Transforms, Differential Equations & Linear Algebra			
Course Code	**1BIO301**	Scheme	2025
Type of Course	**PCC**	Semester	III
Teaching Hours/Week (L:T:P)	42: 28 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:28:0:50	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

- CO1: Apply Laplace transforms and Fourier series techniques to solve differential equations and boundary value problems encountered in engineering applications.
- CO2: Solve ordinary and partial differential equations using appropriate analytical methods for modeling physical and engineering systems.
- CO3: Analyze systems of linear equations and vector spaces using matrix operations, linear transformations, and basis concepts.
- CO4: Determine eigenvalues, eigenvectors, diagonalization, and orthogonalization of matrices to solve engineering and scientific problems.

Module-1

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.

Number of Hours:9

Module-2

Fourier Series: Introduction, Fourier series on arbitrary intervals, half range expansions, Applications of Fourier series to solve wave equation and heat equation.

Number of Hours:9

Module-3

First order Ordinary Differential Equations Exact equations, Equations reducible to exact equations using integrating factors, Linear equations, Bernoulli equation, Orthogonal trajectories. Higher order Ordinary Differential Equations Higher order linear differential equations with constant coefficients.

Number of Hours:8

Module-4

Partial Differential Equations Introduction, Formation of Partial Differential Equations, Classification of second order Partial Differential Equations, Integrals of Partial Differential Equations, Solutions of Partial Differential Equations by the Method of Direct Integration, separation of variables method to simple problems in Cartesian coordinates, Initial & boundary value problems and solutions by separation of variables.

Number of Hours:8

Module-5

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.

Number of Hours:8

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

Text books:

1. Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).
2. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

Reference books / Manuals:

1. E.Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10^{th} Ed.,2018
2. *Jain, R.K. and Iyenger, S.R.K, Advanced Engineering Mathematics, Narosa Publishing House (2011)*

Web links and Video Lectures (e-Resources):

1.https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_mg59

2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ma20

Teaching-Learning Process (Innovative Delivery Methods):

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

1. Problem-based and application-oriented learning through real-world engineering examples, case studies, assignments, and group discussions to develop analytical and problem-solving skills.
2. Use of ICT tools such as MATLAB/Python, graphs, and spreadsheets to improve understanding of numerical methods, probability, and statistics.

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

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

	Superior	Good	Fair	Needs Improvement	Unacceptable
Problem Solving (CO1, CO2)	Completely correct	Minor errors	Partially correct	Mostly incorrect	Unable to solve
Concept Application (CO2, CO3)	Excellent understanding	Good understanding	Basic understanding	Limited understanding	No understanding
Presentation (CO1, CO3)	Clear and organized	Mostly clear	Adequate	Poor	Not presented

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.	Assignments	06 Hours
2.	Problem Solving Tutorials	06 Hours
3.	Seminar/Quiz	04 Hours
4.	Mini Project/Case Study on Applications	04 Hours

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	NPTEL/MOOC videos	16 hours
2.	Practice using MATLAB/Python/Spreadsheet tools	04 Hours
3.	Solving previous question papers and model problems	06 Hours
4.	Reference reading from online educational resources	04 Hours

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).

Data Structures and Algorithms			
Course Code	**1BIO302**	Scheme	2025
Type of course	**Integrated Professional Core Course (IPCC)**	Semester	03
Teaching Hours/Week (L:T:P)	3 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 28 : 20 : 30	SEE Marks	50
Credits	**04**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

1. Explain the fundamentals of algorithmic analysis and select appropriate data structures for engineering problems.
2. Implement arrays, stacks, queues and linked lists for mechatronics and robotics data-handling applications.
3. Apply trees, hashing and priority-based structures to organize, retrieve and process engineering data efficiently.
4. Analyse graph representations and traversal algorithms for robotic navigation, automation networks and connectivity problems.
5. Design and demonstrate C/Python-based DSA solutions for interdisciplinary engineering problems using laboratory practice and documentation.

Module-1

Introduction, Stacks, Queues: Introduction to data structures and algorithms; algorithm analysis; time and space complexity; arrays and dynamic arrays; applications in sensor buffers and actuator command sequences; stacks and queues; stack applications; queue applications in job scheduling and sensor streams.

Number of Hours: 09

Module-2

Linked List, Recursion: Singly linked lists, circular linked lists and doubly linked lists; insertion, deletion and traversal; memory representation; recursion; recursive problem-solving; engineering examples: robot task lists, route checkpoint lists and recursive search problems.

Number of Hours: 08

Module-3

Trees: Tree terminology; binary trees; binary search trees; tree traversals; heaps and priority queues; applications in decision logic, task priority scheduling, sensor-event ranking and hierarchical representation of robotic subsystems.

Number of Hours: 08

Module-4

Searching and Sorting: Linear search and binary search, bubble sort, selection sort, insertion sort, merge sort and quick sort; comparison of sorting methods along with their computing efficiencies; hashing concepts; collision resolution; applications in lookup tables, component identification, machine state retrieval and maintenance record indexing.

Number of Hours: 08

Module-5

Graphs and Navigation: Graph terminology and representations; adjacency matrix and adjacency list; BFS and DFS with computing efficiencies; connected components; shortest path overview; minimum spanning tree concepts; Prim and Kruskal algorithms with computing efficiencies; applications in mobile robot navigation, automation cell layout, network connectivity and path planning abstractions.

Number of Hours: 09

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS

1. Implement an array-based data processing program to store sensor readings and compute the number of readings, minimum value, maximum value, average value and range using sample data from temperature, water-level, distance or motor-speed sensors.
2. Design and demonstrate stack operations such as push, pop, peek and display, and apply the stack to reverse actuator commands or verify the correct order of machine-operation steps.
3. Construct a queue-based task processing program to perform insertion, deletion and display operations for robot movement commands, workshop job scheduling, pump requests or sensor-data buffering.
4. Implement a singly linked list to perform insertion, deletion, searching and traversal operations for maintaining robot task IDs, machine service records or route checkpoint numbers.
5. Model a doubly linked list to support insertion, deletion, forward traversal and reverse traversal for representing robot forward–reverse movement, conveyor stations or inspection checkpoints.
6. Apply recursion to solve selected computational problems such as factorial, Fibonacci series, binary search or Tower of Hanoi, and trace the recursive calls to understand repeated engineering tasks.
7. Construct a binary search tree and perform insertion, searching, inorder traversal, preorder traversal and postorder traversal using component IDs, tool numbers, sensor-event IDs or machine-part codes.
8. Implement a heap or priority queue to arrange tasks according to priority, using examples such as emergency stop alerts, robot job priority, maintenance requests or sensor warning levels.
9. Evaluate linear search and binary search using a list of component numbers, tool IDs, machine IDs or student roll numbers, and compare the number of comparisons required by each method.
10. Analyse the performance of sorting algorithms such as bubble sort, insertion sort and quick sort by sorting motor speeds, sensor values, component IDs or student marks.
11. Implement hashing using linear probing or chaining to store and retrieve machine IDs, component numbers, employee IDs or tool codes, and demonstrate collision handling.
12. Model a simple path or network using graph representation and perform BFS and DFS traversal for robot movement between locations, workshop-station connectivity, warehouse route planning or automation-cell layout.

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

Text books:

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, 2nd Ed., Universities Press, 2014.
2. Robert Sedgewick and Kevin Wayne, Algorithms, 4th Ed., Addison-Wesley / Pearson, 2011.
3. Reema Thareja, Data Structures Using C, 3rd Ed., Oxford University Press, 2025.

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

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, 4th Ed., MIT Press, 2022.
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 4th Ed., Pearson, 2014.

3. Gilberg and Forouzan, Data Structures: A Pseudo-code Approach with C, 2nd Ed., Cengage Learning, 2014.
4. Seymour Lipschutz, Data Structures, Schaum's Outlines, Revised 1st Ed., McGraw Hill, 2014.

Web links and Video Lectures (e-Resources):

1. NPTEL: Data Structures and Algorithms: https://nptel.ac.in/courses/106102064
2. NPTEL YouTube Playlist: Data Structures and Algorithms: https://www.youtube.com/playlist?list=PLBF3763AF2E1C572F
3. MIT OpenCourseWare: Introduction to Algorithms: https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
4. Princeton University: Algorithms, Part I: https://online.princeton.edu/algorithms-part-i
5. VisuAlgo: Data Structure and Algorithm Visualization: https://visualgo.net/
6. University of San Francisco: Data Structure Visualizations: https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
7. Virtual Labs, IIIT Hyderabad: Data Structures Lab: https://ds1-iiith.vlabs.ac.in/
8. Virtual Labs, IIIT Hyderabad: Stacks and Queues Experiment: https://ds1-iiith.vlabs.ac.in/exp/stacks-queues/index.html
9. Virtual Labs, IIIT Hyderabad: Linked List Basics: https://ds1-iiith.vlabs.ac.in/exp/linked-list/basics/overview.html
10. Virtual Labs, IIIT Hyderabad: Tree Traversal Experiment: https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/index.html

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.

- **Flipped Classroom:** Students may review learning materials such as videos, notes, presentations, or reading resources before class. Classroom time may be utilized for discussions, problem-solving, concept clarification, and application-oriented activities.
- **Simple Evaluation Method:** Faculty may conduct a short quiz, ask students to explain a concept, solve a brief problem, or submit a short pre-class/post-class reflection note.
- **Problem-Based Learning (PBL):** Each module may begin with a practical or real-world problem that encourages students to analyze the situation, identify relevant concepts, and develop appropriate solutions.
  Simple Evaluation Method: Faculty may assess a short worksheet containing problem understanding, solution approach, methodology, and expected outcomes.
- **Case-Based Teaching:** Faculty may explain concepts using real-life case studies, industrial examples, societal challenges, or interdisciplinary applications to improve contextual understanding.
  Simple Evaluation Method: Students may submit a brief case analysis highlighting the concepts involved and their applicability.
- **Simulation and Virtual Labs:** Concepts may be demonstrated using simulations, virtual laboratories, interactive software tools, or visual models to enhance conceptual understanding.
  Simple Evaluation Method: Faculty may assess simulation exercises, observation records, result interpretation, or output analysis.
- **ICT-Enabled Teaching:** Learning Management Systems (LMS), online assessment tools, digital content, multimedia resources, collaborative platforms, and educational software may be integrated into teaching and learning activities.
  Simple Evaluation Method: Faculty may evaluate online quizzes, assignments, digital submissions, discussion forum participation, or activity reports.
- **Peer Instruction and Collaborative Learning:** Students may work individually or in groups to discuss concepts, solve problems, review each other's work, and share learning experiences.
  Simple Evaluation Method: Faculty may use peer assessment, group activity reports,

presentations, or reflective summaries.

- **Industry-Oriented and Application-Based Learning:** Relevant examples, case studies, guest lectures, workshops, industrial practices, and emerging technologies may be incorporated to demonstrate real-world applications of course concepts. **Simple Evaluation Method:** Students may submit a short report explaining the relevance of course concepts to a practical application or industry scenario.

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.**

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

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

CIE Practical component:

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

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

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

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Suggested rubrics for Practical continuous assessment:

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

	(7-8)			

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

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.		
2.		
3.		
4.	(Add rows if required)	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.		
2.		
3.		
4.	(Add rows if required)	

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.

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

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus.
The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined for regular class work and practical test as indicated in the Table – ICs/IPCCs 1.
(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 – ICs/IPCCs 1 Distribution of marks

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

Passing requirement in SEE

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

Digital Electronics and Logic Design

Course Code	**1BIO303**	Scheme	2025
Type of course	**Integrated Professional Core Course (IPCC)**	Semester	03
Teaching Hours/Week (L:T:P)	3 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 28 : 20 : 30	SEE Marks	50
Credits	**04**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Apply number systems, codes, and binary arithmetic techniques to represent, manipulate, and process digital information.

CO2: Analyze and simplify Boolean expressions using Boolean algebra and Karnaugh maps, and implement logic functions using basic and universal gates.

CO3: Design and evaluate combinational logic circuits such as adders, subtractors, multiplexers, demultiplexers, encoders, decoders, and ALUs.

CO4: Design and analyze sequential circuits including flip-flops, registers, and synchronous/asynchronous counters for digital system applications.

CO5: Develop state machine models and explain the operation of data converters, memory devices, and programmable logic devices used in modern digital systems.

Module-1

Number Systems and Codes: Binary, Octal and hexadecimal conversions- ASCII code, Excess -3 code, Gray code, Error detection and correction - Parity generators and checkers – Fixed point and floating point arithmetic. Binary addition and subtraction, unsigned and signed numbers, 1's complement and 2’s complement arithmetic.

Number of Hours: 08

Module-2

TTL logic and CMOS logic - Logic gates, Universal gates - Boolean Laws and theorems, Sum of Products method, Product of Sum method – K map representation and simplification (upto four variables) - Pairs, Quads, Octets, Dont care conditions.

Number of Hours: 08

Module-3

Combinational circuits: Adders _ Full adder and half adder – Subtractors, half-subtractor and fullsubtractor – Carry Look ahead adders – ALU (block diagram only). Multiplexers, Demultiplexers, Encoders, BCD to decimal decoders.

Number of Hours: 08

Module-4

Sequential circuits: Flip-Flops, SR, JK, D and T flip-flops, JK Master Slave Flip-flop, Conversion of flip-flops, Registers -SISO,SIPO, PISO, PIPO. Counters : Asynchronous Counters – Modulus of a counter – Mod N counters. Synchronous counters: Preset and clear modes, Counter Synthesis: Ring counter, Johnson Counter, Mod N counter, Decade counter.

Number of Hours: 09

Module-5

State Machines: State transition diagram, Moore and Mealy Machines – Design equation and circuit diagram. Digital to Analog conversion – R-2R ladder, weighted resistors. Analog to Digital Conversion - Flash ADC, Successive approximation, Integrating ADC. Memory Basics, Read and Write, Addressing, ROMs, PROMs and EPROMs, RAMs, Sequential Programmable Logic Devices - PAL, PLA, FPGA (Introduction and basic concepts

only) Number of Hours: 09

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS

1. Verify (a) Demorgan's Theorem for 2 variables. (b) The sum-of product and product-of-sum expressions using universal gates.
2. Design and implement (a) Full Adder using i) Basic logic gates ii) NAND gates. (b) Full Subtractor using i) Basic logic gates ii) NAND gates.
3. (a) Design and implement 4-bit Parallel Adder/ Subtractor using IC 7483. (b) BCD to Excess – 3 Code conversion and vice versa.
4. (a) Design and Implementation of 1-bit Comparator. (b) Design and Implementation of 5-bit Magnitude Comparator using IC 7485.
5. Realize (a) Adder and Subtractor using IC 74153 (b) 4-variable function using IC 74151(8:1MUX).
6. (a) Adder & Subtractors using IC 74139 (b) Binary to Gray code Conversion & Vice Versa (74139)
7. Realize the following flip-flops using NAND Gates Master slave JK, D & T Flip-flops.
8. Realize the following shift registers using IC7474/ IC 7495 (a) SISO (b) SIPO (c) PISO (d)PIPO (e) Ring Counter (f) Johnson Counter
9. Realize i) Design Mod N synchronous up / Down counter using IC 7476 JK Flip Flop ii) Mod N counter using IC 7490/7476 iii) Synchronous counter using IC 74192
10. Design Pseudo Random sequence generator using IC 7495
11. Design Serial Adder with Accumulator and simulate using simulation tool.
12. Design Binary Multiplier and simulate using simulation tool. Movement between locations, workshop-station connectivity, warehouse route planning or automation-cell layout.

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

Text books:

1. Floyd T.L, Digital Fundamentals, 10/e, Pearson Education, 2011
2. C.H.Roth and L.L.Kimney Fundamentals of Logic Design, 7/e, Cengage Learning, 2013

Reference books / Manuals:

1. Donald P Leach, Albert Paul Malvino and GoutamSaha., Digital Principles and Applications, 8/e, by Mc Graw Hill
2. Mano M.M, Logic and Computer Design Fundamentals, 4/e, Pearson Education.
3. Tocci R.J and N.S.Widmer, Digital Systems, Principles and Applications, 11/e, , Pearson Education.
4. John F. Wakerly, Digital Design: Principles and Practices, 4/e, Pearson, 2005 5. Taub & Schilling: Digital Integrated Electronics, McGraw Hill,1997

Web links and Video Lectures (e-Resources):

1. NPTEL: Introduction to Digital Systems Design: https://nptel.ac.in/courses/117105080
2. Virtual Labs: https://de-iitr.vlabs.ac.in/

Teaching-Learning Process (Innovative Delivery Methods):

1. **Flipped Classroom:** Students may review learning materials such as videos, notes, presentations, or reading resources before class. Classroom time may be utilized for discussions, problem-solving, concept clarification, and application-oriented activities.

2. **Simple Evaluation Method:** Faculty may conduct a short quiz, ask students to explain a concept, solve a brief problem, or submit a short pre-class/post-class reflection note.
3. **Problem-Based Learning (PBL):** Each module may begin with a practical or real-world problem that encourages students to analyze the situation, identify relevant concepts, and develop appropriate solutions.
   Simple Evaluation Method: Faculty may assess a short worksheet containing problem understanding, solution approach, methodology, and expected outcomes.
4. **Case-Based Teaching:** Faculty may explain concepts using real-life case studies, industrial examples, societal challenges, or interdisciplinary applications to improve contextual understanding.
   Simple Evaluation Method: Students may submit a brief case analysis highlighting the concepts involved and their applicability.
5. **Simulation and Virtual Labs:** Concepts may be demonstrated using simulations, virtual laboratories, interactive software tools, or visual models to enhance conceptual understanding.
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6. **ICT-Enabled Teaching:** Learning Management Systems (LMS), online assessment tools, digital content, multimedia resources, collaborative platforms, and educational software may be integrated into teaching and learning activities.
   Simple Evaluation Method: Faculty may evaluate online quizzes, assignments, digital submissions, discussion forum participation, or activity reports.
7. **Peer Instruction and Collaborative Learning:** Students may work individually or in groups to discuss concepts, solve problems, review each other’s work, and share learning experiences.
   Simple Evaluation Method: Faculty may use peer assessment, group activity reports, presentations, or reflective summaries.
8. **Industry-Oriented and Application-Based Learning:** Relevant examples, case studies, guest lectures, workshops, industrial practices, and emerging technologies may be incorporated to demonstrate real-world applications of course concepts.
   Simple Evaluation Method: Students may submit a short report explaining the relevance of course concepts to a practical application or industry scenario.

Assessment Structure:

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

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- 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.

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

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
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Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
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Suggested rubrics for Practical continuous assessment:

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
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Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
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Note: Can add Engineering & IT tool usage based on the nature of the course

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
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Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
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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

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).

Sensors & Transducers

Course Code	**1BIO304**	Scheme	2025
Type of course	**Professional Core Course (PCC)**	Semester	03
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 0 : 20 : 28	SEE Marks	50
Credits	**03**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Explain the principles and characteristics of resistive and strain gauge sensors.

CO2: Analyze the operation and applications of inductive sensors, LVDTs, and proximity sensors.

CO3: Evaluate the performance of capacitive and piezoelectric sensors for measurement applications.

CO4: Apply thermal and radiation sensing principles for temperature measurement and monitoring.

CO5: Analyze magnetic, optical, and smart sensors used in modern instrumentation systems.

Module-1

Mechanical and Electromechanical sensor: Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.

Number of Hours: 08

Module-2

Inductive sensor: common types -Reluctance change type, Mutual inductance change type, transformer action type, Magneto strictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis. LVDT: Construction, material, output input relationship, I/O curve, discussion. Proximity sensor.

Number of Hours: 08

Module-3

Capacitive sensors: Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics. Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors.

Number of Hours: 09

Module-4

Thermal sensors: Material expansion type: solid, liquid, gas & vapor Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermistor material, shape, ranges and accuracy specification. Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type. Radiation sensors: types, characteristics and comparison. Pyroelectric type.

Number of Hours: 09

Module-5

Magnetic sensors: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics. Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response. Geiger counters, Scintillation detectors, Introduction to smart sensors

Number of Hours: 08

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

Text books:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI

Reference books / Manuals:

1. Instrument transducers, H.K.P. Neubert, Oxford University press.
2. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill

Web links and Video Lectures (e-Resources):

1. NPTEL: Transducers for Instrumentation: https://nptel.ac.in/courses/108102191

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.

- **Flipped Classroom:** Students may review learning materials such as videos, notes, presentations, or reading resources before class. Classroom time may be utilized for discussions, problem-solving, concept clarification, and application-oriented activities.
- **Simple Evaluation Method:** Faculty may conduct a short quiz, ask students to explain a concept, solve a brief problem, or submit a short pre-class/post-class reflection note.
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Performance Indicator- 1 (CO/PO Mapping)					
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Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	Good	Fair	Needs Improvement	Unacceptable
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Rubrics for SEE / CIE Test:

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

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- Programming Assignment
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Fundamentals of Industrial IoT

Course Code	**1BIO305**	Scheme	2025
Type of course	**Professional Core Course (PCC)**	Semester	03
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 0 : 20 : 28	SEE Marks	50
Credits	**03**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Explain the principles and characteristics of resistive and strain gauge sensors.

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CO3: Evaluate the performance of capacitive and piezoelectric sensors for measurement applications.

CO4: Apply thermal and radiation sensing principles for temperature measurement and monitoring.

CO5: Analyze magnetic, optical, and smart sensors used in modern instrumentation systems.

Module-1

Basic Concept of IoT, Building Blocks of IoT Systems, Top-Down Design Strategy, IoT Demands and Markets, Technical Challenges, Fundamental Characteristics of IoT, IoT Cloud Services, Industry 4.0.

Number of Hours: 08

Module-2

IoT Protocol Standardization, M2M Protocols, Wireless Sensor Network (WSN) Protocols, SCADA Protocols, RFID Protocols, Issues in IoT Standardization, Unified Data Standards, IEEE 802.15.4, Slot Frame Structure, IEEE 802.11ah, IoT Ecosystem.

Number of Hours: 09

Module-3

IoT Data Link Protocol, Wireless-HART, Z-Wave, Zigbee Smart Energy, DASH7, Network Layer Encapsulation Protocols.

Number of Hours: 08

Module-4

LoRaWAN, RPL, CORPL, CARP, 6LoWPAN, TiSCH, IPv6 over G.9959, IPv6 over Bluetooth Low Energy (BLE), MQTT, AMQP, XMPP, DDS.

Number of Hours: 08

Module-5

Security Issues in IoT Systems, Privacy Preservation, IoT Security Requirements, IoT Security Control, IoT Security Models, IoT Security Framework, Lightweight Cryptography, IoT Data Encryption and Decryption, Case Studies

Number of Hours: 09

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

Text books:

1. Internet of Things – Surya Durbha and Jyoti Joglekar, Oxford University Press, 2020.
2. Internet of Things and its Application, BPB Publications, 2020.
3. IoT (Internet of Things) and Its Application, T. Balaji Publication.
4. Microcontrollers: Architecture, Programming, Interfacing and System Design – Raj Kamal, Pearson Education India, Second Edition.

Reference books / Manuals:

1. Learning Internet of Things – Pete Waher.
2. Getting Started with the Internet of Things – Cuno Pfister.
3. Building the Internet of Things – Maciej Kranz.

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1. NPTEL: Design for Internet of Things: https://nptel.ac.in/courses/108108098

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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.		
2.		
3.		
4.	(Add rows if required)	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.		
2.		
3.		
4.	(Add rows if required)	

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

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).

Sensors & IoT Devices Lab		Scheme	2025
Course Code	1BIOL306	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	02-03

Course outcome (Course Skill Set)

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

1. **CO1:** Develop Arduino programs for interfacing and controlling input/output devices.
2. **CO2:** Interface sensors and acquire data for monitoring physical and environmental parameters.
3. **CO3:** Design embedded applications using sensors, actuators, and communication interfaces for automation tasks.
4. **CO4:** Develop innovative IoT-based solutions for real-world monitoring and control applications.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 conventional experiments, PART-B has 6 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. Introduction to Arduino Board and Arduino IDE – Installation, setup, and familiarization with the Arduino development environment.
2. LED Interfacing and Control – Develop programs for LED blinking and LED fading using PWM techniques.
3. Push Button Interfacing – Develop programs to count button presses and control an LED using a push button.
4. Analog and Digital Sensor Interfacing – Read analog inputs and interface an IR obstacle sensor for object detection.
5. Environmental Monitoring – Measure temperature and humidity using a DHT11 sensor and detect gas/smoke using appropriate sensors.
6. Actuator and Output Device Control – Control electrical appliances using a relay module and generate melodies using a piezo speaker.

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. Smart Automatic Street Lighting System using LDR and LED.
2. Smart Home Automation System using Arduino, Relay Module, and Sensors.
3. IoT-Based Environmental Monitoring System for Temperature, Humidity, Gas, and Smoke Detection.
4. Smart Intruder Detection and Alert System using PIR and IR Sensors.
5. Industrial Safety Monitoring System using Gas, Smoke, and Temperature Sensors with Alarm Indication.
6. Design and Development of a Mini Smart Agriculture Monitoring System using Arduino and Suitable Sensors.

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

Text books:

1. **Getting Started with Arduino** – Massimo Banzi and Michael Shiloh, Maker Media, 3rd Edition.
2. **Exploring Arduino: Tools and Techniques for Engineering Wizardry** – Jeremy Blum, Wiley Publications.
3. **Arduino Cookbook** – Michael Margolis, O'Reilly Media, 3rd Edition.
4. **Programming Arduino: Getting Started with Sketches** – Simon Monk, McGraw-Hill Education.

Reference books / Manuals:

1. **Beginning Arduino** – Michael McRoberts, Apress Publications.
2. **Practical Electronics for Inventors** – Paul Scherz and Simon Monk, McGraw-Hill Education.
3. **Internet of Things with Arduino** – Agus Kurniawan, Packt Publishing.
4. **Arduino for Beginners: Essential Skills Every Maker Needs** – John Baichtal, Que Publishing.

Web links and Video Lectures (e-Resources):

1. Virtual Labs: https://iot-amrt.vlabs.ac.in/

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 Laboratory Sessions** using Arduino boards, sensors, and actuators for experiential learning.
2. **Project-Based Learning (PBL)** through development of real-world IoT and automation applications.
3. **Simulation-Based Learning** using tools such as Tinkercad Circuits and Proteus for virtual prototyping and testing.
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

Python Programming for IoT		Scheme	2025
Course Code	1BIOL307A	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	02-03

Course outcome (Course Skill Set)

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

CO1: Develop Raspberry Pi programs to interface sensors, actuators, and communication modules for data acquisition and control applications.

CO2: Implement IoT communication protocols such as Bluetooth and MQTT for device-to-device and device-to-cloud communication.

CO3: Design and develop IoT-based monitoring and automation systems using Raspberry Pi, sensors, and wireless communication technologies.

SET OF EXPERIMENTS

1. To interface LED/Buzzer with Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
2. To interface Push button/Digital sensor (IR/LDR) with Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
3. To interface DHT11 sensor with Raspberry Pi and write a program to print temperature and humidity readings.
4. To interface Bluetooth with Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
5. To interface Bluetooth with Raspberry Pi and write a program to turn LED ON/OFF when ‗1'/'0' is received from smartphone using Bluetooth.
6. Write a program on Raspberry Pi to publish temperature data to MQTT broker.
7. Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print

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

Text books:

1. Getting started with Raspberry PI, Matt Richardson and Shawn Wallace, O'Reilly (SPD), 2014, ISBN : 9789350239759

Reference books / Manuals:

1. Raj Kamal, Internet of Things: Architecture and Design‖, McGraw Hill
2. Cuno Pfister, Getting Started with the Internet of Things‖, O Reilly Media

Web links and Video Lectures (e-Resources):

1. Virtual Labs: https://python-iitk.vlabs.ac.in/

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 Laboratory Sessions** using Arduino boards, sensors, and actuators for experiential learning.
2. **Project-Based Learning (PBL)** through development of real-world IoT and automation applications.
3. **Simulation-Based Learning** using tools such as Tinkercad Circuits and Proteus for virtual prototyping and testing.
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

PCB Design & Soldering Skills		Scheme	2025
Course Code	1BIOL307B	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	03

Course outcome (Course Skill Set)

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

CO1: Create electronic schematics and PCB layouts using standard PCB design software tools.

CO2: Fabricate, assemble, and solder electronic circuits using through-hole and surface-mount components.

CO3: Test, troubleshoot, and validate PCB-based electronic circuits using appropriate instruments and techniques.

CO4: Design and develop simple PCB-based electronic products by integrating design, fabrication, assembly, and testing skills.

SET OF EXPERIMENTS

1. **Introduction to Electronic Components and PCB Design Tools** – Familiarization with resistors, capacitors, diodes, transistors, ICs, PCB layout concepts, and EDA tools such as KiCad/EasyEDA.
2. **Schematic Capture of a Simple Electronic Circuit** – Create the schematic of an LED flasher or power supply circuit using PCB design software.
3. **PCB Layout Design for a Single-Sided PCB** – Design and route a single-sided PCB from the developed schematic.
4. **PCB Fabrication Using Toner Transfer/Photoresist Method** – Prepare and fabricate a simple PCB from the designed layout.
5. **Identification and Practice of Soldering Tools** – Study soldering iron, solder wire, flux, desoldering pump, and safety precautions.
6. **Through-Hole Component Soldering Practice** – Assemble a simple electronic circuit using through-hole components on a fabricated PCB.
7. **Surface Mount Device (SMD) Soldering Practice** – Practice soldering and desoldering basic SMD components.
8. **Assembly and Testing of a Regulated Power Supply PCB** – Populate, solder, and test a PCB-based regulated power supply circuit.
9. **Design and Fabrication of an Arduino Interface PCB** – Design, fabricate, assemble, and test a simple Arduino-compatible interface board.
10. **PCB Inspection, Troubleshooting, and Rework Techniques** – Perform continuity testing, fault identification, desoldering, component replacement, and circuit validation.

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

Text books:

1. Printed Circuit Boards: Design, Fabrication and Assembly – R. S. Khandpur, McGraw-Hill Education.
2. PCB Design for Real-World EMI Control – Bruce R. Archambeault and James Drewniak, Springer.
3. The Circuit Designer's Companion – Peter Wilson, Newnes/Elsevier.
4. Practical Electronics for Inventors – Paul Scherz and Simon Monk, McGraw-Hill Education.

Reference books / Manuals:

1. Complete PCB Design Using OrCAD Capture and PCB Editor – Kraig Mitzner, Newnes.
2. PCB Design Tutorial – David L. Jones, Electronics Tutorials.
3. Electronic Assembly Fabrication – Frank Riley, McGraw-Hill.
4. Soldering in Electronics Assembly – Mike Judd and Keith Brindley, Newnes

Web links and Video Lectures (e-Resources):

1. Virtual Labs: https://fab-coep.vlabs.ac.in/exp/pcb-design-fabrication/theory.html

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 Laboratory Sessions** using Arduino boards, sensors, and actuators for experiential learning.
2. **Project-Based Learning (PBL)** through development of real-world IoT and automation applications.
3. **Simulation-Based Learning** using tools such as Tinkercad Circuits and Proteus for virtual prototyping and testing.
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

Fundamentals of Linux & Shell Scripting (IoT-Focused)		Scheme	2025
Course Code	1BIOL307C	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	03

Course outcome (Course Skill Set)

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

CO1: Apply Linux commands and utilities for file management, process control, and system administration tasks.

CO2: Develop shell scripts using control structures, functions, and file handling techniques for task automation.

CO3: Configure and manage Linux-based IoT devices and network services using appropriate system tools.

CO4: Design automation solutions using shell scripting for monitoring, logging, and management of IoT systems.

SET OF EXPERIMENTS

1. Study and practice basic Linux commands for file and directory management, navigation, and system information.
2. Perform file management and permission operations using Linux commands such as chmod, chown, and file manipulation utilities.
3. Implement text processing operations using Linux utilities such as grep, sort, wc, head, tail, and find.
4. Write and execute basic shell scripts using variables, operators, and user inputs.
5. Develop shell scripts using decision-making and looping constructs such as if-else, case, for, and while.
6. Create shell scripts using functions to automate routine Linux system tasks.
7. Monitor and manage Linux processes using commands such as ps, top, kill, and resource monitoring tools.
8. Configure and test network connectivity using Linux networking commands such as ping, ip, ifconfig, netstat, and SSH.
9. Develop a shell script for sensor data logging and report generation in an IoT environment.
10. Develop an automation script for IoT device monitoring, backup, and alert generation using shell scripting.

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

Text books:

5. The Linux Command Line: A Complete Introduction – William E. Shotts Jr., No Starch Press.
6. Linux Shell Scripting Cookbook – Sarath Lakshman, Packt Publishing.
7. Beginning Linux Programming – Neil Matthew and Richard Stones, Wiley Publications.

Reference books / Manuals:

1. Classic Shell Scripting – Arnold Robbins and Nelson H. F. Beebe, O'Reilly Media.
2. UNIX and Linux System Administration Handbook – Evi Nemeth, Garth Snyder, Trent Hein, and Ben Whaley, Pearson.

Web links and Video Lectures (e-Resources):

1. Not applicable

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 Laboratory Sessions** using Arduino boards, sensors, and actuators for experiential learning.
2. **Project-Based Learning (PBL)** through development of real-world IoT and automation applications.
3. **Simulation-Based Learning** using tools such as Tinkercad Circuits and Proteus for virtual prototyping and testing.
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

MATLAB / Simulink for IoT		Scheme	2025
Course Code	1BIOL307D	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	03

Course outcome (Course Skill Set)

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

CO1: Apply MATLAB programming concepts for mathematical computation, data analysis, and visualization.

CO2: Develop and simulate basic models using Simulink for engineering and IoT applications.

CO3: Analyze and process sensor data using MATLAB tools for monitoring and decision-making applications.

CO4: Design simple IoT-based applications using MATLAB and Simulink for data acquisition, visualization, and control.

SET OF EXPERIMENTS

1. Introduction to MATLAB Environment – Study MATLAB interface, basic commands, variables, and workspace operations.
2. Perform Basic Mathematical Operations in MATLAB – Write programs using arithmetic operators, matrices, and arrays.
3. Plotting and Visualization – Generate 2D and 3D plots using MATLAB plotting functions.
4. MATLAB Programming Basics – Write simple programs using decision-making and looping statements.
5. Introduction to Simulink – Create and simulate a basic Simulink model using standard blocks.
6. Modeling of a Sensor Signal in Simulink – Simulate temperature or light sensor data using signal source blocks.
7. Data Import and Analysis – Import sensor data from a file and perform basic analysis in MATLAB.
8. Signal Processing using MATLAB – Perform filtering and visualization of sensor signals.
9. IoT Data Visualization – Display and analyze simulated IoT sensor data using graphs and charts.
10. Mini Project – Develop a simple MATLAB/Simulink model for monitoring a physical parameter such as temperature, humidity, or light intensity..

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

Text books:

1. MATLAB for Engineers – Holly Moore, Pearson Education.
2. MATLAB and Simulink for Engineers – Agam Kumar Tyagi, Oxford University Press.

Reference books / Manuals:

1. MATLAB Programming for Engineers – Stephen J. Chapman, Cengage Learning.
2. Mastering MATLAB – Duane Hanselman and Bruce Littlefield, Pearson Education.
3. Applied Simulation and Modeling with MATLAB and Simulink – Wen Y. Yang, Springer.
4. MATLAB: An Introduction with Applications – Amos Gilat, Wiley India.

Web links and Video Lectures (e-Resources):

1. https://www.mathworks.com/help/matlab/arduinoio-applications-IoT.html

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 Laboratory Sessions** using Arduino boards, sensors, and actuators for experiential learning.
2. **Project-Based Learning (PBL)** through development of real-world IoT and automation applications.
3. **Simulation-Based Learning** using tools such as Tinkercad Circuits and Proteus for virtual prototyping and testing.
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance					

Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangam, Machhe, Belagavi-590018

Scheme of Teaching and Examinations 2025

Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS)

(Effective from the academic year 2025-26)

NUMERICAL METHODS, PROBABILITY AND STATISTICS

Course Code	**1BIO401**	Scheme	2025
Type of Course	**PCC**	Semester	IV
Teaching Hours/Week (L:T:P)	42: 28 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:28:0:50	SEE Marks	50
Credits	**3**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Apply statistical techniques for engineering data analysis
2. Solve probability and random variable problems
3. Analyze stochastic processes using Markov chains
4. Perform hypothesis testing and sampling analysis
5. Apply ANOVA and experimental design methods in agricultural engineering

Module-1

Numerical Methods and Statistics:

Introduction, Basic definitions and formulae in statistics, Curve fitting by the method of least squares: Fitting a straight line y=a+bx, Fitting a second degree parabola y=a+bx+cx2, fitting a curve of the form y=abx, Correlation and regression.

Number of Hours:9

Module-2

Probability and Random variable :

Introduction, Probability associated with set theory, Axioms of probability, Addition rule, conditional probability, multiplication rule, Baye's theorem, central limit theorem, Discrete and Continuous random variable(PDF,CDF),Binomial, Poisson, Exponential and Normal Distributions.

Number of Hours:9

Module-3

Joint Probability Distribution and Markov Chains

Concept of JoinT Probability, Joint distribution- discrete random variables, Independent random variables, problem on expectation and variance. Markov Chains- Introduction, probability vectors, stochastic matrices, fixed points and regular stochastic matrices, Markov chains, higher transition probabilities, stationary distribution of regular markov chains and absorbing states.

Number of Hours:8

Module-4

Sampling distribution

Sampling, Sampling Distribution, standard error, Null and alternate hypothesis, type I and type II errors, testing of hypothesis for means, Level of significance for means, confidence limits for means, large and small samples, student t- distribution, F-distribution, Chi-square distribution

Number of Hours:8

Module-5

Principles of Design of Experiments, Principles of ANOVA -One-Way ANOVA and Two-Way ANOVA, **Analysis of Experimental Designs-** Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD).

Number of Hours:8

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

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, KhannaPublishers,44th Ed., 2021.
2. B.V.Ramana, Higher Engineering Mathematics, McGraw-HillEducation,11thEd., 2017
3. N. P.Bali and ManishGoyal, A Textbook of Engineering Mathematics, Laxmi Publications,10thEd.,2022.

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

1. E.Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.,2018
2. H.K.Das and Er.Rajnish Verma, Higher Engineering Mathematics, S.Chand Publication, 3rd Ed.,2014

Web links and Video Lectures (e-Resources):

1.https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_mg59

2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ma20

Teaching-Learning Process (Innovative Delivery Methods):

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

1. Problem-based and application-oriented learning through real-world engineering examples, case studies, assignments, and group discussions to develop analytical and problem-solving skills.
2. Use of ICT tools such as MATLAB/Python, graphs, and spreadsheets to improve understanding of numerical methods, probability, and statistics.

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/Problem Solving on Numerical Methods and Statistics	15
2	Quiz/Seminar on Probability, Hypothesis Testing, and Markov Chains	10

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

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Problem Solving (CO1, CO2)	Completely correct	Minor errors	Partially correct	Mostly incorrect	Unable to solve
Concept Application (CO2, CO3)	Excellent understanding	Good understanding	Basic understanding	Limited understanding	No understanding
Presentation (CO1, CO3)	Clear and organized	Mostly clear	Adequate	Poor	Not presented

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.	Assignments on Numerical Methods and Statistics	06 Hours
2.	Problem Solving Tutorials	06 Hours
3.	Seminar/Quiz on Probability and Markov Chains	04 Hours
4.	Mini Project/Case Study on Applications of Statistics	04 Hours

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

Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	NPTEL/MOOC videos on Probability and Statistics	16 hours

2.	Practice using MATLAB/Python/Spreadsheet tools	04 Hours
3.	Solving previous question papers and model problems	06 Hours
4.	Reference reading from online educational resources	04 Hours

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).

Industrial Automation & PLC

Course Code	**1BIO402**	Scheme	2025
Type of course	**Integrated Professional Core Course (IPCC)**	Semester	IV
Teaching Hours/Week (L:T:P)	3 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 28 : 20 : 30	SEE Marks	50
Credits	**04**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

1. Explain the architecture, components, and communication protocols of industrial automation systems.
2. Apply sensors, actuators, PLCs, and SCADA systems for industrial automation and process control.
3. Analyze PLC- and DCS-based automation systems for industrial monitoring and control applications.

Module-1

Introduction: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus. Role of computers in measurement and control.

Number of Hours: 08

Module-2

Automation components: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

Number of Hours: 09

Module-3

Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

Number of Hours: 09

Module-4

SCADA Systems: Introduction, definition and history of SCADA, typical SCADA System Architecture, Communication requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA.

SCADA Architecture: First Generation-Monolithic, Second Generation-Distributed, Third Generation-Networked Architecture, SCADA systems in operation and case studies.

Number of Hours: 08

Module-5

Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.
Process Safety Automation: Levels of process safety through use of PLCs, Integrating Process safety PLC and DCS, Application of international standards in process safety control.

Number of Hours: 08

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS

1. Use industrial grade sensors and transducer introduction and characteristics like proximity detector, linear encoder, rotary encoder, touch sensor, force sensor, accelerometer, RTDs, loadcells and LVDT for measurement.
2. Use Various actuators such as relay, solenoid valve, process control valve and motors for control applications.

3. Simulate analog and digital function blocks
4. Relay logic diagram and ladder logic diagram
5. Understand and perform experiments on timers and counters
6. Logic implementation for traffic Control Application
7. Logic implementation for Bottle Filling Application
8. Tune PID controller for heat exchanger using DCS
9. FBD for autoclavable laboratory fermentor
10. Develop graphical user interface for the plant visited by you
11. Industrial visit report

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

Text books:

1. M.P.Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing, 5th edition, Pearson, 2024.
2. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Ronald L Krutz, "Securing SCADA System", First Edition, Wiley Publication, 2005.

Reference books / Manuals:

1. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International, 2013.
2. Lukas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
3. N. Viswanandham, Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", 1st Edition, 2009.
4. Smith Carlos and Corripio, "Principles and Practice of Automatic Process Control",3 rd Edition, John Wiley and Sons, 2006.

Web links and Video Lectures (e-Resources):

1. NPTEL: Industrial Automation and Control: https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me67

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:** Students may watch short videos or read simple notes on stacks, queues, linked lists, trees, hashing or graphs before the class. Classroom time shall be used for algorithm tracing, dry run, discussion and implementation. **Simple Evaluation Method:** Faculty may conduct a 5-minute quiz, ask students to explain one concept, or collect a short pre-class note.
2. **Problem-Based Learning (PBL):** Each module may begin with a practical engineering problem such as robot task scheduling, machine ID searching, sensor-data handling, priority alert processing or path traversal. Students shall identify the suitable data structure and implement the solution. **Simple Evaluation Method:** Faculty may evaluate a short worksheet containing the problem statement, selected data structure, reason for selection, algorithm steps and expected output.
3. **Case-Based Teaching:** Faculty may explain DSA concepts using simple cases from robotics, automation, mechatronics systems, conveyor control, warehouse movement, machine maintenance and component tracking. **Simple Evaluation Method:** Students may submit a brief case interpretation note explaining where the data structure is used and why it is suitable.
4. **Simulation and Virtual Labs:** Stack operations, queue scheduling, linked-list pointer movement,

recursion, tree traversal, hashing collision handling and graph traversal may be demonstrated using simple simulators, virtual labs or classroom diagrams. **Simple Evaluation Method:** Faculty may ask students to complete a dry-run table or trace the output for a given input.

5. **ICT-Enabled Teaching:** Google Colab, Jupyter Notebook, online C compilers, Python Tutor, algorithm visualizers and LMS quizzes may be used for demonstration, practice and submission. **Simple Evaluation Method:** Faculty may evaluate execution screenshots, submitted source code, LMS quiz marks or program output files.
6. **Peer Instruction and Debugging Sessions:** Students may work in pairs to identify syntax errors, logical errors, pointer mistakes, wrong traversal order, recursion errors and incorrect outputs. **Simple Evaluation Method:** Faculty may use a peer-debugging checklist where students identify errors, suggest corrections and verify the corrected output.
7. **Industry/Workshop-Oriented Examples:** Examples from robotic arms, AGVs, CNC machines, drones, automated production lines, warehouse robots, sensors and maintenance systems may be used to show real-world relevance. **Simple Evaluation Method:** Students may map one industry example to a suitable data structure or algorithm and justify the selection in 3–5 lines.
8. **Micro Project-Based Learning:** Students may complete a small activity such as robot task manager, machine maintenance record system, component search system, sensor alert priority system or simple route traversal model. **Simple Evaluation Method:** Faculty may evaluate based on problem understanding, correct data structure usage, working code, output explanation and documentation.

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**.

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

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

CIE Practical component:

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

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

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

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

Suggested rubrics for Practical continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

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

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

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.		
2.		
3.		
4.	(Add rows if required)	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.		
2.		
3.		
4.	(Add rows if required)	

Continuous Internal Evaluation (CIE)

(i)Theory component

The CIE marks of 25 shall be earmarked for two tests.

The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.

Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus.

The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined for regular class work and practical test as indicated in the Table – ICs/IPCCs 1.

(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.

Passing

Table – ICs/IPCCs 1 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**

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).

Database Management Systems

Course Code	**1BIO403**	Scheme	2025
Type of course	**Integrated Professional Core Course (IPCC)**	Semester	IV
Teaching Hours/Week (L:T:P)	3 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 28 : 20 : 30	SEE Marks	50
Credits	**04**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

1. Describe the basic elements of a relational database management system
2. Design entity relationship for the given scenario.
3. Apply various Structured Query Language (SQL) statements for database manipulation.
4. Analyse various normalization forms for the given application.
5. Develop database applications for the given real-world problem.
6. Understand the concepts related to NoSQL databases.

Module-1

Introduction to Databases: Introduction, Characteristics of database approach, Advantages of using the DBMS approach, History of database applications. Overview of Database Languages and Architectures: Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment. Conceptual Data Modelling using Entities and Relationships: Entity types, Entity sets and structural constraints, Weak entity types, ER diagrams, Specialization and Generalization.

Number of Hours: 09

Module-2

Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations. Relational Algebra: Unary and Binary relational operations, additional relational operations (aggregate, grouping, etc.) Examples of Queries in relational algebra. Mapping Conceptual Design into a Logical Design: Relational Database Design using ER-to-Relational mapping..

Number of Hours: 08

Module-3

Normalization: Database Design Theory – Introduction to Normalization using Functional and Multivalued Dependencies: Informal design guidelines for relation schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form. SQL: SQL data definition and data types, Schema change statements in SQL, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL.

Number of Hours: 09

Module-4

SQL: Advanced Queries: More complex SQL retrieval queries, Specifying constraints as assertions and action triggers, Views in SQL. Transaction Processing: Introduction to Transaction Processing, Transaction and System concepts, Desirable properties of Transactions, Characterizing schedules based on recoverability, Characterizing schedules based on Serializability, Transaction support in SQL.

Number of Hours: 08

Module-5

Concurrency Control in Databases: Two-phase locking techniques for Concurrency control, Concurrency control based on Timestamp ordering, Multiversion Concurrency control techniques, Validation Concurrency control techniques, Granularity of Data items and Multiple Granularity Locking. NOSQL Databases and Big Data Storage Systems: Introduction to NOSQL Systems, The CAP Theorem, Document-Based NOSQL Systems and MongoDB, NOSQL Key-Value Stores, Column-Based or Wide Column NOSQL Systems, NOSQL Graph Databases and Neo4j

Number of Hours: 08

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS

1. Create a table called Employee & execute the following.
   Employee (EMPNO,ENAME,JOB, MANAGER_NO, SAL, COMMISSION)
   1. Create a user and grant all permissions to theuser.
   2. Insert the any three records in the employee table contains attributes EMPNO,ENAME JOB, MANAGER_NO, SAL, COMMISSION and use rollback. Check the result.
   3. Add primary key constraint and not null constraint to the employee table.
   4. Insert null values to the employee table and verify the result
2. Create a table called Employee that contain attributes EMPNO,ENAME,JOB, MGR,SAL & execute the following.
   1. Add a column commission with domain to the Employeetable.
   2. Insert any five records into the table.
   3. Update the column details of job
   4. Rename the column of Employ table using alter command.
   5. Delete the employee whose Empno is 105
3. Queries using aggregate functions(COUNT,AVG,MIN,MAX,SUM),Group by,Orderby. Employee(E_id, E_name, Age, Salary)
   1. Create Employee table containing all Records E_id, E_name, Age, Salary.
   2. Count number of employee names from employeetable
   3. Find the Maximum age from employee table.
   4. Find the Minimum age from employeetable.
   5. Find salaries of employee in Ascending Order.
   6. Find grouped salaries of employees.
4. Create a row level trigger for the customers table that would fire for INSERT or UPDATE or DELETE operations performed on the CUSTOMERS table. This trigger will display the salary difference between the old & new Salary. CUSTOMERS(ID,NAME,AGE,ADDRESS,SALARY).
5. Create cursor for Employee table & extract the values from the table. Declare the variables ,Open the cursor & extrct the values from the cursor. Close the cursor. Employee(E_id, E_name, Age, Salary).
6. Write a PL/SQL block of code using parameterized Cursor, that will merge the data available in the newly created table N_Rollcall with the data available in the table O_RollCall. If the data in the first table already exist in the second table, then that data should be skipped.
7. Install an Open-Source NoSQL Data base MangoDB & perform basic CRUD (Create, Read, Update & Delete) operations. Execute MangoDB basic Queries using CRUD operations.

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

Text books:

1. Fundamentals of Database Systems, Ramez Elmasri and Shamkant B. Navathe, 7th Edition, 2017, Pearson.
2. Database management systems, Ramakrishnan, and Gehrke, 3rd Edition, 2014, McGraw Hill

Reference books / Manuals:

1. Data base System Concepts, Silberschatz, Korth, McGraw hill, Sixth Edition.
2. An Introduction to Database systems, C.J. Date, A.Kannan, S.Swami Nadhan, Pearson, Eight Edition for UNIT III.,1997

Web links and Video Lectures (e-Resources):

1. NPTEL: Database Management System: https://nptel.ac.in/courses/106105175
2. Virtual Labs: https://www.iiitbh.ac.in/dbms-lab

Teaching-Learning Process (Innovative Delivery Methods):

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

1. **Flipped Classroom:** Students may watch short videos or read simple notes on stacks, queues, linked lists, trees, hashing or graphs before the class. Classroom time shall be used for algorithm tracing, dry run, discussion and implementation. **Simple Evaluation Method:** Faculty may conduct a 5-minute quiz, ask students to explain one concept, or collect a short pre-class note.
2. **Problem-Based Learning (PBL):** Each module may begin with a practical engineering problem such as robot task scheduling, machine ID searching, sensor-data handling, priority alert processing or path traversal. Students shall identify the suitable data structure and implement the solution. **Simple Evaluation Method:** Faculty may evaluate a short worksheet containing the problem statement, selected data structure, reason for selection, algorithm steps and expected output.
3. **Case-Based Teaching:** Faculty may explain DSA concepts using simple cases from robotics, automation, mechatronics systems, conveyor control, warehouse movement, machine maintenance and component tracking. **Simple Evaluation Method:** Students may submit a brief case interpretation note explaining where the data structure is used and why it is suitable.
4. **Simulation and Virtual Labs:** Stack operations, queue scheduling, linked-list pointer movement, recursion, tree traversal, hashing collision handling and graph traversal may be demonstrated using simple simulators, virtual labs or classroom diagrams. **Simple Evaluation Method:** Faculty may ask students to complete a dry-run table or trace the output for a given input.
5. **ICT-Enabled Teaching:** Google Colab, Jupyter Notebook, online C compilers, Python Tutor, algorithm visualizers and LMS quizzes may be used for demonstration, practice and submission. **Simple Evaluation Method:** Faculty may evaluate execution screenshots, submitted source code, LMS quiz marks or program output files.
6. **Peer Instruction and Debugging Sessions:** Students may work in pairs to identify syntax errors, logical errors, pointer mistakes, wrong traversal order, recursion errors and incorrect outputs. **Simple Evaluation Method:** Faculty may use a peer-debugging checklist where students identify errors, suggest corrections and verify the corrected output.
7. **Industry/Workshop-Oriented Examples:** Examples from robotic arms, AGVs, CNC machines, drones, automated production lines, warehouse robots, sensors and maintenance systems may be used to show real-world relevance. **Simple Evaluation Method:** Students may map one industry example to a suitable data structure or algorithm and justify the selection in 3–5 lines.
8. **Micro Project-Based Learning:** Students may complete a small activity such as robot task manager, machine maintenance record system, component search system, sensor alert priority system or simple route traversal model. **Simple Evaluation Method:** Faculty may evaluate based on problem understanding, correct data structure usage, working code, output explanation and documentation.

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**.

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

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must

secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.

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

CIE Practical component:

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

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

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

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Suggested rubrics for Practical continuous assessment:

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

	sections are smooth. (7-8)			

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

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.		
2.		
3.		
4.	(Add rows if required)	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.		
2.		
3.		
4.	(Add rows if required)	

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

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).

Microcontrollers & Embedded Systems			
Course Code	**1BIO404**	Scheme	2025
Type of course	**Professional Core Course (PCC)**	Semester	IV
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 0 : 20 : 28	SEE Marks	50
Credits	**03**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Demonstrate interfacing and serial communication using the 8051 microcontroller for IoT applications.

CO2: Explain the architecture, programming, and hardware features of 8096, PIC, and dsPIC microcontrollers.

CO3: Describe the fundamentals, characteristics, applications, and processor technologies of embedded systems.

CO4: Compare embedded system architectures and processor types, including CISC, RISC, ARM, DSP, and 8051.

CO5: Apply peripheral interfacing concepts such as timers, interrupts, PWM, ADCs, and RTCs in embedded and IoT systems.

Module-1

8051 Interfacing, Applications and serial communication 8051 interfacing to ADC and DAC, Stepper motor interfacing, Timer/ counter functions, 8051 based data acquisition system 8051 connections to RS-232, 8051 Serial communication, Serial communication modes, Serial communication programming, Serial port programming in C.

Number of Hours: 08

Module-2

Microcontroller 8096 Introduction to 16-bit Microcontroller, functional block-diagram, memory status, complete 8096 instruction set, classification of instruction set, addressing modes, programming examples using 8096, hardware features of 8096,parallel ports, control &status Registers, Introduction to 16/32 bit PIC microcontrollers and DSPIC.

Number of Hours: 09

Module-3

Introduction to Embedded Systems:

Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, classification, major application areas, purpose of embedded systems, characteristics and quality attributes of embedded systems, common design metrics, and processor technology: general purpose processor, application specific processor, single purpose processor.

Number of Hours: 09

Module-4

Embedded System Architecture:

Von Neumann v/s Harvard architecture, instruction set architecture, CISC and RISC instructions set architecture, basic embedded processor, microcontroller architecture, CISC & RISC examples: 8051, ARM, DSP processors.

Number of Hours: 08

Module-5

Input Output and Peripheral Devices, Timers and counters, watchdog timers, interrupt controllers, PWM, keyboard controller, analog to digital converters, real time clock

Number of Hours: 08

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

Text books:

1. Ayala J.K., The 8051 Microcontroller: Architecture, programming and applications, Penram International (2005) 3rd ed.
2. Mazidi,E. and Mazidi,F., The 8051 Microcontroller and Embedded Systems, Prentice-Hall of India (2004) 2nd ed.

Reference books / Manuals:

1. Peatman J., Embedded system Design using PIC18Fxxx, Prentice Hall, 2003.

Web links and Video Lectures (e-Resources):

1. NPTEL: Microcontrollers and Applications: https://nptel.ac.in/courses/117104072

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:** Students may watch short videos or read simple notes on stacks, queues, linked lists, trees, hashing or graphs before the class. Classroom time shall be used for algorithm tracing, dry run, discussion and implementation. **Simple Evaluation Method:** Faculty may conduct a 5-minute quiz, ask students to explain one concept, or collect a short pre-class note.
2. **Problem-Based Learning (PBL):** Each module may begin with a practical engineering problem such as robot task scheduling, machine ID searching, sensor-data handling, priority alert processing or path traversal. Students shall identify the suitable data structure and implement the solution. **Simple Evaluation Method:** Faculty may evaluate a short worksheet containing the problem statement, selected data structure, reason for selection, algorithm steps and expected output.
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5. **ICT-Enabled Teaching:** Google Colab, Jupyter Notebook, online C compilers, Python Tutor, algorithm visualizers and LMS quizzes may be used for demonstration, practice and submission. **Simple Evaluation Method:** Faculty may evaluate execution screenshots, submitted source code, LMS quiz marks or program output files.
6. **Peer Instruction and Debugging Sessions:** Students may work in pairs to identify syntax errors, logical errors, pointer mistakes, wrong traversal order, recursion errors and incorrect outputs. **Simple Evaluation Method:** Faculty may use a peer-debugging checklist where students identify errors, suggest corrections and verify the corrected output.
7. **Industry/Workshop-Oriented Examples:** Examples from robotic arms, AGVs, CNC machines, drones, automated production lines, warehouse robots, sensors and maintenance systems may be used to show real-world relevance. **Simple Evaluation Method:** Students may map one industry example to a suitable data structure or algorithm and justify the selection in 3–5 lines.
8. **Micro Project-Based Learning:** Students may complete a small activity such as robot task manager, machine maintenance record system, component search system, sensor alert priority system or simple route traversal model. **Simple Evaluation Method:** Faculty may evaluate based on problem understanding, correct data structure usage, working code, output explanation and documentation.

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**.

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

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

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

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

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

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**

Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Suggested rubrics for Practical continuous assessment:

Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)

Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

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

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.		

2.		
3.		
4.	(Add rows if required)	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.		
2.		
3.		
4.	(Add rows if required)	

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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).

Embedded Systems Lab		Scheme	2025
Course Code	1BIOL405	Semester	IV
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	02-03

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:
CO1: Understand Assembly Language/embedded C programming of Microcontroller.
CO2: Understand interfacing simple peripheral devices to Microcontroller.
CO3: Engage student groups to design and implement simple embedded systems.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 conventional experiments, PART-B has 6 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. Interfacing ADC with 8051 and acquisition of analog sensor data.
2. Interfacing DAC with 8051 and generation of analog output waveforms.
3. Stepper motor interfacing and control using 8051 microcontroller.
4. Programming of 8051 timers and counters for delay generation and event counting.
5. Serial communication between 8051 and PC using RS-232/UART.
6. Implementation of interrupts, PWM, watchdog timer, and real-time clock functions using a microcontroller platform.

PART – B
OPEN ENDED EXPERIMENTS

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

1. Design and development of an IoT-based environmental monitoring system.
2. Design and development of a smart home automation system.
3. Design and implementation of an industrial data acquisition and monitoring system.
4. Development of a smart energy meter and power monitoring system.
5. Design of an IoT-based motor monitoring and control system.
6. Development of an application-oriented embedded/IoT system integrating sensors, actuators, and communication interfaces.

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

Text books:

1. Ayala J.K., The 8051 Microcontroller: Architecture, programming and applications, Penram International (2005) 3rd ed.
2. Mazidi,E. and Mazidi,F., The 8051 Microcontroller and Embedded Systems, Prentice-Hall of India (2004) 2nd ed.

Reference books / Manuals:

1. Peatman J., Embedded system Design using PIC18Fxxx, Prentice Hall, 2003.

Web links and Video Lectures (e-Resources):

1. NPTEL: Microcontrollers and Applications: https://nptel.ac.in/courses/117104072

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 Laboratory Sessions**
2. **Project-Based Learning (PBL)**
3. **Simulation-Based Learning**
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

Biology for Engineers			
Course Code	1BIO407	Scheme	2025
Type of Course	Basic Science Course	Semester	IV
Teaching Hours/Week (L:T:P)	2: 0: 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	28: 0: 0: 32	SEE Marks	50
Credits	**2**	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:** Explain the organization of living systems, cell structure, and biological diversity.
- **CO2:** Interpret the basic principles of genetics and biological information transfer.
- **CO3:** Describe the role of biomolecules, enzymes, and metabolism in sustaining life processes.
- **CO4:** Apply biological concepts to understand engineering solutions in industrial automation, and sustainable technologies.

Module-1

Introduction to Biology and Living Systems

Introduction to Biology: Biology as a science, relevance of biology to engineering, characteristics of living organisms, levels of biological organization, biological systems as natural engineering systems.

Cell as the Basic Unit of Life: Cell theory, prokaryotic and eukaryotic cells, plant and animal cells, structure and functions of cell organelles, cell membrane and transport of materials.

Applications: Bio-inspired engineering, biological principles in modern technology and healthcare.

Number of Hours: 06

Module-2

Cells and Biological Diversity

Cell Organization: Structure–function relationship in living systems, specialization of cells and tissues. Biological Diversity: Overview of classification of living organisms, microorganisms, plants and animals, importance of biodiversity and ecosystem balance.

Applications: Microorganisms in industry, agriculture, environmental management, and biotechnology.

Number of Hours: 05

Module-3

Genetics and Information Transfer

Fundamentals of Genetics: Genes, chromosomes, heredity, Mendel's laws of inheritance, dominant and recessive traits.

Cell Division: Mitosis and meiosis, significance of cell division.

Information Transfer in Living Systems: DNA and RNA, structure and functions, DNA replication, central dogma of molecular biology, transcription and translation.

Applications: Genetic engineering, recombinant DNA technology, biotechnology and healthcare applications.

Number of Hours: 06

Module-4

Biomolecules, Enzymes and Metabolism

Biomolecules: Carbohydrates, proteins, lipids and nucleic acids; structure and biological significance.

Enzymes: Classification, properties, mechanism of enzyme action, factors affecting enzyme activity, industrial and medical applications.

Metabolism: Energy in biological systems, ATP as energy currency, overview of cellular respiration and energy conversion.

Applications: Biosensors, industrial biotechnology, enzyme-based technologies.

Number of Hours: 06

Module-5

Biology for Engineering Applications

Biological Technologies: Biomaterials, biosensors, biomedical devices, tissue engineering and regenerative medicine.

Environmental Biotechnology: Biofertilizers, biopesticides, biofuels, bioremediation and waste management.

Emerging Technologies: Bioinformatics, synthetic biology, artificial intelligence in biology, precision agriculture, bio-inspired robotics and sustainable engineering solutions.

Number of Hours: 05

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

Text Book

- Dr. Annamma Odaneth, Biology for Engineers, AICTE Training and Learning (ATAL) Academy, All India Council for Technical Education (AICTE), New Delhi. Available through the AICTE e-book initiative.

Reference Books

1. Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Bharathi S. and Jaganathan M.K., Biology for Engineers, Tata McGraw-Hill Education, New Delhi.
2. Arthur T. Johnson, Biology for Engineers, CRC Press, Taylor & Francis.
3. Tanushree Chakraborty and Nasim Akhtar, Biology for Engineers, PHI Learning Pvt. Ltd., New Delhi. Designed around the AICTE Biology curriculum.
4. G.K. Suraishkumar, Biology for Engineers, Oxford University Press, New Delhi.

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

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.

- **Case-Based Learning:** Discuss real-world applications of biology in agricultural engineering, mechanical systems, precision farming, biomaterials, and environmental sustainability.
- **Biomimicry-Based Problem Solving:** Encourage students to analyze natural systems and develop engineering solutions inspired by biological processes and structures.
- **Multimedia and Simulation-Based Learning:** Use animations, videos, virtual laboratories, and simulation tools to demonstrate biological processes and engineering analogies.
- **Group Discussions and Concept Mapping:** Facilitate collaborative learning through discussions on bio-inspired technologies, biotechnology applications, and emerging trends in bioengineering.
- **Project-Based Learning:** Assign mini-projects related to biosensors, smart farming, bioenergy systems, agricultural automation, and sustainable engineering solutions.
- **Flipped Classroom Approach:** Students explore learning resources before class and participate in interactive problem-solving sessions during class.
- **Industry and Research Exposure:** Invite experts from biotechnology, agricultural engineering, healthcare, and environmental sectors to deliver lectures on contemporary biological innovations.
- **ICT-Enabled Learning:** Utilize MOOCs, NPTEL lectures, online case studies, and digital content for self-paced learning.

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
3.	Case Study Presentation on Bio-inspired Engineering Applications	10
4.	Literature Review / Assignment on Emerging Bioengineering Technologies	15

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

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)	Excellent understanding and interpretation	Good understanding	Moderate understanding	Limited understanding	No understanding
Performance Indicator-2 (CO/PO Mapping)	Innovative application demonstrated	Appropriate application	Basic application	Weak application	No application
Performance Indicator-3 (CO/PO Mapping)	Highly effective	Effective	Satisfactory	Poor	Unsatisfactory

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**
5.	Assignment on Biological Systems and Engineering Analogies	4
6.	Case Study on Biomimicry and Nature-Inspired Engineering	4
7.	Seminar on Emerging Bioengineering robotic Technologies	4
8.	Mini Project on Bio-Innovations in robotics	4
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
12.	NPTEL/MOOC Course Modules on Biology for Engineers	4
13.	Study of Precision Agriculture and Biosensors	4
14.	Exploration of Bio-inspired Technologies and Innovations	4

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).

ENVIRONMENTAL SCIENCE PROJECT			
Course Code	**1BIO408/1BEP408**	Scheme	**2025**
Type of Course	Societal Development Course (SDC)	Semester	IV
Teaching Hours/Week (L:T:P)	30 (0:0:0)	CIE Marks	50
Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL	30 (0:0:0:30)	SEE Marks	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. 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. CO1: Identify and analyze environmental and societal problems through field surveys, data collection, and stakeholder interaction.
2. CO2: Design sustainable engineering solutions for environmental conservation, resource management, renewable energy, waste management, or community development.
3. CO3: Evaluate the technical, environmental, economic, and social impacts of the proposed solution using appropriate engineering tools and field data.
4. CO4: Prepare technical reports and present project outcomes effectively while demonstrating teamwork, ethical responsibility, and commitment to sustainable development.

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	Industrial Equipment Health Monitoring	Design an IoT-based condition monitoring system and quantify fault detection accuracy, equipment uptime, or maintenance efficiency.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 9, SDG 12
2	Smart Energy Monitoring for Industries	Develop an IoT-based energy monitoring dashboard and quantify energy consumption patterns and potential energy savings.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 12
3	Predictive Maintenance System	Design a predictive maintenance solution using sensor data and estimate reduction in equipment downtime and maintenance cost.	PO1, PO2, PO3, PO4, PO5, PO12	SDG 9, SDG 12

4	Smart Factory Environmental Monitoring	Develop an IoT system for monitoring temperature, humidity, air quality, and noise, and assess compliance with industrial standards.	PO1, PO2, PO3, PO4, PO5, PO6	SDG 3, SDG 9, SDG 11
5	IoT-Based Water Management in Industries	Design an automated water monitoring system and quantify water consumption, leakage detection, and conservation potential.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 6, SDG 9, SDG 12
6	Smart Inventory Management System	Develop an RFID/IoT-enabled inventory tracking system and evaluate inventory accuracy and retrieval efficiency.	PO1, PO2, PO3, PO4, PO5, PO11	SDG 9, SDG 12
7	Industrial Asset Tracking System	Design a real-time asset tracking solution using IoT technologies and measure tracking accuracy and asset utilization.	PO1, PO2, PO3, PO4, PO5, PO11	SDG 9, SDG 12
8	Smart Cold Storage Monitoring	Develop an IoT-based cold storage monitoring system and quantify temperature stability and reduction in product spoilage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12
9	Industrial Safety Monitoring System	Design a worker safety monitoring system using wearable or environmental sensors and evaluate incident detection and response time.	PO1, PO2, PO3, PO4, PO5, PO6	SDG 3, SDG 8, SDG 9
10	Smart Production Line Monitoring	Develop a production monitoring dashboard and quantify machine utilization, cycle time, and production efficiency.	PO1, PO2, PO3, PO4, PO5, PO11	SDG 8, SDG 9, SDG 12
11	Industrial Air Quality Monitoring	Design an IoT-based air quality monitoring system and analyse pollutant trends with compliance reporting.	PO1, PO2, PO3, PO4, PO5, PO6	SDG 3, SDG 9, SDG 13
12	IoT-Based Waste Management System	Develop a smart waste collection and monitoring system and quantify waste segregation efficiency and disposal optimization.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 11, SDG 12, SDG 13
13	Industrial Process Automation	Design an IoT-enabled process control system and evaluate process efficiency, response time, and automation performance.	PO1, PO2, PO3, PO4, PO5, PO11	SDG 8, SDG 9, SDG 12
14	Remote Industrial Equipment Monitoring	Develop a cloud-based remote monitoring solution and assess system reliability, latency, and accessibility.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 9, SDG 12
15	Smart Power Quality Monitoring	Design an IoT-based power quality monitoring system and quantify voltage, current, harmonics, and power factor variations.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 12
16	Digital Twin for Industrial Process	Develop a digital twin of an industrial process using real-time IoT data and validate system behaviour against physical measurements.	PO1, PO2, PO3, PO4, PO5, PO12	SDG 9, SDG 12
17	Smart Warehouse Monitoring System	Design an IoT-enabled warehouse monitoring solution and quantify improvements in inventory visibility, environmental control, and operational efficiency.	PO1, PO2, PO3, PO4, PO5, PO11	SDG 9, SDG 11, SDG 12

Suggested Learning Resources

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

Teaching Learning Process:

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

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

6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / 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 totaling 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 problem statement; engineering approach, innovation & feasibility	20	Precise; demonstrates engineering depth, novelty and feasibility.	Technically sound and feasible with minor limitations.	Basic; limited technical depth or feasibility concerns.	No viable 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:

1. Benny Joseph, *Environmental Studies*, Tata McGraw-Hill, 2nd Edition.
2. R. Rajagopalan, *Environmental Studies: From Crisis to Cure*, Oxford University Press, 2005.
3. Erach Bharucha, *Textbook of Environmental Studies*, University Press, latest edition as available in library.
4. M. P. Poonia and S. C. Sharma, *Environmental Studies*, Vikas Publishing House, latest edition as available

Reference Books:

1. R. Sivakumar, Principles of Environmental Science and Engineering, Cengage Learning, 2nd Edition.
2. G. Tyler Miller Jr., Environmental Science: Working with the Earth, Thomson Brooks/Cole, 11th Edition.
3. Pratibha Singh, Anoop Singh, and Piyush Malaviya, Text Book of Environmental and Ecology, Acme Learnin 1st Edition.
4. S. M. Prakash, Environmental Studies, Elite Publishing House, Mangalore, 3rd Edition, 2018.

Web links and Video Lectures (e-Resources):

1. VTU e-Learning Centre: http://elearning.vtu.ac.in
2. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php
3. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php
4. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec
5. VTU e-Learning Centre: http://elearning.vtu.ac.in
6. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php
7. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php
8. 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.

Signals & Systems

Course Code	**1BIO409**	Scheme	2025
Type of course	**Professional Core Course (PCC)**	Semester	IV
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 0 : 48	SEE Marks	50
Credits	**03**	Total Marks	100
Type of Examination (IPCC):	Theory - CIE +SEE, and Lab - CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Discuss the properties and classification of signals & systems, and the time domain representation of LTI systems.

CO2: Analyse signals in frequency domain using Fourier transform and Z-transform methods

CO3: Analyse LTI system in frequency domain.

Module-1

Introduction to signals and systems

Definitions of a signal and a system, classification of signals, Basic operations on signals, elementary signals, Properties of systems.

Number of Hours: 08

Module-2

Time-domain representation of LTI systems

Block diagram representations of LTI systems, convolution, impulse response representation, properties of impulse response. Differential and difference equation representations

Number of Hours: 08

Module-3

Fourier representation of signals

Introduction, Fourier representations for four signal classes, Discrete Time Fourier Series representation and FT representations, properties of Fourier representations

Number of Hours: 08

Module-4

Representation of Signals Using Laplace Transform:

Introduction to Laplace Transform, The Unilateral Laplace Transform, Properties of Laplace Transform: linearity, scaling, time shift, s-domain shift, convolution, differentiation, Initial and final value theorems, Inversion of Laplace Transform, Transfer function in S-domain, Solving Differential Equations with Initial Conditions

Number of Hours: 09

Module-5

Representation of Signals Using Z Transform

Introduction, Z-transform, properties of ROC, Properties of Z-transforms: linearity, time reversal, time shift, multiplication by exponential sequence, convolution, differentiation, Inversion of the Z-transform, Transfer function in Z-domain, Solution of difference equations, Z- Transform Realization of system function

Number of Hours: 09

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

Text books:

1. Simon Haykin and Bary Van Veen, **"Signals and Systems"**, John Wiley and Sons, 2008

Reference books / Manuals:

1. Alan V Oppenheim, Alan S Wilskey and S. Hamid Movas, **"Signals and Systems",** 2 nd edition 1997, Indian Reprint 2002.
2. Michel J Roberts, **"Signal and Systems: Analysis of Signals through Linear Systems",** Tata McGraw-Hill.
3. B. P. Lathi, **"Linear Systems and Signals"**, Oxford University Press, 2005

Web links and Video Lectures (e-Resources):

1. NPTEL: Signals and Systems: https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee28

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:** Students may watch short videos or read simple notes on stacks, queues, linked lists, trees, hashing or graphs before the class. Classroom time shall be used for algorithm tracing, dry run, discussion and implementation. **Simple Evaluation Method:** Faculty may conduct a 5-minute quiz, ask students to explain one concept, or collect a short pre-class note.
2. **Problem-Based Learning (PBL):** Each module may begin with a practical engineering problem such as robot task scheduling, machine ID searching, sensor-data handling, priority alert processing or path traversal. Students shall identify the suitable data structure and implement the solution. **Simple Evaluation Method:** Faculty may evaluate a short worksheet containing the problem statement, selected data structure, reason for selection, algorithm steps and expected output.
3. **Case-Based Teaching:** Faculty may explain DSA concepts using simple cases from robotics, automation, mechatronics systems, conveyor control, warehouse movement, machine maintenance and component tracking. **Simple Evaluation Method:** Students may submit a brief case interpretation note explaining where the data structure is used and why it is suitable.
4. **Simulation and Virtual Labs:** Stack operations, queue scheduling, linked-list pointer movement, recursion, tree traversal, hashing collision handling and graph traversal may be demonstrated using simple simulators, virtual labs or classroom diagrams. **Simple Evaluation Method:** Faculty may ask students to complete a dry-run table or trace the output for a given input.
5. **ICT-Enabled Teaching:** Google Colab, Jupyter Notebook, online C compilers, Python Tutor, algorithm visualizers and LMS quizzes may be used for demonstration, practice and submission. **Simple Evaluation Method:** Faculty may evaluate execution screenshots, submitted source code, LMS quiz marks or program output files.
6. **Peer Instruction and Debugging Sessions:** Students may work in pairs to identify syntax errors, logical errors, pointer mistakes, wrong traversal order, recursion errors and incorrect outputs. **Simple Evaluation Method:** Faculty may use a peer-debugging checklist where students identify errors, suggest corrections and verify the corrected output.
7. **Industry/Workshop-Oriented Examples:** Examples from robotic arms, AGVs, CNC machines, drones, automated production lines, warehouse robots, sensors and maintenance systems may be used to show real-world relevance. **Simple Evaluation Method:** Students may map one industry example to a suitable data structure or algorithm and justify the selection in 3–5 lines.
8. **Micro Project-Based Learning:** Students may complete a small activity such as robot task manager, machine maintenance record system, component search system, sensor alert priority system or simple route traversal model. **Simple Evaluation Method:** Faculty may evaluate based on problem understanding, correct data structure usage, working code, output explanation and documentation.

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.**

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

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

CIE Practical component:

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

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

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

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for CIE – Continuous assessment:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

Suggested rubrics for Practical continuous assessment:

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)

Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

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

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**
5.		
6.		
7.		
8.	(Add rows if required)	
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
5.		
6.		
7.		
8.	(Add rows if required)	

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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).

IoT Device Programming with Arduino & ESP32		Scheme	2025
Course Code	1BIOL406A	Semester	IV
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	02-03

Course outcome (Course Skill Set)

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

CO1: Develop embedded programs using Arduino and ESP32 to interface sensors and actuators for data acquisition and control applications.

CO2: Implement communication protocols, Wi-Fi connectivity, and cloud integration for IoT-based monitoring and automation systems.

CO3: Design and develop end-to-end IoT solutions using Arduino/ESP32 for real-world smart applications.

SET OF EXPERIMENTS

1. LED Blinking and GPIO Programming using Arduino and ESP32
2. Interfacing Push Buttons and Buzzers with Arduino/ESP32
3. Interfacing LDR and Potentiometer Sensors for Analog Data Acquisition
4. Temperature and Humidity Monitoring using DHT Sensor
5. PWM-Based LED Brightness and DC Motor Speed Control
6. Serial Communication and Sensor Data Monitoring
7. Wi-Fi Configuration and Network Connectivity using ESP32
8. IoT Cloud-Based Sensor Data Logging and Visualization
9. Remote Monitoring and Control of Devices using Mobile/Web Applications
10. MQTT-Based Machine-to-Machine Communication using ESP32

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

Text books:

1. **P. Horowitz and W. Hill**, *The Art of Electronics*, 3rd Edition, Cambridge University Press, 2015.
2. **Marco Schwartz**, *Internet of Things with ESP32*, Packt Publishing, 2021.

Reference books / Manuals:

1. **Agus Kurniawan**, *ESP32 for IoT and Embedded Systems*, PE Press, 2021.
2. **Arshdeep Bahga and Vijay Madisetti**, *Internet of Things: A Hands-On Approach*, Universities Press, 2015.

Web links and Video Lectures (e-Resources):

1. Virtual Labs: https://iot-dei.vlabs.ac.in/

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 Laboratory Sessions**
2. **Project-Based Learning (PBL)**

3. **Simulation-Based Learning**
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2					

(CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

Signal processing using Matlab		Scheme	2025
Course Code	1BIOL406B	Semester	IV
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	02-03

Course outcome (Course Skill Set)

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

CO1: Generate, analyze, and process discrete-time signals and systems using MATLAB, including convolution, correlation, DFT, FFT, and spectral analysis techniques.

CO2: Design, implement, and evaluate FIR and IIR digital filters using MATLAB and analyze their frequency-domain characteristics.

CO3: Perform multirate signal processing operations and implement real-time DSP applications using MATLAB-based tools and digital signal processors.

SET OF EXPERIMENTS

1. Generate the following standard discrete time signals. i) Unit Impulse ii) Unit step iii) Ramp iv) Exponential v) Sawtooth. Generate sum of two sinusoidal signals and find the frequency response (magnitude and phase).
2. Implement and verify linear and circular convolution between two given signals.
3. Implement and verify autocorrelation for the given sequence and cross correlation between two given signals.
4. Compute and implement the N-point DFT of a given sequence and compute the power density spectrum of the sequence.
5. Implement and verify N-point DIT-FFT of a given sequence and find the frequency response (magnitude and phase).
6. Implement and verify N-point IFFT of a given sequence.
7. Design IIR Butterworth filter and compare their performances with different orders (Low Pass Filter /High Pass Filter)
8. Design IIR Chebyshev filter and compare their performances with different orders (Low Pass Filter /High Pass Filter).
9. Design FIR filter (Low Pass Filter /High Pass Filter) using windowing technique. i. Using rectangular window ii. Using hamming window iii. Using Kaiser window
10. Design and verify Filter (IIR and FIR) frequency response by using Filter design and Analysis Tool.
11. Compute the Decimation and Interpolation for the given signal.
12. Real time implementation of an audio signal using a digital signal processor.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): **Text books:** 1. The Linux Command Line: A Complete Introduction – William E. Shotts Jr., No Starch Press. 2. Linux Shell Scripting Cookbook – Sarath Lakshman, Packt Publishing. 3. Beginning Linux Programming – Neil Matthew and Richard Stones, Wiley Publications. **Reference books / Manuals:** 1. Classic Shell Scripting – Arnold Robbins and Nelson H. F. Beebe, O'Reilly Media. **2.** UNIX and Linux System Administration Handbook – Evi Nemeth, Garth Snyder, Trent Hein, and Ben Whaley, Pearson.
Web links and Video Lectures (e-Resources): 1. Virtual Lab: http://vlabs.iitkgp.ac.in/dsp/#
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 Laboratory Sessions** 2. **Project-Based Learning (PBL)** 3. **Simulation-Based Learning** 4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources. 5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.
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. Rubrics for CIE – Continuous assessment:

	Superior	Good	Fair	Needs Improvemen t	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

Dashboard & Data Visualization Lab		Scheme	2025
Course Code	1BIOL406C	Semester	IV
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	02-03

Course outcome (Course Skill Set)

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

CO1: Create electronic schematics and PCB layouts using standard PCB design software tools.

CO2: Fabricate, assemble, and solder electronic circuits using through-hole and surface-mount components.

CO3: Test, troubleshoot, and validate PCB-based electronic circuits using appropriate instruments and techniques.

CO4: Design and develop simple PCB-based electronic products by integrating design, fabrication, assembly, and testing skills.

SET OF EXPERIMENTS

1. Introduction to various Data Visualization tools
2. Basic Visualization in Python
3. Basic Visualization in R
4. Introduction to Tableau and Installation
5. Connecting to Data and preparing data for visualization in Tableau
6. Data Aggregation and Statistical functions in Tableau
7. Data Visualizations in Tableau
8. Basic Dashboards in Tableau

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

Text books:

1. Data visualization with python: create an impact with meaningful data insights using interactive and engaging visuals, Mario Dobler, Tim Grobmann, Packt Publications, 2019

Reference books / Manuals:

1. Practical Tableau: 100 Tips, Tutorials, and Strategies from a Tableau Zen Master, Ryan Sleeper, Oreilly Publications, 2018
2. Data Visualization with R: 111 Examples by Thomas Rahlf, Springer, 2020

Web links and Video Lectures (e-Resources):

1. Virtual Labs: https://www.youtube.com/playlist?list=PLHutrxqbP1Bzx4wbSCGhCh572Ylmcw8

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 Laboratory Sessions**
2. **Project-Based Learning (PBL)**
3. **Simulation-Based Learning**
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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

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

Industrial Safety & IoT Standards		Scheme	2025
Course Code	1BIOL406D	Semester	IV
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	03

Course outcome (Course Skill Set)

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

CO1: Identify industrial hazards and apply appropriate safety measures and standards in industrial environments.

CO2: Develop IoT-based monitoring and communication systems using sensors, cloud platforms, and industrial communication protocols.

CO3: Design and evaluate safe, secure, and standards-compliant Industrial IoT solutions for real-world applications.

SET OF EXPERIMENTS

1. dentification of Workplace Hazards and Risk Assessment Using Standard Safety Procedures
2. Study and Demonstration of Personal Protective Equipment (PPE) and Industrial Safety Practices
3. Implementation of an IoT-Based Temperature and Humidity Monitoring System
4. Development of an IoT-Based Gas Leakage Detection and Alert System
5. Implementation of MQTT-Based Communication for Industrial Sensor Monitoring
6. Monitoring and Visualization of Industrial Sensor Data Using an IoT Cloud Platform
7. Implementation of a Worker Safety Monitoring System Using Wearable Sensors
8. Design of an IoT-Based Fire Detection and Emergency Alert System
9. Secure IoT Device Communication Using Authentication and Encryption Techniques
10. Case Study and Simulation of an Industry 4.0 Smart Factory Monitoring System

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

Text books:

1. **David L. Goetsch**, *Occupational Safety and Health for Technologists, Engineers and Managers*, 10th Edition, Pearson Education, 2019.
2. **Arshdeep Bahga and Vijay Madisetti**, *Internet of Things: A Hands-On Approach*, Universities Press, 2015.

Reference books / Manuals:

1. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms and Use Cases, CRC Press, 2017.
2. W. Bolton, Programmable Logic Controllers, 7th Edition, Newnes, 2021.

Web links and Video Lectures (e-Resources):

Not Applicable

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 Laboratory Sessions**
2. **Project-Based Learning (PBL)**
3. **Simulation-Based Learning**
4. **Flipped Classroom Approach** with pre-lab videos, tutorials, and self-learning resources.
5. **Mini Projects and Open-Ended Experiments** to promote innovation, problem-solving, and design thinking.

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.

Rubrics for CIE – Continuous assessment:

	Superior	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
…					
Performance Indicator-n (CO/PO Mapping)					

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