock distribution.

Module 5	**Introduction to Semiconductor memories and ASIC**	**8 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, Flash Memory- NOR flash and NAND flash.
Introduction of Application Specific Integrated Circuit (ASIC) Design Flow: An overview of Backend VLSI Design Flow – Libraries, Floor planning, Placement, Routing, Verification, Testing, Design Rule, Micron Rules, Lambda rules of the design and design rule check, Fabrication methods of circuit elements, Layout design of different cells.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title	Author
1	"CMOS Digital Integrated Circuits", TMH, 3rd Edition.Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.	Kang, Leblebici
2	"Digital Integrated Circuit: A Design Perspective", PHI; Latest Edition	Rabat, Chandrakasan and Nikolic

3	"Principles of CMOS VLSI Design" Addison Wesley, Latest Edition.	Weste and Eshraghian

Reference Books:

S.No	Book Title	Author
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

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://onlinecourses.nptel.ac.in/noc20_ee29/preview
Module 2	https://www.youtube.com/watch?v=MuBiC9yz2fc
Module 3	https://nptel.ac.in/courses/108/106/108106158
Module 4	https://www.youtube.com/watch?v=UuafwIJAKhY

Course Code: BEC0402N	Course Name: Microprocessor & Microcontroller	L	T	P	C
Course Offered in: B.Tech ECE/VLSI		3	0	0	3

Pre-requisite: Basics of digital electronics

Course Objectives: Students will learn about The fundamentals of general microprocessor & microcontroller, The fundamentals of 8086 microprocessor, The architecture of 8051 microcontroller with real time application, The fundamentals of ARM Processor and embedded systems, The knowledge of ARM Instruction Set for programming.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the fundamentals of general microprocessor & microcontroller.	K2
CO2	Explain the fundamentals of 8086 microprocessor.	K5
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.	K4

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
BEC0402.1	3	3	2	-	-	-	-	-	-	-	1	2	3	2
BEC0402.2	3	3	2	-	-	-	-	-	-	-	1	3	3	2
BEC0402.3	3	3	3	-	-	-	-	-	-	-	1	2	3	2
BEC0402.4	3	3	3	-	-	-	-	-	-	-	1	2	3	2
BEC0402.5	3	3	3	-	-	-	-	-	-	-	1	2	2	2

Course Contents / Syllabus

Module 1	**Basics of Microprocessor and microcontrollers**	**8 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.

Module 2	**Introduction to 8086**	**8hours**

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.

Module 3	**Introduction to 8051**	**8 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.

Module 4	**ARM Processor1**	**8 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.

Module 5	**ARM Processor2**	**8 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	**40 hours**

Textbook:

S.No	Book Title	Author
1	"Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International Publication (India) Pvt. Ltd.	Ramesh Gaonkar

2	"Microprocessors and Interfacing", Tata McGraw Hill	Douglas V. Hall
3	"The 8051".	Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D

Reference Books:

S.No	Book Title	Author
1	Microcontroller and Embedded Systems using Assembly and C", Pearson Publication.	Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D
2	ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.	Andrew N Sloss, Dominic Symes and Chris Wright

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=xBYhHC8_A6o
Module 2	https://www.youtube.com/watch?v=cNN_tTXABUA
Module 3	https://www.youtube.com/watch?v=sLW1TptEJBQ
Module 4	https://www.youtube.com/watch?v=9zOo4JkZgSI
Module 5	https://www.youtube.com/watch?v=pphUIgjvqJ8

Course Code: BEC0412	Course Name: Introduction to Robotics and it's Applications	L	T	P	C
Course Offered in: B.Tech		**3**	**0**	**0**	**3**

Pre-requisite: Engineering mechanics, Basic Electrical & Electronics, Sensor & Instrumentation

Course Objectives: Students will learn about the concept of robotics, Mathematical relations for forward and inverse kinematic analysis, The various types of actuators and drive systems, Different types of sensors for a robot in a specific job task, The applications of robotics in industry.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the concept of robotics.	K1, K2
CO2	Formulate the mathematical relations for forward and inverse kinematic analysis.	K2
CO3	Interpret the various types of actuators and drive systems.	K4, K6
CO4	Explain the different type's sensor for a robot in a specific job task.	K4, K6
CO5	Describe the applications of robotics in industry.	K1, K3

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	PSO3
CO1	3	2	-	-	2	2	2	2	-	3	2	2	2	2
CO2	3	3	2	-	2	-	-	-	-	3	2	2	2	2
CO3	3	1	1	-	2	2	-	-	-	3	2	2	2	2
CO4	3	1	2	-	2	-	-	-	-	3	2	2	2	2
CO5	3	-	-	-	-	2	-	-	-	3	2	2	2	2

Course Contents / Syllabus

Module 1	**Introduction**	**8 hours**

Classification of Robots, Advantages and Disadvantages of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages.

Module 2	**Kinematics of Robots**	**8hours**

Position Analysis – Introduction, Robots as Mechanisms, Conventions, Matrix Representation, Homogeneous Transformation Matrices, Representation of Transformations Forward and Inverse Kinematics of Robots, Forward and Inverse Kinematics of Planar Parallel Robots.

Module 3	**Actuators and Drive Systems**	**8 hours**

Introduction, Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Actuators, Pneumatic Devices, Electric Motors, Microprocessor Control of Electric Motors, Pulse Width Modulation, Direction Control of DC Motors with an H-Bridge, Speed Reduction

Module 4	**Sensors**	**8 hours**

Introduction, Sensor Characteristics, Sensor Utilization, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Micro-switches, Visible Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Range Finders, Sniff Sensors.

Module 5	**Robotics Applications**	**8 hours**

Robotics applications in Manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation. Limitation of usage of robots in processing operation.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title	Author
1	An Introduction to Robot Technology.	CoifetChirroza, Kogan Page
2	Robotic Engineering - An Integrated Approach	Richard D. Klafter Thomas A.
3	Robotics for Engineers, McGraw Hill.	Y. Koren,

Reference Books:

S.No	Book Title	Author
1	"Introduction to Robotics – Analysis, Systems and Application": PHI 2006	Saeed B. Niku

2	Robotics, Addison-Wesley, 1986.	J.J. Craig
3	Robotics, McGraw Hill, 1987.	K.S Fu, R.C. Gonzalez, C.S.G. Lee

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=P_PP76flZfw
Module 2	https://www.youtube.com/watch?v=XOg1KT6xD04&list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH&index=5
Module 3	https://www.youtube.com/watch?v=ksOgvhYdqX8
Module 4	https://www.youtube.com/watch?v=Gc4BiUGiV-Q
Module 5	https://www.youtube.com/watch?v=pSEjWxqE3R0

Course Code: BEC0411	Course Name: Artificial Intelligence	L	T	P	C
Course Offered in: B.Tech		3	0	0	3

Pre-requisite: Basic knowledge of AI and Machine Learning Concepts

Course Objectives: Students will learn about various aspect of Artificial Intelligence. They will learn AI towards problem solving inference, perception and knowledge representation. They will be able to demonstrate knowledge about intelligent systems by assembling solutions to concrete computational problems. They will acquire the knowledge of various forms of learning and computation statistics.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Elaborate historical perspective of AI and its foundations.	K1
CO2	Apply principles of AI toward problem solving and drawing inference thereof.	K4
CO3	Describe perception, knowledge representation, and different learning techniques.	K3
CO4	Implement architecture of knowledge-Based System, Rule-based systems, and other expert systems.	K5
CO5	Apply evolutionary computational algorithms and different search algorithms.	K5

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	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	3	3	2	-	-	-	-	-	-	-	3	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	2	3	-
CO4	3	2	2	-	-	-	-	-	-	-	-	3	3	-
CO5	3	3	3	3	-	-	-	-	-	-	-	3	3	-

Course Contents / Syllabus

Module 1	**Introduction to Artificial Intelligence**	**8 hours**

Historical developments of Artificial Intelligence, Well defined learning problems, Designing a Learning System.
Intelligent Agents: Characteristics of Intelligent Agents, Typical Intelligent Agents, Problem Solving Approach to Typical AI problems.

Module 2	**Problem Solving Methods**	**8hours**

Search Strategies: Uninformed Search Strategies: DFS, BFS, Informed Search Strategies: Local search algorithms and optimistic problems, adversarial Search, Search for games, minimax, Alpha - Beta pruning, Heuristic Search techniques, Hill Climbing, Best-first search, Iterative deepening Heuristic Search and A*.

Module 3	**Logic and Knowledge Representation**	**8 hours**

Introduction of Logic, Propositional Logic Concepts, Semantic Tableaux and Resolution ,Propositional logic, FOPL, Semantic Tableaux and Resolution in FOPL, Logic Programming in Prolog.Production systems and rules for some AI problems: Water Jug Problem, Missionaries-CannibalsProblem, n-Queen problem, monkey banana problem, Travelling Salesman Problem. Knowledge representation, semantic nets, partitioned nets, parallel implementation of semantic nets. Frames, Common Sense reasoning and thematic role frames.

Module 4	**Expert System**	**8 hours**

Architecture of knowledge-Based System, Rule-based systems, Forward and Backward Chaining, Frame Based systems. Architecture of Expert System, Forward & Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.

Module 5	**Planning and Uncertainty**	**8 hours**

Planning with state Space Search, Conditional Planning, Continuous planning, MultiAgent Planning, Forms of learning, inductive learning, Reinforcement Learning, learning decision trees, Neural Net learning, and Genetic learning. Probabilistic Methods, Bayesian Theory, Dempster Shafer Theory, Bayes Network.
Evolutionary computation: Swarm Intelligence, ant colony optimization.Case Study: Health Care, ECommerce, Smart Cities.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title	Author
1	"Artificial Intelligence–A Modern Approach", Pearson Education. Fourth Edition 2021	Stuart Russell, Peter Norvig
2	"Artificial Intelligence", McGraw-Hill 3rd Edition 2010	Elaine Rich and Kevin Knight

Reference Books:

S.No	Book Title	Author
1	"Artificial Intelligence", Pearson Education Inc., Third edition.	Patrick Henry Winston
2	Python Machine Learning: Learn Python in a Week and Master It. A Hands-On Introduction to Artificial Intelligence Coding, a Project Based Guide with Practical Exercises (7 Days Crash Course, Book2) 2020.	Computer programming Academy

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://nptel.ac.in/courses/106102220
Module 2	https://nptel.ac.in/courses/106102220
Module 3	https://nptel.ac.in/courses/106102220
Module 4	https://nptel.ac.in/courses/106102220
Module 5	https://nptel.ac.in/courses/106102220

Course Code: BEC0413	Course Name: VLSI Technology	L	T	P	C
Course Offered in: B.Tech		3	0	0	3

Pre-requisite: Basic knowledge of Semiconductor devices

Course Objectives: This course provides an introduction to the principles and processes of microfabrication, with a focus on semiconductor materials and devices. Students will learn about the key steps in microfabrication, such as photolithography, etching, deposition, and diffusion. They will also learn about the properties of semiconductor materials and how they are used to fabricate electronic devices.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles of microfabrication.	K4
CO2	Design and implement microfabrication processes.	K3
CO3	Characterize semiconductor materials and devices.	K4
CO4	Apply microfabrication techniques to fabricate electronic devices.	K3
CO5	Know the safety issues involved in the fabrication process.	K4

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	PSO3
BEC0413.1	3	2	1	2	2	1	2	1	-	2	1	2	3	2
BEC0413.2	3	2	3	2	3	2	2	2	1	2	2	3	3	2
BEC0413.3	3	2	2	3	3	2	1	1	-	1	1	2	3	2
BEC0413.4	3	2	3	3	3	2	2	2	1	2	2	2	3	2
BEC0413.5	2	1	1	1	2	3	3	2	1	1	1	2	2	2

Course Contents / Syllabus

Module 1	**Environment for VLSI Technology and Impurity incorporation**	**8 hours**

Environment for VLSI Technology: Clean room and safety requirements. Wafer cleaning processes and wet chemical etching techniques. Impurity incorporation: Solid State diffusion modelling and technology; Ion Implantation modelling, technology and damage annealing; characterization of Impurity profiles.

Module 2	**Epitaxy and Oxidation**	**8hours**

Epitaxy: Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation
Oxidation: Growth Kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxides Properties.

Module 3	**Lithography**	**8 hours**

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

Module 4	**Diffusion and Ion implantation**	**8 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: lon-Implantation Technique, Range Theory, Implantation Equipment.

Module 5	**Metal film deposition**	**8 hours**

Metal film deposition: Metallization: Metallization Application, Metallization Choices, Evaporation and sputtering techniques, Physical Vapor Deposition, Vacuum Deposition, Failure mechanisms in metal interconnects; multi-level metallization schemes. CMOS fabrication steps.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title	Author
1	Introduction to Microelectronics Fabrication, 2002	**Jaeger**
2	Physics of Semiconductor Device	Szesm & Kwok, 2006

Reference Books:

S.No	Book Title	Author
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.
3	Introduction to microelectronic fabrication (2nd ed.). Upper Saddle River, NJ: Prentice Hall. (2002).	Jaeger, R. C.
4	Physics of semiconductor devices (3rd ed.). Hoboken, NJ: Wiley. (2006).	Sze, S. M., & Kwok, K. N.

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://archive.nptel.ac.in/noc/courses/noc15/SEM1/noc15-ec02/
Module 2	https://video.search.yahoo.com/search/video;_ylt=AwrjbCfLAhtoPicCgpRXNyoA;_ylu=Y29sbwNncTEEcG9zAzEEdnRpZAMEc2VjA3BpdnM-?p=VLSI+Technology&fr2=piv-web&type=E210US826G0&fr=mcafee#id=7&vid=5e694387d34857a70efe44d25f2595c7&action=view
Module 3	https://video.search.yahoo.com/search/video;_ylt=AwrjbCfLAhtoPicCgpRXNyoA;_ylu=Y29sbwNncTEEcG9zAzEEdnRpZAMEc2VjA3BpdnM-?p=VLSI+Technology&fr2=piv-web&type=E210US826G0&fr=mcafee#id=15&vid=5fa3bdf0373ac3724665542bdfb6fb3d&action=view
Module 4	https://nptel.ac.in/courses/117101106

Course Code: BAS0403	Course Name: Advanced Engineering Mathematics	L	T	P	C
Course Offered in: B.Tech.		3	1	0	4

Pre-requisite: B.Tech 1st year

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.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
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-PO Mapping	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**	**8 hours**

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

Module 2	**Random Variables and distribution**	**10 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.

Module 3	**Complex Variable – Differentiation**	**10 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**	**10 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.

Module 5	**Integral Transforms**	**10 hours**

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

	Total Lecture Hours	**48 hours**

Textbook:

S.No	Book Title	Author
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:

S.No	Book Title	Author

1	Introduction to Probability Models	Ross, Sheldon M
2	Probability, Random Variables and Stochastic Processes	Papoulis, Athanasios
3	Advanced engineering mathematics	Kreyszig, E.

NPTEL/ Youtube/ Faculty Video Link:	
Module 1	https://youtu.be/1MiT06JFNo4?si=zVH-5AdAeu7Qcs9x https://youtu.be/6lQn1hdG43o?si=2WJXQHXJE-ByAghk https://archive.nptel.ac.in/courses/110/107/110107114/
Module 2	https://archive.nptel.ac.in/courses/111/104/111104032/
Module 3	https://archive.nptel.ac.in/courses/111/107/111107056/
Module 4	https://archive.nptel.ac.in/courses/111/103/111103070/
Module 5	NPTEL :: Mathematics - NOC:Integral Transforms And Their Applications

LAB Course Code: BEC0452	LAB Course Name: Microprocessor & Microcontroller Lab	L	T	P	C
Course Offered in: B.Tech ECE/VLSI		**0**	**0**	**4**	**2**

Pre-requisite: Basic Knowledge of microprocessor and microcontroller

Course Objectives:

8086 Microprocessor for writing assembly level language, The timer of 8051 microcontroller for generating waveforms, Interfacing of various I/O devices with programming, ARM Instruction Set for writing program.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Apply the knowledge of 8086 Microprocessor for writing assembly level language.	K3
CO2	Analyze the interfacing of various I/O devices with programming.	K4
CO3	Implement timer in 8051 microcontrollers for generating waveforms.	K6
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-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	-	-	-	-	3	3	2
CO2	3	3	3	-	3	-	-	-	-	-	-	3	3	2
CO3	3	3	3	-	3	-	-	-	-	-	-	3	3	2
CO4	3	3	3	-	3	-	-	-	-	-	-	3	3	2

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

Module 2	To study 8086 microprocessor system.	CO2
Module 2	Write a program using 8086 Microprocessor for Hexadecimal addition of two 8-bit Numbers.	CO2
Module 2	Write a program using 8086 Microprocessor for Hexadecimal subtraction of two 8-bit Numbers.	CO2
Module 2	Write a program using 8086 Microprocessor for Hexadecimal addition of two 16-bit Numbers.	CO2
Module 2	Write a program using 8086 Microprocessor for Hexadecimal subtraction of two 16-bit Numbers.	CO2
Module 2	Write a program using 8086 Microprocessor for addition of two BCD numbers.	CO2
Module 2	Write a program using 8086 Microprocessor for subtraction of two BCD numbers.	CO2
Module 2	To perform multiplication of two 8-bit numbers using 8086.	CO2
Module 2	To perform division of two 8-bit numbers using 8086.	CO2
Module 2	To find the smallest number in an array of data using 8086 instructions set.	CO2
Module 2	To find the largest number in an array of data using 8086 instructions set.	CO2
Module 2	To write a program to arrange an array of data in ascending order using 8086.	CO2
Module 2	To write a program to arrange an array of data in descending order using 8086.	CO2
Module 2	To convert given ASCII number in to its equivalent Hexadecimal number using 8086 instructions set.	CO2
Module 2	To convert given Hexadecimal number in to its equivalent ASCII number using 8086 instructions set.	CO2
Module 3	Write a program to find smallest and largest number in the array using 8051 microcontroller.	CO3

Module 3	Write a program to arrange numbers in ascending and descending order using 8051 microcontroller.	CO3
Module 3	Write a program to find addition and subtraction of two 8 bit numbers using 8051 microcontroller.	CO3
Module 3	Write a program to find multiplication and division of two 8 bit numbers using 8051 microcontroller.	CO3
Module 3	Write a program to square of a 8 bit numbers using 8051 microcontroller.	CO3
Module 3	Write a program to cube of a 8 bit numbers using 8051 microcontroller.	CO3
Module 3	Write a program of flashing LED connected to port of the 8051 microcontroller.	CO3
Module 3	Write a program to generate 10 kHz square wave using 8051 microcontroller.	CO3
Module 3	Write a program to generate a Ramp waveform of 1 KHz using DAC with 8051 micro controller.	CO3
Module 3	Write a program to show the use of INT0 and INT1 of 8051 microcontrollers.	CO3
Module 3	.Interfacing of sensors and display devices like Serial Communication Code, Bluetooth, seven segments with 8051 microcontrollers.	CO3
Module 3	Interfacing of Relay & Stepper Motor with 8051 microcontrollers.	CO3
Module 4	Write and simulate a program for data transfer using ARM freedom board.	CO4
Module 4	Write and simulate a program for arithmetic operations using ARM freedom board.	CO4
Module 4	Write and simulate a program for logical operations using ARM freedom board.	CO4
Module 4	Write a program for Interfacing of temperature sensor with ARM freedom board (or any other ARM microprocessor board) and display object temperature on LCD.	CO4
Module 4	Write an embedded C program to blink the LED with time delay intervals using LPC2148 ARM microcontroller.	CO4
Module 4	Write an embedded C program to read switch status and display in LED using LPC2148 ARM microcontroller.	CO4
Module 5	Write an embedded C program to ON/OFF buzzer with time delay intervals using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program generate a square wave using internal 10 bit DAC using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program generate a triangular wave using internal 10 bit DAC using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program generate a PWM waveform using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program to transmit and receive data from PC using UART serial port using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program to read on-chip ADC value of temperature sensor LM35 and display in hyper terminal using UART1 using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program to read the external interrupts INT1 and INT2 and display in hyper-terminal using UART1 using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program to toggle relays with delay intervals using LPC2148 ARM microcontroller.	CO5
Module 5	Write an embedded C program to control the stepper motor using LPC2148 ARM microcontroller.	CO5
		Total Hours: 40 hrs.

LAB Course Code: BEC0451N	LAB Course Name: Analog and Digital Communication Lab	L	T	P	C
Course Offered in: B.Tech		**0**	**0**	**2**	**1**

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

Course Objectives:

Amplitude modulation (AM), frequency modulation (FM) and their demodulation, The skill to analyze and implement analogue to digital converters like Pulse Code Modulation (PCM), Line coding schemes in digital communication, The practical aspects of digital communication system and various band-pass digital modulation techniques, The simulation of convolutional coding using MATLAB software.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
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.	K4
CO5	Analyze convolutional code using MATLAB.	K4

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

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
AEC 0451.1	3	2	1	2	-	-	-	-	-	-	-	3	2	2	1
AEC 0451.2	3	2	1	2	-	-	-	-	-	-	-	3	2	2	1
AEC 0451.3	3	2	1	2	-	-	-	-	-	-	-	3	2	2	1
AEC 0451.4	3	2	1	2	-	-	-	-	-	-	-	3	2	2	1
AEC 0451.5	3	2	1	2	-	-	-	-	-	-	-	3	2	2	1

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

Module 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
Module 1	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
Module 2	Perform and draw the output waveform of Pulse Code Modulation (PCM) and its demodulation with modulating frequency fm = 80 KHz.	CO2
Module 2	Demonstrate and draw the output waveform with input code 10101010 for the Unipolar RZ & NRZ Line Coding.	CO2
Module 2	Demonstrate and draw the output waveform with input code 10101010 for the Polar RZ & NRZ Line Coding.	CO2
Module 2	Demonstrate and draw the output waveform with input code 10101010 for the Manchester line coding technique	CO2
Module 2	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
Module 2	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
Module 2	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
Module 2	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
Module 3	Calculation of BER of BASK using MATLAB.	CO3

Module 3	Calculation of BER of BFSK using MATLAB.	CO3
Module 3	Calculation of BER of BPSK using MATLAB.	CO3
Module 4	Perform Huffman Coding for given symbols using MATLAB and calculate efficiency.	CO4
Module 4	Perform encoder of (7, 4) Hamming code using MATLAB	CO4
Module 5	Analysis and performance evaluation of convolutional codes using MATLAB for message code = [1 0 1 1]	CO5
		Total Hours: 40 hrs.

LAB Course :Code BEC0455	**LAB Course Name:** Verilog-HDL (Departmental Workshop II	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**0**	**0**	**6**	**3**

Pre-requisite: Hardware coding language

Course Objectives: The course will introduce the participants to the verilog hardware description language. It will help them to learn various digital circuit modeling issues using verilog, writing test benches, and some case studies.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Develop and identify the suitable abstraction level for a particular digital design	K3
CO2	Develop verilog codes in gate, dataflow (RTL) modeling levels of abstraction.	K3
CO3	Develop verilog codes in behavioral (RTL) modeling levels of abstraction	K4
CO4	Design and verify the functionality of digital circuit/system using test benches	K4
CO5	Design and simulate basic modules using switch level modeling.	K5

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**	**PSO3**
CO1	3	2	2	-	3	-	-	-	-	2	1	3	-	2
CO2	3	3	2	-	3	-	-	-	-	2	1	3	-	-
CO3	3	2	2	-	3	-	-	-	-	2	1	3	2	-
CO4	3	2	-	-	3	-	-	-	-	2	1	3	-	2
CO5	2	3	2	-	2	-	-	-	-	2	1	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 modules and module instances, parts of a simulation, design block, stimulus block. Lexical conventions, data types: value set, registers, vectors, arrays, strings, system tasks, compiler directives. Module definition, port declaration, connecting ports, hierarchical name referencing	15 Hour
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.	15 Hour
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.	20 Hour
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.	20 Hour
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.	20 Hour

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 Demultiplexer
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 Demultiplexer
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
T Flip Flop</td><td>CO3</td></tr>
<tr><td>9</td><td>Simulate and synthesize flip flops using behavioral modeling
a) Using positive edge and negative edge.
b) Using synchronous and asynchronous reset</td><td>CO3</td></tr>
</table>

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**

Required Software and Tools (Any one)

- ISE Simulator (Xilinx) / Xilinx Vivado
- Verilog-XL (Cadence)
- VCS ('big 3') (Synopsys)

Total : 40 hrs

LAB Course Code: BCSCC0452	LAB Course Name: Problem Solving Approaches	L	T	P	C
Course Offered in: IV SEM		**0**	**0**	**2**	**1**

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

Course Objectives:

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 Knowledge Level (KL)
CO1	Develop logic-based solutions using control statements and recursion to solve basic and intermediate computational problems.	K6
CO2	Apply bit manipulation techniques to find efficient solutions for binary and low-level operations.	K3
CO3	Implement and manipulate arrays and strings using fundamental and advanced searching sorting techniques.	K3
CO4	Utilize algorithmic strategies to optimize solutions for complex problem scenarios.	K3
CO5	Analyze and debug code for logical errors and improve the efficiency of the solution using appropriate data structures and algorithmic patterns.	K4

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

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	2	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	2	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	2	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	2	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	2	-	-	-	-	-	-

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

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

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

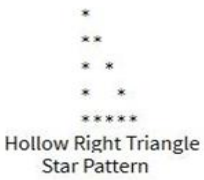
Secure Password: 19

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

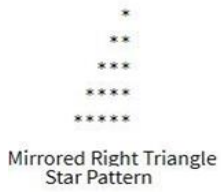
4. Draw **the following Patterns for N=5**


Right Triangle Star Pattern

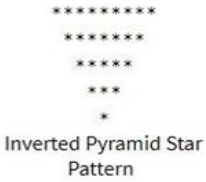

Hollow Right Triangle Star Pattern


Pyramid Star Pattern


Hollow Pyramid Star Pattern


Mirrored Right Triangle Star Pattern


Hollow Mirrored Right Triangle Star Pattern


Inverted Pyramid Star Pattern


Hollow Inverted Pyramid Star Pattern


Diamond Star Pattern

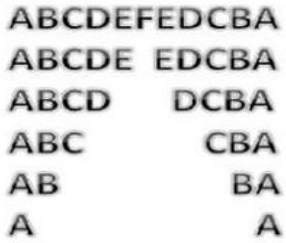

Hollow Diamond Star Pattern

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:**
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

7. Sort a binary array with values 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: N = 5 Arr[] = {3, 30, 34, 5, 9} **Output**: 9534330	**Input**: N = 4 Arr[] = {54, 546, 548, 60} **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: **Input:** S = "149811", K = 3 **Output:** 111	**Example 2:** **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 encodedString 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: 30 hrs.

Course Code: BNC0402Y	Course Name: Environmental Science	L	T	P	C
Course Offered in: All the branches		**2**	**0**	**0**	**2**

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

Course Outcome- After completion of the course, the student will be able to understand ecosystems, promote sustainability, address environmental issues, conserve biodiversity, and ensure responsible use of natural resources for future generations.		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem, food chains and food webs. Ecological pyramids, biodiversity.	K1,K2
CO2	Understand the different types of natural recourses like food, forest, Minerals and energy and their conservation.	K1,K2
CO3	Understand the different types of pollution, pollutants, their sources, effects and their control methods.	K1,K2
CO4	Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment	K1,K2

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

Course Contents / Syllabus

Module 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.

Module 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

Module 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.

Module 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 UNSDsGs, System Thinking and Sustainability.

Total Lecture Hours	**20 hours**

Textbook:

S.No	Book Title	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

S.No		
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

Unit 1:	https://www.youtube.com/watch?v=T21OO0sBBfc, https://www.youtube.com/watch?v=qt8AMjKKPDo
Unit 2:	https://www.youtube.com/watch?v=mOwyPENHhbc, https://www.youtube.com/watch?v=yqev1G2iy2 https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2
Unit 3:	https://www.youtube.com/watch?v=7qkaz8ChelI, https://www.youtube.com/watch?v=NuQE5fKmfME https://www.youtube.com/watch?v=9CpAjOVLHII, ttps://www.youtube.com/watch?v=yEci6iDkXYw
Unit 4	https://www.youtube.com/watch?v=ad9KhgGw5iA, https://www.youtube.com/watch?v=nW5g83NSH9 M, https://www.youtube.com/watch?v=xqSZL4Ka8xo