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 Engineering (VLSI Design and Technology)

Second Year

(Effective from the Session: 2025-26)

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

Bachelor of Technology
Electronics Engineering (VLSI Design and Technology)

EVALUATION SCHEME
SEMESTER-III

S. No.	Subject Codes	Subject	Types of Subjects	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	BECVL0301	VLSI Technology	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	BECVL0355	Linux and Scripting	Mandatory	0	0	6				50		100	150	3
11	BEC0359X	Social Internship	Mandatory	0	0	2				50			50	1
12	BNC0301/ BNC0302	Artificial Intelligence and Cyber Ethics / Environmental Science	Compulsory Audit	2	0	0	30	20	50					NA
		*Massive Open Online Courses (For B.Tech. Hons. Degree)												
		TOTAL		**16**	**0**	**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 weeks Internship shall be conducted during summer break after semester-II and will be assessed during semester-III**
- **Compulsory Audit (CA) Courses (Non-Credit - BNC0301/BNC0302)**
  - 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.

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Bachelor of Technology

Electronics Engineering (VLSI Design and Technology)

EVALUATION SCHEME

SEMESTER-IV

Sl. No.	Subject Codes	Subject	Types of Subjects	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	BECVL0401	Analog and Digital Signal Processing & Communication	Mandatory	3	0	0	30	20	50		100		150	3
3	BECVL0402	CMOS Analog 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		Departmental Elective 1	Departmental 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	BECVL0452	CMOS Analog Integrated Circuit Lab	Mandatory	0	0	2				25		25	50	1
9	BEC0455	Verilog-HDL	Mandatory	0	0	6				50		100	150	3
	BCSCC0452	Problèm Solving Approches	Mandatory	0	0	2				50			50	1
10	BEC0459	Mini Project	Mandatory	0	0	2				50			50	1
12	BNC0402/ BNC0401	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)												
		TOTAL		**19**	**1**	**16**			**350**	**225**	**500**	**175**	**1250**	**26**

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

S. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0080	Hardware Description Languages for FPGA Design	Infosys Wingspan (Infosys Springboard)	36h 15m	3
2	BMC0023	Internet of Things 201	Infosys Wingspan (Infosys Springboard)	15h 59m	1
3	BMC0021	IoT Raspberry Pi with Projects	Infosys Wingspan (Infosys Springboard)	12h 25m	0.5

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-IV and will be assessedduring Semester-V**
- **Compulsory Audit (CA) Courses (Non-Credit - BNC0401/BNC0402)**
  - 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	BECVL0412	Data Analytics	AI & ML
2	Elective-I	BECVL0413	IoT Architecture and Protocols	Embedded & IoT
3	Elective-I	BECVL0411	Compound Semiconductor	Semiconductor Devices & Display Technologies

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AICTE Guidelines in Model Curriculum:

A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as 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: EE/VLSI		2	0	0	2

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

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.	K3
CO5	Explain the concept of Semiconductor Memories and implement the digital logic functions using PLDs.	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	3	2	2
CO2	3	3	2	-	-	-	-	-	-	-	2	3	2	2
CO3	3	3	2	-	-	-	-	-	-	-	2	3	2	2
CO4	3	3	2	-	-	-	-	-	-	-	2	3	2	2
CO5	3	3	2	-	-	-	-	-	-	-	2	3	2	2

Course Contents / Syllabus

Module 1	Logic Simplification and Binary Codes	8 hours

11Number 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	10 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	10 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	12 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	48 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, 2ndedition ,2006.	W.H. Gothmann
3	" Theory and Logic Design", PHI, 2013.	A. Anand Kumar

NPTEL/ Youtube/ Faculty Video Link:

Unit I	https://www.youtube.com/watch?v=juJR_JDJRa0 https://www.youtube.com/watch?v=2cpl_HjcI3A https://www.youtube.com/watch?v=KergVtV3SxU https://www.youtube.com/watch?v=kgL5UaSVuro https://www.youtube.com/watch?v=EznCqZ1eh5Q
Unit II	https://www.youtube.com/watch?v=sUutDs7FFeA https://www.youtube.com/watch?v=XCiLHOZsQl8
Unit III	https://www.youtube.com/watch?v=ibQBb5yEDlQ https://www.youtube.com/watch?v=LHAbLXfRYXk https://www.youtube.com/watch?v=Gc3DL-tmr-g https://www.youtube.com/watch?v=8S1kvCJRfvc
Unit IV	https://www.youtube.com/watch?v=ntiv1g7G_C4 https://www.youtube.com/watch?v=Qe_9CPac23c
Unit V	https://www.youtube.com/watch?v=4GpWA_hmRhw https://www.youtube.com/watch?v=p4R0Ej6FCn0&list=PLAuW6sm6dy0yRMXL47Kz4nfhB7tURK88p https://www.youtube.com/watch?v=jrQ1YYgiOTo

Course Code: BEC0302Z	**Course Name: Analog Circuits**	**L**	**T**	**P**	**C**
Course Offered in: EE / 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**	**-**
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**	**10 hours**

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**	**10 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**	**10 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**	**10 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	**48 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	The Art of Electronics, 2nd edition, Cambridge University Press, 1989.	P. Horowitz and W. Hill
2	The Art of Electronics, 2nd edition, Cambridge University Press, 1989.	Paul R.Gray & Robert G.Meyer
3	L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.	J.V. Wait

NPTEL/ Youtube/ Faculty Video Link:

1	https://www.youtube.com/watch?v=2bprLH4cUSo
2	https://www.youtube.com/watch?v=XDy-rD5AJl0
3	https://www.youtube.com/watch?v=dHSaPhQIQqE
4	https://nptel.ac.in/courses/117101106

Course Code:BEC0306	**Course Name: Data Structures**	**L**	**T**	**P**	**C**
Course Offered in: EE/VLSI		**2**	**0**	**0**	**2**

Pre-requisite: Knowledge of data types and their organization.

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	Describe how arrays, linked lists, stacks, queues, trees, and graphs are represented in memory, used by the algorithms and their common applications.	K1
CO2	Discuss the computational efficiency of the sorting and searching algorithms.	K2
CO3	Implementation of Trees and Graphs and perform various operations on these data structure.	K4
CO4	Understanding the concept of recursion, application of recursion and its implementation and removal of recursion.	K2
CO5	Identify the alternative implementations of data structures with respect to its performance to solve a real-world problem.	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

Module 1	**Introduction to data structures,Arrays and Linked Lists**	**10 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.

Module 2	**Stacks and Queues**	**10 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.

Module 3	**Trees**	**10 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.

Module 4	**Graphs**	**10 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.

Module 5	**Searching, sorting and file structure**	**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	**48 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	"Data structures using C and C++", Pearson Education,2010	Aaron M. Tenenbaum, Yeedidyah Langsam, Moshe J. Augenstein
2	"Data Structures With C", Tata McGraw-Hill Education. 2008	Lipschutz

Reference Books:

S.No	Book Title with publication agency & year	Author
1	"Data Structure using C", OUP Publication.	Reema Theraja
2	"Introduction to Algorithms", MIT Press	TH Koreman
3	"Programming in ANSI C', Second Edition, Tata McGraw Hill Publication.	E. Balagurusamy

NPTEL/ Youtube/ Faculty Video Link:

Unit 1	https://nptel.ac.in/courses/106/106/106106127/ https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F https://nptel.ac.in/courses/106/106/106106127/ https://www.youtube.com/watch?v=g1USSZVWDsY&list=PLBF3763AF2E1C572F&index=2
Unit 2	https://nptel.ac.in/courses/106/106/106106127/
Unit 3	https://nptel.ac.in/courses/106/106/106106127/ https://www.youtube.com/watch?v=tORLeHHtazM&list=PLBF3763AF2E1C572F&index=6 https://www.youtube.com/watch?v=eWeqqVpgNPg&list=PLBF3763AF2E1C572F&index=7
Unit 4	https://nptel.ac.in/courses/106/106/106106127/ https://www.youtube.com/watch?v=9zpSs845wf8&list=PLBF3763AF2E1C572F&index=24 https://www.youtube.com/watch?v=hk5rQs7TQ7E&list=PLBF3763AF2E1C572F&index=25 https://www.youtube.com/watch?v=KW0UvOW0XIo&list=PLBF3763AF2E1C572F&index=5
Unit 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=BmayUdDaDYM&list=PLBF3763AF2E1C572F&index=4 https://www.youtube.com/watch?v=KW0UvOW0XIo&list=PLBF3763AF2E1C572F&index=5

Course Code: BECVL0301	**Course Name: VLSI Technology**	**L**	**T**	**P**	**C**
Course Offered in: EE-VLSI		**3**	**0**	**0**	**3**

Pre-requisite: Basic knowledge of Semiconductor materials.

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.	K 2
CO2	Design and implement microfabrication processes.	K5
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.	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	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
CO3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
CO4	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
CO5	**3**	**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**	**8 hours**

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 with publication agency & year	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.

Reference Books:

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

NPTEL/ Youtube/ Faculty Video Link:

1	https://archive.nptel.ac.in/noc/courses/noc15/SEM1/noc15-ec02/
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
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
4	https://nptel.ac.in/courses/117101106

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

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

Course Objectives:The student will learn about

1.	Verification of truth table of various type of logic gates.	K2
2.	Designing and verification of different type of combinational circuits.	K4
3.	Implementation and verification of truth table of various type of flip-flops.	K3
4.	Designing and implementation of different types of sequential circuits.	K4

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 analyse 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**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**-**	**1**	**2**	**2**
CO2	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**-**	**1**	**2**	**2**
CO3	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**-**	**1**	**2**	**2**
CO4	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**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)

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)

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)

4. Implement and verify
   4-bit Binary to Gray code converter and
   4- bit Gray to Binary code converter.

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.

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.

7. Implementation of 4-bit Parallel adder using 7483 IC and verify the outputfor the given inputs.
   (i) A = 1011, B = 1001

(ii) (ii) A = 0011, B = 0010
8. Implementation of 2:4 Decoder, 1:4 Demultiplexer using Logic Gates (NOT gate- 7404, AND gate- 7408) and verify its truth table.
9. Implementation of 4:2 Encoder , 4 : 1 m u l t i p l e x e r using logic gate (OR gate-7432) and verify its truth table.
10. Implement and verify F (A,B,C) = ∑ (3, 5, 6, 7) using a) 8:1 multiplexer. b) 4:1 multiplexer.
11. Implement 2 Bit magnitude comparator using logic gates and verify the truthtable.
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
13. Implement D flip flop using SR flip flop and verify the truth table.
14. Design and implement 4-bit ring counter using D flip flop and verify the result.
15. Design MOD 5 asynchronous counter using T flip flop and verify the truth table.
16. Design MOD 5 synchronous counter using T flip flop and verify the truth table.
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
18. Design Pseudo Random Sequence generator using 7495.
Total Hours: 48 hrs.

LAB Course Code: BEC0352	**LAB Course Name: Analog Circuits Lab**	**L**	**T**	**P**	**C**
Course Offered in: EE/VLSI		**0**	**0**	**4**	**2**

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

Course Objectives: Students will learn about

1.	Designing, implementation and verification of various characteristics of transistor amplifiers.	K5
2.	Design and implementation of various applications of Op-amp.	K5
3.	Design and implementation of oscillators.	K5
4.	Simulation of Electronic circuits on simulation software.	K4
5.	Introduction and circuit design by PCB design software (PCB Express, Ki cad).	K1

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.	K3
CO2	Design and verify Op-amp base circuits.	K3
CO3	Design and verify of oscillator circuits.	K3
CO4	Simulate the Electronic circuits on simulation software.	K3
CO5	Design and implement electronics circuits by PCB design software (PCB Express, Ki cad).	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**	**1**		**2**	**2**	**-**	**2**	**2**	**2**	**-**	**1**	2	2
CO2	**3**	**3**	**2**		**3**	**2**	**-**	**2**	**2**	**2**	**-**	**1**	2	2
CO3	**3**	**3**	**2**		**2**	**2**	**-**	**2**	**2**	**2**	**-**	**1**	2	2
CO4	**3**	**3**	**2**		**3**	**2**	**-**	**2**	**2**	**2**	**-**	**1**	2	2
CO5	**3**	**3**	**3**		**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 V_i = 20 mV, R_1=100KΩ R_2= 10KΩ, R_C= 4.7 KΩ, R_E= 1KΩ). Verify the following parameters with the theoretical values:
   (i) Voltage gain A_v
   (ii) Current gain A_i
   (iii) Input Resistance (R_i)
   Output Resistance (R_o)

2. Design and analysis of Single stage common source MOSFET amplifier with potential divider biasing (for V_i = 20 mV, R_1=1MΩ R_2= 1KΩ, R_D= 4.7 KΩ, Rs= 1KΩ) and Plot Gain (dB) Vs frequency curve, also measure following parameters
   (i) Bandwidth
   (ii) Input impedance
   Maximum signal handling capacity (MSHC).

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, V_{CC} = 12V, Stability factor (S) =10 and R_L= 10 KΩ. Observe the effect on gain and bandwidth.

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.

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.

6. Design and analyze the output voltage V_0 for OP-AMP (IC 741) as:
   (i) Inverting and Non-inverting amplifier for input voltage 0.5V with input Resistance (R_i) of 10 KΩ and feedback Resistance (R_f) of 100 KΩ.
   (ii) Voltage follower circuits for input voltage 1V.

7. Design a differential amplifier with ±12V DC power supply and calculate Common mode gain, differential mode gain, CMRR and slew-rate.
8. Design and analyze OP-AMP applications as a difference amplifier, integrator and differentiator Circuits for 1 KHz input signal.
9. Draw the input and output waveforms of a given full wave precision rectifier.
10. Design and implment of 2^{nd} 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.
11. Design and implement of 2^{nd} 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.
12. Design the following RC sinusoidal oscillators; Also verify the theoretical and practical Oscillating frequency. (i) RC phase shift oscillator, if its frequency of oscillation is 955 Hz and $R_1=R_2=R_3$ =680KΩ. Wien bridge oscillator uses R=4.7KΩ, C=0.01μF, and $R_F=2R_1$
13. Design the following LC oscillators; Also verify the theoretical and practical Oscillating frequency. (i) For a Hartley oscillator, self-inductance of the two coils are L_1=100mH, L_2=1mH and mutual inductance between the two coils is 20μH. its output for a capacitor of value 20pF. 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.
14. Design and implement square wave generator (Astable Multivibrator) for 1 KHz using, (i) Op-amp (ii) IC 555.
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.
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, V_{CC}= 12V, Stability factor (S)=10 and R_L= 10 KΩ. (*TARGET, PSPICE-1*etc.)
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-1*etc.)
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.
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.
20. Design and simulate of 2^{nd} 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.
21. Design and simulate of 2^{nd} 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.
22. **Introduction of PCB design software (PCB Express, Ki cad).**
23. **Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.**
24. **PCB Lab: Artwork & printing of a simple PCB.**
25. **Etching & drilling of PCB.**
26. **Wiring & fitting shop: Fitting of power supply along with a meter in cabinet.**
27. **Mini Project:** ***Design a mini project using the applications of this Lab.***
Total Hours: 48 hrs.

LAB Course Code: BEC0356	LAB Course Name: Data Structure Lab	L	T	P	C
Course Offered in: EE-VLSI		0	0	2	1

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

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	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.	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.

LAB Course Code: BECVL0355	LAB Course Name: Linux and Scripting	L	T	P	C
Course Offered in: EE-VLSI		**0**	**0**	**6**	**3**

Pre-requisite: Basis concept of operating system.

Course Objectives: The student will learn about

1. To introduce the basics of the Linux operating system and its command-line interface.
2. To perform essential file, directory, and system operations using Linux commands.
3. To develop basic scripting skills using TCL for automation tasks.
4. To apply Linux and TCL scripting for solving real-world system problems.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand Linux basics, directory structure, and essential command-line utilities.	**K2**
CO2	Apply Linux commands for file handling, system monitoring, and disk management.	**K3**
CO3	Develop and execute TCL scripts for automation and basic system tasks.	**K3**
CO4	Analyze and differentiate Linux commands and TCL scripts to solve administrative 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	3	2	2
CO2	3	3	-	3	3	-	-	-	-	2	3	3	2	2
CO3	3	3	-	3	3	-	-	-	3	2	3	3	2	2
CO4	3	3	3	3	3	-	-	-	3	2	3	3	2	2

Course Contents/Syllabus

Module 1	**Introduction to Linux for VLSI Design**	**8 hours**
Overview of Linux distributions and their relevance in VLSI design. Basic Linux commands and file system navigation		
Module 2	**Advanced Linux Commands for VLSI Design**	**8 hours**
Networking and system administration in a VLSI design environment. Version control systems for collaborative VLSI projects.		
Module 3	**Introduction to Python Programming for VLSI**	**8 hours**
Basic Python syntax and data structures. Writing and executing Python scripts for VLSI design automation.		
Module 4	**Introduction to TCL Scripting for VLSI**	**8 hours**
TCL fundamentals and scripting in VLSI applications, Integrating TCL with EDA tools for automation.		
Module 5	**Advanced TCL Scripting for VLSI Design**	**8 Hours**
Developing complex TCL scripts for VLSI design tasks. Interfacing TCL with Python for enhanced functionality.		

Textbook:

S.No	Book Title	Author
1	Practical Programming in TCL and TK	Jones, Ken, Welch, Brent
2	Linux Commands for Beginners	Khalid Husain

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Commands Of Kali Linux: Commands	Pavan Kumar Nalluri
2	Learning Linux Shell Scripting - Second Edition	Ganesh Sanjiv Naik Ganesh Naik
3	**Perl Language Reference Manual - for Perl Version 5.12.1**	Larry Wall

Certification Courses:

1. Linux Programming and Scripting, IIT Madras, Prof. Indranil Sengupta

https://archive.nptel.ac.in/courses/117/106/117106113/

2. C-DAC (PG-DVLSI)

https://www.cdac.in/index.aspx?id=DVLSI&courseid=20

3. Linux for Beginners, Infosys Springboard

TOC - Linux for Beginners | Infosys Springboard

Links:

https://www.youtube.com/watch?v=ZRi2VHoS8qE&list=PL1h5a0eaDD3rsGDFnVki_fFEtDWQfXjca&index=2

https://www.youtube.com/watch?v=SI4_zKTmKdk&list=PL1h5a0eaDD3rsGDFnVki_fFEtDWQfXjca&index=4

https://www.youtube.com/watch?v=J7SLbhZv08c&list=PL1h5a0eaDD3rsGDFnVki_fFEtDWQfXjca&index=5

List Of Practical's (Indicative & Not Limited To)	
PART I – Linux experiments	
Description	**CO**
1. To Study Linux Basics.	CO1
2. To implement and execute Linux Directory Structure.	CO1
3. To implement and execute Linux Basic Commands.	CO1
4. To implement and execute Copy, Remove, Move and Time Commands.	CO1
5. To implement and execute df, diff and Grep Commands and differentiate between df and diff commands.	CO1
6. To implement and execute Head, tail, sort and more commands.	CO1
7. To implement and execute tr and wc commands.	CO1
8. To Study Getting Help From Command Line user Interface (CLI).	CO1
9. To implement and execute rmdir and exit command.	CO1
10. To implement and execute date and more command.	CO2
11. To implement and execute cat, less and more command and explain the difference between cat and less command.	CO2
12. To implement and execute sort, scp command.	CO2
13. To implement and execute Disk utilities like fdisk, df and du commands.	CO2
14. To implement and execute w, who, hostnamem hostnamectl and uname commands.	CO2
15. To implement and execute Search for files and directories using find and locate commands	CO2
16. To implement and execute top command and its output explanation **Part II - TCL Scripting experiments**	CO2
17. To Write Example TCL script that takes a user's name as input and greets them.	CO3
18. To Write Example TCL script that do 1. String Comparison 2. Index creation 3. Calculation of Length of String	CO3
19. To Write Example TCL script demonstrating Handling Cases.	CO3

20. To Write Example TCL script that creates 1. Trimming of Characters. 2. Identification of Matching Strings.	CO3
21. To Write Example TCL script demonstrating Append Command 1. List Creation. 2. Appending Item to a List 3. Length of List	CO3
22. To Write Example TCL script that calculates the sum of integers from 1 to N using a loop.	CO4
23. To Write Example TCL script that searches for a specific word in a file and counts its occurrences.	CO4
24. To Write Example TCL script to illustrate 'for' loop.	CO4
25. To Write Example TCL script to illustrate Arithmetic operators.	CO4
26. To Write Example TCL script to display the structure of your file system directory.	CO4
27. To Write Example TCL script to modify all files in a directory.	CO4
28. To Write Example TCL script to Take Backup of a Particular File.	CO4
29. To Write Example TCL script to Connect to remote host and send the password (create automate login SSH).	CO4
30. To Write Example TCL script to Collect Multiple Servers CPU, MEM, DISK usage in single report.	CO4
Total Hours: 60 hrs.	

Course Code: BNC0301	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: BECVL0401	**Course Name: Analog and Digital Signal Processing & Communication**	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**3**	**0**	**0**	**3**

Pre-requisite: Basic Knowledge of signals.

Course Objectives: This course is Fundamentals of amplitude modulation (AM) and angle modulation and demodulation techniques and its application. Fundamentals of amplitude modulation (AM) and angle modulation and demodulation techniques and its application. The performance of a various digital communication modulation and demodulation techniques. The concept of different communication protocols used in data communication and network & various emerging communication technologies.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the fundamentals of signal and systems with signal processing.	K2
CO2	Design of digital IIR and FIR filters.	K5
CO3	Explain various modulation and demodulation methods of Amplitude Modulation and Angle Modulation.	K4
CO4	Explain various digital modulation and demodulation techniques.	K3
CO5	Explain different communication protocols and various emerging communication technologies	K1

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	3	2	2
CO2	3	3	3	-	-	-	-	-	-	-	2	3	2	2
CO3	3	3	2	-	-	-	-	-	-	-	2	3	2	2
CO4	3	3	2	-	-	-	-	-	-	-	2	3	2	2
CO5	3	3	3	-	-	-	-	-	-	-	2	3	2	2

Course Contents / Syllabus

Module 1	**Signal Classification and Frequency-Domain Processing**	**8 hours**

Classification of Signals: Time-shifting, time scaling, time-reversal properties.
Classification of systems: Time stability of LTI system.
Signal processing: ASP and DSP, DFT, Circular convolution, Linear filtering using circular convolution Fast Fourier transform: DIT-FFT and DIF-FFT algorithms.

Module 2	**Digital Filter Design: IIR and FIR Techniques**	**8 hours**

IIR filter: Filter transformation: impulse invariant and Bi linear transformation method, All pole filter, Frequency Transformation
FIR filter: Frequency response of linear phase filter, Designing of FIR filter using Fourier series and window techniques

Module 3	**Fundamentals of Analog Communication Systems**	**8 hours**

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

Module 4	**Digital Transmission and Modulation Techniques**	**8 hours**

Sampling Theorem, Pulse Code Modulation (PCM), Line coding, Binary ASK, FSK & PSK Modulation and Demodulation, Differential phase shift keying (DPSK), Quadrature phase shift keying (QPSK).

Module 5	**Communication Protocols and Emerging Technologies**	**8 hours**

Introduction to Communication Protocols: Need and role of protocols, OSI and TCP/IP models, Protocol standards and organizations (IETF, IEEE, ITU), Basic Communication Protocols: IP, UDP, TCP, Application Level Communication Protocols: FTP, TELNET, Switching Level Convergence Protocol: ATM, IP Addressing: IPV4, IPV6, Web Communication Protocols: HTTP, WAP, LTP.

Emerging Communication Technologies: Internet of Things (IoT): Protocols – MQTT, CoAP, 6LoWPAN, Industrial IoT (IIoT): Modbus, CAN, OPC UA, Edge and Fog Computing in communication, Low-Power Wide Area Networks (LPWAN): LoRaWAN, NB-IoT		
	Total Lecture Hours	**40 hours**
Textbook:		
S.No	**Book Title with publication agency & year**	**Author**
1	John G Prokias, Dimitris G Manolakis, "Digital signal processing Principles Algorithms & Applications", 4th edition, Pearson education, 2007.	John G Prokias, Dimitris G Manolakis
2	Herbert Taub and Donald L. Schilling, "Principles of Communication Systems", Tata McGraw Hill	Herbert Taub and Donald L. Schilling
3	B.P. Lathi, "Modern Digital and Analog communication Systems", 4th Edition, Oxford University Press,2010.	B.P. Lathi,
4	Behrouz A. Forouzan, "Data Communications and Networking", 5th Edition, McGraw- Hill	Behrouz A. Forouzan
Reference Books:		
S.No	**Book Title with publication agency & year**	**Author**
1	Simon Haykin, "Communication Systems", 4th Edition, Wiley, India	Simon Haykin
2	H.P.Hsu & D. Mitra "Analog and Digital Communications", 2nd Edition, Tata McGraw- Hill.	H.P.Hsu & D. Mitra
3	Oppenheim & Schafer, "Discrete Time Signal Processing", Pearson education, Prentice Hall, 2nd edition,2003	Oppenheim & Schafer
NPTEL/ Youtube/ Faculty Video Link:		
1	https://archive.nptel.ac.in/noc/courses/noc15/SEM1/noc15-ec02/	
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	
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	
4	https://nptel.ac.in/courses/117101106	

Course Code: BECVL0402	**Course Name:** CMOS Analog Integrated Circuit	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**3**	**0**	**0**	**3**

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

Course Objectives: Student will learn about analog CMOS circuit design, focusing on small signal modeling of MOSFETs and their non-ideal effects. It covers the design and analysis of current mirrors, CMOS amplifiers, differential amplifiers, and operational amplifiers. Emphasis is placed on performance metrics, gain enhancement, and stability techniques.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Analyze MOSFET small signal models including channel length modulation and back gate effects.	**K 2**
CO2	Design current sources, mirrors, and voltage/current references.	**K5**
CO3	Implement and analyze differential, cascode, and high-gain amplifiers.	**K4**
CO4	Analyze two-stage op-amps and address stability using compensation.	**K3**
CO5	Compare and enhance open-loop and discrete-time comparators.	**K1**

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**	**-**	**-**	**-**	**-**	**1**	**-**	**3**		
CO2	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**		
CO3	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**		
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**3**		
CO5	**3**	**3**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**3**		

Course Contents / Syllabus

Module 1	**Basic MOS Device Physics**	**8 hours**

The MOS Transistor, Passive Components- Capacitor & Resistor, Effect of channel length modulation and back gate effect, evaluation of figure of merit for MOSFET under different biasing conditions

Module 2	**Current Mirrors and Biasing Techniques**	**8 hours**

MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors, Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

Module 3	**Differential Amplifiers**	**8 hours**

Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures

Module 4	**OP-AMP**	**8 hours**

Characteristics of ideal operational amplifier, constituents of op-amp, small signal analysis of 2 stage op-amp, stability challenges and solutions

Module 5	**Comparator**	**8 hours**

Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators

	Total Lecture Hours	**40 hours**
Textbook:		
S.No	**Book Title with publication agency & year**	**Author**
1	Behzad Razavi, Design of Analog CMOS Integrated Circuit, McGraw Hill Education, 2017, 2nd Edition	Behzad Razavi,
2	Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, 2013	David A. Johns, Ken Martin, Wiley
Reference Books:		
S.No	**Book Title with publication agency & year**	**Author**
1	CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010.	Philip E. Allen and Douglas R. Holberg
2	Geiger, Allen and Stradder, VLSI Design Techniques for Analog and Digital Circuits, Tata McGraw-Hill Education, 2010.	Geiger, Allen and Stradder

NPTEL/ Youtube/ Faculty Video Link:	
1	https://www.youtube.com/watch?v=qf49IvJNsGM
2	https://www.youtube.com/watch?v=PHmrsLfPS8Y
3	https://www.youtube.com/watch?v=JvS-VNDGHV0
4	https://www.youtube.com/watch?v=HIe7Ne6kMo8
	https://www.youtube.com/watch?v=Anj8OYXAY20

Course Code: BEC0402N	**Course Name: Microprocessor & Microcontroller**	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**3**	**0**	**0**	**3**

Pre-requisite: : Basics of digital electronics

Course Objectives: Students will learn about:

1.The fundamentals of general microprocessor & microcontroller.

2.The fundamentals of 8086 microprocessor.

3.The architecture of 8051 microcontroller with real time application.

4.The fundamentals of ARM Processor and embedded systems.

5.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 & micro-controller	**K 2**
CO2	Explain the fundamentals of 8086 microprocessor.	**K5**
CO3	Implement 8051 microcontroller for designing various applications.	**K4**
CO4	Illustrate the fundamentals of ARM Cortex M0 Processor.	**K3**
CO5	Apply the knowledge of ARM Instruction Set for programming.	**K1**

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**	**3**	**2**
CO2	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**2**
CO3	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**3**	**2**
CO4	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**3**	**2**
CO5	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**2**

Course Contents / Syllabus

Module 1	**Fundamentals of Microprocessors and Computer Architecture**	**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	**8086 Microprocessor Architecture and Programming**	**8 hours**

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

Module 3	**8051 Microcontroller: Architecture, Programming, and Applications**	**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 Cortex-M Series: Architecture and Cortex-M0 Fundamentals**	**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	**Cortex-M0 Instruction Set and Low-Power Features**	**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 with publication agency & year	Author
1	Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International Publication (India) Pvt. Ltd.	Ramesh Gaonkar
2	Douglas V. Hall, "Microprocessors and Interfacing", Tata McGraw Hill	Douglas V. Hall,

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D "The 8051	Mazidi Ali Muhammad
2	Microcontroller and Embedded Systems using Assembly and C", Pearson Publication.	Pearson
3	ARM system developers guide, Andrew N Sloss, Dominic Symes and Chris Wright, Elsevier, Morgan Kaufman publishers, 2008.	Andrew N Sloss

NPTEL/ Youtube/ Faculty Video Link:

1	https://www.youtube.com/watch?v=xBYhHC8_A6o
2	https://www.youtube.com/watch?v=cNN_tTXABUA
3	https://www.youtube.com/watch?v=sLW1TptEJBQ
4	https://www.youtube.com/watch?v=9zOo4JkZgSI
5	https://www.youtube.com/watch?v=Anj8OYXAY20

Course Code: BECVL0412	**Course Name: Data Analytics**	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**3**	**0**	**0**	**3**

Pre-requisite: : Basics of digital electronics.

Course Objectives: Student will learn about Various basic concepts & fundamentals of Data analytics. They will learn various types of data formats and their manipulations. They will understand Exploratory data analysis and visualization techniques and will learn R/Python/Tableau programming language.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts of data analytics in the areas that plays major role within the realm of data science	K 2
CO2	Explain and exemplify the most common forms of data and its representations.	K5
CO3	Apply data pre-processing techniques on heterogenous datasets.	K4
CO4	Analyze data using exploratory data analysis	K3
CO5	Apply visualization tool to analyze and draw inference from different types of data sets w.r.t different application scenarios.	K1

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**
CO2	**3**	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO3	**-**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**		**-**	**3**	**3**	**-**
CO4	**-**	**3**	**3**	**-**	**3**	**-**	**-**	**2**	**2**	**2**	**-**	**-**	**3**	**2**
CO5	**-**	**-**	**3**	**-**	**3**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**2**	**-**

Course Contents / Syllabus

Module 1	**Foundations of Data Science: Concepts, Tools, and Applications**	**8 hours**

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

Module 2	**Data Types and Statistical Foundations: Data Representation, Manipulation, and Analysis**	**8 hours**

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

Module 3	**Data Preprocessing and Visualization: Techniques for Cleaning, Reducing, and Transforming Data**	**8 hours**

Form of Data Pre-processing, data Attribute and its types, understanding and extracting useful variables, KDD, process, Data Cleaning: Missing Values, Noisy Data, Discretization and Concept hierarchy generation (Binning, Clustering, Histogram), Inconsistent Data, Data Integration and Transformation. Data Reduction: Data Cube, Aggregation, Data Compression, Numerosity Reduction, R-Square, Adjusted R-Square, Significance of p-value, Introduction to data visualization and various graphical ways of data representation.

Module 4	**Advanced Data Cleaning, Transformation, and Exploration**	**8 hours**

Handling Missing data, Removing Redundant variables, variable Selection, identifying outliers, Removing Outliers, Time series Analysis, Data transformation and dimensionality reduction techniques such as Principal Component Analysis (PCA), Factor Analysis (FA) and Linear Discriminant Analysis (LDA), Univariate and Multivariate Exploratory Data Analysis. Data Munging, Data Wrangling- APIs and other tools for scrapping data from the web/ internet using R/Python

Module 5	**Data Visualization with Tableau**	**8 hours**

Introductions and overview, Debug and troubleshoot installation and configuration of the Tableau. Creating Your First visualization: Getting started with Tableau Software, Using Data file formats, connecting your Data to Tableau, creating basic charts (line, bar charts, Tree maps), Using the Show me panel.

Tableau Calculations: Overview of SUM, AVR, and Aggregate Features Creating custom calculations and fields, Applying new data calculations to your visualization. Manipulating Data in Tableau: Cleaning-up the data with the Data Interpreter, structuring your data, Sorting, and filtering Tableau data, Pivoting Tableau data. Advanced Visualization Tools: Using Filters, Using the Detail panel Using the Size panels, customizing filters, Using and Customizing tooltips, formatting your data with colors, Creating Dashboards & Stories, Distributing & Publishing Your Visualization

Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Text Books:, Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007	Glenn J. Myatt
2	Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.	John Wiley & Sons
3	Open Data for Sustainable Community: Glocalized Sustainable Development Goals, Neha Sharma, Santanu Ghosh, Monodeep Saha, Springer, 2021	Neha Sharma, Santanu Ghosh

Reference Books:

S.No	Book Title with publication agency & year	Author
1	The Data Science Handbook, Field Cady, John Wiley & Sons, Inc, 2017	John Wiley & Sons
2	Data Mining Concepts and Techniques, Third Edition, Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann, 2012.	Jiawei Han

NPTEL/ Youtube/ Faculty Video Link:

1	https://www.youtube.com/watch?v=xBYhHC8_A6o
2	https://www.youtube.com/watch?v=cNN_tTXABUA
3	https://www.youtube.com/watch?v=sLW1TptEJBQ
4	https://www.youtube.com/watch?v=9zOo4JkZgSI
5	https://www.youtube.com/watch?v=Anj8OYXAY20

Course Code: BECVL0413	**Course Name: IoT Architecture and Protocols**	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**3**	**0**	**0**	**3**

Pre-requisite: : Basic knowledge of IoT

Course Objectives: Student will learn about:

1. The architectural overview and IoT reference architecture
2. The open-source architecture and design principles.
3. The various types of IoT connectivity protocols.
4. Different types of IoT layered protocols.
5. Differences between Web of things and Internet of things

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the architectural overview and IoT reference model.	K 2
CO2	Demonstrate the IoT reference architecture.	K5
CO3	Analyze the various types of IoT connectivity protocols.	K4
CO4	Explain the different types of IoT layered protocols.	K3
CO5	Describe the differences between Web of things and Internet of Things.	K1

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**	**1**	**2**	**2**	**1**	**2**	**1**	**-**	**2**	**1**	**2**	**3**	**2**
CO2	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**2**
CO3	**3**	**2**	**2**	**3**	**3**	**2**	**1**	**1**	**-**	**1**	**1**	**2**	**3**	**2**
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**2**
CO5	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**

Course Contents / Syllabus

Module 1	**8 hours**

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, Data representation and visualization, Interaction and remote control, Wireless Sensor Network

Module 2	**8 hours**

IoT Open-source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction. LoRaWAN architecture, Channel access mechanism specific to NB-IoT

Module 3	**8 hours**

IoT Connectivity Overview, Wireless Long Range (WAN) Protocols, LAN Protocols, Serial Protocols, IoT transmission Protocols, Wired LAN Protocols, Features and security in Bluetooth

Module 4	**8 hours**

Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards Protocols IEEE802.15.4, IEEE 802.11, BAC Net Protocol Modbus, KNX, architecture and Protocol stack used in Zig bee, Network layer, APS layer

Module 5	**8 hours**

Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoTPortals and Business Intelligence

Total Lecture Hours	**40 hours**

Textbook:

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

1	Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012	Honbo Zhou
2	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011	Dieter Uckelmann
3	David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.	David Easley and Jon Kleinberg
Reference Books:		
S.No	**Book Title with publication agency & year**	**Author**
1	Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”,1st Edition, VPT, 2014.	Vijay Madisetti
2	Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications,2013	Francis daCosta

NPTEL/ Youtube/ Faculty Video Link:

1	https://www.youtube.com/watch?v=xBYhHC8_A6o
2	https://www.youtube.com/watch?v=cNN_tTXABUA
3	https://www.youtube.com/watch?v=sLW1TptEJBQ
4	https://www.youtube.com/watch?v=9zOo4JkZgSI
	https://www.youtube.com/watch?v=Anj8OYXAY20

Course Code: BECVL0411	**Course Name: Compound Semiconductors**	**L**	**T**	**P**	**C**
Course Offered in: VLSI		**3**	**0**	**0**	**3**

Pre-requisite: : Basic knowledge of Semiconductor materials.

Course Objectives: This course offers an in-depth exploration of compound semiconductors, focusing on the unique properties, materials, and applications that distinguish them from traditional elemental semiconductors. Students will delve into the fabrication processes, device physics, and emerging technologies associated with compound semiconductors.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Comprehensive Understanding of Compound Semiconductor Materials	K 2
CO2	Device Physics of Compound Semiconductor	K5
CO3	Fabrication Techniques and Processes:	K4
CO4	Applications in Electronic and Optoelectronic Devices	K3
CO5	Emerging Technologies and Trends in Compound Semiconductors	K1

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**	**2**	**2**		**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**
CO2	**3**	**1**	**2**	**1**	**1**	**-**	**-**		**-**	**-**	**-**	**2**	**2**	**1**
CO3	**3**	**1**	**2**	**2**	**1**	**-**	**-**	**--**	**-**	**-**	**-**	**2**	**2**	**1**
CO4	**3**	**1**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**
CO5	**3**	**1**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**

Course Contents / Syllabus

Module 1	**8 hours**
Overview of compound semiconductors and their significance, Historical context and evolution of compound semiconductor technologies Introduction to key compound semiconductor materials	
Module 2	**8 hours**
Crystal structures and properties of compound semiconductors, Comparison with elemental semiconductors. Device physics principles specific to compound semiconductors. High-speed transistors and integrated circuits	
Module 3	**8 hours**
Principles and applications of optoelectronic devices using compound semiconductors. Lasers, photodetectors, and light-emitting diodes (LEDs).	
Module 4	**8 hours**
Epitaxial growth techniques for compound semiconductors. Lithography and etching processes specific to compound semiconductors	
Module 5	**8 hours**
Applications of compound semiconductors in high-frequency devices, Microwave transistors and communication devices. Latest developments and trends in compound semiconductor technology	
Total Lecture Hours	**40 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	KehYungCheng.III-VCompoundSemiconductorsandDevices.Springer,2020.	KehYungCheng
2	Udo W.Pohl. Epitaxy of Semiconductors: Physics and Fabrication of Heterostructures. Springer, 2020	Udo W.Pohl.
3		

Reference Books:

S.No	Book Title with publication agency & year	Author
1	. Gupta, S.Optoelectronicdevicesandsystems.PHILearningPvt.Ltd.,2014	Gupta, S
2	Birtalan, Dave. Optoelectronics. CRC Press, 2018	Birtalan, Dave.

NPTEL/ Youtube/ Faculty Video Link:	
1	https://www.youtube.com/watch?v=xBYhHC8_A6o
2	https://www.youtube.com/watch?v=cNN_tTXABUA
3	https://www.youtube.com/watch?v=sLW1TptEJBQ
4	https://www.youtube.com/watch?v=9zOo4JkZgSI
5	https://www.youtube.com/watch?v=Anj8OYXAY20

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: VLSI		**0**	**0**	**4**	**2**

Pre-requisite: Basics of digital circuits.

Course Objectives: Students will learn about

1.The fundamentals of general microprocessor & microcontroller.

2.The fundamentals of 8086 microprocessor.

3.The architecture of 8051 microcontroller with real time application.

4.The fundamentals of ARM Processor and embedded systems.

5.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	Apply the knowledge of Microprocessor for writing assembly level language	**K3**
CO2	Implement timer in 8051 microcontroller for generating waveforms	**K3**
CO3	Analyze the interfacing of various I/O devices with programming	**K4**
CO4	Apply the knowledge of ARM Instruction Set to write the program for given application	**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)

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

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

LAB Course Code: BECVL0452	LAB Course Name: CMOS Analog Integrated Circuit Lab	L	T	P	C
Course Offered in: VLSI		**0**	**0**	**2**	**1**

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

Course Objectives: Student will learn about analog CMOS circuit design, focusing on small signal modeling of MOSFETs and their non-ideal effects. It covers the design and analysis of current mirrors, CMOS amplifiers, differential amplifiers, and operational amplifiers. Emphasis is placed on performance metrics, gain enhancement, and stability techniques.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Analyze the electrical characteristics of MOSFETs and extract design parameters	**K3**
CO2	Design and simulate CMOS amplifier stages (CS, CG, Cascode) using EDA tools	**K3**
CO3	Implement and evaluate differential amplifiers and current mirrors	**K4**
CO4	Analyze the frequency response of amplifier circuits and interpret results	**K4**
CO5	Design, simulate, and layout advanced op-amp architectures like telescopic and folded cascode.	**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**	**3**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**-**
CO2	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**
CO3	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**3**	**-**
CO5	**3**	**3**	**-**	**2**	**2**					**1**	**2**	**3**	**3**	**2**

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

Study of MOS Characteristics and Characterization

Design a CMOS Inverting Amplifier.

Design and Simulation of Single Stage Common Source Amplifiers

Design and Simulation of Single Stage Common Gate Amplifiers

Design and Simulation of Single Stage Cascode Amplifier Amplifiers

Design and Simulation of a Differential Amplifier (with Resistive Load, Current Source Biasing)

Design and Simulation of Basic Current Mirror

Design and Simulation of Cascode Current Mirror

Analysis of Frequency response of various amplifiers (Common Source, Source Follower, Cascode, Differential Amplifier

Design/Simulation/Layout of Telescopic Operational Amplifier/ Folded Cascode Operational Amplifier

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

Lab No.	Program Logic Building	CO Mapping
1	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	**CO1**
2	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	**CO2**
3	**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.	**CO 2**
4	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	**CO 2**
5	Simulate and synthesize 4 bit parallel adder/subtractor using data flow modeling.	**CO 2**
6	Simulate and synthesize following ALU operations using data flow modeling	**CO 2**

	<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>	
7	**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.	**CO 2**
8	Simulate and synthesize following flip flops using behavioral modeling a) SR Flip Flop b) JK Flip Flop **c)** D Flip Flop **d)** T Flip Flop	**CO3**
9	Simulate and synthesize flip flops using behavioral modeling **a)** Using positive edge and negative edge. b) Using synchronous and asynchronous reset	**CO3**
10	Simulate and synthesize following shift registers using behavioral modeling a) Serial input serial output b) Serial input parallel output **c)** Parallel input serial output d) Parallel input parallel output	**CO3**
11	Simulate and synthesize following universal shift register using behavioral modeling	**CO3**
12	Simulate and synthesize following counters using behavioral modeling a) 2 Bit Counter b) Mod 5 Counter c) Decade Counter **d)** Ring Counter e) Johnson Counter	**CO3**
13	Simulate and synthesize array multiplier using behavioral modeling	**CO3**
14	Simulate and synthesize 4:1 MUX by using 2:1 MUX **a)** Using a wire b) Using a reg	**CO3**
15	Simulate and synthesize Moore sequence a) 1010 b) 1011	**CO3**
16	Simulate and synthesize Mealy sequence **a)** 1010 b) 1011	**CO3**
17	Implementation of logic gates on an FPGA and verify gates functionality.	**CO 4**
18	Implementation of 4:1 multiplexer on a FPGA	**CO 4**

19	Implementation of 2*2 multiplier on a FPGA	**CO 4**
20	Implementation of D flip flop on a FPGA	**CO 4**
21	Design and simulation of CMOS inverter using switch level modeling	**CO 5**
22	Simulate and synthesize following logic gates using switch level modeling a) AND Gate b) OR Gate c) NOT Gate d) EX-OR Gate **e)** NAND Gate f) NOR Gate	**CO 5**

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

- Verilog-XL (Cadence)
- VCS ('big 3') (Synopsys)

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

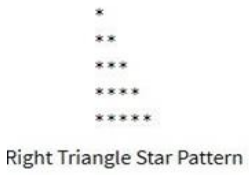
Sample Output

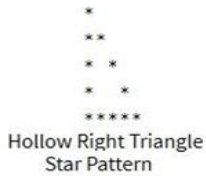
Secure Password: 19

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

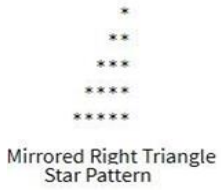
4. Draw **the following Patterns for N=5**


Right Triangle Star Pattern

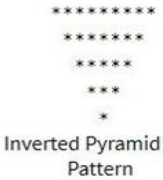

Hollow Right Triangle Star Pattern


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

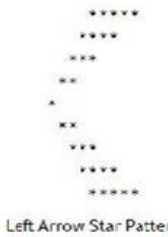

Diamond Star Pattern

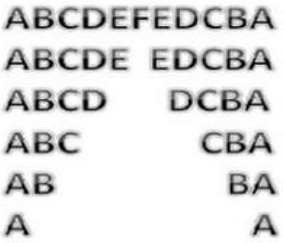

Hollow Diamond Star Pattern


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: BNC0402	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	P
CO1	3	3	2	2		3	3	2	2		**2**	2
CO2	3	3	2	2		3	3	2	2		**2**	2
CO3	3	3	2	2		3	3	2	2		**2**	2
CO4	3	3	2	2		3	3	3	2		**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