This file contains the proposed syllabus for Computer Engineering, 3rd semester. The assessment and rubrics for Mathematics and Community Project (Project Based Learning) Societal Project courses are provided along with the individual syllabus. The assessment and rubrics for all other subjects (PCC, IPCC, PCC-L and AEC) are provided at the end of this file. The rubrics provided are suggested by the BoS, however individual departments may modify them as required.

	Transform Techniques and Optimization Theory			
	Course Code	**1BMATEC301**	Scheme	2025
	Type of Course	**Applied Science Course (ASC)**	Semester	III
	Teaching Hours/Week (L:T:P)	3:2:0	CIE Marks	50
	Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:28:0:50	SEE Marks	50
	Credits	**4**	Total Marks	100
	Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Develop Fourier series representations of periodic functions and perform harmonic analysis for functions with different periodicities, discontinuities, and symmetry properties.
2. Apply Fourier transforms, including sine, cosine, discrete Fourier transforms (DFT), and Fast Fourier Transforms (FFT), to analyze signals and solve engineering problems involving differential equations.
3. Utilize Z-transforms, their properties, inverse transforms, and convolution techniques to analyze discrete-time systems and solve difference equations.
4. Formulate and solve Linear Programming Problems using graphical, simplex, and Big-M methods to obtain optimal solutions in engineering and management applications.
5. Apply transportation and assignment models, including optimization techniques such as Vogel's Approximation Method and Hungarian Method, to solve resource allocation and decision-making problems.

Module-1

Fourier series: Periodic functions, Euler's Formula, Conditions for Fourier expansion(Dirichlet's condition), Fourier series of functions i) having points of discontinuity, ii) with period 2π, iii) with change of interval (arbitrary period) and iv) Even and odd functions. Half rang Fourier series. Practical harmonic analysis.

Number of Hours:13

Module-2

Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Properties- Linear property, Change of scale, shifting property, Modulation theorem. Inverse transforms, Convolution theorem and its significance, Fourier transform of derivatives and integrals, Solution of PDE's using Fourier transforms. Discrete Fourier transform (DFT), Inverse DFT, Fast Fourier transform (FFT)

Number of Hours:15

Module-3

Discrete Transforms - Z transforms: Z-transform of Standard functions, Linearity property, Damping rule, Shifting property, Initial and final value theorems, Inverse Z-transform- Power series method, Partial fraction method, inverse integral method. Convolution theorem, Application of Z-transforms to solve difference equations.

Number of Hours:15

Module-4

	Linear programming problems: Introduction to optimization techniques, nature and characteristics of operation research; Introduction to Linear programming, graphical solution, solution by simplex and Big M method. Number of Hours:13
	Module-5
	Transportation problems: Formulation of transportation problem, Initial Basic feasible solution by North-West Corner method, Least cost method, Vogel's approximation method. Optimal solutions-Problems. Formulation of assignment problems, Hungarian method-Problems Number of Hours:14

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, 45th Edition, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley India.
3. H.K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publications.

Reference books / Manuals:

1. Ruel V. Churchill and James Ward Brown, Fourier Series and Boundary Value Problems, McGraw-Hill Education.
2. Hamdy A. Taha, *Operations Research: An Introduction*, Pearson Education.
3. Schaum's Outline of Fourier Analysis and Applications, McGraw-Hill.
4. Murray R. Spiegel, John Schiller and R. Alu Srinivasan, Schaum's Outline of Probability and Statistics, McGraw-Hill.
5. S. D. Sharma, *Operations Research*, Kedar Nath Ram Nath Publications.

Web links and Video Lectures (e-Resources):

- NPTEL Courses on Engineering Mathematics
- MIT Open Course Ware Mathematics
- SWAYAM Online Courses

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. **Flipped Classroom Approach**
   - Students review video lectures and reading materials before class.
   - Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models.
2. **Problem-Based Learning (PBL)**
   - Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.
3. **ICT-Enabled Teaching** (may be conducted in Tutorial hours)
   - Use of MATLAB, Python, and online simulation tools to visualize transforms, optimization problems, and signal-processing applications.
4. **Collaborative Learning** (may be conducted in Tutorial hours)
   - Group assignments and mini-projects on optimization models and transform applications.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the

combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal EvaluationCIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)**shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 levels)	10
2.	GATE-based Aptitude Test	15

Rubrics **for Learning Activity–1: Assignment (10 Marks)**

Performance Indicator	Superior (10)	Good (8)	Fair (6)	Needs Improvement (5)
Understanding of Concepts	Demonstrates excellent conceptual clarity and application	Good understanding with minor errors	Basic understanding	Poor understanding
Problem Solving Ability	Solves all problems correctly with proper methodology	Solves most problems correctly	Partial solutions with errors	Unable to solve problems effectively
Mathematical Accuracy	Calculations and derivations are error-free	Minor computational errors	Several errors	Significant errors
Presentation & Organization	Well-structured, neat, and professionally presented	Organized with minor deficiencies	Average presentation	Poor presentation

Rubrics for Learning Activity–2: GATE-Based Aptitude Test (15 Marks)

Performance Indicator	**Superior (15)**	**Good (12)**	**Fair (10)**	**Needs Improvement (8)**
Quantitative Aptitude	≥90% correct responses	75–89% correct	60–74% correct	<60% correct
Analytical Thinking	Excellent logical reasoning and interpretation	Good reasoning ability	Moderate reasoning	Weak reasoning
Time Management	Completes all questions within allotted time	Completes most questions	Requires additional time	Unable to complete
Accuracy & Precision	Very high accuracy	Good accuracy	Moderate accuracy	Low accuracy

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar on Fourier Series of periodic functions and harmonic analysis	5
2.	MATLAB/Python Simulation of Fourier and Z-Transform problems	5
3.	Mini Project on Linear Programming Models in Engineering Applications	5
4.	Case Study on Signal Processing using Transform Techniques	5

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Application of Fourier Series in signal representation and on harmonic analysis of periodic signals.	6
2.	Explore applications of DFT and FFT in digital signal processing.	6
3.	Solve a set of difference equations using Z-transforms	6
4.	Develop and solve two real-world optimization problems	6
5.	Study industrial applications of transportation and assignment models	6

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

	Digital System Design using Verilog			
	Course Code	**1BEC302**	Scheme	2025
	Type of course	**Theory and Lab**	Semester	III
	Teaching Hours/Week (L:T:P)	3:0:2	CIE Marks	50
	Total Hours of Pedagogy L:T:P:SL/TW	42:0:28:50	SEE Marks	50
	Credits	**04**	Total Marks	100
	Type of Examination (IPCC):	Theory- CIE +SEE, Lab- CIE only.	Exam Hours	3

Course outcome (Course Skill Set)
At the end of the course, students will be able to:

1. Apply Boolean algebra principles to simplify logic functions using Karnaugh Maps (K-Maps) and the Quine–McCluskey minimization technique.
2. Analyze the operation and behavior of combinational logic circuits and standard logic building blocks.
3. Design combinational digital systems using logic gates, multiplexers, decoders, and arithmetic circuits.
4. Analyze and design synchronous and asynchronous sequential circuits using SR, JK, D, and T flip-flops.
5. Model, simulate, and verify combinational and sequential digital circuits using the Verilog Hardware Description Language (HDL).

Module-1

Principles of Combinational Logic: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps-up to 4 variables, Quine McCluskey Minimization Technique. Quine-McCluskey using Don't Care Terms. (Section 3.1 to 3.5 of Text 1).

Number of Hours: 08

Module-2

Logic Design with MSI Components and Programmable Logic Devices: Binary Adders and Subtractors, Decimal Adders, Comparators, Decoders, Encoders, Multiplexers, Programmable Logic Devices (PLDs) (Section 5.1 to 5.7 of Text 2)

Number of Hours: 08

Module-3

Introduction to Verilog: Structure of Verilog module, Styles of Description, Ports, Operators, Data Types,. (Section 1.1 to 1.6.2 (only Verilog), Text 3)

Verilog Data flow description: Highlights of Data flow description, Signal Declaration And Assignment Statement, Structure of Data flow description. (Section 2.1 to 2.2 (only Verilog) of Text 3)

Number of Hours: 08

Module-4

Flip-Flops and its Applications: The Master-Slave Flip-flops(Pulse-Triggered flip-flops): The basic bistable element, Latches, Timing Considerations, SR flip flops, JK flip flops, Characteristic equations, Registers, Binary Ripple Counters, Synchronous Binary Counters, Counters based on Shift Registers, Design of Synchronous mod-n Counter using clocked T, J K, D and SR flip-flops.(Section 6.1 to 6.4, 6.6 to 6.9 (Excluding 6.9.3) of Text 2)

Number of Hours: 10

Module-5

Verilog Behavioral Description: Structure, Variable Assignment Statement, Sequential Statements, Loop Statements, Verilog Behavioral Description of Multiplexers. (Section 3.1 to 3.4 (only Verilog) of Text 3)

Verilog Structural Description: Highlights of Structural description, Organization of structural description, Structural description of ripple carry adder.(Section 4.1 to 4.2 of Text 3)

Number of Hours: 10

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. To simplify the given Boolean expressions and realize using Verilog program
2. To realize Adder/Subtractor (Full/half) circuits using Verilog data flow description.
3. To realize 4-bit ALU using Verilog program.
4. To realize the following Code converters using Verilog Behavioral description a) Gray to binary and vice versa b) Binary to excess3 and vice versa
5. To realize using Verilog Behavioral description: 8:1mux, 8:3 encoder, Priority encoder
6. To realize using Verilog Behavioral description: 1:8 Demux, 3:8 decoder, 2 –bit Comparator
7. To realize using Verilog Behavioral description: Flip-flops: a)JK type b)SR type c)T type and d) D type
8. To realize Counters-up/down (BCD and binary) using Verilog Behavioral description.
9. Write Verilog Program to interface a Stepper motor to the FPGA/CPLD and rotate the motor in the specified direction (by N steps).
10. Verilog programs to interface Switches and LEDs to the FPGA/CPLD and demonstrate its working.

PART – B: OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. Design and Optimization of a Combinational Logic System
2. Configurable Arithmetic Logic Unit (ALU) Design
3. Design of a Finite State Machine (FSM) for a Real-Time Application
4. Sequential Circuit Design Using Flip-Flops
5. Memory-Based System Design Using Verilog Concept

Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):

Textbooks:

1. J. M. Yarbrough, Digital Logic Applications and Design. Clifton Park, NY, USA: Thomson Learning, 2006.
2. D. D. Givone, Digital Principles and Design. New York, NY, USA: McGraw-Hill, 2002.
3. N. Botros, HDL with Digital Design: VHDL and Verilog. Dulles, VA, USA: Mercury Learning and Information, 2015

Reference books / Manuals:

1. Fundamentals of logic design, by Charles H Roth Jr., Cengage Learning
2. Fundamentals of HDL, by Cyril PR, Pearson/Sanguine 2010
3. Logic Design, by Sudhakar Samuel, Pearson/Sanguine, 2007

Web links and Video Lectures (e-Resources):

1. www.chipverify.com
2. https://www.youtube.com/watch?v=vHLBO05TeyU&list=PLwdnzlV3ogoVlY7iVqr-FhWUQEX7JDdiP
3. https://www.youtube.com/playlist?list=PLbRMhDVUMngePP5JcezxImF-FzOC9wstz

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Interactive lectures using digital design visualization tools and multimedia presentations to explain logic design concepts.
2. Simulation-based learning using Verilog HDL simulators to model, simulate, and verify digital circuits.
3. Flipped classroom methodology, where students study digital design concepts before class and engage in design exercises during class.
4. Mini-projects and project-based learning involving the design and verification of digital systems such as counters, ALUs, finite state machines, and controllers.
5. Collaborative learning activities through group discussions, peer reviews, and team-based design projects.
6. Continuous assessment through quizzes, Verilog coding challenges, and design reviews to reinforce learning and provide timely feedback.

Network Analysis			
Course Code	**1BEC303**	Scheme	2025
Type of Course	**PCC**	Semester	III
Teaching Hours/Week (L:T:P)	3:2:0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:28:0:50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Analyze electronic networks using mesh and nodal analysis techniques for DC and AC circuits with dependent and independent sources.
2. Evaluate electronic circuit responses (currents, voltages, and power) using network theorems.
3. Analyze RL, RC, and RLC circuits under transient conditions using initial and final condition concepts.
4. Analyze linear electronic circuits using Laplace transform techniques.
5. Evaluate the performance of two-port networks by determining parameters and impedance characteristics.

Module-1

Basic Concepts- Mesh and Node Analysis: Introduction, Source of Electrical Energy, Kirchoffs Laws,, Source transformations, General Network Transformations, Mesh and Node analysis with linearly dependent and independent sources for DC and AC networks.

Number of Hours: 15

Module-2

Network Theorems: Introduction, Superposition Theorem, Reciprocity Theorem, Conditions for Reciprocity, Examples of Reciprocal/Non-Reciprocal circuits, Thevenin's Theorem, Maximum Power transfer theorem.
Case Study–1: Maximum Power Transfer in Electronic Systems Design

Number of Hours: 13

Module-3

Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their Representation, Evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations.
Case Study: RC Circuit–Based Power-ON Delay in Electronic Indicator Systems

Number of Hours: 14

Module-4

Laplace Transformation & Applications: Solution of networks, step, ramp and impulse responses, Waveform Synthesis, Transfer function of elementary passive circuits, Network Synthesis
Case Study: Concept of poles for first order passive filters and their use in computing time response characteristics and bandwidth.

Number of Hours: 14

Module-5

Two -Port Network: Introduction, Characterisation of Linear Time-invariant Two-port Networks, Open-Circuit Impedance Prameters, Short- circuit Admittance Parameters, Transmission Parameters,
Short introduction to Hybrid parameters (1 hour material), Why multiple representations are required, Two-port Symmetry, Input impedance in terms of Two-port Parameters, Output Impedance

Number of Hours: 14

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. M.E.Van Valkenburg (2000), Network Analysis, Prentice Hall of India, 3rdedition, 2000, ISBN:9780136110958.
2. 2. Roy Choudhury-Networks and Systems, 2nd edition, New Age International Publications, 2006, ISBN: 9788122427677

Reference books / Manuals:

1. Hayt, Kemmerly and Durbin-Engineering Circuit Analysis, TMH7th Edition, 2010.
2. J.David Irwin/ R.Mark Nelms- Basic Engineering Circuit Analysis JohnWiley,8thed,2006.
3. Charles K Alexander and Mathew NO Sadiku-Fundamentals of Electric Circuits, Tata Page 17 BE III Semester in ECE/TCE 15.09.2023 McGraw-Hill,3rc1 Ed,2009.

Web links and Video Lectures (e-Resources):

- **https://nptel.ac.in/courses/108105159**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Ensure at least 2 hours of review of mathematical concepts such as matrix algebra, complex variables, first and second order differential equations during the tutorial sessions
2. Present case studies for each module which have industry relevance
3. Use of simulation tool or even hardware demonstrations in the classroom to illustrate complex concepts

Analog Electronics and Linear Integrated Circuits			
Course Code	**1BEC304**	Scheme	2025
Type of Course	**PCC**	Semester	III
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Describe the working principle, fundamental characteristics of various semiconductor devices such as transistors, MOSFETs, and operational amplifiers in basic electronic circuits.
2. Analyze basic amplifier circuits using the principles BJTs, MOSFETS, and operational amplifiers.
3. Illustrate the fundamental concepts of oscillators and timers.
4. Design basic filters and power amplifiers.
5. Analyze the fundamental concepts of linear Op-Amps, linear Op-Amps and their applications.
6. Analyze the electronic circuit schematic and its working.

Module-1

BJT AC Models: Base Biased Amplifier, Emitter Biased Amplifier, Small Signal Operation, AC Beta, AC Resistance of The Emitter Diode, Two Transistor Models, Analyzing Amplifier.
Voltage Amplifiers: Voltage Gain, Multistage Amplifiers.
CC And CB Amplifiers: CC Amplifier, Output Impedance, Cascading CE And CC, Darlington Connections, Voltage Regulation, The Common Base Amplifier.
Text book 1: 8.1-8.7, 8.9, 9.1, 9.3-9.8

Number of Hours:9

Module-2

MOSFET Biasing in MOS Amplifier Circuits: Fixing VGS, Fixing VG, Drain to Gate Feedback Resistor.
Small Signal Operation and Modelling: The DC Bias Point, Signal Current in Drain, Voltage Gain, Small Signal Equivalent Circuit Models, Transconductance, The T Equivalent Circuit Model.
MOSFET Amplifier Configuration: Basic Configurations, Characterizing Amplifiers, CS Amplifier with And Without Source Resistance, The Common Gate Amplifier, Source Follower.
Text book 2: 7.2, 7.2.1, 7.3, 7.3.1 - 7.3.6, 7.4, 7.4.1

Number of Hours:9

Module-3

Negative Feedback: Four Types of Negative Feedback, VCVS Voltage Gain, Other VCVS Equations, ICVS Amplifier, VCIS Amplifier, ICIS Amplifier (No Mathematical Derivation).
Oscillator: Theory of Sinusoidal Oscillation, The Wein-Bridge Oscillator, RC Phase Shift Oscillator, The Colpitts Oscillator, Hartley Oscillator, Crystal Oscillator.
The 555 Timer: Monostable Operation, Astable Operation.
Text book 1: 17.1-17.6, 21.1-21.8

Number of Hours:8

Module-4

Power Amplifiers: Amplifier Terms, Two Load Lines, Class A Operation, Class B Operation, Class B Push Pull Emitter Follower, Class C Operation.
Active Filters: Ideal Responses, First Order Stages, VCVS Unity Gain Second Order Low Pass Filters, VCVS Equal Component Low Pass Filters, VCVS High Pass Filters, MFB Bandpass Filters, Bandstop Filters.
Text book 1: 10.1-10.5, 10.8, 19.1, 19.4, 19.5, 19.7-19.10

Number of Hours:8

Module-5

Linear Op-amp Circuits: Digital to Analog Conversion: Weighted Resistor DAC, R-2R DAC, Analog to Digital Conversion: Digital RAMP ADC, Successive Approximation ADC. Signal Processing Circuits: Saturating and Non Saturating Precision HWR, Precision FWR Using HWR and Summing Circuit.
Nonlinear Op-Amp Circuits: Zero Crossing Detector, Inverting Schmitt Trigger Circuit, Non-Inverting Schmitt Trigger Circuit.
DC Voltage Regulators: Introduction, Voltage Regulator Basics.
Text book 3: 15.2, 15.4, 9.1, 9.2, 8.2-8.4, 13.1

Number of Hours:8

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Albert Malvino, David J Bates, Patrick E. Hoppe, Electronic Principles, 9th Edition, Mc Graw Hill Education, 2021.
2. Adel S Sedra, Kenneth C Smith, Microelectronic Circuits, 7th Edition, Oxford University Press, 2015.
3. David A. Bell, Operational Amplifiers and Linear ICs, 3rd Edition, Oxford University Press, 2011.

Reference books / Manuals:

1. Integrated Electronics: Analog and Digital Circuits and Systems, Jacob Millman, Christos C. Halkias, McGraw-Hill, 2015.
2. Electronic Devices and Circuit, Boylestad & Nashelsky, Eleventh Edition, Pearson, January 2015.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108102112
- https://onlinecourses.nptel.ac.in/noc25_ee157/preview
- https://nptel.ac.in/courses/108106188

Teaching-Learning Process (Innovative Delivery Methods):
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
4. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
5. Arrange visits to nearby industries to give brief information about the electronics manufacturing industry.
6.. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Object Oriented Programming using C++			
Course Code	**1BUE305**	Scheme	2025
Type of Course	**PCC**	Semester	III
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:0:0:48	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Apply object-oriented programming concepts to design and implement C++ programs using classes, objects, constructors, and related features.
2. Develop C++ programs utilizing arrays, pointers, dynamic memory allocation, and function mechanisms including overloading and copy constructors.
3. Design and implement C++ applications using operator overloading and inheritance concepts, including multiple and virtual inheritance.
4. Apply polymorphism and templates to develop flexible and reusable C++ programs.
5. Implement exception handling and file handling techniques to build robust and efficient C++ applications.

Module-1

An overview of C++: What is object-Oriented Programming? Introducing C++ Classes, The General Form of a C++ Program.
Classes and Objects: Classes, Friend Functions, Friend Classes, Inline Functions, Parameterized Constructors, Static Class Members, When Constructors and Destructors are Executed, The Scope Resolution Operator, Passing Objects to functions, Returning Objects, Object Assignment
Ch 11, Ch 12 **Number of Hours:10**

Module-2

Arrays, Pointers, References, and the Dynamic Allocation Operators: Arrays of Objects, Pointers to Objects, The This Pointer, Pointers to derived types, Pointers to class members.
Functions Overloading, Copy Constructors: Functions Overloading, Overloading Constructor Functions. Copy Constructors, Default Function Arguments, Function Overloading and Ambiguity.
Ch 13, Ch 14 **Number of Hours:08**

Module-3

Operator Overloading: Creating a Member Operator Function, Operator Overloading Using a Friend Function, Overloading new and delete
Inheritance: Base-Class Access Control, Inheritance and Protected Members, Inheriting Multiple Base Classes, Constructors, Destructors and Inheritance, Granting Access, Virtual Base Classes
Ch 15, Ch 16 **Number of Hours:08**

Module-4

Virtual Functions and Polymorphism: Virtual Functions, The Virtual Attribute is Inherited, Virtual Functions are Hierarchical, Pure Virtual Functions, Using Virtual Functions, Early vs Late Binding.
Templates: Generic Functions, Applying Generic Functions, Generic Classes. The type name and export Keywords. The Power of Templates
Ch 17, Ch 18 **Number of Hours:08**

Module-5

Exception Handling: Exception Handling Fundamentals, Handling Derived-Class Exceptions, Exception Handling Options, Applying Exception Handling.
The C++ I/O System Basics: C++ Streams, The C++ Classes, Formatted I/O
File I/O: <fstream> and File Classes, Opening and Closing a File, Reading and Writing Text Files, Detecting EOF.
Ch 19, Ch 20, Ch21 **Number of Hours:08**

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Herbert schildt, The Complete Reference C++, 4th edition, TMH, 2005**.**

Reference books / Manuals:

1. Balagurusamy E, Object Oriented Programming with C++, Tata McGraw Hill Education Pvt.Ltd., Sixth Edition 2016.
2. Bhave, "Object Oriented Programming With C++", Pearson Education , 2004.
3. A K Sharma, "Object Oriented Programming with C++", Pearson Education, 2014.

Web links and Video Lectures (e-Resources):

- Basics of C++ - https://www.youtube.com/watch?v=BClS40yzssA
- Functions of C++ - https://www.youtube.com/watch?v=p8ehAjZWjPw
- https://www.w3schools.com/cpp/cpp_intro.asp
- https://www.edx.org/course/introduction-to-c-3https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013843642506788864433 75_shared/overview

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Chalk and board, power point presentations
2. Online material (Tutorials) and video lectures.
3. Demonstration of programming examples.

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Analog Electronics and Linear Integrated Circuit Lab		Scheme	2025
Course Code	**1BECL306**	Semester	III
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL/TW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Examination type (SEE)	**Practical**	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Apply the knowledge of BJT circuit to determine gain, bandwidth and impedance.
2. Apply the knowledge of FET circuit to determine gain, bandwidth and impedance.
3. Understand the working of oscillators.
4. Realize Op-Amp circuit for the application as voltage follower, integrator, and differentiator.
5. Apply modulation technique.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 8 conventional experiments, PART-B has 4 typical open-ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for **70 marks** out of the maximum 100 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for **30 marks.**
4. For Continuous Internal Evaluation (CIE) during the semester, classwork shall typically include open-ended questions from **Part-B**, along with other similar questions designed to enhance the students' skills.

PART – A
FIXED SET OF EXPERIMENTS

1. Design and Set-up the BJT Common Emitter Voltage Amplifier with and Without Feedback and Determine the Gain, Bandwidth, Input and Output Impedance.
2. Design and Set-up BJT/ FET Based I) Colpitts Oscillator, II) Crystal Oscillator
3. Realize BJT Darlington Emitter Follower and Determine Gain, Input and Output Impedances.
4. Design 4-Bit R - 2R OP-Amp Digital to Analog Converter: I) For A 4-Bit Binary Input Using Toggle Switches, II) By Generating Digital Inputs Using Mod-16
5. Design and Test the Second Order Active Filters and Plot the Frequency Response: I) Low Pass Filter, II) High Pass Filter
6. Design and Testing of Precision Rectifiers: I) Half-Wave Precision Rectifier, II) Full-Wave Precision Rectifier
7. Design and Test Monostable and Astable Multivibrator Using 555 Timer.
8. Design and Test a Regulated Power Supply Using IC 7805 And IC 7905.

PART – B
OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and

students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. Concept 1 Design a FET Voltage Series Feedback Amplifier and Determine the Gain, Input and Output Impedances.
2. Concept 2 Design and Experimental Study of a Class-C Tuned Amplifier
3. Concept 3 Design of a Schmitt Trigger for Given UTP And LTP.
4. Concept 4 Design and Testing of a Sample and Hold Circuit.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Electronic Devices and Circuits, David A Bell, 5th Edition, Oxford, 2018.
2. Op-amps and Linear Integrated Circuits, Ramakanth A Gayakwad, Pearson Education, 4th Edition.
3. Basic electronics, D.P Kothari and I J Nagrath, McGraw Hill Education Pvt ltd, 2015.
4. Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, PHI, 2016.

Web links and Video Lectures (e-Resources):

- http://digimat.in/nptel/courses/video/108102112/L01.html
- https://www.youtube.com/playlist?list=PLp6ek2hDcoNDAw1BehPFazZ5ogPV8UlQa

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. While explaining each experiment, also focus on the application of that particular experiment in the electronics industry
2. In labs utilizing software programming, the emphasis must be on student understanding of the logic (e.g. pseudo-code) of the code, which libraries are required, which important functions calls need to be made and expected output. Faculty should not penalize students for making syntax errors in codes in the write up – however students must be able to debug the errors during program execution
3. Students should not memorize pin diagrams, these must be provided to the student during CIE and SEE
4. For record writing, faculty should ensure students write the main objective, design and procedure in their own words – and do not copy from manuals/online. Also, record writing should involve higher Blooms levels and not just Remember and Understand levels.

	Programming using C++ Laboratory			
	Course Code	**1BUEL307A**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
	Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL/TW	0:0:28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. CO1: Develop C++ programs to solve basic computational problems such as finding maximum values and sorting data using appropriate control structures.
2. CO2: Design and implement C++ programs using object-oriented concepts including classes, objects, constructors, and inheritance.
3. CO3: Apply function overloading and operator overloading to create flexible and reusable program components.
4. CO4: Implement file handling operations in C++ to perform reading and writing of text and binary files using file streams.
5. CO5: Develop robust C++ programs by applying exception handling mechanisms to manage runtime errors such as division by zero and array bounds violations.

SET OF PROGRAMS

1. Develop a C++ program to find the largest of three numbers
2. Develop a C++ program to sort the elements in ascending and descending order.
3. Develop a C++ program using classes to display student name, roll number, marks obtained in two subjects and total score of students.
4. Develop a C++ program for a bank employee to print name of the employee, account No. & balance. Print invalid balance if amount
5. Develop a C++ program to demonstrate function overloading for the following prototypes. Add (int a, int b) add (double a, double b)
6. Develop a C++ program using Operator Overloading for overloading Unary minus operator
7. Develop a C++ program to implement Multiple inheritance for performing arithmetic operation of two numbers
8. Develop a C++ program using Constructor in Derived classes to initialize alpha, beta and gamma and display corresponding values.
9. Develop a C++ program to create a text file, check file created or not, if created it will write some text into the file and then read the text from the file.
10. . Develop a C++ program to write and read time in/from binary file using fstream
11. Develop a function which throws a division by zero exception and catch it in catch block. Write a C++ program to demonstrate usage of try, catch and throw to handle exception.
12. Develop a C++ program that handles array out of bounds exception using C++.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **The C++ Programming Language – Covers core and advanced C++ concepts including OOP, inheritance, and file handling.**
2. **Object Oriented Programming with C++ – Widely used for beginners; strong focus on lab-oriented programs.**
3. **C++ How to Program – Provides practical examples on OOP, exception handling, and file I/O**

Reference books / Manuals:

1. **Programming: Principles and Practice Using C++, Bjarne Stroustrup, 2008 (Addison-Wesley)**

2. **Object Oriented Programming with C++, E. Balagurusamy, 2020, McGraw Hill Education .**
3. **C++ Primer,Stanley B. Lippman, Josée Lajoie, Barbara E. Moo,2012, 5th edition, Addison-Wesley.**

Web links and Video Lectures (e-Resources):

- Code: Blocks – Beginner-friendly IDE for writing and executing C++ programs.
- Dev-C++ – Lightweight compiler for lab practice.
- Visual Studio Code – Modern editor with C++ extensions.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Demonstration-Based Learning
2. Problem-Based Learning (PBL)
3. Hands-on Lab Practice with Incremental Complexity

	Python Programming Laboratory			
	Course Code	**1BUEL307B**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
	Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL/TW	0:0:28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. CO1: Develop Python programs using variables, operators, input/output statements, decision-making statements, and looping constructs.
2. CO2: Design and implement Python programs using functions, strings, lists, tuples, dictionaries, and sets.
3. CO3: Develop object-oriented Python programs using classes, objects, constructors, inheritance, and polymorphism.
4. CO4: Implement file handling and exception handling techniques to develop reliable Python applications.
5. CO5: Develop Python-based applications using modules and packages for solving real-world computational problems.

SET OF PROGRAMS

1. Develop a Python program to perform arithmetic, relational, and logical operations.
2. Develop a Python program to find the largest among three numbers using decision-making statements.
3. Develop a Python program to generate multiplication tables and number patterns using looping constructs.
4. Develop a Python program to check whether a given number is Prime, Palindrome, or Armstrong number.
5. Develop a Python program to generate the Fibonacci series and calculate factorial using user-defined functions.
6. Develop a Python program to demonstrate recursive functions.
7. Develop a Python program to perform operations on Lists, Tuples, Dictionaries, and Sets.
8. Develop a Python program to sort a list of numbers in ascending and descending order.
9. Develop a Python program to perform string operations such as concatenation, searching, replacing, splitting, and joining.
10. Develop a Python program using Classes and Objects to store and display student information.
11. Develop a Python program to demonstrate Inheritance and Method Overriding.
12. Develop a Python program to demonstrate Polymorphism using suitable examples.
13. Develop a Python program to create, write, append, and read data from a text file.
14. Develop a Python program to demonstrate Exception Handling for division by zero and invalid user input.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **Python Crash Course: A Hands-on, Project-based Introduction to Programming by Eric Matthes**
2. **Think Python: An Introduction to Software Design by Allen B. Downey**
3. **Python for Everybody: Exploring Data Using Python 3 by Charles Severance**

Reference books / Manuals:

1. **Automate the Boring Stuff with Python, 2nd Edition: Practical Programming for Total Beginners**
   Book by Al Sweigart

2. **Fluent Python: Clear, Concise, and Effective Programming Book by Luciano Ramalho**
Web links and Video Lectures (e-Resources): • https://nptel.ac.in/courses/106106145 • https://nptel.ac.in/courses/106106182 • https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/video_galleries/lecture-videos/
Teaching-Learning Process (Innovative Delivery Methods): The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes. 1. Demonstration-Based Learning 2. Problem-Based Learning (PBL) 3. Hands-on Lab Practice with Incremental Complexity

	Internet Of Things (IOT) Lab			
	Course Code	**1BUEL307C**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
	Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL/TW	0:0:28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Explain the Internet of Things and its hardware and software components
2. Interface I/O devices, sensors & communication modules
3. Remotely monitor data and control devices
4. Develop real-life IoT-based projects

CORE/BASIC EXPERIMENTS

1. (a) To interface LED/Buzzer with Raspberry Pi and write a program to 'turn ON' LED for 1 sec after every 2 seconds.
   (b) To interface Push button/Digital sensor (IR/LDR) with Raspberry Pi and write a program to 'turn ON' LED when push button is pressed or at sensor detection.
   (c) To interface motor using relay with Raspberry Pi and write a program to 'turn ON' motor when push button is pressed.
2. (a) To interface DHT11 sensor with Raspberry Pi and write a program to print temperature and humidity readings.
   (b) To interface OLED with Raspberry Pi and write a program to print temperature and humidity readings on it.
3. (a) Write an Arduino/Raspberry Pi program to interface the Soil Moisture Sensor.
   (b) Write an Arduino/Raspberry Pi program to interface the LDR/Photo Sensor.
4. (a) Write a program to interface an Ultrasonic Sensor with Raspberry Pi.
   (b) Write a program to interface an IR sensor with Raspberry Pi.
5. (a) Write a program on Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
   (b) Write a program on Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
6. Write a program to interface LED using Telegram App
7. (a) Write a program on Raspberry Pi to publish temperature data to MQTT broker.
   (b) Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it
8. (a) Write a program to create TCP server on Raspberry Pi and respond with temperature and humidity data to TCP client when requested.
   (b) Write a program to create UDP server on Raspberry Pi and respond with temperature and humidity data to UDP client when requested.

9. (a) Write a program to interface Bluetooth with Raspberry Pi and turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
   (b)Write a program to interface Bluetooth with Raspberry Pi and send sensor (IR/LDR) data to smartphone using Bluetooth
10. Write a program to interface servo motor to Raspberry Pi using PWM control.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things. "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs.
3. Internet of Things with Raspberry Pi and Arduino, Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, CRC Press (Taylor & Francis Group),2019.

Reference books / Manuals:

1. **Exploring Raspberry Pi by Derek Molloy,2016, Wiley.**

Web links and Video Lectures (e-Resources):

- **NPTEL Course - https://nptel.ac.in/courses/106105166**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1.While explaining each experiment, also focus on the application of that particular experiment in the electronics industry

2. Students should not memorize pin diagrams, these can be provided to the student during CIE and SEE

	Circuit Simulation using P-Spice			
	Course Code	**1BUEL307D**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
	Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL/TW	0:0:28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Apply circuit analysis techniques using PSPICE to determine DC voltages, currents, and perform nodal analysis of electrical networks.
2. Analyze and simulate frequency-dependent behavior of circuits such as RLC resonant circuits and low-pass/high-pass filters.
3. Evaluate the performance of rectifier circuits (half-wave and full-wave) through simulation and verification.
4. Analyze frequency response characteristics of transistor amplifiers including CE and CC configurations.
5. Design and verify analog amplifier circuits such as Class-A power amplifiers, differential amplifiers, and RC coupled amplifiers using PSPICE.

SET OF EXPERIMENTS

1. PSPICE Simulation of Nodal Analysis For DC Circuits.
2. PSPICE Simulation for finding DC voltages and currents.
3. PSPICE Simulation for finding resonant frequency of series RLC circuit.
4. Verification of Low pass and High pass Filters using PSPICE.
5. Verification of Half–Wave and Full-Wave Rectifier.
6. Frequency Response of CE Amplifier.
7. Frequency Response of CC Amplifier.
8. Design and Verification of Class-A Power Amplifier.
9. Design and Verification of Differential amplifier.
10. Design and Verification of RC coupled amplifier.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **SPICE: A Guide to Circuit Simulation and Analysis Using PSpice, Prentice Hall, 1995.**
2. **PSpice for Analog Communications Engineering, Morgan & Claypool, 2007.**

Reference books / Manuals:

1. **PSPICE for Circuit Theory and Electronic Devices, Paul W. Tuinenga, Prentice Hall, 1995**
2. **Engineering Circuit Analysis,William H. Hayt Jr., Jack E. Kemmerly and Steven M. Durbin,McGraw-Hill Education,10th edition.**

Web links and Video Lectures (e-Resources):

1. **Basic Electrical Circuits, NPTEL course, IIT Madras**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1.**Problem-Based Learning (PBL):** Real-world circuit design problems are assigned to encourage analytical thinking and troubleshooting skills.

2.**Simulation-to-Hardware Correlation:** Comparison of PSPICE simulation results with theoretical calculations and practical observations to develop engineering judgment.

Community Project (Project Based Learning) Societal Project

[Common to all disciplines of Engineering]

CourseCode	**1BCP308**	Scheme	2025
TypeofCourse	SDC	Semester	III
TeachingHours/Week(L:T: P)	0:0:0	CIEMarks	50
TotalHoursofPedagogyCI(L:T):LI(P):SL:TW	0:0:0:30	SEEMarks	50
Credits	1	TotalMarks	100
Typeof Examination	Practical	ExamHours	02

Courseobjective:

Rapid urbanisation, population growth, environmental concerns, energy demand, water scarcity, waste management, transportation issues and rural development challenges have created practical problems affecting communities and public welfare. This course aims to integrate technical knowledge, field exposure and societal engagement so that students identify real community issues, frame problem statements and attempt appropriate, feasible and sustainable engineering responses within the scope of a one-semester project.

Courseoutcome(CourseSkillSet):

Attheendofthecourse,thestudentwillbeableto:

1. **CO1(L2–Understand):**Identifyandanalysesocietalproblemsthroughfieldinteractionandtechnical assessment.
2. **CO2(L3–Apply):**Developskillsinprojectplanning,fieldsurvey,datacollection,implementation, documentation and reporting.
3. **CO3(L4–Analyse):**Formulatefeasibleengineeringproblemstatementsandsolutionsconsidering practical constraints and sustainability aspects.
4. **CO4(L3–Apply):**Applyprinciplesofenvironmentalresponsibility,ethicsandsocietalwelfarein engineering practice through community-oriented interventions.
5. **CO5 (L4 – Analyse):**Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.
6. **CO6(L5–Evaluate):**Demonstrateteamworkandcommunicationskillswhileinteractingwithtechnical and non-technical stakeholders and reflect on project impact on society.

Restrictionsandprofessionalconduct:

Community / Societal Projects shall remain **academic, socially responsible, technically focused, andpoliticallyneutral**.Studentsandfacultyshallmaintainprofessionalism,ethicalconduct,public respect and institutional integrity while interacting with communities, public groups, organisations and stakeholders.

Studentsandfaculty**shallavoid**thefollowingduringprojectexecution:

- Associationwithpoliticalpartyactivities,campaignsorpropaganda.
- Participationinactivitiesthatmaydisturbcommunalharmony,publicorderorinstitutional reputation.
- Useoftheprojectplatformforpersonal,political,ideologicalorcommercialpromotion.
- Disrespectful,discriminatoryorunethicalinteractionwithcommunitymembersor stakeholders.

Projectsmustalsorecogniseconstraintsrelatedto**cost,resources,environmentandsafety,and stakeholderbehaviour/cooperation/acceptance**whenplanningandimplementingactivities.

Sustainable Development Goals

The faculty shall encourage students to undertake community projects that align with and contribute towards satisfying the National Board of Accreditation (NBA) Criterion 3.6, namely, Evidence of Addressing Sustainable Development Goals (SDGs), which is a major emphasis of the United Nations (UN). The Sustainable Development Goals (SDGs) are illustrated in the figure shown below:

SETOFPROJECTACTIVITIES(TW/SL=30HOURS)

Methodsforprojectidentification:

Studentsmayidentifytheprojecttopicusingoneormoreofthefollowingmethods:

- Interactionwithlocalruralorurbanstakeholderssuchaslocalleaders,corporation/municipality personnel, NGOs, panchayat representatives, etc.
- Reviewofissueshighlightedinprintandelectronicmedia,andsocialnetworks(WhatsApp, Facebook,X,Instagram,etc.).
- After selecting a broad topic, students shall collect data, conduct a feasibility survey, estimate timelinesandresources,approximateexpenditure,andthendefinetheproblemstatementand objectives clearly.

ListofProjectTopicsandEngineeringOutcomes:

Thefollowingstructuredsequenceofactivitiesistobecarriedoutduringthesemester:

Sl. No.	Projecttitle	Measurableengineeringoutcome	MappedPOs	SDGs
1	Ruralandurbanwater conservation and managementsystems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10,PO11	SDG 6, SDG 11, SDG 12
2	Wastemanagement and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8,PO10	SDG 11, SDG 12, SDG 13

Sl. No.	Projecttitle	Measurableengineeringoutcome	MappedPOs	SDGs
3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7,PO11	SDG 11, SDG 13, SDG 15
4	Biogasgenerationand power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5,PO10	SDG 7, SDG 11, SDG 12
5	DPRforsolarpower rural plant	PrepareaDPRwithloadassessment,panel sizing,cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5,PO10	SDG 7, SDG 9, SDG 11
6	DPRforelectrification ofvillage/tribal community	Map unserved/underserved households, propose electrificationlayout, and estimate coverage,losses,andimplementationcost.	PO1, PO2, PO3, PO4, PO10,PO11	SDG 7, SDG 9, SDG 10
7	DPRforruraldrainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handlingcapacityandflood-riskreduction.	PO1, PO2, PO3, PO4, PO6,PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmentalhealth projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2,PO3, PO4,PO6, PO7,PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plasticfreecampaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8,PO10	SDG 11, SDG 12, SDG 13
10	Healthandnutrition awareness	Conduct baseline and post-program awareness survey and document improvementinawarenessscoreor adoptionofhealthierpractices.	PO2, PO6, PO7, PO8, PO9,PO10	SDG 2, SDG 3, SDG 11
11	Societalprojects involvinghealth wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9,PO10	SDG 3, SDG 11, SDG 17
12	Airqualitymonitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6,PO10	SDG 3, SDG 11, SDG 13
13	Plasticwastereduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8,PO10	SDG 11, SDG 12, SDG 13
14	Urbangreening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7,PO11	SDG 11, SDG 13, SDG 15

Sl. No.	Projecttitle	Measurableengineeringoutcome	MappedPOs	SDGs
15	Smartagriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or cropsupport.	PO1, PO2, PO3, PO4, PO5,PO10	SDG 2, SDG 6, SDG9
16	Smartirrigation system	Estimatecropwaterrequirement,propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5,PO10	SDG 2, SDG 6, SDG 12
17	Youthmentoring programmes	Deliver a structured mentoring activity andmeasureparticipation,engagement, and skill/awareness improvement.	PO6, PO8, PO9,PO10, PO11	SDG 4, SDG 10, SDG 17
18	Adulteducation	Conduct learner-needs assessment, prepare instructional content, and measure improvement in basic literacy or numeracy indicators.	PO6, PO8, PO9,PO10, PO11	SDG 4, SDG 10, SDG 17
19	Foodsecurity initiatives/cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5,PO10	SDG 2, SDG 9, SDG 12
20	Human rights awarenesswithlegal systems	Prepare and deliver an awareness module andassessincreaseinlegalawarenessand access-to-rights understanding.	PO6,PO7, PO8,PO9, PO10	SDG 5, SDG 10, SDG 16
21	House tax collection throughdigitalmedia	Develop a simple digital workflow or awareness support and measure improvement in compliance, convenience, or response time.	PO2, PO3, PO4, PO5, PO10,PO11	SDG 9, SDG 11, SDG 16
22	Use of application / applicationprogram	Build or demonstrate a useful community app and measure usability, adoption, or efficiency improvement.	PO1, PO3, PO4, PO5, PO9,PO10	SDG 9, SDG 11, SDG 17
23	CreationofPanchayat library	Plan the library model, catalogue resources, and measure usage, accessibility, or participation outcomes.	PO6, PO8, PO9,PO10, PO11	SDG 4, SDG 10, SDG 11, SDG 17

SuggestedLearningResources:

Textbooks:

1. **Phadke,N.D**.CommunityEngagementandSocialInnovation.1sted.,OxfordUniversityPress,New Delhi.
2. **Garg,N.R**.Project-BasedLearninginEngineeringEducation.1sted.,PearsonIndiaEducation Services, Noida.
3. **Gupta,A.andP.Singh.**ServiceLearningandCommunityProjects.1sted.,McGraw-HillEducation (India), New Delhi.
4. **Wilson,G.**PracticalGuidetoCommunityDevelopmentProjects.2nded.,Routledge,London.

Referencebooks:

1. NPTELcoursesonProject-BasedLearningandSocialInnovation.
2. SWAYAMcoursesoncommunityengagementandsustainability.
3. UNSustainableDevelopmentGoalsportal:https://sdgs.un.org
4. MyGovIndiaandlocalcivicbodyportalsforcommunityinitiatives.
5. YouTuberesourcesondesignthinking,socialinnovation,andcommunityservicelearning.
6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.

Weblinks andVideo Lectures(e-Resources):

1. NPTELcoursesonEngineering Geology(IITRoorkee,IITKharagpur).
2. NPTEL coursesonSoilMechanicsand Foundation Engineering(IITDelhi, IITBombay).
3. Virtual Labs– GeotechnicalEngineeringVirtual Lab(IITKanpur):https://vlab.co.in
4. GeologicalSurvey ofIndia(GSI)–Maps,reports, andpublications: https://www.gsi.gov.in
5. YouTubechannels:CivilEngineeringEssentials,TheEngineeringClassroom(soilmechanics experiments).
6. AmericanSocietyofCivilEngineers(ASCE)–Geotechnicalresourcesandstandards

TeachingLearningProcess:

ThesuggestedTLPforCommunity/SocietalProjectisasfollows;

Week/ Phase	Teaching–Learning Activity	FacultyRole	StudentActivity	Output/Evidence
1	Course introduction, objectives,ethics, conduct,and assessmentbriefing	Explaincoursescope, rules, rubrics, and expecteddeliverables	Understandcourse requirementsandform teams	Teamlist,course plan
2	Communityproblem identificationand topicselection	Guidetopicframing andfeasibility	Identify local issues throughdiscussionand observation	Shortlistedproject topic
3	Stakeholder interactionand preliminarysurvey	Demonstratesurvey methodsand stakeholder engagement	Collectinitialdatafrom community/users	Survey notes, interviewrecord
4	Problemstatement andobjective	Review and refine problemstatement	Prepareproblem statement,scope,and	Approvedproblem statement
	formulation		objectives	
5	Literature/casestudy review and baseline analysis	Suggestrelevant referencesand examples	Studyexistingsolutions andcompare approaches	Baselineanalysis summary

Week/Phase	Teaching–Learning Activity	FacultyRole	StudentActivity	Output/Evidence
6	Projectplanningand roleassignment	Helpteamsorganize tasks, timeline, and responsibilities	Planactivities,divide roles, and prepare schedule	Workplan/Gantt chart
7	Feasibilityanalysis andsolution brainstorming	Checktechnical feasibilityand practicality	Generatepossible engineeringsolutions	Solutionalternatives sheet
8	Selection of final solutionanddesign approach	Reviewfinalconcept and design logic	Finalizeconcept, methods,andexpected outcome	Conceptnote/ designoutline
9	Data processing / calculations/sizing/ mapping	Support computationsand technicalreview	Analyzedata,perform calculations,prepare maps/charts	Technicalanalysis sheet
10	Prototype/model/ audit / DPR / app development	Monitorprogress andcorrecttechnical issues	Developtheselected output	Workingmodel/ draftDPR/map/ app
11	Testing,refinement, andimplementation planning	Evaluatetechnical correctnessand improvements	Test prototype or validateproposalwith users	Test results / revisedoutput
12	Fieldimplementation /demonstration/ awarenessactivity	Facilitatecommunity interactionand documentation	Conduct implementationor demonstration	Photos,attendance, implementation record
13	Documentationof outcomes,feedback, andimpact	Reviewreport structureand completeness	Compilefindings, stakeholderfeedback, andobservations	Draftreport
14	Presentation preparationandviva practice	Conductmock presentationand feedback	Prepareslides/poster andrehearse	Presentationdeck
15	Finalpresentation, submission,and reflection	Evaluate performanceusing rubrics	Presentproject,submit report, reflect on learning	Finalreport, presentation,viva

Assessmentstructure:

A.ContinuousInternalEvaluation(CIE)–50marks

- Students,inbatchesof3–4,shallundertakeatleast oneproject(oracombinationoftworelated activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIEwillbeconductedbyadepartmentalcommittee(HoD/nominee,guideandoneseniorfaculty)using the following rubrics totalling 50 marks:

CIEpassrequirement:

- Astudentshallsecureaminimumof20marksoutof50inCIEtobecomeeligibletoappearforSEE.

- StudentswhofailtoearntherequiredCIEmarksmaybegivenadditionalopportunities beforeclosure of the semester; no re-doing of CIE is permitted after the end of the semester.

B.SemesterEndExamination(SEE)–100marks(scaledto 50)

- Examinationduration:2hours.
- Maximumexaminationmarks: 100(enteredas100intheVTUportal;theITI-SMUmodule automatically scales 100 → 50 for result processing).
- TheSEEshallbeconductedbatch-wisebyacommitteeofthreefaculty:projectguide,onefacultyfrom the same department and one from a different department.

SEEpassrequirementandoverallpassingrule:

- ForapassinSEE,astudentshallsecureminimum35marksoutof100.
- Fordeclarationofapassgrade,the sumofCIEmarks(outof50)andscaledSEEmarks(outof50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIERubric—ContinuousInternalEvaluation(Total50marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification& Relevance to society/industry /community	8	Problemis clearly identified with strongevidence ofsocietal relevance and well-defined scope.	Problem is relevant and scopeisclear withadequate supporting evidence.	Problem definedbut justification orevidence is weak.	Problemunclear ornotrelevant; little/no supporting evidence.
Formationof problemstatement; Engineering approach,innovation & feasibility	10	Problem statementis precise; approachis sound, innovativeand clearly feasible.	Problem statement adequate; approach feasible with minorgaps.	Problem statement partial; approach feasibilityis marginal.	Problem statement missing or approachnot feasible.
Interactionwith stakeholders; Data collection,analysis&interpretation	8	Thorough stakeholder engagement; datacollection is comprehensive; analysisis well-interpreted.	Good engagement; data and analysis adequatewith minorgaps.	Limited engagement; data incomplete andanalysis superficial.	Little/no stakeholder contact; insufficientor no data/ analysis.
Project documentation; Clarity,organization & problem-solving demonstrated	10	Documentation iscomplete, well-organized, analytical, and shows strong problem-solving.	Documentationcompleteand clear withsome analytical content.	Documentationbasicwith omissions; problem-solvinglimited.	Documentation missing/poorly organized; no clear problem-solving .
Communication& Presentation skills	6	Presentationis confident, structured,and answersqueries fully; visuals effective.	Presentation clear and satisfactory; responds to most queries.	Presentation acceptable butlacks clarityor confidence; weakresponses.	Presentation poororabsent; unableto respond.
Contribution & Benefitto society (impact, sustainability)	8	Clear, demonstrable societalbenefit and sustainability; realisticpathto implementation.	Benefit plausible; sustainability considered withminor gaps.	Limited or unclear societal benefit; sustainabilityn otwell addressed.	Noevident benefit or sustainability; projectnot community-oriented.

NotesforCIErubric:

- MinimumCIEpassrequirement:20/50tobeeligibleforSEE.[Usedepartmentalcommittee (HoD/guide + senior faculty) to apply the rubric and record marks.]

SEERubric—SemesterEndExamination(Entermarksoutof100;scaledto50later):

Criterion	Weight (marks)	Excellent(Fullmarks)	Good	Fair	Needs Improvement
Problem identification& Relevance to society/industry/ community	16	Problem and relevance are articulated clearly with strong evidence and context.	Problem relevanceclear with reasonable evidence.	Problem statedbut evidence/ contextweak.	Problem poorly defined or irrelevant.
Formationof problem statement; Engineering approach, innovation&feasibility	20	Problemstatementis precise; approach demonstrates engineeringdepth, novelty and feasibility.	Approach is technically soundand feasiblewith minor limitations.	Approach basic;limited technical depthor feasibility concerns.	No viable engineering approachor infeasible plan.
Interactionwith stakeholders;Data collection, analysis & interpretation	16	Excellent stakeholder engagement; rigorous data collection and insightful analysis.	Good engagement andacceptable analysis.	Superficial datacollectionand limited analysis.	Inadequateor nodata; pooranalysis.
Project documentation; Clarity,technical rigor& problem-solving demonstrated	20	Reportiscomprehensive, technicallyrigorous, anddemonstrates systematic problem-solving.	Reportis completeand technically correctwith minorgaps.	Reportlacks technical depthorhas notable omissions.	Report missingkey elementsor technically incorrect.
Communication, Presentation &Viva-voce responses	12	Candidate presents expertly, defends work persuasively and answers all queries correctly.	Good presentation andsatisfactory answersto most queries.	Presentation adequatebut failsto answersome technical questions.	Poor presentation andunableto defendwork.
Contribution & Benefittosociety; Impact assessment&sustainability	16	Clear, evidence-based assessment of social impactand Sustainabilitywith scaling recommendations.	Reasonable impact discussionand sustainability considerations.	Limited evaluationof impactor sustainability.	Nocoherent assessmentofimpactor sustainability.

SEEpassrule:

- Studentmustsecureatleast35/100inSEEitselftobeeligibleforpassconsideration.
- FinalpassingisbasedonCIE(outof50)+SEE(scaledto50)>=40.Otherwise,gradeF(Fail)isawarded.

Suggestedimplementationnotes(forBoS/examcommittees):

- Usenumericalscoresfromtherubricandkeepbriefevaluatorcommentsforeachcriterion.
- Forteamprojects:recordindividualcontributionwithinthedocumentationandadjustindividual marks using a peer-evaluation sheet or guide's assessment.
- Maintainevidence(fieldnotes,photos,questionnaires,DPRs,reports)asannexuresforSEE moderation.
- Usestandardizedscoresheet(spreadsheet)mappingrubricitemstocolumnsforeasyaggregationand archival.

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Assessment Structure for PCC Courses

Assessment Structure:
The assessment in each PCC course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks].
A minimum of two Internal Assessment Tests(IA) shall be conducted, carrying a total of 25 marks.
In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.
It is recommended to include a maximum of two learning activities as part of the CCA to foster the holistic development of students. The suggested activities shall be

Sl. No.	Name of the Learning activity	Maximum Marks
1	Group seminar	15
2	Assignment (at RBL3, RBL4, or RBL5 levels)	10

Rubrics for assessment of these learning activities are provide in the Rubrics Section.

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Playing

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1	Group seminar	24
2	Assignment	24
OR SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1	NPTEL/MooCs course on Analog Electronics and Linear Integrated Circuits (faculty have to verify the dates that the NPTEL course is being offered)	48

Continuous Internal Evaluation (CIE)

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.

(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Assessment Structure for IPCC Courses

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

Questions from the practical component of the IPCC subject shall not appear in the theory SEE component.

CIE Theory component: It consists of IA tests for 25 marks. The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical Component:
The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.

The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks. For laboratory test, the student is required to conduct one experiment each from both Part A and Part B.

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.
The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.
Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed. The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined.

(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Table – IPCCs Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

Passing Requirements for SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Assessment Structure for PCC-Lab and AEC Lab Courses

Assessment Structure:
The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks. For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester (2) Faculty are suggested to offer only TW and not SL.	
Suggested Term Work (TW) Activity	**Number of Hours / Semester**
New Experiment to practice on their own	2
OR	
Practice some of the regular experiments with different design requirements on their own	2

Suggested Rubrics for PCC Courses

Note: the rubrics provided below are a reference and can be modified as required.

Rubrics for Learning Activity1: Group seminar (at RBL3, RBL4, or RBL5 levels)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Subject Knowledge (CO/PO Mapping)	Demonstrates deep knowledge of the subject with clear explanation.	Demonstrates adequate knowledge of most topics with clear explanation.	Demonstrates only basic concepts with Superficial knowledge of topic.	Does not have clear understanding of the topic and lacks grasp of information.	No explanation.
Communication Skills (CO/PO Mapping)	Clearly audible by the entire audience.	Audible by most of the audience.	Audience has difficulty to hear and follow the presentation.	Minimal command on vocabulary with inaccurate pronunciation.	Communication characterized by minimal degree of grammatical accuracy with frequent errors.
Viva Voce (CO/PO Mapping)	Able to understand and answer all the questions confidently with relevant explanation.	Able to understand and answer some of the questions with relevant explanation.	Able to answer and explain few questions with less relevance.	Unable to answer most of the questions.	No proper answer.

Rubrics for Learning Activity2: Assignment (at RBL3, RBL4, or RBL5 levels)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Problem understanding (CO/PO Mapping)	Demonstrates complete understanding of the question and assumptions.	Demonstrates good understanding with only minor omissions.	Demonstrates partial understanding with only some unclear assumptions.	Shows limited understanding of the questions.	Weak understanding of the question.
Correct application of	Applies all relevant	Applies most of the	Applies a few relevant	Frequent incorrect	Major errors in application of

theory and correctness of solution (CO/PO Mapping)	engineering principles, laws, and analytical methods correctly.	relevant engineering principles, laws, and analytical methods correctly.	engineering principles, laws, and analytical methods correctly	application of engineering principles and analytical methods.	engineering principles and analytical methods.

Suggested Rubrics for IPCC courses

Rubrics for CIE Lab test (50marks – later scaled down to 10marks):

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (10) (PO1)	The student has in depth knowledge of the topics related to the course (9-10)	Student has good knowledge of some of the topics related to course (7-9)	Student is capable of narrating the answer but not capable to show in depth knowledge (6-7)	Student has not understood the concepts clearly (5-6)
Design Of Experiment (15) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (14-15)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (12-14)	Student is capable of discussing single design with its merits and de-merits (10-12)	Student is capable of explaining the design (9-10)
Implementation with appropriate HW/SW (15) (PO3 , PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm/HW considering optimal solution explanation. (14-15)	Student is capable of implementing the design with best suitable algorithm/HW and should be capable of explaining it (12-14)	Student is capable of implementing the algorithm/HW with some explanation. (10-12)	Student is just capable of implementing the algorithm/HW , and unsatisfactory explanation. (8-10)
Result &Analysis (10) (PO4, PO5, PO9)	Student is able to run the program on various cases and compare the result with proper analysis. (10)	Student will be able to run the program for most of the cases and provide proper analysis. (7-9)	Student will be able to run the code for few cases and provide analysis for a few cases. (5-7)	Student will be able to run the program for a simple case but not able to analyze the output. (3-5)

Rubrics for CIE – Continuous assessment (30marks – later scaled to 15 marks):

	Superior	**Good**	**Needs Significant Improvement**
Fundamental Knowledge about each experiment (6) (PO1)	The student has in depth knowledge of the topics (4-6)	Student has good knowledge of some of the topics (4)	Student has not understood the concepts clearly (2)
Design Of Experiment (8) (PO2, PO3, PO5)	Student capable of discussing more than one design for problem statement and capable of proving the best suitable design with proper reason (6-8)	Student capable of discussing few designs for problem statement , not capable of selecting best design (6)	Student struggles to explain the design (2-4)
Implementation (10) (PO3, PO4, PO5, PO8)	Student capable of implementing the design (either alone or in a team) with best suitable algorithm considering optimal solution. (8-10)	Student capable of implementing design (either alone or in a team) with best suitable algorithm and capable of explaining it (8)	Student struggle to implement the design (either alone or in a team) . (2-8)
Quality of Record and Observation write up (6) (PO8,PO5,PO9)	Lab record & observation book are well-organized, with clear sections (4-6)	Lab record/ observation book are organized,, but some sections are not well-defined. (4)	The lab record/ observation book poorly organized, with missing or unclear sections. (2-4)

Note: Term Work and Self Learning components are not included in the assessment. IPCC already has theory and lab assessment in CIE, including a TW/SL component may cause burden on students. Faculty may give 50 hours of SL, however this may not be included for assessment.

Suggested Rubrics for PCC-Lab and AEC Lab Courses

Rubrics for CIE – Continuous Lab assessment (30 marks):

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge about each experiment (4) (PO1)	The student has in depth knowledge of the topics (4)	Student has good knowledge of some of the topics (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1-2)	Student barely has fundamental knowledge (1)
Design Of Experiment (5) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4-5)	Student is capable of discussing single design with its merits and de-merits (3-4)	Student struggles to explain the design (2-3)	Student has very weak understanding of the design (1-2)
Implementation (8) (PO3, PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)	Implementation has major errors (1)
Result &Analysis (5) (PO4, PO5, PO9)	Student is able to execute the program/experiment on various cases and compare the result with proper analysis. (4-5)	Student will be able to execute the program/experiment for all the cases. (3-4)	Student will be able to execute the program/experiment for few cases and analyze the output. (2-3)	Student will be able to execute the program/experiment but not able to analyze the output. (1-2)	Program/Experiment execution has important errors and student is incapable to explaining any of them (1)
Quality of Record and	The lab record & observation book	The lab record	The lab record & observation	The lab record	Student has not submitted lab

Observation write up (8) (PO8,PO9)	are well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). l (7-8)	&observation book are organized, with clear sections, but some sections are not well-defined. (5-6)	book lack clear organization or structure. Some sections are unclear or incomplete. (3-4)	&observation book are poorly organized, with missing or unclear sections. (1-2)	record or observation book (0)

Rubrics for CIE Lab Test (50 marks, later scaled to 20 marks) and SEE:

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (5) (PO1)	The student has in depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation with appropriate HW/SW (5) (PO3 , PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm/HW considering optimal solution explanation. (7-8)	Student is capable of implementing the design with best suitable algorithm/HW and should be capable of explaining it (5-6)	Student is capable of implementing the algorithm/HW with some explanation. (3-4)	Student is just capable of implementing the algorithm/HW, and unsatisfactory explanation. (1-2)
Result &Analysis (5) (PO4, PO5, PO9)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for most of the cases and provide proper analysis. (4)	Student will be able to run the code for few cases and provide analysis for a few cases. (3)	Student will be able to run the program for a simple case but not able to analyze the output. (1-2)

This file contains the proposed syllabus for Computer Engineering, 4th semester. The assessment and rubrics for Mathematics, Biology For Electrical And Electronics Engineers and Environmental Science Project courses are provided along with the individual syllabus. The assessment and rubrics for all other subjects (PCC, IPCC, PCC-L and AEC) are provided at the end of this file. The rubrics provided are suggested by the BoS, however individual departments may modify them as required.

Mathematics for Machine Learning			
Course Code	**1BMATEC401**	Scheme	2025
Type of Course	Applied Science Course (ASC)	Semester	IV
Teaching Hours/Week (L:T:P)	42(3:0:0)	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	90(42:0:0:48)	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

CO1: Apply the concepts of vector spaces, linear transformations, basis, dimension, rank, and nullity to solve problems arising in machine learning and data analysis.

CO2: Analyze inner product spaces, orthogonality, orthonormal bases, Gram-Schmidt orthogonalization, and QR decomposition for efficient representation of data.

CO3: Evaluate eigenvalues, eigenvectors, matrix decompositions, positive definite matrices, singular value decomposition, and matrix differentiation techniques used in machine learning algorithms.

CO4: Apply probability distributions, expectation, variance, covariance, and correlation concepts to model uncertainty and analyze data-driven systems.

CO5: Utilize sampling theory, hypothesis testing, confidence intervals, stochastic processes, and Markov chains for statistical inference and predictive modeling applications.

Module-1: Vector spaces

Vector spaces: Definition and examples, subspace, linear span, Linearly independent and dependent sets, Basis and dimension.
Linear transformations: Definition and examples, Matrix of alinear transformation. Change of bases, Rank and nullity of a linear operator, RankNullity theorem.

Number of Hours:8

Module-2: Inner Product Spaces

Inner Product Spaces: Inner product, orthogonal sets, angles and orthogonality, orthonormal Basis, orthogonal projections; Gram-Schmidt orthonormalization process; QR-decomposition.

Number of Hours:8

Module-3: Eigen values and Eigenvectors

Eigen values and Eigenvectors -Diagonalization, Positive definite Matrices and test for positive definiteness, Singular Value Decomposition (2×2).
Matrix derivatives: Jacobian matrix, Hessian matrix, Gradient of vector and matrix with respect to vector and matrix, pseudo inverse.

Number of Hours:8

Module-4:

Review of basic probability theory, Random variables-discrete and continuous Probability distribution function, cumulative distribution function.
Mathematical Expectation: mean and variance.
Binomial, Poisson, Exponential and Normal distribution– Problems.
Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.

Number of Hours:9

Module-5:

Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.
Stochastic process: Stochastic processes, probability vector, stochastic matrices, fixed probability vector,regular stochastic matrices, Markov chains, higher transition probability-problems.

Number of Hours:9

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong**. "Mathematics for MachineLearning" , Published by Cambridge University Press, Copyright 2020
2. **Gilbert Strang**, "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia,2003.
3. **B.S. Grewal**, *Higher Engineering Mathematics*, 45th Edition, Khanna Publishers.
4. **Erwin Kreyszig**, *Advanced Engineering Mathematics*, 10th Edition, Wiley India.
5. **H.K. Dass and Er. Rajnish Verma**, *Higher Engineering Mathematics*, S. Chand Publications.

Reference books / Manuals:

1. **Christopher M. Bishop**, *Pattern Recognition and Machine Learning*, Springer, 2006.
2. **Trevor Hastie, Robert Tibshirani and Jerome Friedman**, *The Elements of Statistical Learning*, 2nd Edition, Springer, 2009.
3. **Sheldon Ross**, *A First Course in Probability*, 10th Edition, Pearson Education, 2019.
4. Kenneth Hoffman and Ray Kunze,*Linear Algebra*, 2nd Edition, Pearson.
5. **David C. Lay**, Steven R. Lay and Judi J. McDonald, *Linear Algebra and Its Applications*, 5th Edition, Pearson.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/111107137

- NPTEL Courses on Engineering Mathematics
- MIT Open Course Ware Mathematics
- SWAYAM Online Courses

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. **Flipped Classroom Approach**
   - Students review video lectures and reading materials before class.
   - Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models.
2. **Problem-Based Learning (PBL)**
   - Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.
3. **ICT-Enabled Teaching**
   - Use of MATLAB, Python, and online simulation tools to visualize transforms, optimization problems, and signal-processing applications.
4. **Collaborative Learning**
   Group assignments and mini-projects on optimization models and transform applications.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal EvaluationCIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)**shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment at RBL3 and RBL4levels based on Team Work(TW) activities.	10
2.	GATE-based Aptitude Test.	15

Rubrics **for Learning Activity–1: Assignment (10 Marks)**

Performance Indicator	**Superior (15)**	**Good (12)**	**Fair (10)**	**Needs Improvement (8)**
Quantitative Aptitude	≥90% correct responses	75–89% correct	60–74% correct	<60% correct
Analytical Thinking	Excellent logical reasoning and interpretation	Good reasoning ability	Moderate reasoning	Weak reasoning
Time Management	Completes all questions within allotted time	Completes most questions	Requires additional time	Unable to complete
Accuracy & Precision	Very high accuracy	Good accuracy	Moderate accuracy	Low accuracy

Rubrics for Learning Activity–2: GATE-Based Aptitude Test (15 Marks)

Performance Indicator	Superior (10)	Good (8)	Fair (6)	Needs Improvement (5)
Understanding of Concepts	Demonstrates excellent conceptual clarity and application	Good understanding with minor errors	Basic understanding	Poor understanding
Problem Solving Ability	Solves all problems correctly with proper methodology	Solves most problems correctly	Partial solutions with errors	Unable to solve problems effectively
Mathematical Accuracy	Calculations and derivations are error-free	Minor computational errors	Several errors	Significant errors
Presentation & Organization	Well-structured, neat, and professionally presented	Organized with minor deficiencies	Average presentation	Poor presentation

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Collaborative Problem Solving on Gram-Schmidt Orthogonalization and QR Decomposition	6
2.	Mini Project on Eigenvalues, Eigenvectors and Principal Component Analysis (PCA)	6
3.	Team-Based Analysis of Hypothesis Testing and Confidence Intervals	6
4.	Group Presentation on Applications of SVD in Image Compression and Data Analytics	6
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Python Programming Practice using NumPy for Matrix Operations	6
2.	Study of Machine Learning Applications using SVD and PCA	6
3.	Preparation of Summary Notes on Markov Chains and Stochastic Processes	6
4.	Literature Survey on Mathematical Foundations of Machine Learning	6

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Data Structures & Algorithms using C++			
Course Code	**1BUE402**	Scheme	2025
Type of course	**Theory and Lab**	Semester	IV
Teaching Hours/Week (L:T:P)	3:2:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:28:50:0	SEE Marks	50
Credits	**04**	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, Lab- CIE only.	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, students will be able to:

1. Compare two functions for their rates of growth.
2. Understand abstract specification of data-structures and their implementation.
3. Compute time and space complexity of operations on a data-structure.
4. Identify the appropriate data structure(s) for a given application and understand the trade-offs involved in terms of time and space complexity.
5. Apply recursive techniques to solve problems.

Module-1

Growth of Functions, Recurrence Relations: Functions used in analysis, asymptotic notations, asymptotic analysis, solving recurrences using recursion tree, Master Theorem. (Section 3,4.4 to section 4.6 of Text2).

Number of Hours: 08

Module-2

Arrays, Linked Lists, Stacks, Queues, Deques: Arrays: Array operations, applications, sorting, two-dimensional arrays. (section 3.1 of Text 1)

Linked Lists: singly linked lists, doubly linked lists, circularly linked lists. (section 3.2 to section 3.4 of Text 1)

Stacks: stack as an ADT, implementing stacks using arrays, implementing stacks using linked lists, applications of stacks.(section 5.1 of Text 1)

Queues: queue as an ADT, implementing queues using arrays, implementing queues using linked lists, double-ended queue as an ADTimplementing queues using linked lists, double-ended queue as an ADT. (Section 5.2, 5.3 of Text 1)

Number of Hours: 08

Module-3

Sorting: Elementary sorting algorithms, Decision trees, Efficient sorting algorithms.
(Section 9.1 to 9.3, Text 3)

Number of Hours: 08

Module-4

Recursion: Definitions, Function call and recursion implementation, Anatomy of recursive call, Tail Recursion, NonTail Recursion**.**
(Section 5.1 to 5.5 of Text3)

Trees, Binary Trees. Trees: Definition of B Trees, basic operations on B Trees, Deleting a key from B Tree. (Section 18 of Text 2)

Number of Hours: 10

Module-5

Binary Search Tree: Binary Tree ADT, A C++ Binary Tree interface, properties of Binary Trees, A linked structure of Binary Trees, Vector base structure for Binary Trees, Traversal of Binary Tree,The template function pattern, Representing general trees with binary trees **(**Section7.3 of Text 1)

Heap, Priority Queue: The priority Queue Abstract Data Type, Implementing priority queue with a list, Heaps, **(**Section 8.1 to section 8.3 of Text 1)Number of Hours: 10

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. Perform matrix addition and multiplication.
2. Implement following recursive functions: a. Factorial of a number b. Nth fibonacci number c. Power function: xy
3. Implement singly linked lists.
4. Implement doubly linked lists.
5. Implement circular linked lists.
6. Implement stack data structure and its operations using arrays.
7. Implement stack data structure and its operations using linked lists.
8. Convert Prefix expression to Infix and Postfix expressions, and evaluate

PART – B: OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. Implement queue data structure and its operations using arrays.
2. Implement queue data structure and its operations using linked lists.
3. Implement Binary Trees and its traversals

Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):

Textbooks:

1.Goodrich, M., Tamassia, R., & Mount, D., Data Structures and Algorithms Analysis in C++, 2nd edition. Wiley, 2011.
2. Cormen, T.H., Leiserson, C.E., Rivest, R. L., Stein C., Introduction to Algorithms, 3rd edition, Prentice Hall of India, 2010.
3. Drozdek, A., Data Structures and Algorithms in C++, 4th edition, Cengage Learning, 2012.

Reference books / Manuals:

1. Sahni, S. Data Structures, Algorithms and applications in C++. 2nd Edition. Universities Press, 2011.
2. Tanenbaum, A. M., Augenstein, M. J., & Langsam Y., Data Structures Using C and C++. 2nd edition. Prentice Hall of India, 2009.

Web links and Video Lectures (e-Resources):

1. **NPTEL – Programming, Data Structures and Algorithms Using C++**
2. **IIT Kharagpur Virtual Lab – Data Structures Lab**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. **Interactive Lectures** using presentations, whiteboard illustrations, and real-world examples to explain data structures and algorithm concepts.
2. **Problem-Based Learning (PBL)** through analysis of computational problems requiring appropriate data structures and algorithms.
3. **Demonstration Sessions** for illustrating operations on arrays, linked lists, stacks, queues, trees, heaps, and binary search trees.
4. **Algorithm Visualization Tools** such as VisuAlgo and animations to demonstrate sorting, recursion, tree traversals, and heap operations.
5. **Programming Laboratory Sessions** emphasizing implementation of data structures and algorithmic techniques in C++.

6. **Code Walkthroughs and Debugging Exercises** to improve programming skills and understanding of algorithm behavior.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

Questions from the practical component of the IPCC subject shall not appear in the theory SEE component.

The CIE Theory component consists of IA tests for 25 marks.The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical Component:

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.

The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks.For laboratory test, the student is required to conduct one experiment each from both Part A and Part B.

Rubrics for CIE Lab test (50marks – later scaled down to 10marks):

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (10) (PO1)	The student has in depth knowledge of the topics related to the course (9-10)	Student has good knowledge of some of the topics related to course (7-9)	Student is capable of narrating the answer but not capable to show in depth knowledge (6-7)	Student has not understood the concepts clearly (5-6)

Design Of Experiment (15) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (14-15)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (12-14)	Student is capable of discussing single design with its merits and de-merits (10-12)	Student is capable of explaining the design (9-10)
Implementation with appropriate HW/SW (15) (PO3 , PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm/HW considering optimal solution explanation. (14-15)	Student is capable of implementing the design with best suitable algorithm/HW and should be capable of explaining it (12-14)	Student is capable of implementing the algorithm/HW with some explanation. (10-12)	Student is just capable of implementing the algorithm/HW, and unsatisfactory explanation. (8-10)
Result &Analysis (10) (PO4, PO5, PO9)	Student is able to run the program on various cases and compare the result with proper analysis. (10)	Student will be able to run the program for most of the cases and provide proper analysis. (7-9)	Student will be able to run the code for few cases and provide analysis for a few cases. (5-7)	Student will be able to run the program for a simple case but not able to analyze the output. (3-5)

Suggested Rubrics for CIE – Continuous assessment (30marks – later scaled to 15 marks):

	Superior	**Good**	**Needs Significant Improvement**
Fundamental Knowledge about each experiment(6) (PO1)	The student has in depth knowledge of the topics (4-6)	Student has good knowledge of some of the topics (4)	Student has not understood the concepts clearly (2)
Design Of Experiment (8) (PO2, PO3, PO5)	Student capable of discussing more than one design for problem statement and capable of proving the best suitable design with proper reason (6-8)	Student capable of discussing few designs for problem statement , not capable of selecting best design (6)	Student struggles to explain the design (2-4)
Implementation (10) (PO3, PO4, PO5, PO8)	Student capable of implementing the design (either alone or in a team) with best suitable algorithm considering optimal solution (8-10)	Student capable of implementing design (either alone or in a team) with best suitable algorithm and capable of explaining it (8)	Studentstruggle toimplement the design (either alone or in a team) . (2-8)
Quality of Record and Observation write up (6) (PO8,PO5,PO9)	Lab record& observation book are well-organized, with clear sections (4-6)	Lab record/ observation bookare organized,, but some sections are not well-defined. (4)	The lab record/ observation book poorly organized, with missing or unclear sections. (2-4)

Note: Term Work and Self Learning components are not included in the assessment. IPCC already has theory and lab assessment in CIE, including a TW/SL component may cause burden on students. Faculty may give 50 hours of SL, however this may not be included for assessment.

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.
The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.
Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus.
The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined.
(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Table – IPCCs Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Computer organization and Microcontroller Programming			
Course Code	**1BUE403**	Scheme	2025
Type of Course	**PCC**	Semester	3
Teaching Hours/Week (L:T:P)	42 : 28 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42: 28 : 0 : 50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

CO1: Analyze computer organization, instruction execution, addressing modes, and evaluate system performance.

CO2: Evaluate I/O organization, interrupt handling, DMA operations, and cache memory design techniques.

CO3: Examine processing unit operations and assess pipelining performance and efficiency.

CO4: Understand and analyze ARM-based embedded system architecture, processorfundamentals, and basic embedded software development.

CO5: Apply ARM instruction set concepts for embedded programming and for differentapplications.

Module-1

Basic Structure of Computers: Functional Units, Basic Operational Concepts, Bus structure, Performance – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement.
Machine Instructions and Programs: Memory Location and Addresses, Memory Operations, Instruction and Instruction sequencing, Addressing Modes, Assembler directives

Text book-1: 1.2, 1.3, 1.4, 1.6, 2.2, 2.3, 2.4, 2.5,2.6.1

Number of Hours: 8

Module-2

Input/output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices
Direct Memory Access: Bus Arbitration, Speed, size and Cost of memory systems. Cache Memories – Mapping Functions.

Text book-1: 4.1, 4.2,4.2.1, 4.2.2, 4.2.3, 4.4, 5.4, 5.5.1

Number of Hours: 8

Module-3

Basic Processing Unit: Some Fundamental Concepts: Register Transfers, Performing ALU operations, fetching a word from Memory, Storing a word in memory. Execution of a Complete Instruction.
Pipelining: Basic concepts, Role of Cache memory, Pipeline Performance.

Text book-1: 7.1, 7.2, 8.1

Number of Hours: 8

Module-4

ARM Embedded Systems:

Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware – AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT) code, Operating System, Applications.

ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table, Core extensions.

Text book-2: 1.1to 1.5,2.1 to 2.5

Number of Hours:10

Module-5

Introduction to the ARM Instruction set:

Introduction, Data processing instructions, Load – Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, ARMv5E extensions, Conditional Execution.

Text book-2: 3.1 to 3.9

Number of Hours:8

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **Carl Hamacher, ZvonkoVranesic, SafwatZaky, Computer Organization, 5 th Edition, Tata McGraw Hill.**
2. **Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008.**

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/106106092
2. https://nptel.ac.in/courses/106106166
3. https://nptel.ac.in/courses/106103180
4. https://nptel.ac.in/courses/108105102

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. **Concept Visualization and Demonstration:** Use processor simulators, ARM development environments, and visual demonstrations to illustrate instruction execution, addressing modes, pipelining, cache memory operations, interrupts, and processor architecture.
2. **Hands-on Programming Activities:** Conduct ARM assembly language programming exercises and embedded system application demonstrations to reinforce instruction set concepts, processor fundamentals, and embedded software development.
3. **Application-Oriented Learning:** Incorporate case studies and real-world examples from computer systems and embedded applications, such as IoT devices, consumer electronics, and industrial controllers, to connect theoretical concepts with practical implementations.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.

- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal EvaluationCIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)**shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
3.	ARM Assembly Programming Assignment / Mini Project	15
4.	Case Study Presentation on Embedded Systems or Computer Architecture Applications	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Activity -1 : ARM Assembly Programming Assignment / Mini Project (15M)

Performance Indicator (CO/PO Mapping)	Superior (15)	Good (12)	Fair (9)	Needs Improvement (6)	Unacceptable (3)
Program Design and Logic (CO5, PO1)	Correct, optimized, and innovative solution	Correct solution with minor issues	Functional but limited optimization	Partially correct solution	Incorrect or incomplete solution
Application of ARM Instructions (CO4, CO5, PO2)	Excellent use of ARM instruction set	Good use with minor errors	Adequate implementation	Limited understanding	Unable to apply concepts
Documentation and Interpretation of Results (CO4, CO5, PO10)	Comprehensive and well-organized	Clear documentation	Adequate documentation	Incomplete documentation	Poor or missing documentation

Rubrics for Learning Activity-2 : Case Study Presentation on Embedded Systems or Computer Architecture Applications

Performance Indicator (CO/PO Mapping)	Superior (10)	Good (8)	Fair (6)	Needs Improvement (4)	Unacceptable (2)
Understanding of Embedded Systems/Computer Architecture Concepts (CO1, CO2, PO1)	Demonstrates thorough understanding of concepts and accurately relates them to the selected case study.	Demonstrates good understanding with minor gaps in explanation.	Demonstrates basic understanding with limited depth.	Shows partial understanding with significant conceptual gaps.	Fails to demonstrate understanding of the concepts.
Analysis and Application (CO3, PO2)	Provides insightful analysis and effectively explains practical applications, advantages, and challenges.	Provides good analysis with adequate explanation of applications.	Provides basic analysis with limited discussion of applications.	Analysis is superficial and lacks clarity.	Little or no analysis provided.
Presentation Skills and Communication (CO1, PO10)	Presentation is highly organized, engaging, and delivered confidently with excellent visual aids.	Well-organized presentation with clear communication and appropriate visual aids.	Adequate presentation with acceptable communication skills.	Presentation lacks organization or clarity; limited use of visual aids.	Poorly organized presentation with ineffective communication.
Documentation and References (CO1, PO10)	Comprehensive report/slides with proper citations and professional formatting.	Well-prepared documentation with minor formatting or citation issues.	Adequate documentation with limited references.	Incomplete documentation with insufficient references.	Missing or poorly prepared documentation.

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
5.	Course Project	30
6.	Assignment	20

OR

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
5.	NPTEL course on Network Analysis (faculty have to verify the dates that the NPTEL course is being offered)	50

Continuous Internal Evaluation (CIE)

5. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
6. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
7. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
8. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

4. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
5. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
6. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Nanoelectronics: Materials, Devices and Fabrication Overview			
CourseCode	**1BUE404**	CIEMarks	50
Type of Course	**PCC**	Semester	III
TeachingHours/Week(L:T:P)	3:0:0	SEEMarks	50
Total Hours of Pedagogy per semester L /T/P/SL/TW:	42:0:0:48	TotalMarks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory	Exam Hours	3

Course Outcomes:

1. Explain the fundamental properties of semiconductors, including energy band theory, charge carriers, conductivity, mobility, and the effects of temperature and doping.
2. Analyze the operation of PN junction diodes under forward and reverse bias conditions, including breakdown mechanisms and rectifier applications.
3. Describe the working principles and characteristics of optoelectronic devices such as photodiodes, solar cells, photodetectors, and LEDs.
4. Evaluate the operation and performance of Bipolar Junction Transistors (BJTs) in amplification and switching applications, including device models and fabrication concepts.
5. Understand the fundamentals of nanoscience and nanotechnology, including nanostructures, fabrication methods, and characterization techniques for analyzing material properties.

Module-1

Semiconductors: Bonding forces in solids, Energy bands, Metals, Semiconductors and Insulators, Direct and Indirect semiconductors, Electrons and Holes, Intrinsic and Extrinsic materials, Conductivity and Mobility, Drift and Resistance, Effects of temperature and doping on mobility, Hall Effect. (Text1:3.1.1,3.1.2,3.1.3,3.1.4,3.2.1,3.2.3,3.2.4,3.4.1,3.4.2,3.4.3,3.4.5).

Teaching-LearningProcess	ChalkandTalk,YouTubevideos **RBT Level:** L1, L2, L3

Module-2

PN Junctions: Forward and Reverse biased junctions-Qualitative description of Current flow at a junction, reverse bias, Reverse bias breakdown- Zener breakdown, avalanche breakdown, Rectifiers.(Text1:5.3.1,5.3.3,5.4,5.4.1,5.4.2,5.4.3) Optoelectronic Devices Photodiodes: Current and Voltage in an Illuminated Junction, Solar Cells, Photodetectors. Light Emitting Diode: Light Emitting materials. (Text1:8.1.1,8.1.2,8.1.3,8.2,8.2.1)

Teaching-LearningProcess	ChalkandTalk,YouTubevideos **RBTLevel:**L1,L2,L3

Module-3

Bipolar Junction Transistor: Fundamentals of BJT operation, Amplification with BJTS,BJT Fabrication, The coupled Diode model(Ebers-Moll Model),Switching operation of a transistor, Cutoff, saturation, switching cycle, specifications, Drift in the base region, Base narrowing, Avalanche breakdown. (Text1:7.1,7.2,7.3,7.5.1,7.6,7.7.1,7.7.2, 7.7.3)

Teaching-LearningProcess	ChalkandTalk,YouTubevideos **RBTLevel:**L1,L2,L3

Module-4

Generic methodologies for nanotechnology: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moore's law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy

bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 2).
Teaching-LearningProcess ChalkandTalk, YouTubevideos **RBTLevel:**L1,L2,L3
Module-5
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques, spectroscopy techniques: photon, radiofrequency, electron, surface analysis and depth profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties (Text 2).

CourseOutcomes

SuggestedLearningResources:

TextBooks

1. Ben. G. Streetman, Sanjay Kumar Banerjee, "Solid State Electronic Devices",7 th Edition, Pearson Education,2016,ISBN978-93-325-5508-2.
2. 'Nanoscale Science and Technology', Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, John Wiley, 2007

Reference Books:

1. "Physics of Semiconductor Devices", 3 rd Edition, Wiley,2018.
2. 'Hand Book of Nanoscience Engineering and Technology', Ed William A Goddard III, Donald WBrenner, Sergey E. Lyshevski, Gerald J Iafrate, CRC press, 2003

Attheendofthecoursethestudentwillbeableto:

6. Explain the fundamental properties of semiconductors, including energy band theory, charge carriers, conductivity, mobility, and the effects of temperature and doping.
7. Analyze the operation of PN junction diodes under forward and reverse bias conditions, including breakdown mechanisms and rectifier applications.
8. Describe the working principles and characteristics of optoelectronic devices such as photodiodes, solar cells, photodetectors, and LEDs.
9. Evaluate the operation and performance of Bipolar Junction Transistors (BJTs) in amplification and switching applications, including device models and fabrication concepts.
10. Understand the fundamentals of nanoscience and nanotechnology, including nanostructures, fabrication methods, and characterization techniques for analyzing material properties.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
4. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
5. Arrange visits to nearby industries to give brief information about the electronics manufacturing industry.
6.. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal EvaluationCIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)**shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1	Group seminar	15
2	Assignment (at RBL3, RBL4, or RBL5 levels)	10

Rubrics for Learning Activity1: Group seminar (at RBL3, RBL4, or RBL5 levels)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Subject Knowledge (CO/PO Mapping)	Demonstrates deep knowledge of the subject with clear explanation.	Demonstrates adequate knowledge of most topics with clear explanation.	Demonstrate only basic concepts with Superficial knowledge of topic.	Does not have clear understanding of the topic and lacks grasp of information.	No explanation.
Communication Skills (CO/PO Mapping)	Clearly audible by the entire audience.	Audible by most of the audience.	Audience has difficulty to hear and follow the presentation.	Minimal command on vocabulary with inaccurate pronunciation.	Communication characterized by minimal degree of grammatical accuracy with frequent errors.
Viva Voce (CO/PO Mapping)	Able to understand and answer all the questions confidently with relevant explanation.	Able to understand and answer some of the questions with relevant explanation.	Able to answer and explain few questions with less relevance.	Unable to answer most of the questions.	No proper answer.

Rubrics for Learning Activity2: Assignment (at RBL3, RBL4, or RBL5 levels)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Problem understanding (CO/PO Mapping)	Demonstrates complete understanding of the question and assumptions.	Demonstrates good understanding with only minor omissions.	Demonstrates partial understanding with only some unclear assumptions.	Shows limited understanding of the questions.	Weak understanding of the question.
Correct application of theory and correctness of solution (CO/PO Mapping)	Applies all relevant engineering principles, laws, and analytical methods correctly.	Applies most of the relevant engineering principles, laws, and analytical methods correctly.	Applies a few relevant engineering principles, laws, and analytical methods correctly	Frequent incorrect application of engineering principles and analytical methods.	Major errors in application of engineering principles and analytical methods.

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1	Group seminar	24
2	Assignment	24

OR

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1	NPTEL/MooCs course on Analog Electronics and Linear Integrated Circuits (faculty have to verify the dates that the NPTEL course is being offered)	48

Continuous Internal Evaluation (CIE)

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.

(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

PCB DESIGN LAB		Scheme	2025
Course Code	**1BUEL405**	Semester	4
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SLTW	0:0:28:2	SEE Marks	50
Credits	1	Total Marks	100
Examination type (SEE)	**Practical**	Exam Hours	3

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Design, analyze, and simulate basic analog electronic circuits such as rectifiers (half-wave and full-wave) and regulated power supplies.
2. Develop PCB layouts for fundamental electronic circuits including low-pass filters and common-emitter amplifiers, following standard design practices.
3. Implement and test digital and display circuits such as simple 7-segment display systems.
4. Design and realize practical electronic systems like IR proximity sensors, touchless doorbells, laser security alarms, and mobile phone detector circuits.
5. Analyze thermal effects in electronic circuits and evaluate PCB thermal management techniques along with transistor heat dissipation methods.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 8 conventional experiments, PART-B has 4 typical open ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for **70 marks** out of the maximum 100 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for **30 marks.**
4. For Continuous Internal Evaluation (CIE) during the semester, classwork shall typically include open-ended questions from **Part-B**, along with other similar questions designed to enhance the students' skills.

PART – A
FIXED SET OF EXPERIMENTS

1. Design and Set-up a ±5V Dual Power Supply using IC 7805 and IC 7905 and verify the regulated output voltages.
2. Design and Simulate Half-Wave and Full-Wave Rectifier Circuits and analyze rectification efficiency and ripple characteristics.
3. Design the PCB Layout of a Low-Pass Filter Circuit and study component placement, routing, and grounding techniques.
4. Design the PCB Layout of a Common Emitter (CE) Amplifier and analyze layout considerations affecting circuit performance.
5. Design and Simulate Simple Seven-Segment Display Circuits for displaying decimal digits using appropriate driver circuitry.
6. Design and Implement an IR Proximity Sensor-Based Touchless Door Bell using Zero PCB and verify its operation.
7. Design and Test a Laser Light Security Alarm System using optical sensing principles.
8. Study and Analyze PCB Thermal Management Techniques used in electronic circuit design.

PART – B
OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking,

and inquiry-based learning.

Concept 1Design and Experimental Study of a Mobile Phone Detector Circuit for detecting RF emissions from active mobile devices.

Concept 2Design and Analysis of Transistor Heat Dissipation Techniques using PCB Design Methods and evaluate thermal performance.

oncept 3Design and Development of a Smart Intrusion Detection System using IR/Laser Sensors and Alarm Circuitry.

Concept 4Design and Optimization of a PCB Layout for a Mixed Analog-Digital Circuit considering noise reduction and signal integrity.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

6. Simon Monk, "Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards (Electronics)" 2017
7. S. Yogesh, "OSCAD: An Open Source EDA Tool for Circuit Design, Simulation, Analysis and PCB Design", Shroff Publishers & Distributors Pvt. Ltd, 2013.

Web links and Video Lectures (e-Resources):

- https://www.udemy.com/course/circuit-design-simulation-and-pcb-manufacturing-bundle
- https://www.allaboutcircuits.com/technical-articles/pcb-thermal-management-techniques/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. While explaining each experiment, also focus on the practical applications of PCB design, fabrication, and testing in the electronics manufacturing and embedded systems industries.
2. In experiments involving PCB design software, the emphasis must be on student understanding of circuit design flow, component selection, footprint assignment, schematic capture, PCB routing, design rule checks (DRC), and expected circuit performance. Faculty should not penalize students for minor software operation errors in the record, provided they can identify and rectify them during design implementation.
3. Students should not memorize component footprints, package details, PCB design rules, or software commands. Relevant datasheets, design specifications, and reference materials must be provided during CIE and SEE.
4. For record writing, faculty should ensure students write the main objective, circuit design methodology, PCB layout considerations, fabrication procedure, testing procedure, observations, and conclusions in their own words and do not copy from manuals or online resources. Record writing should involve higher Bloom's levels such as analysis, evaluation, and design rather than only Remember and Understand levels.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester

/after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Suggested Rubrics for CIE – Continuous assessment (30 marks):

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge about each experiment (4) (PO1)	The student has in depth knowledge of the topics (4)	Student has good knowledge of some of the topics (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1-2)	Student barely has fundamental knowledge (1)
Design Of Experiment (5) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4-5)	Student is capable of discussing single design with its merits and de-merits (3-4)	Student struggles to explain the design (2-3)	Student has very weak understanding of the design (1-2)
Implementation (8) (PO3, PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)	Implementation has major errors (1)
Result &Analysis (5) (PO4, PO5, PO9)	Student is able to execute the program/experiment on various cases and compare the result with proper analysis. (4-5)	Student will be able to execute the program/experiment for all the cases. (3-4)	Student will be able to execute the program/experiment for few cases and analyze the output. (2-3)	Student will be able to execute the program/experiment but not able to analyze the output. (1-2)	Program/Experiment execution has important errors and student is incapable to

					explaining any of them (1)
Quality of Record and Observation write up (8) (PO8,PO9)	The lab record &observation book are well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). l (7-8)	The lab record & observation book are organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record & observation book lack clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record & observation book are poorly organized, with missing or unclear sections. (1-2)	Student has not submitted lab record or observation book (0)

Suggested Rubrics for CIE Test (50 marks, later scaled to 20 marks) and SEE:

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (5) (PO1)	The student has in depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation with appropriate HW/SW (5) (PO3 , PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm/HW considering optimal solution explanation. (7-8)	Student is capable of implementing the design with best suitable algorithm/HW and should be capable of explaining it (5-6)	Student is capable of implementing the algorithm/HW with some explanation. (3-4)	Student is just capable of implementing the algorithm/HW , and unsatisfactory explanation. (1-2)
Result &Analysis (5) (PO4, PO5, PO9)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for most of the cases and provide proper analysis. (4)	Student will be able to run the code for few cases and provide analysis for a few cases. (3)	Student will be able to run the program for a simple case but not able to analyze the output. (1-2)

Term Work (TW) and Self Learning (SL) components in

Number of Hours per semester (2) Faculty are suggested to offer only TW and not SL.	
Suggested Term Work (TW) Activity	**Number of Hours / Semester**
New Experiment to practice on their own	2
OR	
Practice some of the regular experiments with different design requirements on their own	2

Scripting with Python Lab			
Course Code	**1BUEL406A**	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	4
Teaching Hours/Week (L:T:P)	0: 0 :28	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0 :28:2	SEE Marks	50
Credits	01	Total Marks	100
Type of Examination	Practical	Exam Hours	02

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. CO1: Develop simple Python scripts using built-in modules and file handling operations.
2. CO2: Apply string processing and basic regular expression techniques for text manipulation and validation.
3. CO3: Create scripts to process and manage data stored in text and CSV files.
4. CO4: Utilize Python libraries and operating system utilities for basic file and directory automation tasks.
5. CO5: Develop simple utility applications using Python scripting techniques for real-world problems.

SET OF EXPERIMENTS

1. Develop a Python script to display the current system date and time using built-in modules.
2. Develop a Python script to count the number of lines, words, and characters in a text file.
3. Develop a Python script to create a text file, write data into it, append additional data, and display the contents of the file.
4. Develop a Python script to perform string operations such as concatenation, searching, replacing, splitting, and joining.
5. Develop a Python script to count the frequency of words in a given text.
6. Develop a Python script to check whether a given string is a palindrome.
7. Develop a Python script using regular expressions to validate an email address.
8. Develop a Python script using regular expressions to extract all numbers from a given text.
9. Develop a Python script to display all files present in a specified directory.
10. Develop a Python script to create a folder and copy a file from one location to another.
11. Develop a Python script to rename multiple files in a directory using a common naming pattern.
12. Develop a Python script to write student records into a CSV file and display them.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **Automate the Boring Stuff with Python: Practical Programming for Total Beginners, Al Sweigart,2nd Edition**
2. **Python Programming: An Introduction to Computer Science, John M. Zelle, 3rd Edition.**
3. **Learning Python, Mark Lutz, 5th Edition.**

<u>Reference books / Manuals:</u>

1. **Think Python: How to Think Like a Computer Scientist, Allen B. Downey, 2nd Edition.**

2. **Core Python Programming, Wesley J. Chun,2nd Edition.**

3. **Python Crash Course: A Hands-On, Project-Based Introduction to Programming, Eric Matthes, 3rd Edition**

Web links and Video Lectures (e-Resources):

- **Python Software Foundation (Python.org)**
- **MIT OpenCourseWare – Introduction to Computer Science and Programming in Python**

Teaching-Learning Process (Innovative Delivery Methods):
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
Problem-Based Learning (PBL) – Encourage students to analyze and solve computational problems using Python.
Case Study Analysis – Discuss applications of Python in domains such as data analytics, automation, AI, and web development

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE – Continuous assessment:

Performance Indicator	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge (4) (PO1)	In-depth understanding of all topics (4)	Good understanding of most topics (3)	Basic explanation without depth (2)	Limited understanding (1)	No understanding (0)
Design of Experiment (4) (PO2 & PO3)	Multiple designs with justified best choice (4)	Few designs, weak selection (3)	Single design with pros/cons (2)	Basic explanation only (1)	No understanding (0)
Implementation (5) (PO3 & PO8)	Optimal algorithm with clear justification (5)	Correct implementation with explanation (4)	Implementation with partial clarity (3)	Implementation without clarity (2)	Unable to implement (1)
Result & Analysis (4) (PO4)	Runs all cases with detailed analysis (4)	Runs all cases (3)	Runs few cases with partial analysis (2)	Runs but cannot analyze (1)	Poor setup and analysis (0)
Demonstration (8) (PO9)	Well-organized record with clear sections (8–7)	Organized with minor issues (6–5)	Some sections unclear (4–3)	Poor structure (2–1)	Very poorly organized (0)

Rubrics for SEE / CIE Test:

Performance Indicator	Superior	Good	Fair	Needs Improvement	Unacceptable
Fundamental Knowledge (4) (PO1)	In-depth understanding of all topics (4)	Good understanding of most topics (3)	Basic explanation without depth (2)	Limited understanding (1)	No understanding (0)
Design of Experiment (4) (PO2 & PO3)	Multiple designs with justified best choice (4)	Few designs, weak selection (3)	Single design with pros/cons (2)	Basic explanation only (1)	No understanding (0)
Implementation (5) (PO3 & PO8)	Optimal algorithm with clear justification (5)	Correct implementation with explanation (4)	Implementation with partial clarity (3)	Implementation without clarity (2)	Unable to implement (1)
Result & Analysis (4) (PO4)	Runs all cases with detailed analysis (4)	Runs all cases (3)	Runs few cases with partial analysis (2)	Runs but cannot analyze (1)	Poor setup and analysis (0)

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge(2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best(4)	Student is capable of discussing single design with its merits and de-merits(3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation.(3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases.(4)	Student will be able to run the code for few cases and analyze the output.(3)	Student will be able to run the program but not able to analyze the output.(1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

Note: Can add Engineering & IT tool usage based on the nature of the course

	Microcontroller Programming Lab			
	Course Code	**1BUEL406B**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	4
	Teaching Hours/Week (L :T : P)	0: 0 :28	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL:TW	0:0 :28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	02

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. **CO1:** Develop and execute ARM Assembly Language Programs (ALPs) to perform arithmetic, logical, looping, and memory manipulation operations for solving computational problems.
2. **CO2:** Design and implement ARM assembly programs for array processing, searching, sorting, lookup table applications, and bit manipulation techniques.
3. **CO3:** Interface and control external hardware devices such as LEDs, seven-segment displays, switches, relays, buzzers, DACs, and stepper motors using ARM microcontrollers.
4. **CO4:** Develop, test, and debug ARM-based embedded applications involving peripheral interfacing, waveform generation, and real-time hardware control.

SET OF EXPERIMENTS

1. Write an ALP to i) multiply two 16-bit binary numbers. ii) add two 64-bit numbers.
2. Write an ALP to find the sum of first 10 integer numbers.
3. Write an ALP to find factorial of a number.
4. Write an ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM.
5. Write an ALP to find the square of a number (1 to 10) using look-up table.
6. Write an ALP to find the largest/smallest number in an array of 32 numbers.
7. Write an ALP to arrange a series of 32-bit numbers in ascending/descending order.
8. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
9. Write an ALP to count the number of ones and zeros in two consecutive memory locations.
10. Interface a DAC and generate Triangular and Square waveforms.
11. Display the Hex digits 0 to F on a 7-segment LED interface, with a suitable delay in between.
12. Interface a simple Switch and display its status through Relay, Buzzer and LED.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008.

Reference books / Manuals:

1. **Bai, Y. (2016). Microcontroller Engineering with MSP432: Fundamentals and Applications. United States: CRC Press.**

Web links and Video Lectures (e-Resources):

NPTEL course : https://nptel.ac.in/courses/108105102

https://nptel.ac.in/courses/117106111

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Demonstration-Based Learning
2. Problem-Based Learning (PBL)

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE – Continuous assessment:

Performance Indicator	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge (4) (PO1)	In-depth understanding of all topics (4)	Good understanding of most topics (3)	Basic explanation without depth (2)	Limited understanding (1)	No understanding (0)
Design of Experiment (4)	Multiple designs with	Few designs, weak	Single design with	Basic explanation	No understandin

(PO2 & PO3)	justified best choice (4)	selection (3)	pros/cons (2)	only (1)	g (0)
Implementation (5) (PO3 & PO8)	Optimal algorithm with clear justification (5)	Correct implementation with explanation (4)	Implementation with partial clarity (3)	Implementation without clarity (2)	Unable to implement (1)
Result & Analysis (4) (PO4)	Runs all cases with detailed analysis (4)	Runs all cases (3)	Runs few cases with partial analysis (2)	Runs but cannot analyze (1)	Poor setup and analysis (0)
Demonstration (8) (PO9)	Well-organized record with clear sections (8–7)	Organized with minor issues (6–5)	Some sections unclear (4–3)	Poor structure (2–1)	Very poorly organized (0)

Rubrics for SEE / CIE Test:

Performance Indicator	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge (4) (PO1)	In-depth understanding of all topics (4)	Good understanding of most topics (3)	Basic explanation without depth (2)	Limited understanding (1)	No understanding (0)
Design of Experiment (4) (PO2 & PO3)	Multiple designs with justified best choice (4)	Few designs, weak selection (3)	Single design with pros/cons (2)	Basic explanation only (1)	No understanding (0)
Implementation (5) (PO3 & PO8)	Optimal algorithm with clear justification (5)	Correct implementation with explanation (4)	Implementation with partial clarity (3)	Implementation without clarity (2)	Unable to implement (1)
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- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must

secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.

- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementin g the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output. (3)	Student will be able to run the program but not able to analyze the output. (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

Note: Can add Engineering & IT tool usage based on the nature of the course

	LabView Laboratory			
	Course Code	**1BUEL406C**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	4
	Teaching Hours/Week (L :T : P)	0: 0 :28	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL:TW	0:0 :28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	02

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. **CO1:** Construct Virtual Instruments in LabVIEW to perform basic arithmetic and Boolean operations.
2. **CO2:** Demonstrate the use of iterative control structures (for loop and while loop) in LabVIEW to implement algorithms such as summation of 'n' numbers and factorial computation.
3. **CO3:** Develop LabVIEW programs to manipulate arrays for operations including sorting of even numbers and identification of maximum and minimum values.
4. **CO4:** Design and simulate simple real-time systems using LabVIEW, including heating and cooling control, basic calculator, and water level detection.
5. **CO5:** Build user-interactive Virtual Instruments to compute engineering parameters such as area and perimeter of a circle using appropriate programming structures.

SET OF EXPERIMENTS

1. Basic arithmetic operations: addition, subtraction, multiplication and division
2. Boolean operations: AND, OR, XOR, NOT and NAND
3. Sum of 'n' numbers using 'for' loop
4. Factorial of a given number using 'for' loop
5. Determine square of a given number
6. Factorial of a given number using 'while' loop
7. Sorting even numbers using 'while' loop in an array
8. Finding the array maximum and array minimum
9. Build a Virtual Instrument that simulates a heating and cooling system. The system must be able to be controlled manually or automatically.
10. Build a Virtual Instrument that simulates a Basic Calculator (using formula node).
11. Build a Virtual Instrument that simulates a Water Level Detector.
12. Demonstrate how to create a basic VI which calculates the area and perimeter of a circle.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Virtual Instrumentation using LABVIEW, Jovitha Jerome, PHI, 2011.
2. Virtual Instrumentation using LABVIEW, Sanjay Gupta, Joseph John, TMH, McGrawHill, Second Edition, 2011.
3. LabVIEW for Everyone: Graphical Programming Made Easy and Fun, Jeffrey Travis; Jim Kring, Third edition, Prentice Hall / Pearson

Reference books / Manuals:

1. Learning with LabVIEW, Robert H. Bishop, 2002 , 8th Edition, Prentice Hall.
2. Virtual Instrumentation Using LabVIEW , Sanjay Gupta and Joseph John, 2nd Edition , Tata McGraw-Hill Education
3. LabVIEW Graphical Programming, Gary W. Johnson, Richard Jennings, McGraw-Hill

Web links and Video Lectures (e-Resources):

- labviewwiki.org/wiki/LabVIEW_Learning_Materials.
- NI Learning Portal – LabVIEW Courses

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1.**Mini Design Challenges:** Short design tasks involving loops, arrays, Boolean operations, formula nodes, and user interfaces are assigned to enhance programming and analytical skills.

2.**Case Study Discussions:** Applications of Virtual Instrumentation in industrial automation, biomedical systems, process control, robotics, and test-and-measurement systems are discussed.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Rubrics for CIE – Continuous assessment:

Performance Indicator	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge (4) (PO1)	In-depth understanding of all topics (4)	Good understanding of most topics (3)	Basic explanation without depth (2)	Limited understanding (1)	No understanding (0)
Design of Experiment (4) (PO2 & PO3)	Multiple designs with justified best choice (4)	Few designs, weak selection (3)	Single design with pros/cons (2)	Basic explanation only (1)	No understanding (0)
Implementation (5) (PO3 & PO8)	Optimal algorithm with clear justification (5)	Correct implementation with explanation (4)	Implementation with partial clarity (3)	Implementation without clarity (2)	Unable to implement (1)
Result & Analysis (4) (PO4)	Runs all cases with detailed analysis (4)	Runs all cases (3)	Runs few cases with partial analysis (2)	Runs but cannot analyze (1)	Poor setup and analysis (0)
Demonstration (8) (PO9)	Well-organized record with clear sections (8–7)	Organized with minor issues (6–5)	Some sections unclear (4–3)	Poor structure (2–1)	Very poorly organized (0)

Rubrics for SEE / CIE Test:

Performance Indicator	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge (4) (PO1)	In-depth understanding of all topics (4)	Good understanding of most topics (3)	Basic explanation without depth (2)	Limited understanding (1)	No understanding (0)
Design of Experiment (4) (PO2 & PO3)	Multiple designs with justified best	Few designs, weak selection (3)	Single design with	Basic explanation only (1)	No understanding (0)

	choice (4)		pros/cons (2)		
Implementation (5) (PO3 & PO8)	Optimal algorithm with clear justification (5)	Correct implementation with explanation (4)	Implementation with partial clarity (3)	Implementation without clarity (2)	Unable to implement (1)
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- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
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Note: Can add Engineering & IT tool usage based on the nature of the course

	Electronics Networks Lab with PSpice			
	Course Code	**1BUEL406D**	Scheme	2025
	Type of Course	Ability Enhancement Course (Laboratory)	Semester	4
	Teaching Hours/Week (L :T : P)	0: 0 :28	CIE Marks	50
	Total Hours of Pedagogy L :T:P:SL:TW	0:0 :28:2	SEE Marks	50
	Credits	01	Total Marks	100
	Type of Examination	Practical	Exam Hours	02

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. **CO1:** Apply network theorems such as Superposition, Thevenin, Norton, and Millman to analyze and simplify electrical circuits.
2. **CO2:** Determine and evaluate two-port network parameters (Z, Y, ABCD, and H) for analyzing electrical network behavior.
3. **CO3:** Measure and analyze active and reactive power in balanced three-phase circuits under star and delta configurations.
4. **CO4:** Use simulation tools (PSPICE) to analyze multi-loop DC circuits and validate theoretical results.
5. **CO5:** Design and analyze filter circuits and RLC networks to study frequency response and resonance characteristics under varying conditions

SET OF EXPERIMENTS

1. Verification of Superposition Theorem
2. Verification of Thevenin's Theorem and Norton's Theorem
3. Verification of Millman's Theorem
4. Determination of Y-and Z- Parameters of Two-Port Network
5. Determination of ABCD and H-Parameters of Two-Port Network
6. Measurement of Active Power For Star and Delta Connected Balanced Load
7. Measurement of Reactive Power For Star and Delta Connected Balanced Load
8. Multi-Loop DC Circuit Analysis Using P Spice.
9. Design a low-pass, high-pass and band-pass filter for a real-world application. Choose cutoff frequency based on application and compare different filter types (RC, RL, RLC) , Analyze trade-offs such as gain, phase shift, attenuation.
10. Study resonance in RLC circuits under different conditions. What happens when damping is increased/decreased? Explore Shift in resonant frequency with component variation.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. **Engineering Circuit Analysis , William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, 10th Edition (2023), McGraw-Hill Education.**
2. **Network Analysis by M. E. Van Valkenburg , 1950s (Prentice-Hall)**
3. **Electric Circuits , James W. Nilsson, Susan A. Riedel, 1983 (Addison-Wesley)**

Reference books / Manuals:

1. **PSPICE for Circuit Theory and Electronic Devices, Paul W. Tuinenga, Prentice Hall**
2. **Basic Engineering Circuit Analysis, J. David Irwin, R. Mark Nelms, 12th edition (2021), John**

Wiley & Sons

3. **Network Analysis and Synthesis, Franklin F. Kuo, John Wiley & Sons**

Web links and Video Lectures (e-Resources):

- **https://nptel.ac.in/courses/108106075**

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

Design-Oriented Experiments: Students design low-pass, high-pass, and band-pass filters based on application requirements and evaluate performance trade-offs.

Hands-on Experimental Learning: Students perform laboratory experiments to validate theoretical concepts and compare practical results with analytical calculations.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

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Demonstration (8) (PO9)	Well-organized record with clear sections (8–7)	Organized with minor issues (6–5)	Some sections unclear (4–3)	Poor structure (2–1)	Very poorly organized (0)

Rubrics for SEE / CIE Test:

Performance Indicator	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
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Note: Can add Engineering & IT tool usage based on the nature of the course

BIOLOGY FOR ELECTRICAL AND ELECTRONICS ENGINEERS		Semester	IV
Course Code	**1BEC407**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:2	SEE Marks	50
Total Hours of Pedagogy	28	Total Marks	100
Credits	02	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Introduce biological concepts relevant to electrical/electronic systems.
- Apply biodesign principles to sensors, circuits, and biomedical devices.
- Explore biomimetic for signal processing, control, and energy systems.
- Motivate interdisciplinary innovation between biology and electronics

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry based teaching.
2. Instructions with interactions in classroom lectures (physical/hybrid).
3. Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
4. Flipped classroom sessions (~10% of the classes).
5. Industrial visits, Guests talks and competitions for learning beyond the syllabus.
6. Students' participation through audio-video based content creation for the syllabus (as assignments).
7. Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
8. Students' seminars (in solo or group) /oral presentations.

Module-1 (5 Hours)

INTRODUCTION TO BIOLOGY:

The cell(as an information-processing unit): the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells (inspiration for regenerative bioelectronics) and their application. Importance of special biomolecules: Enzymes, vitamins and hormones.(Classification with one example each,Properties and functions)

Module-2(5 Hours)

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE):

DNA/RNA for bio-computing and molecular electronics, Forensics – DNA fingerprinting, lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

Module-3(8 Hours)

HUMAN ORGAN SYSTEMS AND BIO DESIGNS (QUALITATIVE):

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems).

Module-4 (5 Hours)

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE):

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train).

Module-5(5 Hours)

TRENDSBIOENGINEERING (QUALITATIVE):

Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Bioremediation and Bio mining.Medical imaging technologies—X-ray, CT, MRI and Ultrasound (overview);

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Elucidate the basic biological concepts via relevant industrial applications and case studies.
2. Evaluate the principles of design and development, for exploring novel bioengineering projects.
3. Corroborate the concepts of biomimetics for specific requirements.
4. Think critically towards exploring innovative bio-based solutions for socially relevant problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 2 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Text Book: Text Book: Engineering with Biology- Fundamentals and Applications, 2nd Edition, S. Fatima, R. S. Deshpande, M. Ziaullah, Mahantesh Mattada, Santosh Nejakar and Sadashiv Halbhavi, Najekar Publications, 2026

Suggested Learning Resources:

Books

- Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
- Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
- Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
- Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011 Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
- Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
- Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
- Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
- Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C Udayashankar Lambert Academic Publishing, 2019.
- 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
- Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006 https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Group Discussion of Case studies

- Model Making and seminar/poster presentations
- Design of novel device/equipment like Cellulose-based water filters, Filtration system

ENVIRONMENTALSCIENCEPROJECT			
Course Code	**1BEP408**	Scheme	**2025**
TypeofCourse	SocietalDevelopmentCourse(SDC)	Semester	IV
TeachingHours/Week(L:T:P)	30(0:0:0)	CIEMarks	50
TotalHoursofPedagogyper SemesterCI(L/T):LI(P):TW&SL	30(0:0:0:30)	SEEMarks	50
Credits	**1**	TotalMarks	100
Examinationtype (SEE)	**Theory**	ExamHours	03

Course Objectives:

The Environmental Science Project is a practical, applied-learning course that builds students' environmental awareness and responsibility. It focuses on real issues such as climate change, pollution, biodiversity, resource use, soil erosion, and thermal comfort, using field surveys, case studies, data collection, audits, and analysis to develop feasible and sustainable solutions. Students may work individually or in groups of up to four, including interdisciplinary topics, and assessment is based on the prescribed rubrics.

Courseoutcome (CourseSkillSet):

Attheendofthecourse,thestudentwillbeableto:

1. **CO1 (L2 – Understand):** Identify and analyse environmental problems through field interaction and technical assessment.
2. **CO2 (L3 – Apply):** Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.
3. **CO3 (L4 – Analyze):** Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.
4. **CO4 (L3 – Apply):** Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
5. **CO5 (L4 – Analyze):** Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.
6. **CO6 (L5 – Evaluate):** Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.

Restrictionsandprofessionalconduct:

Environmental Science Projects should be academic, socially responsible, technically focused, and politically neutral. Students and faculty must maintain professionalism, ethical conduct, and respect while working with communities and stakeholders, and avoid any political, ideological, commercial, or disruptive activities. Projects should also consider practical constraints such as cost, resources, safety, environmental impact, and stakeholder cooperation.

SET OF PROJECT ACTIVITIES (TW/SL = 30 HOURS)

Methods for project identification:

Students may identify the project topic using one or more of the following methods: interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.; review of issues highlighted in print and electronic media, and social networks; and, after selecting a broad topic, collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and define the problem statement and objectives clearly.

List of Project Topics and Engineering Outcomes:

The following structured sequence of activities is to be carried out during the semester:

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8, PO10	SDG 11, SDG 12, SDG 13
3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate	PO2, PO3, PO4, PO6, PO7,	SDG 11, SDG 13,

		tracking and maintenance schedule for saplings.	PO11	SDG 15
4	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10
7	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10	Health and nutrition awareness	Conduct baseline and post-program awareness survey and daocument improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17
12	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
14	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
15	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in	PO1, PO2, PO3, PO4, PO5,	SDG 2, SDG 9, SDG 12

		spoilage or wastage.	PO10	

Suggested Learning Resources

Particulars	Titles and Publishers
Textbooks	1. Phadke, N. D., *Community Engagement and Social Innovation*, Oxford University Press, New Delhi. 2. Garg, N. R., *Project-Based Learning in Engineering Education*, Pearson India Education Services, Noida. 3. Gupta, A. and P. Singh, *Service Learning and Community Projects*, McGraw-Hill Education (India), New Delhi. 4. Wilson, G., *Practical Guide to Community Development Projects*, Routledge, London.
Reference books	1. NPTEL courses on Project-Based Learning and Social Innovation. 2. SWAYAM courses on community engagement and sustainability. 3. UN Sustainable Development Goals portal. 4. MyGov India and local civic body portals for community initiatives. 5. YouTube resources on design thinking, social innovation, and community service learning. 6. NGO and government field action case studies related to sanitation, water, health, education, and environment.
Web links and Video Lectures (e-Resources)	1. NPTEL courses on Engineering Geology. 2. NPTEL courses on Soil Mechanics and Foundation Engineering. 3. Virtual Labs – Geotechnical Engineering Virtual Lab. 4. Geological Survey of India. 5. YouTube channels on civil engineering experiments. 6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards.

Teaching Learning Process:

The suggested TLP for Community / Societal Project is as follows;

Week / Phase	Teaching–Learning Activity	Faculty Role	Student Activity	Output / Evidence
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan
2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record
4	Problem statement and objective formulation	Review and refine problem statement	Prepare problem statement, scope, and objectives	Approved problem statement
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary
6	Project planning and role assignment	Help teams organize tasks, timeline, and	Plan activities, divide roles, and prepare	Work plan / Gantt chart

		responsibilities	schedule	
7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyze data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output
12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and viva practice	Conduct mock presentation and feedback	Prepare slides/poster and rehearse	Presentation deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

- Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totalling 50 marks:

CIE pass requirement:

A student shall secure a minimum of 20 marks out of 50 in CIE to become eligible to appear for SEE.

- Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; no re-doing of CIE is permitted after the end of the semester.

B. Semester End Examination (SEE) – 100 marks (scaled to 50)

- Examination duration: 2 hours.
- Maximum examination marks: 100 (entered as 100 in the VTU portal; the ITI-SMU module automatically scales 100 → 50 for result processing).
- The SEE shall be conducted batch-wise by a committee of three faculty: project guide, one faculty from the same department and one from a different department.

SEE pass requirement and overall passing rule:

- For a pass in SEE, a student shall secure minimum 35 marks out of 100.
- For declaration of a pass grade, the sum of CIE marks (out of 50) and scaled SEE marks (out of 50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIE Rubric — Continuous Internal Evaluation (Total 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/environment	8	Problem clearly identified with strong evidence of relevance and well-defined scope.	Relevant problem with clear scope and adequate evidence.	Problem defined but justification is weak.	Problem unclear or not relevant.
Formation of problem statement; engineering approach, innovation & feasibility	10	Precise statement; sound, innovative, feasible approach.	Adequate statement; feasible with minor gaps.	Partial statement; marginal feasibility.	Missing or infeasible.
Interaction with stakeholders; data collection, analysis & interpretation	8	Thorough engagement; comprehensive data and well-interpreted analysis.	Good engagement; adequate data and analysis.	Limited engagement; incomplete data and superficial analysis.	Little or no stakeholder contact; no data/analysis.
Project documentation; clarity, organization & problem-solving demonstrated	10	Complete, well-organized, analytical, and strong problem-solving.	Complete and clear with some analytical content.	Basic with omissions; problem-solving limited.	Missing/poorly organized; no clear problem-solving.
Communication & presentation skills	6	Confident, structured, and answers queries fully; visuals effective.	Clear and satisfactory; responds to most queries.	Acceptable but lacks clarity or confidence; weak responses.	Poor or absent; unable to respond.
Contribution & benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and realistic sustainability path.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear benefit; sustainability weak.	No evident benefit or sustainability.

Notes for CIE rubric:

- Minimum CIE pass requirement: 20/50 to be eligible for SEE. [Use departmental committee (HoD/guide + senior faculty) to apply the rubric and record marks.]

SEE Rubric — Semester End Examination (Enter marks out of 100; scaled to 50 later):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification &relevance to society/environment	16	Clearly articulated with strong evidence and context.	Clear with reasonable evidence.	Problem stated but evidence/context weak.	Poorly defined or irrelevant.
Formation of	20	Precise;	Technically	Basic; limited	No viable

problem statement; engineering approach, innovation & feasibility		demonstrates engineering depth, novelty and feasibility.	sound and feasible with minor limitations.	technical depth or feasibility concerns.	engineering approach or infeasible plan.
Interaction with stakeholders; data collection, analysis & interpretation	16	Excellent engagement; rigorous data collection and insightful analysis.	Good engagement and acceptable analysis.	Superficial data collection and limited analysis.	Inadequate or no data; poor analysis.
Project documentation; clarity, technical rigor & problem-solving demonstrated	20	Comprehensive, technically rigorous, and systematic.	Complete and technically correct with minor gaps.	Lacks technical depth or has notable omissions.	Missing key elements or technically incorrect.
Communication, presentation & viva-voce responses	12	Presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	Adequate but fails to answer some technical questions.	Poor presentation and unable to defend work.
Contribution & benefit to society; impact assessment & sustainability	16	Clear, evidence-based impact assessment with scaling recommendations .	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impact or sustainability.	No coherent assessment of impact or sustainability.

SEE pass rule:

- Student must secure at least 35/100 in SEE itself to be eligible for pass consideration.
- Final passing is based on CIE (out of 50) + SEE (scaled to 50) >= 40. Otherwise, grade F (Fail) is awarded.

Suggested implementation notes (for BoS / exam committees):

- Use numerical scores from the rubric and keep brief evaluator comments for each criterion.
- For team projects: record individual contribution within the documentation and adjust individual marks using a peer-evaluation sheet or guide's assessment.
- Maintain evidence (field notes, photos, questionnaires, DPRs, reports) as annexures for SEE moderation.
- Use standardized score sheet (spreadsheet) mapping rubric items to columns for easy aggregation and archival.

- Awareness Campaign on Single-Use Plastic and E-Waste Management

SuggestedLearningResources:

TextBooks:

1. BennyJoseph,*EnvironmentalStudies*,TataMcGraw-Hill,2ndEdition.
2. R.Rajagopalan,*EnvironmentalStudies:FromCrisistoCure*,OxfordUniversityPress,2005.
3. ErachBharucha,*TextbookofEnvironmentalStudies*,UniversityPress,latesteditionasavailablein library.
4. M.P.PooniaandS.C.Sharma,*EnvironmentalStudies*,VikasPublishingHouse,latesteditionasavailable

ReferenceBooks:

1. R.Sivakumar,PrinciplesofEnvironmentalScienceandEngineering,CengageLearning,2ndEdition.
2. G.TylerMillerJr.,EnvironmentalScience:WorkingwiththeEarth,ThomsonBrooks/Cole,11thEdition.
3. PratibhaSingh,AnoopSingh,andPiyushMalaviya,TextBookofEnvironmentalandEcology,AcmeLearnin 1stEdition.
4. S.M.Prakash,EnvironmentalStudies,ElitePublishingHouse,Mangalore,3rdEdition,2018.

WeblinksandVideoLectures(e-Resources):

1. VTUe-LearningCentre:http://elearning.vtu.ac.in
2. VTUe-Resources/e-Content:http://elearning.vtu.ac.in/e-Res.php
3. VTUe-ShikshanaLectureVideos:http://elearning.vtu.ac.in/esk3.php
4. VTUConsortiumDigitalResources:https://access.vtuconsortium.com/msec
5. VTUe-LearningCentre:http://elearning.vtu.ac.in
6. VTUe-Resources/e-Content:http://elearning.vtu.ac.in/e-Res.php
7. VTUe-ShikshanaLectureVideos:http://elearning.vtu.ac.in/esk3.php
8. VTUConsortiumDigitalResources:https://access.vtuconsortium.com/msec

AssessmentStructure:

ContinuousInternalEvaluation(CIE):shallbeconductedbytheDepartmentalProjectReviewCommitteeconsisting of a Senior Professor, the Project Guide, and one additional faculty member nominated by the Head of the Department.SemesterEndEvaluation(SEE)shallbeconductedbyuniversity-appointedexaminers.Theevaluation shall be basedonrubrics designedtoassess the attainmentofNBA-defined graduate attributes,includingproblem analysis, investigation, design of solutions, communication, teamwork, and professionalism**.**

TheweightageofmarksforCIEandSEEis50% each.

Pass Criteria:A candidate shall secure a minimum of 40% of the total marks prescribed for Project Work, subject to the required minimum in Continuous Internal Evaluation and Semester End Evaluation as per VTU regulations.

Sample Rubrics for Campus water-quality and development of a water-conservation plan.

Criterion	Weight (%)	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs improvement
Problem definition and campus context	10	Clearly defines campus water issue, boundaries, water sources, and purpose.	Defines issue and context with minor gaps.	Basic problem stated, but scope is incomplete.	Vague or incorrect problem definition.
Water-quality data collection	15	Uses appropriate sampling points, methods, and frequency; data are well documented.	Methods are mostly appropriate with minor omissions.	Limited methods or incomplete documentation.	Weak or unclear data collection.
Water-quality parameters and analysis	20	Correctly analyzes key physical, chemical, and	Analyzes most parameters correctly with	Some parameters analyzed, but	Minimal or incorrect analysis.

Criterion	Weight (%)	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs improvement
		microbiological parameters and interprets results.	minor interpretation gaps.	interpretation is weak.	
Evidence and standards comparison	15	Compares results against relevant standards/guidelines and draws valid conclusions.	Compares most results with reasonable conclusions.	Comparison is partial or uneven.	No meaningful comparison with standards.
Diagnosis of issues and causes	10	Identifies likely causes of poor quality or water loss using evidence.	Identifies main causes with some support.	Causes are mentioned, but weakly supported.	Causes are speculative or absent.
Conservation plan objectives and measures	15	Plan includes clear goals, realistic measures, prioritization, and campus suitability.	Plan is relevant and mostly realistic.	Plan has some useful measures but limited prioritization.	Plan is generic or impractical.
Feasibility and implementation	10	Addresses resources, responsibilities, timeline, and implementation steps clearly.	Covers most implementation aspects.	Implementation is partial or underdeveloped.	Little or no implementation planning.
Cost, savings, and sustainability	5	Provides reasonable cost-benefit thinking and expected savings.	Includes some cost or savings discussion.	Limited financial/savings analysis.	No cost or savings consideration.
Presentation and documentation	0–10	Clear structure, tables/figures, references, and professional report quality.	Well organized with minor issues.	Acceptable but uneven formatting or writing.	Poorly organized and difficult to follow.

Basics of Signal Processing

Course Code	1BUE409	Scheme	2025
Type of Course	PCC	Semester	3
Teaching Hours/Week (L:T:P)	3:2:0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:0:0:48:90	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3 Hrs

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Explain the characteristics and classification of continuous-time and discrete-time signals, and interpret their frequency representation.
2. Analyse discrete-time signals and Linear Time Invariant (LTI) systems using convolution, difference equations, and system properties.
3. Apply Z-transform and Discrete Fourier Transform (DFT) techniques to analyse and represent discrete-time signals and systems in the frequency domain.
4. Evaluate DFT properties and implement Fast Fourier Transform (FFT) algorithms for efficient computation and signal processing applications.
5. Design and realize digital filters, including linear-phase FIR filters using windowing techniques and IIR filters using bilinear transformation methods.

Module-1

Introduction: Signals, Systems and Signal Processing, Classification of Signals, The Concept of Frequency in Continuous Time and Discrete Time Sinusoidal Signals. [Text1: 1.1, 1.2, 1.3: 1.3.1, 1.3.2]

Discrete Time Signals and Systems: Discrete Time Signals, Discrete Time Systems, Analysis of Discrete Time Linear Time Invariant Systems. [Text 1: 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.3.3, 2.3.5]

Number of Hours: 10

Module-2

Z-Transforms: The Z-Transform, Properties of the Z-Transform (Statements only), The System Function of a Linear Time Invariant system. Text1:3.1, 3.2, 3.3.3.

The Discrete Fourier Transform: Frequency Domain sampling and Reconstruction of Discrete Time Signals, The DFT, The DFT as Linear Transformation. Properties of DFT: Periodicity, Linearity and Symmetry for real valued sequence, Multiplication of two DFTs and Circular Convolution. [Text1: 7.1.1, 7.1.2, 7.1.3, 7.2: 7.2.1, 7.2.2]

Number of Hours: 08

Module-3

DFT Properties: Time reversal of a sequence, Circular Time shift of a sequence, Circular frequency shift, Complex conjugate property, Multiplication of two sequences, Perceval's theorem. Linear Filtering Methods based on the DFT. (Text 1: 7.3].

Efficient Computation of the DFT- FFT Algorithms: Direct Computation of the DFT, Radix-2 FFT Algorithms: computation of DFT and IDFT in decimation in time. [Text1: 8.1: 8.1.1, 8.1.3].

Number of Hours: 08

Module-4

Design of FIR Filters: Characteristics of practical frequency-selective filters, Symmetric and Antisymmetric FIR filters, Design of Linear-phase FIR (low pass and High pass) filters using windows - Rectangular, Bartlett, Hanning, Hamming and Blackman windows. Structure for FIR Systems: Direct form and Cascade form. [Text1: 10.1.2, 10.2.1, 10.2.2]

Number of Hours: 08

Module-5

IIR Filter Design: Infinite Impulse response Filter Format, Bilinear Transformation Design Method, Analog Filters using Low pass prototype transformation, Normalized Butterworth Functions, Bilinear Transformation and Frequency Warping, Bilinear Transformation Design Procedure, Digital Butterworth Filter Design (Lowpass and High pass) using BLT. Realization of IIR Filters in Direct form I and II. [Text2: 8.1, 8.2, 8.3 (Butterworth filter design), 8.8.1]

Number of Hours: 08

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Proakis & Manolakis, "Digital Signal Processing - Principles Algorithms & Applications", 4th Edition, Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.
2. Li Tan, Jean Jiang, "Digital Signal processing - Fundamentals and Applications", Academic Press, 2013, ISBN: 978-0-12-415893.
3. Vinay K. Ingle, John G Proakis , "Digital Signal Processing Using MATLAB, A problem Solving Companion", Cengage Learning, 2018, ISBN: 93-86668-11-4

Reference books / Manuals:

1. Simon Haykin and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN9971-51-239-4.
2. Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2017. ISBN:978-1-25-909858
3. Oppenheim & Schaffer, "Discrete Time Signal Processing", PHI, 2003.
4. D Ganesh Rao and Vineeth P Gejji, "Digital Signal Processing" Cengage India Private Limited, 2017, ISBN: 9386858231

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108108185
- https://nptel.ac.in/courses/108106151
- https://ocw.mit.edu/courses/res-6-008-digital-signal-processing-spring-2011/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to explain the different concepts of Basic Signal Processing
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in a multiple representation.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
9. Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes.
10. Give Programming Assignments.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal EvaluationCIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning Activity	Maximum Marks
5.	**Course Project:** Design and implementation of a signal processing application involving signal generation, DFT/FFT analysis, or FIR/IIR filter design using MATLAB/Python/Octave	**15 Marks**
6.	**Case Study Presentation:** Study and presentation on real-world signal processing applications such as audio processing, image processing, speech processing, biomedical signal analysis, radar, or communication systems	**10 Marks**

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):
Rubrics for Course Project

Performance Indicator (CO/PO Mapping)	Superior (15)	Good (12)	Fair (9)	Needs Improvement (6)	Unacceptable (3)
Problem Analysis and Solution Design (CO2, CO5 / PO2, PO3)	Thorough analysis and innovative solution meeting all requirements	Good analysis and design with minor issues	Adequate design meeting most requirements	Partially correct design	Incorrect or incomplete design
Application of Signal Processing Concepts (CO1, CO3, CO4 / PO1, PO5)	Excellent application of transforms, FFT, and filter design concepts	Good application with minor errors	Adequate application of concepts	Limited application of concepts	Unable to apply concepts correctly
Implementation and Tool Usage (CO3, CO4, CO5 / PO4, PO5)	Accurate implementation with effective use of software tools and validation	Good implementation with minor issues	Adequate implementation	Limited implementation capability	Incomplete implementation
Documentation and Presentation (CO5 / PO9, PO10)	Comprehensive report and excellent presentation	Well-organized documentation and presentation	Adequate documentation	Incomplete documentation	Poor or missing documentation

Rubrics for Case Study

Performance Indicator (CO/PO Mapping)	Superior (10)	Good (8)	Fair (6)	Needs Improvement (4)	Unacceptable (2)
Case Study Analysis and Technical Understanding (CO3, CO4, CO5 / PO1, PO2)	Demonstrates thorough analysis and excellent understanding of the selected nanoelectronics topic with relevant technical insights	Good understanding with minor gaps in analysis	Adequate understanding and analysis	Limited understanding of the topic	Inadequate or incorrect understanding
Application of Nanoelectronics Concepts (CO1, CO2, CO5 / PO1, PO3)	Effectively relates case study findings to semiconductor devices, nanomaterials, fabrication, or characterization concepts	Good application of concepts with minor inaccuracies	Adequate connection to course concepts	Limited application of concepts	Unable to relate the case study to course concepts
Presentation, Documentation and Communication (CO5 / PO9)	Well-organized presentation, excellent communication, and comprehensive documentation with proper references	Clear presentation and documentation with minor shortcomings	Adequate presentation and documentation	Incomplete documentation or unclear presentation	Poor or missing documentation and presentation

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
7.	Course Project	30
8.	Case Study	18

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
6.	NPTEL course on Network Analysis (faculty have to verify the dates that the NPTEL course is being offered)	48

Continuous Internal Evaluation (CIE):

9. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
10. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
11. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
12. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

7. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
8. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
9. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Assessment Structure for PCC Courses

Assessment Structure:
The assessment in each PCC course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks].
A minimum of two Internal Assessment Tests(IA) shall be conducted, carrying a total of 25 marks.
In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks.
It is recommended to include a maximum of two learning activities as part of the CCA to foster the holistic development of students. The suggested activities shall be

Sl. No.	Name of the Learning activity	Maximum Marks
1	Group seminar	15
2	Assignment (at RBL3, RBL4, or RBL5 levels)	10

Rubrics for assessment of these learning activities are provide in the Rubrics Section.

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Playing

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1	Group seminar	24
2	Assignment	24
OR		
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1	NPTEL/MooCs course on Analog Electronics and Linear Integrated Circuits (faculty have to verify the dates that the NPTEL course is being offered)	48

Continuous Internal Evaluation (CIE)

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.

(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Assessment Structure for IPCC Courses

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

Questions from the practical component of the IPCC subject shall not appear in the theory SEE component.

CIE Theory component: It consists of IA tests for 25 marks. The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical Component:
The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.

The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks. For laboratory test, the student is required to conduct one experiment each from both Part A and Part B.

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.
The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.
Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed. The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined.

(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Table – IPCCs Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

Passing Requirements for SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Assessment Structure for PCC-Lab and AEC Lab Courses

Assessment Structure:
The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks. For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester (2) Faculty are suggested to offer only TW and not SL.	
Suggested Term Work (TW) Activity	**Number of Hours / Semester**
New Experiment to practice on their own	2
OR	
Practice some of the regular experiments with different design requirements on their own	2

Suggested Rubrics for PCC Courses

Note: the rubrics provided below are a reference and can be modified as required.

Rubrics for Learning Activity1: Group seminar (at RBL3, RBL4, or RBL5 levels)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Subject Knowledge (CO/PO Mapping)	Demonstrates deep knowledge of the subject with clear explanation.	Demonstrates adequate knowledge of most topics with clear explanation.	Demonstrates only basic concepts with Superficial knowledge of topic.	Does not have clear understanding of the topic and lacks grasp of information.	No explanation.
Communication Skills (CO/PO Mapping)	Clearly audible by the entire audience.	Audible by most of the audience.	Audience has difficulty to hear and follow the presentation.	Minimal command on vocabulary with inaccurate pronunciation.	Communication characterized by minimal degree of grammatical accuracy with frequent errors.
Viva Voce (CO/PO Mapping)	Able to understand and answer all the questions confidently with relevant explanation.	Able to understand and answer some of the questions with relevant explanation.	Able to answer and explain few questions with less relevance.	Unable to answer most of the questions.	No proper answer.

Rubrics for Learning Activity2: Assignment (at RBL3, RBL4, or RBL5 levels)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Problem understanding (CO/PO Mapping)	Demonstrates complete understanding of the question and assumptions.	Demonstrates good understanding with only minor omissions.	Demonstrates partial understanding with only some unclear assumptions.	Shows limited understanding of the questions.	Weak understanding of the question.
Correct application of	Applies all relevant	Applies most of the	Applies a few relevant	Frequent incorrect	Major errors in application of

theory and correctness of solution (CO/PO Mapping)	engineering principles, laws, and analytical methods correctly.	relevant engineering principles, laws, and analytical methods correctly.	engineering principles, laws, and analytical methods correctly	application of engineering principles and analytical methods.	engineering principles and analytical methods.

Suggested Rubrics for IPCC courses

Rubrics for CIE Lab test (50marks – later scaled down to 10marks):

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (10) (PO1)	The student has in depth knowledge of the topics related to the course (9-10)	Student has good knowledge of some of the topics related to course (7-9)	Student is capable of narrating the answer but not capable to show in depth knowledge (6-7)	Student has not understood the concepts clearly (5-6)
Design Of Experiment (15) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (14-15)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (12-14)	Student is capable of discussing single design with its merits and de-merits (10-12)	Student is capable of explaining the design (9-10)
Implementation with appropriate HW/SW (15) (PO3 , PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm/HW considering optimal solution explanation. (14-15)	Student is capable of implementing the design with best suitable algorithm/HW and should be capable of explaining it (12-14)	Student is capable of implementing the algorithm/HW with some explanation. (10-12)	Student is just capable of implementing the algorithm/HW , and unsatisfactory explanation. (8-10)
Result &Analysis (10) (PO4, PO5, PO9)	Student is able to run the program on various cases and compare the result with proper analysis. (10)	Student will be able to run the program for most of the cases and provide proper analysis. (7-9)	Student will be able to run the code for few cases and provide analysis for a few cases. (5-7)	Student will be able to run the program for a simple case but not able to analyze the output. (3-5)

Rubrics for CIE – Continuous assessment (30marks – later scaled to 15 marks):

	Superior	**Good**	**Needs Significant Improvement**
Fundamental Knowledge about each experiment (6) (PO1)	The student has in depth knowledge of the topics (4-6)	Student has good knowledge of some of the topics (4)	Student has not understood the concepts clearly (2)
Design Of Experiment (8) (PO2, PO3, PO5)	Student capable of discussing more than one design for problem statement and capable of proving the best suitable design with proper reason (6-8)	Student capable of discussing few designs for problem statement , not capable of selecting best design (6)	Student struggles to explain the design (2-4)
Implementation (10) (PO3, PO4, PO5, PO8)	Student capable of implementing the design (either alone or in a team) with best suitable algorithm considering optimal solution. (8-10)	Student capable of implementing design (either alone or in a team) with best suitable algorithm and capable of explaining it (8)	Student struggle to implement the design (either alone or in a team) . (2-8)
Quality of Record and Observation write up (6) (PO8,PO5,PO9)	Lab record & observation book are well-organized, with clear sections (4-6)	Lab record/ observation book are organized,, but some sections are not well-defined. (4)	The lab record/ observation book poorly organized, with missing or unclear sections. (2-4)

Note: Term Work and Self Learning components are not included in the assessment. IPCC already has theory and lab assessment in CIE, including a TW/SL component may cause burden on students. Faculty may give 50 hours of SL, however this may not be included for assessment.

Suggested Rubrics for PCC-Lab and AEC Lab Courses

Rubrics for CIE – Continuous Lab assessment (30 marks):

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Fundamental Knowledge about each experiment (4) (PO1)	The student has in depth knowledge of the topics (4)	Student has good knowledge of some of the topics (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1-2)	Student barely has fundamental knowledge (1)
Design Of Experiment (5) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4-5)	Student is capable of discussing single design with its merits and de-merits (3-4)	Student struggles to explain the design (2-3)	Student has very weak understanding of the design (1-2)
Implementation (8) (PO3, PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)	Implementation has major errors (1)
Result &Analysis (5) (PO4, PO5, PO9)	Student is able to execute the program/experiment on various cases and compare the result with proper analysis. (4-5)	Student will be able to execute the program/experiment for all the cases. (3-4)	Student will be able to execute the program/experiment for few cases and analyze the output. (2-3)	Student will be able to execute the program/experiment but not able to analyze the output. (1-2)	Program/Experiment execution has important errors and student is incapable to explaining any of them (1)
Quality of Record and	The lab record & observation book	The lab record	The lab record & observation	The lab record	Student has not submitted lab

Observation write up (8) (PO8,PO9)	are well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). l (7-8)	&observation book are organized, with clear sections, but some sections are not well-defined. (5-6)	book lack clear organization or structure. Some sections are unclear or incomplete. (3-4)	&observation book are poorly organized, with missing or unclear sections. (1-2)	record or observation book (0)

Rubrics for CIE Lab Test (50 marks, later scaled to 20 marks) and SEE:

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (5) (PO1)	The student has in depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2, PO3, PO5)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation with appropriate HW/SW (5) (PO3 , PO4, PO5, PO8)	Student is capable of implementing the design with best suitable algorithm/HW considering optimal solution explanation. (7-8)	Student is capable of implementing the design with best suitable algorithm/HW and should be capable of explaining it (5-6)	Student is capable of implementing the algorithm/HW with some explanation. (3-4)	Student is just capable of implementing the algorithm/HW, and unsatisfactory explanation. (1-2)
Result &Analysis (5) (PO4, PO5, PO9)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for most of the cases and provide proper analysis. (4)	Student will be able to run the code for few cases and provide analysis for a few cases. (3)	Student will be able to run the program for a simple case but not able to analyze the output. (1-2)