

This file contains the proposed syllabus for Advanced Communication, 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.

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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: CO1: Develop Fourier series representations of periodic functions and perform harmonic analysis for functions with different periodicities, discontinuities, and symmetry properties. CO2: 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. CO3: Utilize Z-transforms, their properties, inverse transforms, and convolution techniques to analyze discrete-time systems and solve difference equations. CO4: Formulate and solve Linear Programming Problems using graphical, simplex, and Big-M methods to obtain optimal solutions in engineering and management applications. CO5: 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:8+5
Module-2: Fourier transforms.			
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:9+6
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:9+6
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:8+5
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:8+6
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. B.S. Grewal, <i>Higher Engineering Mathematics</i>, 45th Edition, Khanna Publishers. 2. Erwin Kreyszig, <i>Advanced Engineering Mathematics</i>, 10th Edition, Wiley India. 3. H.K. Dass and Er. Rajnish Verma, <i>Higher Engineering Mathematics</i>, S. Chand Publications. Reference books / Manuals: 1. Ruel V. Churchill and James Ward Brown, <i>Fourier Series and Boundary Value Problems</i>, McGraw-Hill Education. 2. Hamdy A. Taha, <i>Operations Research: An Introduction</i>, Pearson Education. 3. Schaum's Outline of Fourier Analysis and Applications, McGraw-Hill. 4. Murray R. Spiegel, John Schiller and R. Alu Srinivasan, <i>Schaum's Outline of Probability and Statistics</i>, McGraw-Hill. 5. S. D. Sharma, <i>Operations Research</i>, 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 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**. 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

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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: C01: Apply Boolean algebra principles to simplify logic functions using Karnaugh Maps (K-Maps) and the Quine–McCluskey minimization technique. C02: Analyze the operation and behavior of combinational logic circuits and standard logic building blocks. C03: Design combinational digital systems using logic gates, multiplexers, decoders, and arithmetic circuits. C04: Analyze and design synchronous and asynchronous sequential circuits using SR, JK, D, and T flip-flops. C05: 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. 11. Design and Optimization of a Combinational Logic System 12. Configurable Arithmetic Logic Unit (ALU) Design
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=PLwdnzlV3ogoVIY7iVqr-FhWUQEX7JDdiP 3. https://www.youtube.com/playlist?list=PLbRMhDVUMngePP5IcezXlmF-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.

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Network Analysis			
Course Code	1BEC303	Scheme	2025
Type of Course	PCC	Semester	III
Teaching Hours/Week (L:T:P: S)	3:2:0	CIE Marks	50
Total Hours of Pedagogy per semester	42:28:0:50	SEE Marks	50
L /T/P/SL&TW:			
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, Kirchhoff's 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 Parameters, 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, 3rd edition, 2000, ISBN:9780136110958. 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,8th ed,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,3rd 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			
Hours:9		Number	of
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			
Hours:9		Number	of
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			
Hours:8		Number	of
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.

INTRODUCTION TO IoT			
Course Code	1BEA305	Scheme	2025
Type of Course	PCC	Semester	III
Teaching Hours/Week (L:T:P: S)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per Semester (L:T:P: S)	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 networking concepts that allow devices to communicate. 2. Describe evolution of IoT, IoT networking components and addressing strategies in IoT. 3. Determine the importance of choosing the right processing topology and connection technology while designing IoT applications 4. Identify the salient features of various cloud computing models and fog computing architecture. 5. Develop basic Arduino and Python programs applications of IoT in agriculture, vehicular systems, and healthcare domains.			
Module-1			
Basics of Networking: Introduction, Network Types, Layered Network Models, Addressing, TCP/IP Transport Layer. (Section 1.1 to 1.5 of Text1). Basics of Network Security: Introduction, Security, Network Confidentiality, Cryptography, Message Integrity and Authenticity, Key Management, Internet Security, Firewall (Section 2.1 to 2.8 of Text1). Predecessors of IoT: Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems (Section 3.1 to 3.4 of Text1). Number of Hours:8			
Module-2			
Emergence of IoT: Introduction, Evolution of IoT, Enabling IoT and the Complex Interdependence of technologies, IoT Networking components, Addressing strategies in IoT . (Section 4.1 to 4.5 of Text1). IoT Sensing and Actuation: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing types, Sensing Considerations, Actuators, Actuator Types, Actuator Characteristics (Section 5.1 to 5.9 of Text1). Number of Hours:8			
Module-3			
IoT Processing Topologies and Types: Data format, importance of processing in IoT, Processing technologies. IoT device design and selection considerations, Processing offloading (Section 6.1 to 6.5 of Text1). IoT Connectivity Technologies: Introduction, IEEE 802.15.4, Zigbee, Thread, ISA 100.11A, WirelessHART, RFID, NFC, Wi-Fi, Bluetooth (Section 7.1 to 7.16 of Text1). IoT Data Protocols: MQTT, MQTT-SN (Section 8.4.1, 8.4.2 of Text1). Number of Hours:10			
Module-4			
Cloud Computing: Introduction, Virtualization, Cloud Models, Service-Level Agreement in Cloud Computing, Cloud Implementation, Sensor-Cloud (Section 10.1 to 10.6 of Text1). Fog Computing: Introduction, View of a fog computing architecture (Section 11.1 to 11.2 of Text1). Number of Hours:8			
Module-5			

	Arduino UNO: Introduction, Arduino UNO, Fundamentals of Arduino programming, DHT sensor interface with NodeMCU (Section 16.1 to 16.2 of Text1). RaspberryPi: Introduction to Raspberry Pi boards, LED interface hardware layout, programming RaspberryPi with python. (Section 16.4 to 16.5 of Text1). Agricultural IoT, Vehicular IoT, Healthcare IoT, Challenges associated with IoT, Emerging pillars of IoT (Chapter 12 to 15 of Text1). Number of Hours:8
	Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. S. Misra, A. Mukherjee and A. Roy, "Introduction to IoT", Cambridge University Press, 2021 2. R Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education (India) Pvt. Ltd., 2017 Reference books / Manuals: 1. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press. 2. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. 3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
	Web links and Video Lectures (e-Resources): Introduction to IoT, NPTEL https://onlinecourses.nptel.ac.in/noc19_cs65/preview
	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. Use demonstrations with simulation tools in the classroom to illustrate the concepts

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: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. 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=PLp6ek2hDcoNDAw1BehPFazZ5ogPV8UIQa
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.

Data Structures and Algorithms Lab			
Course Code	1BEAL307A	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	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 dynamic memory allocation and structures in C programming. 2: Implement singly linked list operations. 3: Develop stack and queue data structures using arrays and linked lists. 4: Design and implement real-time applications using data structures.			
SET OF EXPERIMENTS			
- Write a C program to dynamically allocate memory for n integer elements using malloc(), store the elements, and display them. - Write a C program using structures to store and display the details of student records, such as USN, Name, Marks, and Total. - Write a C program to implement a singly linked list and demonstrate creation and traversal operations. - Write a C program to implement a singly linked list and demonstrate insertion of a node at the beginning, at the end and at a specific position of the list. - Write a C program to implement a singly linked list and demonstrate deletion of nodes from the beginning, end, and a specified position. - Write a C program to search for an element and count the number of nodes in a singly linked list. - Write a C program to implement stack operations using linked lists and demonstrate push, pop, isempty, and isfull operations dynamically. - Write a C program to implement queue operations using arrays and demonstrate enqueue and dequeue operations. - Write a C program to implement queue operations using linked lists and demonstrate enqueue and dequeue operations. - Write a C program to create a Bus reservation system to help people to book tickets for their journey. The functionality of the Bus reservation system is mentioned below: - Booking of tickets - Cancel tickets - Checking bus ticket status - Write a C program to implement a music playlist management system using singly linked lists and demonstrate insertion, deletion, traversal, and search operations. The operations to be performed are. - Add a New song - Display the Playlist. - Delete the song			

	d. Search the playlist. 12. Write a C program to simulate a printer queue management system using a queue data structure. The operations to be performed are. - Add Print Job. - Process print Job - Display the Queue.
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. Reema Theraja, “Data Structures using C”, Oxford publications,2014 2. Sahni Horowitz, “Fundamentals of Data Structures”, University Press , Second edition,2008 3. Yedidyah Langsam & Moshe J. Augenstein Aaron M. Tanenbaum, “Data Structures using C” O Pearson Publication, 2008. 4. Richard Gilberg and Behrouz Forouzan, “Data Structures: A Pseudo code approach with C”, 2nd edition, Thomson publishing, 2007. 5. E. Balagurusamy, “Data Structures using C”, Tata McGraw Hill, 2017.	
Web links and Video Lectures (e-Resources): https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs146	

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.

SPICE Programming for Electronic Circuits Lab			
Course Code	1BEAL307B	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	0:0:28:02	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	03
Course Outcome (Course Skill Set)			
At the end of the course, the student will be able to:			
1. Understand the fundamentals of the SPICE simulation environment and circuit modeling. 2. Develop and execute SPICE netlists for basic electronic circuits. 3. Perform DC, AC, and transient analyses using SPICE simulation. 4. Analyze the behavior and performance of analog and digital electronic circuits through simulation. 5. Simulate and characterize MOSFET and CMOS-based circuits for VLSI applications.			
SET OF EXPERIMENTS using Simulation Program with Integrated Circuit Emphasis (SPICE)			
1. Familiarization with the LTspice/Ngspice environment and basic SPICE commands. Develop a SPICE netlist for a resistive network and perform DC sweep analysis and measure current through all elements voltage across all nodes. 2. Develop a SPICE netlist for resistor networks and verify circuit behavior through simulation. Validate Ohm's Law using simulation results. 3. Develop a SPICE netlists and analyze the transient response of an RC low pass and RC high pass circuits. 4. Develop a SPICE netlists and analyze the transient response of an RL low pass and RL high pass circuits. 5. Develop a SPICE netlists and perform AC analysis of an RL low pass and RL high pass circuits. 6. Develop a SPICE netlists and perform AC analysis of an RC low-pass filter with and without parasitic inductance. 7. Develop a SPICE netlist and perform AC analysis of an RC high-pass filter with and without parasitic inductance. 8. Develop a SPICE netlists and simulate a diode rectifier circuit and clipping circuits. 9. Develop a SPICE netlist and perform AC analysis of a RLC circuit. 10. Develop a SPICE netlist and study the frequency response and Bode plot of a circuit. Correlate the observed peak impedance characteristics with transient analysis results.			
MOSFET-Based Experiments			
11. Develop a SPICE netlist and simulate the drain characteristics (ID–VDS) of a MOSFET. Analyze the effect of gate voltage on device operation. 12. Develop a SPICE netlist and simulate the transfer characteristics (ID–VGS) of a MOSFET. Determine key device parameters from the simulation results. 13. Develop a SPICE netlist and simulate a common-source MOSFET amplifier. Analyze voltage gain and frequency response. 14. Develop a SPICE netlist and simulate a MOSFET inverter. Analyze its switching characteristics and transient response. 15. Develop a SPICE netlist and simulate a CMOS inverter. Plot and analyze its DC transfer characteristics (VTC). 16. Develop a SPICE netlist for a buffer by creating inverter sub-circuit.			
Mini Project (Recommended)			
Design, write SPICE netlist, simulate and analyze one of the following circuits:			

- Implement 2-stage CMOS domino logic and measure the delay.
- Implement NMOS current mirror circuit for 1:1 and 1:2 scaling.
- Implement NMOS Opamp with unity gain (Voltage Follower) and gain-2.
- Implement CMOS high to low level shifter cell.
- Impedance profile of a simple power delivery network (frequency response)

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

Textbooks:

1. SPICE for Circuits and Electronics Using PSpice, M. H. Rashid, SPICE for Circuits and Electronics Using PSpice. Upper Saddle River, NJ, USA: Pearson Education, 2004.
2. The SPICE Book, A. Vladimirescu, The SPICE Book. New York, NY, USA: John Wiley & Sons, 1994.

Reference books / Manuals:

1. Purdue University, SPICE user manual:
<https://www.physics.purdue.edu/~jones105/phys536.Spring2008/Spice3F4.Manual.pdf>
2. HSPICE® User Guide: Simulation and Analysis -
https://cseweb.ucsd.edu/classes/wi10/cse241a/assign/hspice_sa.pdf

Web links and Video Lectures (e-Resources):

- IITR lecture – “Introduction to spice”:
○ <https://www.youtube.com/watch?v=KfBtduxuxCw>
- IITR lecture – “SPICE Simulation”:
○ <https://www.youtube.com/watch?v=Z6Cfbs00Dpg>
○ <https://www.youtube.com/watch?v=tI5GLv1ipKw>

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) Hands-on Simulation-Based Learning:

Conduct guided laboratory sessions where students develop SPICE netlists, perform simulations, and analyze circuit behavior using LTspice, Ngspice, or equivalent tools. Encourage students to compare simulation results with theoretical calculations and expected circuit responses.

2) Mini-Project and Problem-Based Learning (PBL):

Assign real-world circuit design problems and VLSI-oriented mini-projects involving MOSFETs, CMOS circuits, current mirrors, level shifters, and domino logic. Students shall design, simulate, validate, and present their solutions, fostering self-learning, critical thinking, and industry-relevant design skills.

Recommended Tools:

Free circuit simulation tools such as **LTspice** and **Ngspice**, or commercial VLSI ECAD software packages.

Linux Fundamentals Lab			
Course Code	1BEAL307C	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	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. Install and configure the Linux operating system and perform basic system administration tasks. 2. Execute Linux file and directory handling commands and manage disk partitions, users, groups, and permissions effectively. 3. Develop and execute simple C and C++ programs using Linux compilers such as CC and GCC. 4. Write shell scripts using control statements, arrays, and case structures to automate system tasks. 5. Apply Linux networking and text processing utilities for resource sharing and data manipulation.			
SET OF EXPERIMENTS			
1. Installation of Linux operating system using CD/DVD/USB drive or PXE boot. 2. Execution of various file & directory handling commands. 3. Execution of simple C and C++ programs using CC and GCC compiler. 4. Create, mount & resize partition on disk. 5. Create user, group and assign various permissions to access a directory. 6. Share a directory in LAN using SMB. 7. Write a shell script program input-output statements and loops. 8. Write a shell script program using array & case statement. 9. Use of various text processing tools: grep & sed. 10. Write a program in AWK using loops.			
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. Paul Cobbaut, "Mastering Linux Fundamentals" Reference books / Manuals: 1. Jason Cannon, "Linux for Beginners"			
Web links and Video Lectures (e-Resources): 1. https://nptel.ac.in/courses/117106113			
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.

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Analog Electronic Circuit Simulations Lab			
Course Code	1BECL307D/1BECL307A	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	1	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 the knowledge of BJT circuit to determine gain, bandwidth. 2. Apply the knowledge of FET circuit to determine gain, bandwidth. 3. Gain the knowledge on working of oscillators. 4. Realize Op-Amp circuit for the application as DAC. 5. Realize the working of SCR.			
SET OF EXPERIMENTS			
Siemens HyperLynx AMS/ PSPICE/ Open-source tool can be used for simulation.			
1. Design and Set-up the BJT Common Emitter Voltage Amplifier with and Without Feedback and Determine the Gain, Bandwidth. 2. Design and Set-up BJT/ FET Based I) Colpitts Oscillator, II) Crystal Oscillator 3. Realize BJT Darlington Emitter Follower and Determine Gain. 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. Study the Characteristics of SCR.			
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. M. H. Rashid, "Power Electronics, Circuits, Devices and Applications," 4th Edition Pearson Prentice Hall, Upper Saddle River, 2018.			
Web links and Video Lectures (e-Resources):			
• http://digimat.in/nptel/courses/video/108102112/L01.html • https://www.youtube.com/playlist?list=PLp6ek2hDcoNDAw1BehPFazZ5ogPV8UIQa			

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.

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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)	30(0:0:0)	CIEMarks	50
TotalHoursofPedagogyCI(L:T):LI(P):SL:TW	30(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: C01(L2-Understand):Identifyandanalysesocietalproblemsthroughfieldinteractionandtechnical assessment. C02(L3-Apply):Developskillsinprojectplanning,fieldsurvey,datacollection,implementation, documentation and reporting. C03(L4-Analyse):Formulatefeasibleengineeringproblemstatementsandsolutionsconsidering practical constraints and sustainability aspects. C04(L3-Apply):Applyprinciplesofenvironmentalresponsibility,ethicsandsocietalwelfarein engineering practice through community-oriented interventions. C05 (L4 – Analyse):Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions. C06(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. Studentsandfacultyshallavoidthefollowingduringprojectexecution: • Associationwithpoliticalpartyactivities,campaignsorpropaganda. • Participationinactivities thatmaydisturbcommunalharmony,publicorderorinstitutional reputation. • Useoftheprojectplatformforpersonal,political,ideologicalorcommercialpromotion. • Disrespectful,discriminatoryorunethicalinteractionwithcommunitymembersor stakeholders. Projectsmustalsorecogniseconstraintsrelatedtocost,resources,environmentandsafety,and stakeholderbehaviour/cooperation/acceptancewhenplanningandimplementingactivities.			
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:			

SUSTAINABLE DEVELOPMENT GOALS



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 (WhatsApp, Facebook, X, Instagram, etc.).

- After selecting a broad topic, students shall collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and then 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

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 andassesincreaseinlegalawarenessand 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

Suggested Learning Resources:**Textbooks:**

1. **Phadke, N.D.** Community Engagement and Social Innovation. 1st ed., Oxford University Press, New Delhi.
2. **Garg, N.R.** Project-Based Learning in Engineering Education. 1st ed., Pearson India Education Services, Noida.
3. **Gupta, A. and P. Singh.** Service Learning and Community Projects. 1st ed., McGraw-Hill Education (India), New Delhi.
4. **Wilson, G.** Practical Guide to Community Development Projects. 2nd ed., 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: <https://sdgs.un.org>
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.

Weblinks and Video Lectures (e-Resources):

1. NPTEL courses on Engineering Geology (IIT Roorkee, IIT Kharagpur).
2. NPTEL courses on Soil Mechanics and Foundation Engineering (IIT Delhi, IIT Bombay).
3. Virtual Labs- Geotechnical Engineering Virtual Lab (IIT Kanpur): <https://vlab.co.in>
4. Geological Survey of India (GSI)-Maps, reports, and publications: <https://www.gsi.gov.in>
5. YouTube channels: Civil Engineering Essentials, The Engineering Classroom (soil mechanics 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	Review and refine problem statement	Prepare problem statement, scope, and	Approved problem statement
	formulation		objectives	
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary

Week/Phase	Teaching-Learning Activity	Faculty Role	Student Activity	Output/Evidence
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Workplan/Gantt chart
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/industry/community	8	Problem is clearly identified with strong evidence of societal relevance and well-defined scope.	Problem is relevant and scope is clear with adequate supporting evidence.	Problem defined but justification or evidence is weak.	Problem unclear or not relevant; little/no supporting evidence.
Formation of problem statement; Engineering approach, innovation & feasibility	10	Problem statement is precise; approach is sound, innovative and clearly feasible.	Problem statement adequate; approach feasible with minor gaps.	Problem statement partial; approach feasibility is marginal.	Problem statement missing or approach not feasible.
Interaction with stakeholders; Data collection, analysis & interpretation	8	Thorough stakeholder engagement; data collection is comprehensive; analysis is well-interpreted.	Good engagement; data and analysis adequate with minor gaps.	Limited engagement; data incomplete and analysis superficial.	Little/no stakeholder contact; insufficient or no data/analysis.
Project documentation; Clarity, organization & problem-solving demonstrated	10	Documentation is complete, well-organized, analytical, and shows strong problem-solving.	Documentation complete and clear with some analytical content.	Documentation basic with omissions; problem-solving limited.	Documentation missing/poorly organized; no clear problem-solving.
Communication & Presentation skills	6	Presentation is confident, structured, and answers queries fully; visuals effective.	Presentation clear and satisfactory; responds to most queries.	Presentation acceptable but lacks clarity or confidence; weak responses.	Presentation poor or absent; unable to respond.
Contribution & Benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and sustainability; realistic path to implementation.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear societal benefit; sustainability not well addressed.	No evident benefit or sustainability; project not community-oriented.

Notes for CIE rubric:

- Minimum CIE pass requirement: 20/50 to be eligible for SEE. [Used 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/industry/community	16	Problem and relevance are articulated clearly with strong evidence and context.	Problem relevance clear with reasonable evidence.	Problem stated but evidence/context weak.	Problem poorly defined or irrelevant.
Formation of problem statement; Engineering approach, innovation & feasibility	20	Problem statement is precise; approach demonstrates engineering depth, novelty and feasibility.	Approach is technically sound and feasible with minor limitations.	Approach basic; limited technical depth or feasibility concerns.	No viable engineering approach or infeasible plan.
Interaction with stakeholders; Data collection, analysis & interpretation	16	Excellent stakeholder 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	Report is comprehensive, technically rigorous, and demonstrates systematic problem-solving.	Report is complete and technically correct with minor gaps.	Report lacks technical depth or has notable omissions.	Report missing key elements or technically incorrect.
Communication, Presentation & Viva-voce responses	12	Candidate presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	Presentation 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 assessment of social impact and Sustainability with scaling recommendations.	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impact or sustainability.	No coherent assessment of impact or sustainability.

SEEpasrule:

- 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 scoresheet (spreadsheet) mapping rubric items to columns for easy aggregation and 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.
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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) (P01)	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) (P02, P03, P05)	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) (P03, P04, P05, P08)	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) (P08,P05,P09)	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) (P01)	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) (P02, P03, P05)	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 demerits (3-4)	Student struggles to explain the design (2-3)	Student has very weak understanding of the design (1-2)
Implementation (8) (P03, P04, P05, P08)	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) (P04, P05, P09)	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). I (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)
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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/H W, 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 Advanced Communication, 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.

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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 a linear 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 Machine Learning", 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, <i>Higher Engineering Mathematics</i>, 45th Edition, Khanna Publishers. 4. Erwin Kreyszig, <i>Advanced Engineering Mathematics</i>, 10th Edition, Wiley India. 5. H.K. Dass and Er. Rajnish Verma, <i>Higher Engineering Mathematics</i>, S. Chand Publications. <u>Reference books / Manuals:</u> 1. Christopher M. Bishop, <i>Pattern Recognition and Machine Learning</i>, Springer, 2006. 2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, <i>The Elements of Statistical Learning</i>, 2nd Edition, Springer, 2009. 3. Sheldon Ross, <i>A First Course in Probability</i>, 10th Edition, Pearson Education, 2019. 4. Kenneth Hoffman and Ray Kunze, <i>Linear Algebra</i>, 2nd Edition, Pearson. 5. David C. Lay, Steven R. Lay and Judi J. McDonald, <i>Linear Algebra and Its Applications</i>, 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 PBL3 and RBL4 levels 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).

SIGNALS AND SYSTEMS			
Course Code	1BEA402/1BEC402	Scheme	2025
Type of Course	IPCC	Semester	IV
Teaching Hours/Week (L:T:P: S)	3:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:28:50	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory- CIE +SEE, Lab- CIE only.	Exam Hours	3
Course outcome (Course Skill Set) At the end of the course, the student will be able to: - CO1: Apply knowledge of mathematics and Engineering fundamentals to Identify and characterize different classes of signals - CO2: Compute the response and analyze the properties of an LTI system - CO3: Analyze the signals in time and frequency domain for non periodic signals - CO4: Apply Fourier representations to analyze sampling process and mixed signals - CO5: Apply ZT for broader characterization of discrete time signals and LTI systems.			
Module-1			
Introduction: Definition of signals and systems, Mathematical Representation, Classification of signals, Operation on signals, Elementary signals, Systems viewed as interconnection of operations, Properties of systems. (Chapter 1 of Text Book 1) Number of Hours:8			
Module-2			
Time Domain Representation of LTI Systems: Introduction, Impulse response representation of LTI systems, Properties of impulse response representation, Difference equation representation of LTI systems. (Sections 2.1 to 2.3 and 2.4 only Difference equation of Text Book 1) Number of Hours:8			
Module-3			
Fourier representations for signals: Introduction, Orthogonality of complex sinusoids, Discrete Time non periodic signals: DTFT representation, Continuous Time non periodic signals: FT representation, Properties of Fourier transforms and DTFT. (Sections 3.1 to 3.5 of Text Book 1) Number of Hours:10			
Module-4			
Applications of Fourier representations: Introduction, Frequency response of LTI systems, Fourier Transform representation of periodic signals, Fourier Transform representation of Discrete time signals, Sampling, reconstruction of continuous time signals. (Sections 4.1 to 4.3, 4.5 to 4.6) Number of Hours:8			
Module-5			
Z-Transform: Introduction, Properties of ROC, Properties of Z-transform, inversion of Z-transform, Transform analysis of LTI systems, stability & causality, Unilateral Z-transform and its application. (Sections 6.1 to 6.7, 6.10) Number of Hours:8			
PRACTICAL COMPONENTS OF IPCC			

PART – A: FIXED SET OF EXPERIMENTS	
Integrated Lab 1) Generation of sinusoidal signal 2) Energy computation of real and complex signals 3) Response calculation of Discrete LTI system using Convolution 4) Frequency domain representations of single tone and multi tone sinusoidal signals 5) Sampling theorem verification 6) Plotting spectrum of discrete time signals 7) Given the impulse response of a system, find the response of a system to natural signals and analyze the input and output in time and frequency domains. 8) Comment on the stability of a system given its z-transform by plotting poles and zeros 9) Represent periodic natural signals in time and frequency domain and comment 10) Represent aperiodic natural signals in time and frequency domain and comment 11) Analyze the frequency components of natural signals 12) Compute the fundamental period of periodic natural signals and analyze by listening (can include speech, music, biomedical signals)	
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. Simon Haykin, Barry Van Ven, Signals and systems. Ed 2, John Wiley. Indian Ed, 2021. Reference books / Manuals: 1. H.P. HSU. Schaum's Outlines- Signals & Systems, Ed 2, TMH, 2010 2. Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab, Signals & systems Ed 2, PHI, 2014	
Web links and Video Lectures (e-Resources): 1. https://nptel.ac.in/courses/117101055 2. https://nptel.ac.in/courses/117104074	

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 differentiation, integration and complex variables during the tutorial sessions
2. Use demonstrations with simulation tools in the classroom to illustrate complex concepts

Control Systems		Semester	IV
Course Code	1BEC403	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	50
Total Hours of Pedagogy per semester L:T:P:SW/TL	42:28:0:50	Total Marks	100
Credits	4	Exam Hours	3
Examination type (SEE)	Theory		
Course outcome (Course Skill Set) CO1: Analyze physical systems and their mathematical models using differential equations, transfer functions, and system analogies. CO2:Evaluate the effect of feedback on control systems by examining block diagrams, signal flow graphs, and overall system behavior. CO3:Analyze the time response characteristics and steady-state performance of first- and second-order control systems, including the influence of basic controllers. CO4:Assess the stability and relative stability of control systems using Routh–Hurwitz criterion and root locus techniques. CO5:Analyze control system stability and performance in the frequency domain using Bode, Polar, and Nyquist plots.			
Module-1			
Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs. Text Book T1: Chapter 1: 1.1,1.3,1.5,1.6, Chapter 2: 2.1,2.2,2.4,2.5,2.6,2.7 Text Book T2: Chapter 3 Number of Hours: 14			
Module-2			
Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design). Text Book T1: Chapter 5:5.1,5.2,5.3,5.4,5.5 Text Book T2: Chapter 3 Number of Hours:14			
Module-3			
Stability analysis: Concept of stability, necessary conditions for Stability, Routh- stability criterion, Relative stability criterion Root-Locus Techniques: Root locus concepts, Construction of root loci, Stability of System. Text Book T1: Chapter 6:6.1,6.2,6.3,6.4,6.5 Chapter 7:7.1,7.2,7.3 Text Book T2: Chapter 3 Number of Hours: 14			
Module-4			
Frequency domain analysis and stability using Bode plots: Correlation between time and frequency			

response, Bode Plots, Experimental determination of transfer function. Text Book T1: Chapter 8: 8.2,8.4,8.5,8.6,8.7 Text Book T2:Chapter 3 Number of Hours: 14
Module-5
Frequency domain analysis and stability: Introduction to Polar Plots, Mathematical preliminaries, Nyquist Stability criterion, Nyquist plots. Text Book T1: Chapter 8: 8.1,8.3, Chapter 9: 9.1,9.2,9.3 Number of Hours:14
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. J. Nagarath and MGopa1," ControlSystemsEngineering", NewAge International(p) Limited Publishers, 5 th Edition- 2005, ISBN:81-224-2008-7 2. Analysis and design of Control system using MATLAB by Rao V Dukkipati, New Age international (p) Limited Publishers,2006 Publication. Reference books / Manuals: 1. K.Ogata,"Modem Control Engineering" Pearson .Education Asia I PHI, 4th Edition,2002. 2. K.ChannaVenkatesh and D. Ganesh Rao, "Control Systems", Sanguine TechnicalPublishers. 3. Chi-Tsong Chen, "Analog and Digital Control System Design Transfer-Function, State-Space, and Algebraic Methods", OUP, 2006
Web links and Video Lectures (e-Resources): • https://nptel.ac.in/courses/107106081 • https://onlinecourses.nptel.ac.in/noc24_ee65/preview
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, transfer functions, 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 tools demonstrations in the classroom to illustrate complex concepts

Computer Architecture and Microcontrollers			
Course Code	1BEA404	Scheme	2025
Type of Course	PCC	Semester	3
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:			
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, processor fundamentals, and basic embedded software development.			
CO5: Apply ARM instruction set concepts for embedded programming and for different applications.			
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: 1.1 to 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, Zvonko Vranesic, Safwat Zaky, 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.

Analog Communication Lab			
Course Code	1BEAL405/1BETL405	Scheme	2025
Type of Course	PCC Lab	Semester	IV
Teaching Hours/Week (L:T:P:S)	0:0:2:0	CIE Marks	50
Total Hours of Pedagogy per semester (L:T:P:S)	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. Demonstrate generation and detection of analog modulated signals. 2. Design and demonstrate pulse modulation systems. 3. Analyze the effect of sampling frequency for signal discretization. 4. Perform signal quantization.			
PART - A FIXED SET OF EXPERIMENTS (To be carried out using discrete components)			
1. Review of DSO and function generators operation (not for the exam) 2. Generation and Detection of Amplitude Modulated signal 3. Generation of Frequency Modulated signal 4. Pre-emphasis and De-emphasis of Audio 5. Sampling and Reconstruction 6. Generation and Detection of Pulse Amplitude Modulated signal 7. Generation of pulse width modulated signal			
 PART - B OPEN ENDED EXPERIMENTS (To be carried out using Matlab/python/scilab/GNU Radio simulations) 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. Develop a software code to verify frequency division multiplexing 2. Develop a software code to verify super heterodyne receiver 3. Develop a software code to study the Effect of Narrowband noise for a CW Signal 4. Develop a software code to verify Time Division Multiplexing 5. Develop a software code to verify pulse code modulation 6. Develop a software code to verify delta modulation			
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. Simon Haykin and Michael Moher, Communication Systems, 5th Edition, John Wile and Sons, 2023. Reference books / Manuals: 1. Simon Haykin, "An introduction to analog and digital communications", John Wiley 2010.s 2. Lathi B. P., "Modern digital and analog communication systems", Tata Mc- Graw-Hill, Edition V, 2011.			

Web links and Video Lectures (e-Resources):

Analog Communication: https://onlinecourses.nptel.ac.in/noc21_ee74/preview

Principles of Communication Systems-I https://onlinecourses.nptel.ac.in/noc26_ee36/preview

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.

Python for understanding random processes Lab			
Course Code	1BEAL406A	Scheme	2025
Type of Course	Ability Enhancement Laboratory	Semester	IV
Teaching Hours/Week (L:T:P:S)	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. Generate discrete and continuous probability distributions. 2. Analyze statistical properties of random variables. 3. Visualize and interpret probability distributions. 4. Perform signal and data analysis for real signals.			
SET OF EXPERIMENTS			
1. Generate discrete probability distributions (i) Generate a Bernoulli distribution by simulating a coin toss with probability of heads 'p'. (ii) Simulate tossing a fair coin to see how the law of large numbers work. (iii) Generate a binomial (50, 0.2) random variable. 2. Generate continuous probability distributions (i) Generate an Exponential(1) random variable. (ii) Generate Gamma(20,1) random variable. (iii) Generate a Poisson random variable. 3. Generate a normal random variable with 5000 points and plot the distribution 4. Generate random correlated x and y points and demonstrate with scatterplot. 5. Compute power spectral density for the given data. 6. Compute the covariance between two random variables. 7. Plot distribution of given data samples. 8. Verify central limit theorem. 9. Convert normal distribution of given mean and variance to zero mean and unit variance. 10. Extract features from a real signal. Find the correlation between the two features.			
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. S L Miller and D C Childers, Probability and Random processes: with applications to Signal processing and communication Academic Press/ Elsevier, 2nd Edition, 2014. Reference books / Manuals: 1. H Stark and Woods, Probability, statistics and random processes for engineers, Pearson, 2012. Web links and Video Lectures (e-Resources): https://www.youtube.com/watch?v=wMflxR3KsXg			

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.

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Debugging and Fault Analysis of Analog and Digital Circuits Lab				
Course Code	1BEAL406B	Scheme	2025	
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV	
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	
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. Read and analyse datasheets of various analog and digital IC's. 2. Understand the working of various analog and digital equipment's and instruments. 3. Find the faults in various analog and digital equipment's and instruments. 4. Debug faults in various analog and digital equipment's and instruments.				
1. Data Sheet Reading - Understanding the Electrical/ Mechanical /Thermal Characteristics, Absolute Maximum Ratings. 2. Digital Multimeters-Digital Multimeters and LCR Meters- Resolution, Measurements of Voltage (Range), Current (Range), AC, DC, RMS Values, Ave Values, Ripple, Measurements of Frequency, Measurement Of R, Diode, Transistor, SCR, MOSFET Etc, Buzzer Mode, Using Special Probes to Measure Temperature, Excite Few RLC, Fuse Wire Etc with Destructive and Non-Destructive Tests, Along with The Help of Scope and Power Supply. 3. Power Supplies-Setting Up the Power Supply for Output, Voltage Settings, Resolution, Current Limit Setting, Tracking Mode, Float Ground, Common Ground, Over Loading Effect on Power Supplies, Isolated Ground in Dual or Triple Output Power Supplies, Output Noise Measurements, Rise Time, Fall Time and Ripple. 4. Signal Generators- Understanding the Signal Generators - Resolution, Amplitude, Frequency Settings, Waveform Generation, Modulating Two Channels to Get Various Other Kinds of Waveforms from DC To 500khz, Measure the Same with Scope and Confirm the Read Value, Connect A Few RLC Circuits to Observe the Waveform Characteristics. 5. Finding Fault and Debugging 555 Timer-Based Industry Application-Based Circuit 6. Finding Fault and Debugging 12 Volts Fixed and Variable Voltage Power Supply. 7. Finding Fault and Debugging of Domestic Use Stabilizer. 8. Finding Fault in An Inverter Circuit. 9. Debugging Bluetooth Audio Amplifier Board. 10. Debugging of mobile phones. 11. Finding fault in a BJT amplifier Q-Point Drift 12. Finding fault in a combinational stuck at logic probe. 13. Debugging the glitch in the counter. 14. Debugging FM Radio Receiver Board. 15. Finding fault in BS6 automotive sensors using appropriate OBD scanner.				

General instruction regarding fault finding and debugging 1. Open resistor 2. Shorted capacitor 3. Faulty diode 4. Defective transistor 5. Damaged relay 6. Broken PCB track 7. Loose connector 8. Wrong component value 9. Failed voltage regulator 10. Dry solder joint	
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. Horowitz, P. and Hill, W., <i>The Art of Electronics</i>, 3rd Ed., Cambridge University Press, 2015 2. Pease, R.A., <i>Troubleshooting Analog Circuits</i>, 2nd Ed., Newnes/Elsevier, 2013	
Web links and Video Lectures (e-Resources): • Tektronix Inc., <i>The XYZs of Oscilloscopes</i>, 7th Edition, Tektronix Publications, Beaverton, USA, 2020, https://download.tek.com/document/03W_8605_7_HR_Letter.pdf (this link is to help faculty and students understand how oscilloscopes function, the different features and how to troubleshoot. The same manual can be used for any brand of oscilloscopes, the principles remain the same)	
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.	

Microcontroller Programming Lab			
Course Code	1BEAL406C	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	1	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: C01: Develop and execute ARM Assembly Language Programs (ALPs) to perform arithmetic, logical, looping, and memory manipulation operations for solving computational problems. C02: Design and implement ARM assembly programs for array processing, searching, sorting, lookup table applications, and bit manipulation techniques. C03: Interface and control external hardware devices such as LEDs, seven-segment displays, switches, relays, buzzers, DACs, and stepper motors using ARM microcontrollers. C04: Develop, test, and debug ARM-based embedded applications involving peripheral interfacing, waveform generation, and real-time hardware control.			
SET OF EXPERIMENTS			
- Write an ALP to i) multiply two 16-bit binary numbers. ii) add two 64-bit numbers. - Write an ALP to find the sum of first 10 integer numbers. - Write an ALP to find factorial of a number. - Write an ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM. - Write an ALP to find the square of a number (1 to 10) using look-up table. - Write an ALP to find the largest/smallest number in an array of 32 numbers. - Write an ALP to arrange a series of 32-bit numbers in ascending/descending order. - Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction. - Write an ALP to count the number of ones and zeros in two consecutive memory locations. - Interface a DAC and generate Triangular and Square waveforms. - Display the Hex digits 0 to F on a 7-segment LED interface, with a suitable delay in between. - 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)

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Basics of Machine Learning Lab			
Course Code	1BEAL406D/1BECL406C	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
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
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 machine learning algorithms to real life problems. 2. Able to make use of different machine learning approaches. 3. Able to down load different datasets and analysing the signals. 4. Able to apply different denoising techniques to time series and image signals.			
1. Solve the Tic-Tac-Toe problem using the Depth First Search technique. 2. Show that the 8-puzzle states are divided into two disjoint sets, such that any state is reachable from any other state in the same set, while no state is reachable from any state in the other set. 3. To represent and evaluate different scenarios using predicate logic and knowledge rules. 4. To apply the Find-S and Candidate Elimination algorithms to a concept learning task and compare their inductive biases and outputs. 5. To construct a decision tree using the ID3 or KNN algorithm on a simple classification dataset. 6. To assess how the ID3 algorithm performs on datasets with varying characteristics and complexity, examining overfitting, underfitting, and decision tree depth. 7. To examine different types of machine learning approaches (Supervised, Unsupervised, Semi-supervised, and Reinforcement Learning) by setting up a basic classification problem and exploring how each type applies differently. 8. To understand how Find-S and Candidate Elimination algorithms search through the hypothesis space in concept learning tasks, and to observe the role of inductive bias in shaping the learned concept. 9. To go through all stages of a real-life machine learning project, from data collection to model fine-tuning, and dimensionality reduction using a regression dataset like the "California Housing Prices." 10. To perform binary and multiclass classification on the MNIST dataset, analyze performance metrics, and perform error analysis. 11. Applying different denoising techniques and analyzing the time series signals. 12. Applying different denoising techniques to images and analyzing them.			
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):			
Text books: 1. Stuart J. Russell and Peter Norvig , Artificial Intelligence, 3rd Edition, Pearson,2015 2. Elaine Rich, Kevin Knight, Artificial Intelligence, 3rd Edition,Tata McGraw Hill,2013. 3. Tom M. Mitchell, Machine Learning, McGraw-Hill Education, 2013 4. Aurelien Geron, Hands-on Machine Learning with Scikit-Learn &Tensor Flow , O'Reilly, Shroff Publishers and Distributors Pvt. Ltd 2019.			

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/courses/106106139>
- <https://nptel.ac.in/courses/106105152>

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.

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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 perfluorocarbons (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 biobased 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 Nejekar 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
Type of Course	Societal Development Course (SDC)	Semester	IV
Teaching Hours/Week (L:T:P)	30(0:0:0)	CIEMarks	50
Total Hours of Pedagogy per Semester (L/T): LI(P): TW&SL	30(0:0:0:30)	SEEMarks	50
Credits	1	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	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.

Course outcome (Course Skill Set):

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

1. **C01 (L2 – Understand):** Identify and analyse environmental problems through field interaction and technical assessment.
2. **C02 (L3 – Apply):** Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.
3. **C03 (L4 – Analyze):** Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.
4. **C04 (L3 – Apply):** Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
5. **C05 (L4 – Analyze):** Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.
6. **C06 (L5 – Evaluate):** Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.

Restrictions and professional conduct:

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 document 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	
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Suggested Learning Resources

Particulars	Titles and Publishers
Textbooks	1. Phadke, N. D., <i>Community Engagement and Social Innovation</i> , Oxford University Press, New Delhi. 2. Garg, N. R., <i>Project-Based Learning in Engineering Education</i> , Pearson India Education Services, Noida. 3. Gupta, A. and P. Singh, <i>Service Learning and Community Projects</i> , McGraw-Hill Education (India), New Delhi. 4. Wilson, G., <i>Practical Guide to Community Development Projects</i> , 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
Suggested Learning Resources: Text Books: - Benny Joseph, <i>Environmental Studies</i>, Tata McGraw-Hill, 2nd Edition. R. Rajagopalan, <i>Environmental Studies: From Crisis to Cure</i>, Oxford University Press, 2005. - Erach Bharucha, <i>Textbook of Environmental Studies</i>, University Press, latest edition as available in library. - M.P. Poonia and S.C. Sharma, <i>Environmental Studies</i>, Vikas Publishing House, latest edition as available Reference Books: R. Sivakumar, <i>Principles of Environmental Science and Engineering</i>, Cengage Learning, 2nd Edition. G. Tyler Miller Jr., <i>Environmental Science: Working with the Earth</i>, Thomson Brooks/Cole, 11th Edition. - Pratibha Singh, Anoop Singh, and Piyush Malaviya, <i>Text Book of Environmental and Ecology</i>, Acme Learn in 1st Edition. - S.M. Prakash, <i>Environmental Studies</i>, Elite Publishing House, Mangalore, 3rd Edition, 2018.
Weblinks and Video Lectures (e-Resources): - VTU e-Learning Centre: http://elearning.vtu.ac.in - VTU e-Resources/e-Content: http://elearning.vtu.ac.in/e-Res.php - VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php - VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec - VTU e-Learning Centre: http://elearning.vtu.ac.in - VTU e-Resources/e-Content: http://elearning.vtu.ac.in/e-Res.php - VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php - VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec
Assessment Structure: Continuous Internal Evaluation (CIE) shall be conducted by the Departmental Project Review Committee consisting of a Senior Professor, the Project Guide, and one additional faculty member nominated by the Head of the Department. Semester End Evaluation (SEE) shall be conducted by university-appointed examiners. The evaluation shall be based on rubrics designed to assess the attainment of NBA-defined graduate attributes, including problem analysis, investigation, design of solutions, communication, teamwork, and professionalism. The weightage of marks for CIE and SEE is 50% 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.

ANALOG COMMUNICATION SYSTEMS			
Course Code	1BEA409		
Type of Course	PCC	Semester	IV
Teaching Hours/Week (L:T:P: S)	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: CO1: Comprehend, analyse different techniques of analog modulation and demodulation in both time and frequency domain. CO2: Analyze various methods of generation and detection of continuous wave modulation CO3: Apply the concepts of random theory to evaluate, communication signals. CO4: Distinguish various types of noise and compare the SNR and figure of merit of different types of receivers CO5: Analyze different types of sampling process and pulse modulation techniques			
Module-1			
Introduction: The communication process, The layered approach, Theme examples-wireless communications (Chapter 1 of Text Book 1) Amplitude Modulation: Amplitude modulation (AM), Double Sideband-suppressed Carrier Modulation, Quadrature-Carrier Multiplexing, Single – Sideband and Vestigial-Sideband Methods of Modulation, VSB transmission of analog and digital television, Frequency translation, Frequency division multiplexing (Sections 3.1 to 3.8 of Text Book 1) Number of Hours:09			
Module-2			
Angle Modulation: Basic definitions, frequency modulation, Generation and demodulation of FM signals, phase locked loop, Nonlinear effects in FM systems, Practical Communication Systems (Sections 4.1 to 4.8 of Text Book 1) Number of Hours:8			
Module-3			
Probability theory and Random Process: Probability, Random variables, statistical averages, random processes, mean, correlation and co-variance functions, transmission of a random process through linear filter, power spectral density, Gaussian Process. (Sections 5.1 to 5.11 of Text Book 1) Number of Hours:9			
Module-4			
Noise in Communication systems: Noise, narrowband noise, Receiver model, noise in DSB-SC receivers, noise in AM receivers, Noise in FM receivers, Pre-emphasis and De-emphasis in FM.(Sections 6.1 to 6.8 of Text Book 1) Number of Hours:8			
Module-5			
Digital Representation of Analog Signals: Why digitization, The Sampling Process, pulse amplitude modulation, time division multiplexing, pulse position modulation, PPM in impulse radio, The quantization process, Pulse code modulation, delta modulation. (Sections 7.1 to 7.10 of Text Book 1) Number of Hours:8			

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

Text books:

1. Simon Haykin and Michael Moher, Communication Systems, 5th Edition, John Wile and Sons, 2023.

Reference books / Manuals:

1. Simon Haykin, "An introduction to analog and digital communications", John Wiley 2010.s
2. Lathi B. P., "Modern digital and analog communication systems", Tata Mc- Graw-Hill, Edition V, 2011.

Web links and Video Lectures (e-Resources):

Analog Communication: https://onlinecourses.nptel.ac.in/noc21_ee74/preview

Principles of Communication Systems-I https://onlinecourses.nptel.ac.in/noc26_ee36/preview

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 differentiation, integration and complex variables.
2. Use demonstrations with simulation tools in the classroom to illustrate complex concepts

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.
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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) (P01)	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) (P02, P03, P05)	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) (P03, P04, P05, P08)	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) (P08,P05,P09)	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) (P01)	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) (P02, P03, P05)	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 demerits (3-4)	Student struggles to explain the design (2-3)	Student has very weak understanding of the design (1-2)
Implementation (8) (P03, P04, P05, P08)	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) (P04, P05, P09)	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). I (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)
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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/H W, 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)